Tree Farm Licence #18

Timber Supply Analysis
Analysis Report
June 10, 2005

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Executive Summary

This report describes the timber supply analysis and Twenty-Year Plan (TYP) process for TFL #18, held by Canadian Forest Products – Vavenby Division. Timber supply analysis examines the availability of wood volume for harvesting over time. The Timber Supply Analysis provides the Chief Forester with information regarding the short- and long-term timber supply and is used as a component in determining the Allowable Annual Cut (AAC). The analysis involves the testing and reporting of a variety of assumptions and management strategies using the approved resource inventory of the Tree Farm Licence (TFL). The purpose of this report is to provide the Chief Forester of British Columbia with sufficient information to make an informed Allowable Annual Cut determination.

The following scenarios are described in this report:

Base Case—the standard against which other scenarios are compared. It uses the best available knowledge about current management and tree growth in TFL 18, but excludes major sources of uncertainty, namely the mountain pine beetle infestation.

Sensitivity Analyses—used to determine the risk associated with Base Case Assumptions.

Mountain Pine Beetle Management Scenario—examines the timber supply implications of the mountain pine beetle infestation and several harvest strategies that respond to it.

Canfor Preferred Scenario—incorporates knowledge built from the other scenarios and uses the assumptions and harvest levels that best reflect Canfor's management objectives for TFL18. This scenario incorporates the Twenty-Year Plan harvest sequence into the short term.

Sustainable timber flows of the MP10 Base Case and Preferred Scenario are shown in Figure 1, which also includes the MP9 Base Case for comparison. MP10 timber flows are considerably higher than MP9 throughout the planning horizon.

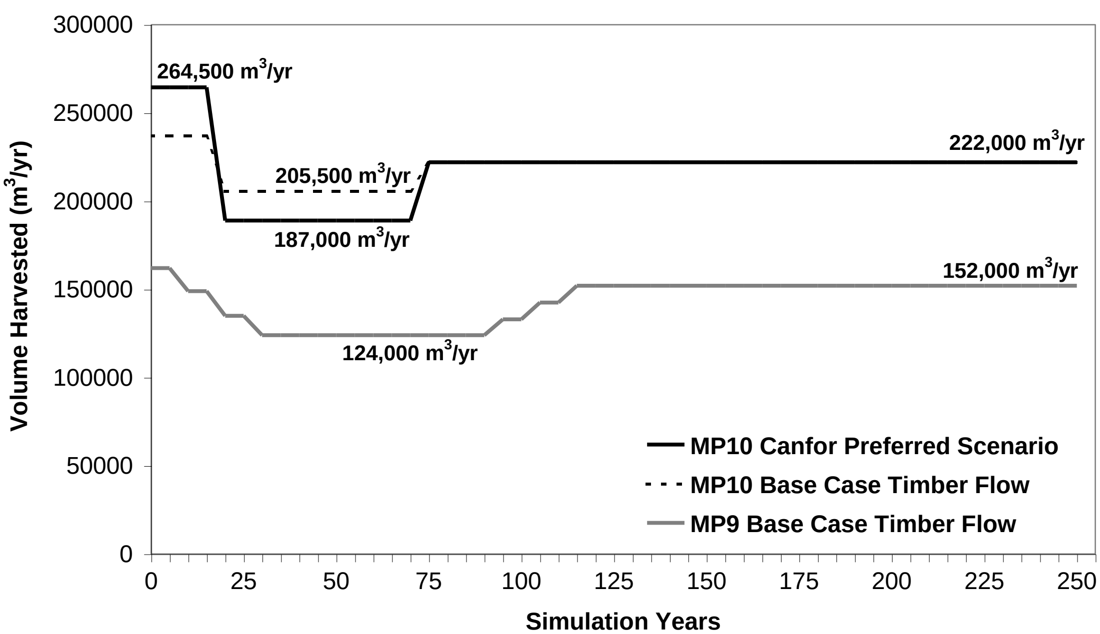

Figure 1: Timber Flows of the Preferred Scenario for TFL 18 Management Plan #10, compared with the MP10 and MP9 Base Case flows.

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The major assumptions that are leading to higher harvest levels in MP10 are:

- Use of potential site index for managed stands is the single most important change in assumptions. Higher growth rates associated with potential site index introduce upward pressures of 24% on the long term and 18% in the medium term. However, this change in assumptions does not directly affect short-term timber supply.
- Custom VDYP curves for IU Balsam stands increase the current volume and also the growth rate of IU Balsam stands. The extra volume harvested from these stands is available at a time when harvest is transitioning to existing managed stands and where there would otherwise be a significant timber supply shortage. Consequently the impact of IU Balsam stands is disproportionate to their volume production. These new assumptions introduce a 12% upward pressure on the medium term, but have no effect on the long term harvest level
- MP9 used an average OAF2 of 14% for managed stand yield tables, while MP10 used the standard 5% OAF2. This translates approximately to a 9% increase in the LTHL in MP10.
- MP 9 used a fully spatial run for the Base Case and sensitivity analysis. MP 10 returns to using a non-spatial timber supply analysis. As noted in the analysis report for MP 9, spatial analysis caused a significant decline in the short term harvest level.

The Beetle Management Scenario assumed that mountain pine beetle will remove 70% of the pine volume in stands >60 years old during the first five years of the planning horizon. There is an associated decline in merchantable pine volume in these stands over the next twenty years. The key conclusions of the Beetle Management Scenario are:

- Beetle-associated volume losses do not appear to cause acute timber shortages in the short term. However, they require adjustments in the short and medium-term harvest levels to maintain long-term sustainable timber supply.
- Within the assumptions of the analysis, it appears that the anticipated timber supply impact of the mountain pine beetle infestation can be mitigated by a large increase in the short term harvest level. However, this increase requires a reduction in the medium-term harvest level. The reduction in the medium term relative to the short term increase is constant at short term harvest levels of 267,000 m^3/yr and above.
- Uncertainties about the behaviour and outcome of the infestation (optimistic vs. pessimistic assumptions) are by some measures more important than the variations in harvest levels in terms of timber supply impacts.

Canfor prefers an initial harvest level of 267,000 m^3/yr to accomplish their management objectives, for the following reasons:

- A short term harvest level of 267,000 m^3/yr will allow Canfor to harvest most of the high and medium susceptibility stands within 15 years, which is the approximate window for responding to the mountain pine beetle infestation;
- Harvest levels higher than 267,000 m^3/yr are subjectively associated with higher risk to the medium term;
- 267,000 m^3/yr is a subtle pivot point in most of the measures considered, where the benefits of raising the short term harvest level begin to taper off; and
- 267,000 m^3/yr is an intermediate response. It leaves room for future determinations to adjust the response depending on how the mountain pine beetle infestation progresses.

TABLE OF CONTENTS

Forest Ecosystem Solutions Ltd.
#210 – 275 Fell Avenue, North Vancouver BC, Canada V7P 3R5
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Forest Ecosystem Solutions Ltd.
#210 – 275 Fell Avenue, North Vancouver BC, Canada V7P 3R5
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LIST OF TABLES

LIST OF FIGURES

Forest Ecosystem Solutions Ltd.
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1 Introduction

1.1 Timber supply analysis

This report describes the timber supply analysis and Twenty-Year Plan (TYP) process for TFL #18, held by Canadian Forest Products – Vavenby Division. Timber supply analysis examines the availability of wood volume for harvesting over time. It involves testing and reporting on a variety of assumptions and management strategies using the approved resource inventory of the Tree Farm Licence (TFL). The Timber Supply Analysis provides the Chief Forester of British Columbia with information about the impact of current harvest levels on long-term timber supply. The purpose of this report is to provide the Chief Forester with sufficient information to make an informed Allowable Annual Cut determination.

Timber supply analysis is intended to ensure that current harvest levels do not threaten the availability of wood volume for future harvests. Sustainability is therefore the central concept to this report and to timber supply analysis in general. However, the sole indicator of sustainability in timber supply analysis is long-term stability of growing stock and therefore the perpetual availability of timber for harvest. No attempt is made to evaluate sustainability in terms of the wider range of biological, social, or economic values that are affected by timber harvesting. Because of its narrow definition of sustainability, timber supply analysis is only one dimension of a larger decision-making process used to set the AAC.

1.2 Scenarios

The complexity of timber supply means that a single scenario is not sufficient to portray the timber supply dynamics of TFL18. There are many uncertainties about how well the assumptions of the analysis reflect the realities of timber supply on TFL18. Also, there are many options for setting harvest levels in response to the timber supply dynamics of the TFL. Several scenarios are developed in this analysis to account for these uncertainties and opportunities. The purpose of presenting scenarios is to build a layered understanding of the timber supply dynamics of TFL18. The general categories of scenarios are summarized below.

Base Case: The Base Case is the standard against which other scenarios are compared. In most timber supply analyses, the Base Case reflects the best available knowledge about current management activities and forest development in TFL 18. This is the case in TFL18, except that assumptions for the current mountain pine beetle infestation are not incorporated into the Base Case for TFL18. This approach was taken partly because there are substantial uncertainties about the outcome of the beetle attack and the appropriate assumptions. Also, the beetle assumptions were excluded because they introduce considerable complexity into the timber supply dynamics that could confound an understanding of the Base Case.

Sensitivity Analyses: Sensitivity analyses are used to determine the risk associated with uncertainties in the assumptions of the analysis. These scenarios isolate an area of uncertainty and test the implications of using more optimistic or pessimistic assumptions.

Mountain Pine Beetle Management Scenario: An epidemic infestation of mountain pine beetle is currently taking place on TFL 18, and is expected to spread throughout the TFL in the next 5 years. This scenario examines the timber supply implications of the mountain pine beetle infestation and several harvest strategies that respond to it.

Canfor Preferred Scenario: This scenario incorporates knowledge built from the other scenarios and uses the assumptions and harvest levels that best reflect Canfor's management objectives for TFL18.

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1.3 Twenty-Year Plan

The Twenty-Year Plan is a map of potential cutblocks for the first 20 years of the planning horizon. The purpose of the Twenty-Year Plan is to spatially confirm the timber harvesting levels presented in the Analysis Report. The Twenty-Year Plan is considered by the Chief Forester in determining the allowable annual cut for the TFL under section 8 of the Forest Act. Typically, the Twenty-Year Plan uses the base case harvest levels and assumptions. In this analysis, the Canfor Preferred Scenario is the final product of this analysis and is consequently used as the basis of the Twenty-Year Plan. The Twenty-Year Plan report and maps are submitted as a separate document.

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2 Description of TFL18

TFL 18 is located west of the Thompson River near Clearwater, and is administered by Canadian Forest Products (Vavenby Division) and the Clearwater Forest District. The TFL is a contiguous unit covering an area of 74,542 ha, of which 63,812 ha is currently available for harvesting. The current standing volume for TFL 18, based on the projected inventory to December 31, 2003, is 12,553,000 m^3.

TFL 18 is located entirely within the Clearwater Landscape Unit, which has a low biodiversity emphasis. All areas of the TFL are classified as Schedule "B" lands. The Clearwater Landscape Unit includes other forest licenses including BC Timber Sales, Woodlots, and Weyerhaeuser Canada.

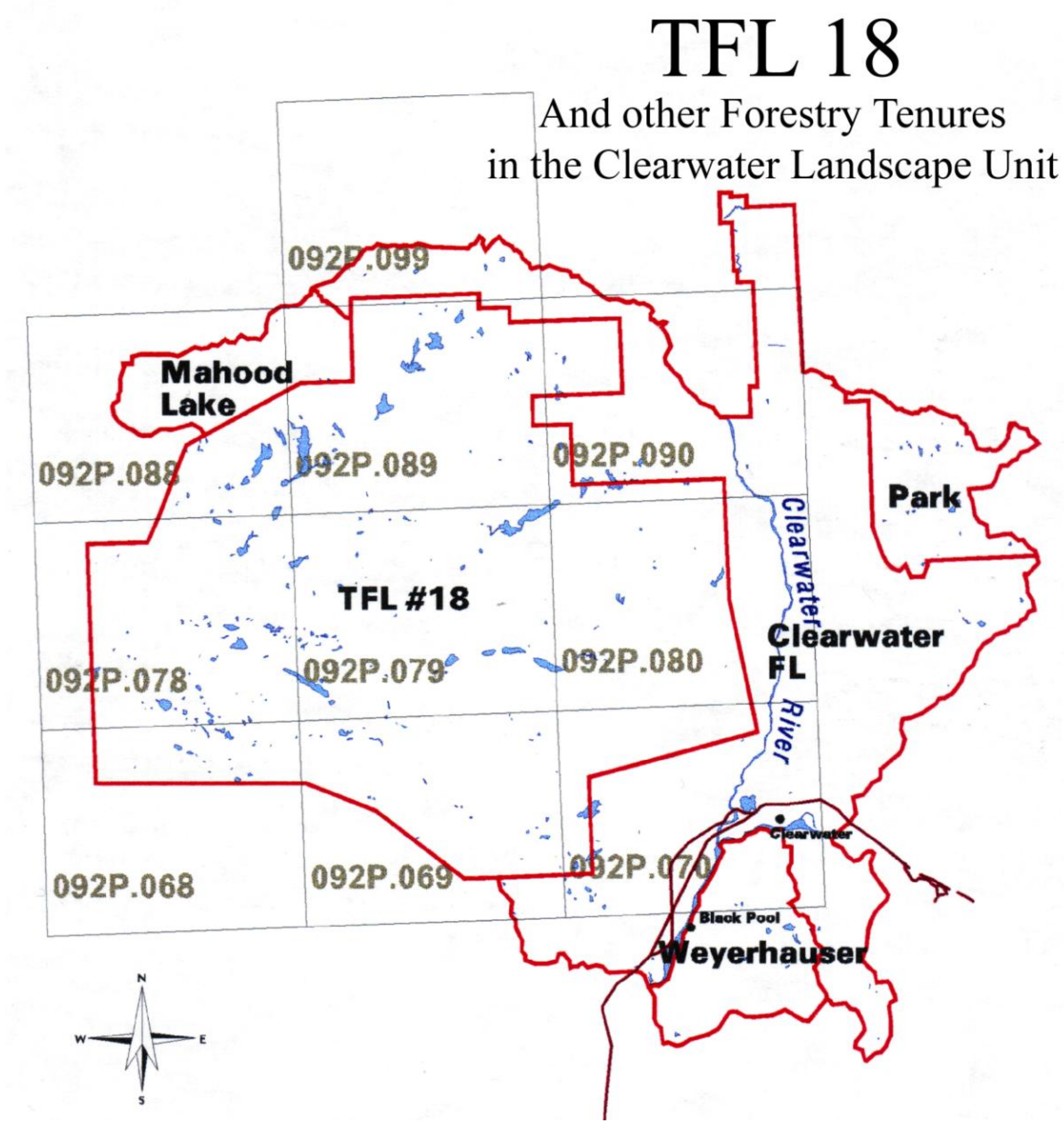

Figure 2: Location of TFL18 within the Clearwater Landscape Unit

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tel 604-998-2222 fax 604-986-0361

Climates of TFL18 are variants of the ESSF and SBS biogeoclimatic zones, with a minor proportion of ICH in the southwest area of the TFL. The dominant climatic variants are ESSFwc2 and SBSmm. Consistent with this climatic range, the leading species are primarily spruce (*Picea engelmanii*, *P. glauca*, and hybrids), lodgepole pine (*Pinus contorta*), and subalpine fir (*Abies lasiocarpa*). Interior Douglas-fir (*Pseudotsuga menziesii v. glauca*) is the leading species in about 4% of the stands in TFL18.

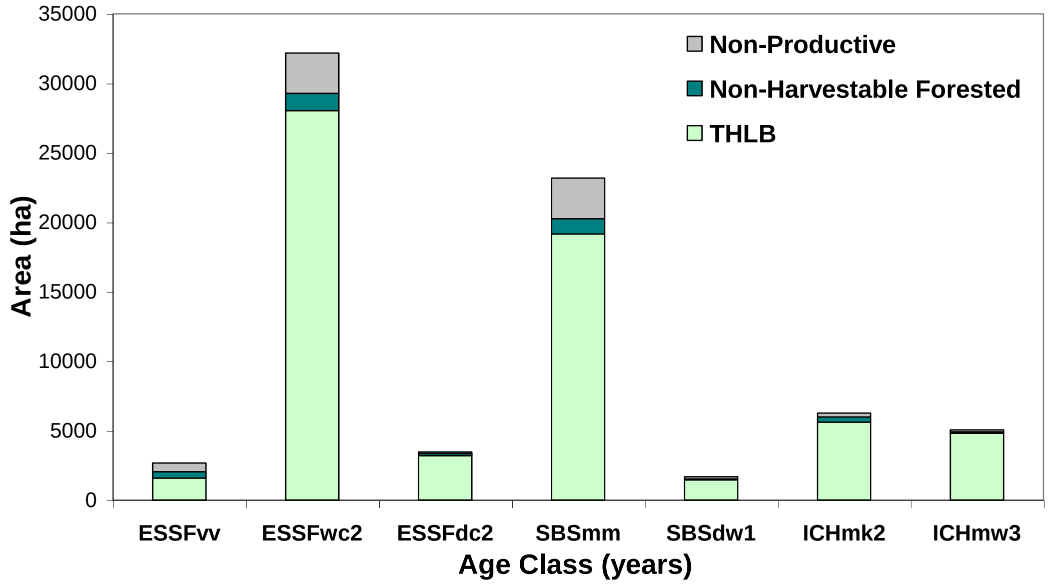

Figure 3: Biogeoclimatic variants of TFL 18

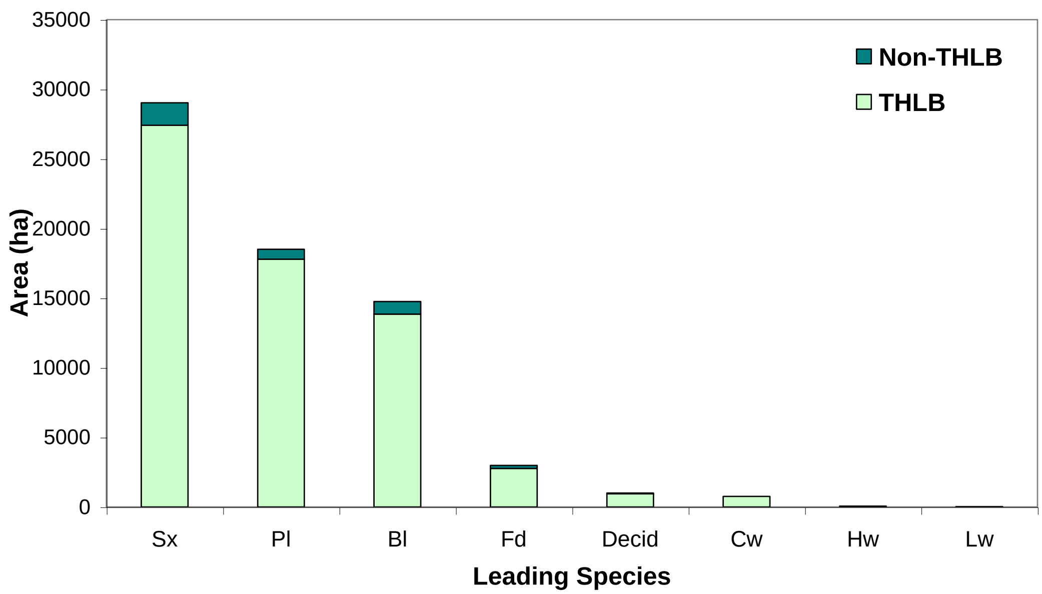

Figure 4: PFLB area by leading species

The age structure of the landscape is bimodal, with more than half of the productive area in either very young (<40 years old) or very old (>140) ages (Figure 5). The non-harvestable (non-THLB) land base is not significantly biased towards any region of the age structure.

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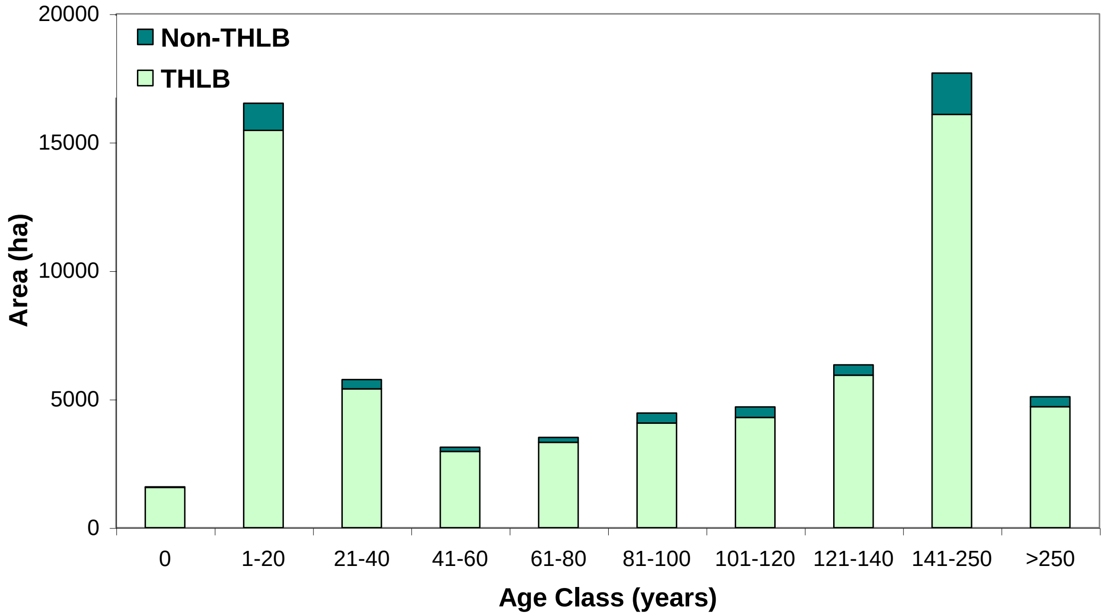

Figure 5: Age Structure of the Productive Forest Land Base

Mean annual increment (MAI) is the average volume growth rate of a stand measured since the stand started growing. Culmination MAI is the maximum rate of growth for a stand, and is a good way of comparing the productivity of a stand in terms of timber volume. Site index is another such measure, but it is not used here because it is a species-specific index. The diversity of leading species in TFL18 limits the utility of site index as a comparative measure of site productivity. Figure 6 shows that natural stands and future managed stands occupy a similar range of stand productivity, but that natural stands are biased towards lower stand productivity. This is primarily due to the use of potential site index for existing and future managed stands. The range of productivity of future managed stands is narrow, and is generally confined to the range from 2.5 m^3/ha/yr to 4.5 m^3/ha/yr.

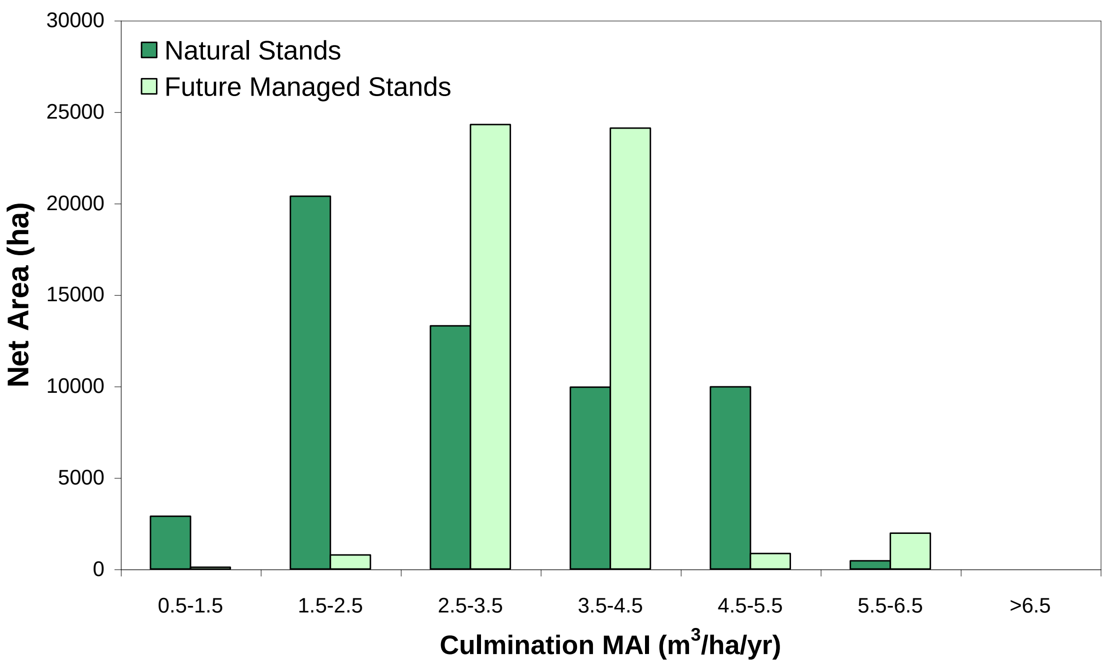

Figure 6: Stand productivity of the Timber Harvesting Land Base (excluding OGMAs).

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3 Assumptions and Methods

This section briefly describes the inputs and assumptions to the timber supply analysis. A full description of these issues is provided in the TFL 18 MP10 Information Package.

3.1 Forest Cover Inventory

The forest cover inventory provides the basic information on which a timber supply analysis is built. The current forest cover inventory for TFL is based on a 1992 forest inventory photo stratification using 1974 aerial photography. A forest inventory rectification project was completed for TFL18 in December 2003 (Silvatech 2003b), which involved corrections to linework and labels. Prior to the initiation of timber supply analysis, forest cover attributes were updated for growth and depletions (harvesting) to January 1, 2004. This date is the start date for all simulations presented in this report

3.2 Definition of the timber harvesting land base

The timber harvesting land base (THLB) is determined by the netdown process, in which stands ineligible for harvest are sequentially removed from the total land base. Table 1 summarizes this procedure. The netdown is an exclusionary procedure. Once an area has been removed, it cannot be deducted further along in the process. For this reason, the gross area of netdown factors (e.g. Non-merchantable forest) is often greater than the net area removed; a result of overlapping resource issues. Portions of the land base that are reserved from harvest may still contribute to forest cover objectives.

Table 1: Timber harvesting land base determination.

Land Classification	Total Area (ha)[1]	Net Reduction Area (ha)	Net Reduction Volume ('000s m^3)
Total Area of TFL 18		**74,542**	**13,514**
Non-forest and Non-productive forest	5,834	5,834	6
Non-Commercial Brush	13	12	0
Existing Roads	1,402	1,381	132
Total NP reductions		7,227	138
Total Productive Forest		**67,315**	**13,376**
Protected Areas	282	268	73
Riparian Reserve Zones	1991	1879	520
Class V (unstable) terrain	39	36	4
Difficult regeneration	901	741	129
Permanent sample plots	50	46	6
Non-merchantable stands	175	37	1
Future wildlife tree retention	513	496	90
Total Reductions to Productive Forest		3,503	823
Current THLB		**63,812**	**12,553**
Future reductions			
Proposed roads		102	n/a[2]
Future roads		526	n/a[2]
Long-term THLB		**63,184**	**12,553**

[1] Total Area of TFL 18 covered by a given land classification.

[2] Volume for proposed/future roads is not removed from the THLB, since it will contribute to harvest.

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The area of TFL 18 is 74,542 ha, of which 67,315 ha is productive forest. The current Timber Harvesting Land Base is 63,812. Proposed and future road reductions are not deducted from the current Timber Harvesting Land Base because the volume associated with these features will contribute to the first harvest. These future reductions are applied once the polygon has been harvested for the first time. After all future reductions have been applied, the long-term Timber Harvesting Land Base is 63,184 ha.

3.3 Growth and yield

Growth and yield is a general category for assumptions about how forest stands will develop over time. The key growth and yield attributes monitored in this analysis are merchantable volume, stand height, and species composition. Many other input assumptions were made in order to predict the development of these attributes for existing stands, and the stands that will replace them after disturbance, specifically:

- TIPSY yields for stands younger than 41 years old;
- VDYP yields for stands older than 40 years old;
- Custom growth and yield assumptions for IU Balsam stands;
- TEM-based potential site index for existing and future managed stands;
- Ecosystem-based regeneration assumptions using TEM;
- OAF1 of 15% and OAF2 of 5%;
- Genetic gain for pine and spruce components of future stands, adjusted for ingress and proxy species;

3.4 Unsalvaged losses

Unsalvaged losses result from natural events that are epidemic in origin. Endemic losses are accounted for by operational adjustment factors (OAFs) in the managed stand yield tables and decay, waste, and breakage (DWB) factors in the natural stand yield curves. The primary unsalvaged epidemic losses in TFL 18 are insect infestations, windthrow, and fire. Bark Beetle infestations have escalated to epidemic levels, and windthrow continues to be a major management issue due to the exposed topographic position of the TFL. Other agents that reduce the commercial productivity of the TFL, such as spruce budworm and root rot, are endemic and are assumed to be adequately accounted for by standard adjustment factors in the yield tables.

Although unsalvaged losses are stochastic and difficult to predict, an average volume loss of 3,000 m^3/year is assumed for TFL18. Harvest levels in this report are net of unsalvaged losses, meaning that actual simulated harvest is 3,000 m^3/yr greater than what is reported in this report.

3.5 Forest cover objectives

Timber supply analysis accounted for forest cover objectives at the landscape level. The purpose of forest cover objectives is to model management for biological diversity, identified wildlife habitat, and visual quality by specifying target height and age distributions. Table 2 is a summary of modelling assumptions for forest cover targets in TFL 18.

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Table 2: Forest cover objectives – Base Case scenario

Resource	Criteria	Cover requirement	Applied to: Zone	Applied to: Cover type
Landscape green-up	Green-up height	No more than 33% of stands can be less than 3 meters in height.	TFL18	THLB
Visual quality	% denudation and visually effective green-up	No more than a specified percentage of each visual quality polygon can be less than the visually effective green-up height.	Visual quality polygons	Productive Forest
			Lakeshore Management Zones	Productive Forest
	% denudation and adjacency green-up	No more than a specified percentage of each Lakeshore Management Zone may be less than the cutblock adjacency green-up height of 3 meters.	Lakeshore Management Zones	Productive Forest
Landscape level biodiversity	Old Growth Management Areas	On average, at least 90% of the OGMAs in each BGC variant must be in old seral condition (minimum percent depends on variant).	OGMAs by BEC variants	Productive Forest
Riparian ecosystem functions	% mature forest in riparian management zones	Mature forest cover must be at least equal to the basal area retention levels recommended in the Riparian Management Area Guidebook.	Riparian Management Zones by Class	Productive Forest

3.6 Harvest Scheduling Rule

Simulation models require harvest scheduling rules to control the order in which stands are harvested. To understand the impacts of the timber supply assumptions and constraints, it is important that these rules are able to organize harvest in a transparent and logical way that also reflects current management. “Relative poorest first” scheduling, a harvest rule recently developed by FESL, was used in this analysis. The “relative poorest first” rule gives harvest priority to stands that are growing slowly relative to the stand that they will regenerate to after harvest. For example, an old stand with a slow growth rate on a good site would get higher priority for harvest than an equally slow-growing stand on a poor site. A detailed description and rationale for the “relative poorest first” harvest rule is given in the information package that accompanies this analysis report (Forest Ecosystem Solutions Ltd. 2004, p. 55-56).

3.7 Duration and Divisions of the Planning Horizon

The planning horizon in this report is 500 years. The rationale for this extended planning horizon is given in Section 4.1.3. For the purposes of simplicity, the short-, medium-, and long-terms are fixed in this report:

- **Short term** (0-15 years)—the response period for the current mountain pine beetle attack. Beyond 15 years, the majority of beetle-affected pine trees are expected to be unsalvageable.
- **Long term** (>70 years)—the point in the planning horizon beyond which the age structure of THLB is in relative equilibrium; the majority of stands have been harvested at least once and are growing on a future MSYT.

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- **Medium term** (16-70 years)—the period between the short and long terms, when harvests can be adjusted to compensate for management actions in the short term in order to facilitate a smooth transition to the long term.

To facilitate comparison between alternative harvest flows and sensitivity analyses, harvest levels are uniform within in each planning term. Traditionally, harvest flows have included a 10%/decade transition between different harvest levels to reflect the need for industry restructuring. However, the transitions confound timber supply analysis by obscuring the relative role of the planning terms. Transitions between harvest levels are not used in the Base Case and sensitivity analyses of this report. In other words, harvest does not “step down” or “step up” gradually while changing from one harvest level to another.

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3.8 Major changes from the previous timber supply analysis (MP9)

Major changes have been made to the timber supply assumptions since the previous analysis (MP9). Table 3 provides a comparison of the major assumptions of the MP9 and MP10 timber supply analyses.

Table 3: Summary Comparison of the assumptions for MP9 and MP10

Assumption	MP9	MP10
Current THLB (excludes OGMAs)	56,569	57,470
Long-term THLB (excludes OGMAs)	60,272	56,927
Growing Stock at Year 0	10,989,459	10,187,148
Riparian Management Zones	Partial netdown reduction by Riparian Management Guidebook guidelines	Forest cover requirement
Regeneration delay	2 years for all stands	0 yr (ESSF); 1 yrs (SBS/ICH)
Incremental silviculture	None	None
Site index for Natural Stands	Forest cover Inventory	Forest cover Inventory
Site index for managed stands	Inventory SI (current age <141 years); OGSI adjustment (>140 years old)	Inventory SI (elevation >1550m); PSI adjustment (<1550m)
Utilization	30cm stump, 10cm top DIB, 50% firmwood std., min DBH 12.5cm (Pl)/ 17.5cm (others)	
Deciduous	Deciduous-leading stands removed from the THLB. Minor deciduous component excluded from harvest	Utilize all deciduous volume
IU Balsam Yields	Standard VDYP tables	Customized VDYP Tables
OAF1	15%	15%
OAF2	15% (Sx/Fd), 14% (Pl), 5% (others)	5%
Genetic gain	9.6% for Sx, 3% for Pl/Fd	12% for Sx, 3% for Pl (prorated for ingress)
Unsalvaged losses	1400 m^3/yr	3000 m^3/yr
Old Seral management	Forest cover requirements as per BGB	Non-replaceable OGMAs with 10% sanitation harvest permitted
Watershed ECAs	<22% <36yrs	None
VQO	Aggregate polygons with same RVQC and apply constraints to aggregate	Apply constraints to individual visual inventory polygons (no aggregation)
VQO-P	54 ha; 1% <23yrs	20 ha; avg. 0.6% <3.7m
VQO-R	315 ha; 5% <23yrs	487 ha; avg. 3.1% <4.6m
VQO-PR	9257 ha; 15% <23yrs	6216 ha; avg. 9.4% <5.0m
VQO-M	315 ha; 25% <23yrs	487 ha; avg. 20.4% <4.8m
Harvest Rules	Oldest First	Relative poorest first
Minimum Harvest Ages	>80 yrs & >120 m^3/ha (Pl, Fd), >100 yrs & >150 m^3/ha (other spp.)	>125 m^3/ha

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4 Base Case

The Base Case is the basis for comparison between timber supply scenarios. "Base Case assumptions" are the set of assumptions and rules described in the information package, including the timber harvesting land base, growth & yield, forest cover requirements, and harvesting rules. Together, the Base Case assumptions create a picture of how TFL 18 will respond to harvesting over time. This section describes the Base Case, first by showing how sustainable harvest levels are determined, and then by describing the changes in the attributes of the TFL associated with one of these sustainable harvest levels.

The Base Case for this timber supply analysis is designed to be a meaningful starting point in understanding the timber supply dynamics of TFL18. It is not the recommended timber flow. The Base Case incorporates a suite of reasonable assumptions about which areas are available for harvest, how stands will develop before and after harvest, and the criteria for choosing which stands will get harvested. However, there is considerable uncertainty about some of these assumptions. The risks and dynamics associated with the Base Case assumptions are investigated in a series of sensitivity analyses that test the timber supply impact of using relatively optimistic and pessimistic assumptions. Also, a scenario incorporating assumptions about the mountain pine beetle infestation will build on the Base Case. The understanding drawn from the Base Case, alternative harvest levels, sensitivity analyses, and beetle scenarios is used to create a final recommended scenario, the Canfor Preferred Scenario.

4.1 Finding Sustainable Harvest Levels

There are many ways of determining sustainable harvest levels. The purpose of this section is to describe the methods used to find the harvest flows presented throughout this analysis report.

4.1.1 Indicators of Sustainability

A reliable and objective indicator of sustainability is required to differentiate sustainable harvest levels from unsustainable harvest levels in timber supply simulations. "Crashes" in timber supply occur at pinch points when there is insufficient merchantable volume to satisfy the target cut level. Timber supply analysts commonly use these crashes as the primary indicator of non-sustainable harvest levels, both in the short and long terms. However, it is important to recognize that pinch points are a direct result of how the modeller defines minimum merchantability. Pinch points are only useful as indicators of sustainability if minimum harvest ages are close to culmination age.

In this timber supply analysis, a new harvesting rule, "relative poorest first" scheduling, is used in conjunction with operationally relevant minimum harvest ages to remove artificial pinch points. Relative poorest first scheduling removes pinch points by allowing harvesting well below the culmination age of stands. This is a more realistic way of modeling harvests, as it is unlikely that during a timber supply shortage a forest manager would forego a merchantable stand simply because it is below culmination age. In the absence of pinch points, the process of setting sustainable harvest levels becomes more flexible. Sustainability is indicated purely by stability of growing stock in the long term, and the corresponding long-term harvest level. Long-term growing stock is the sole indicator of sustainability in this timber supply analysis. Short- and medium-term harvest levels are sustainable if they do not compromise growing stock in the long term.

4.1.2 Determining the long term harvest level

Figure 7 shows the effect of different long-term harvest levels on growing stock. Growing stock becomes stable when the rate of harvest equals the rate of growth of the forest as a whole. At low harvest levels, stands get harvested after their culmination age and growing stock accumulates until a stable equilibrium is reached. Because the stands are harvested post-culmination, the average rate of growth is lower than the potential productivity of the land base. If the harvest level is too high, the model is forced to harvest stands below their culmination age. This results in accelerating decline of growing stock until the harvest level can no longer be supported by the available growing stock. Maximum sustainable even flow is the highest harvest level that results in stable growing stock.

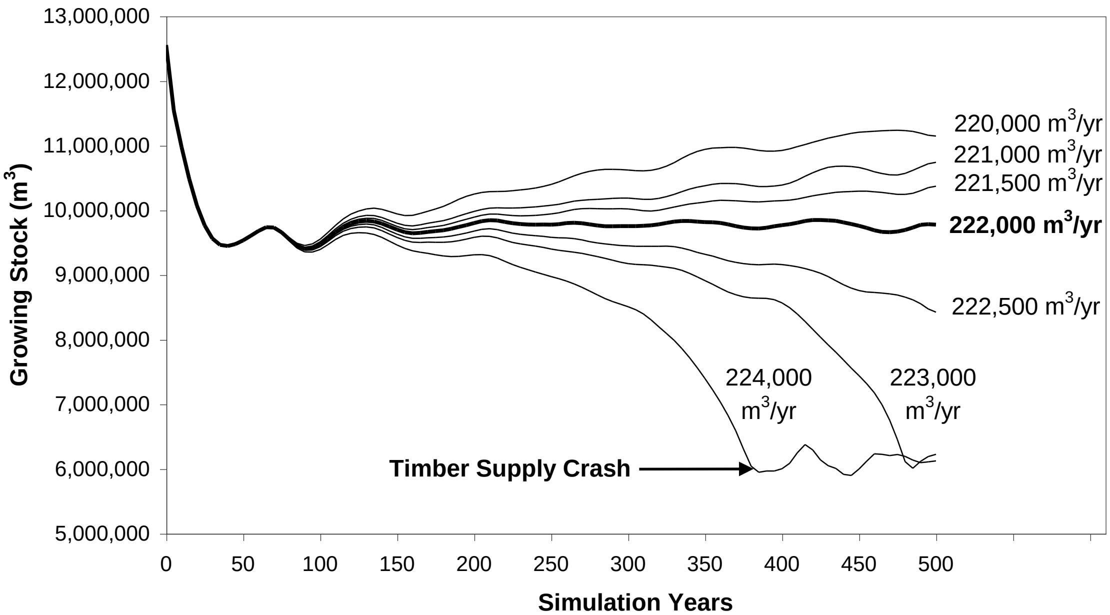

Figure 7: Effect of different long-term harvest levels on growing stock. Moderate harvest produces non-declining equilibrium growing stock.

4.1.3 Precision of harvest flow determinations

Figure 7 demonstrates the sensitivity of growing stock to changes in the even flow harvest level. At the standard timber supply planning horizon of 250 years, the response is subtle. However, the response to 500 m^3/yr (0.25%) changes in the harvest level is clearly detectable over a 500-year planning horizon. Longer planning horizons increase the precision of timber supply analysis by increasing the ability of the analyst to detect response of growing stock to changes in harvest levels and assumptions. Consequently, all timber flows presented in this analysis report were tested on a 500-year planning horizon. The minimum resolution of timber flows is 500 m^3/yr (0.25%) in the long term and 1,000 m^3/yr (0.5%) in the short term.

4.1.4 Determining the short- and medium-term harvest levels

The long-term harvest level is a non-negotiable entity: for a given set of timber supply assumptions there is only one long-term harvest level. In contrast, there is considerable subjectivity in setting harvest levels in the short and medium terms. Harvest levels in the short term are typically a response to immediate management concerns. In TFL 18, the potential volume losses associated with bark beetles are the major management consideration affecting the short-term harvest level. The medium term is a period of transition where harvest levels are designed to compensate for high or low harvest rates in the short term. Together, the short and medium term harvest levels are designed to create an equilibrium condition that can be sustained through the long term. If harvest levels in the short and medium terms are too high, the growing stock will be insufficient to sustain the long term harvest level.

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The process of determining sustainable short and medium term harvest levels is demonstrated in Figure 8. Based on figure 6, the Base Case long term harvest level has been established as 222,000 m^3/yr. For this example, the short term harvest level is arbitrarily chosen as 237,000 m^3/yr. The maximum medium term harvest level will result in stable growing stock in the long term. Figure 8 shows the response of the total growing stock to 500 m^3/yr variations in the medium term harvest level. The initial effect of the higher harvest levels is to reduce growing stock proportionally in the medium term. Despite these differences in the amount of growing stock, the development of growing stock is similar in all runs between 15 and 200 years of the planning horizon. Beyond 200 years, however, the growing stock for medium-term harvests greater than 205,500 m^3/yr goes into accelerating decline. A medium-term harvest level of 205,500 m^3/yr produces a stable growing stock. Lower harvest levels create accumulating growing stock.

The effects of over-harvesting in the short and medium terms may not be detectable until well into the long term, and may not create timber supply crashes within the planning horizon. The decline of long term growing stock, not the associated timber supply crash, is used as the indicator of sustainability in this analysis.

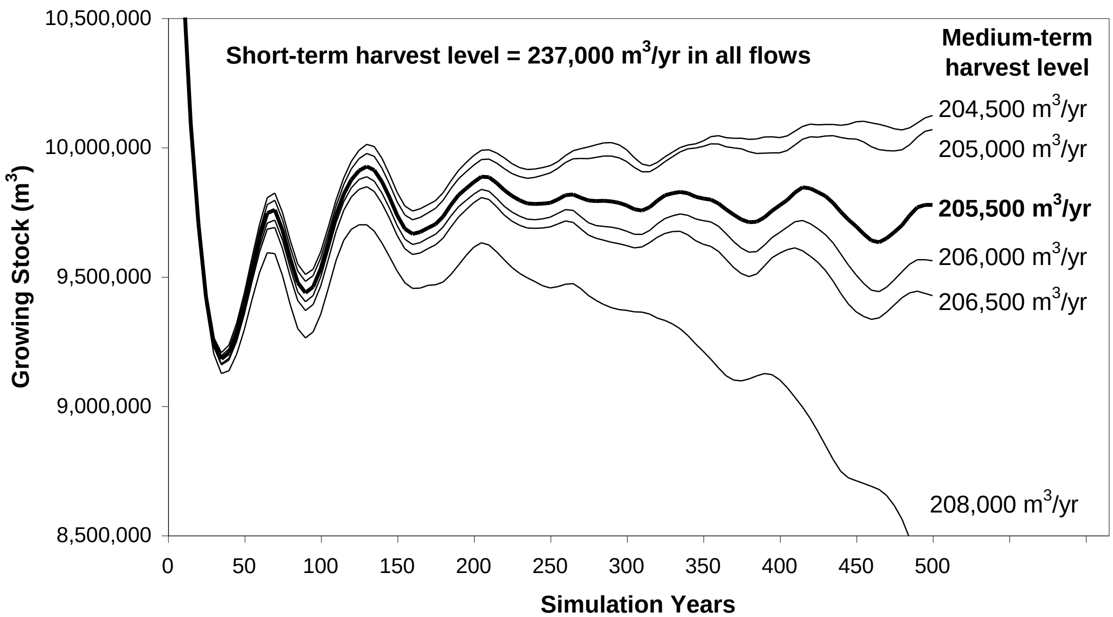

Figure 8: Long-term growing stock produced by different harvest levels in the medium term (15-70 years). Harvest levels in the short and long terms are the same for all flows (237,000 m^3/yr and 222,000 m^3/yr, respectively).

4.1.5 Alternative harvest flows

The example in Figure 8 showed the method for finding the medium term harvest level associated with a single short-term harvest level. This section shows other variations on the relationship between the short and medium term harvest levels. A simple empirical relationship between the short and medium term harvest levels is described. This equation allows decision-makers to calculate other alternative harvest levels without having to use a timber supply model.

Sustainable timber flows were developed for short term harvest levels of 267,000 m^3/yr, 237,000 m^3/yr, 211,000 m^3/yr, and 187,000 m^3/yr (Figure 9). The latter is the current AAC. The growing stock for these flows is shown in Figure 10. Higher short term harvest levels cause a faster decline of growing stock at the beginning of the planning horizon, but these are accompanied by lower medium term

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harvest levels that allow faster accumulation of growing stock. The balance between the short and medium term harvest levels results in a convergence of all flow towards the end of the medium term (70 years). Beyond 70 years, the Base Case and the Alternative Flow are both harvesting 222,000 m^3/yr and so the development of growing stock in the long term is the same. This illustrates the concept of "harvest flow equivalency": two flows are equivalent if they result in the same long-term development of growing stock.

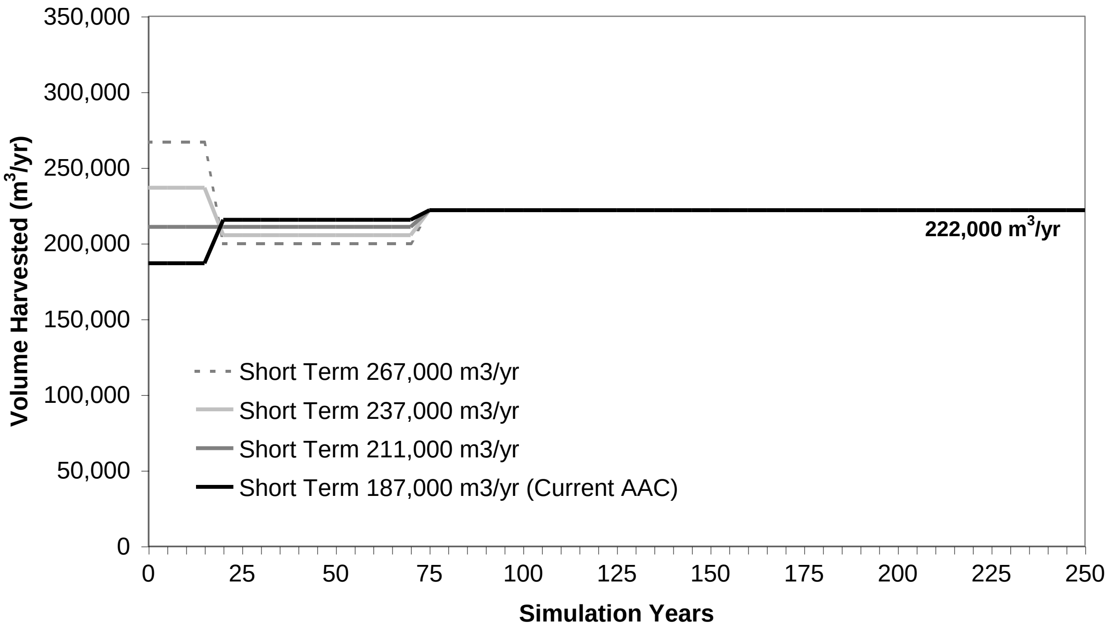

Figure 9: Equivalent harvest flows that sustain the same growing stock in the long term.

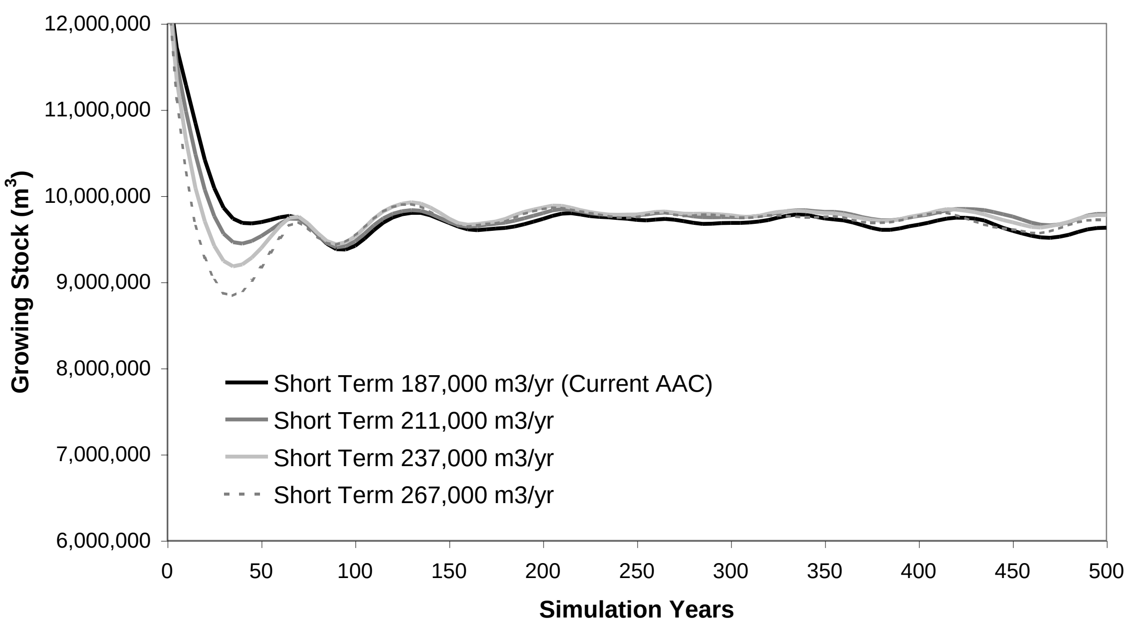

Figure 10: Alternative harvest flows using different harvest levels in the short term. The medium term harvest level is used to create a smooth transition to a stable condition in the long term.

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The harvest flow equivalency concept illustrated in Figure 10 and Figure 9 implies that the short and medium term harvest levels are interdependent and interchangeable. Figure 11 demonstrates that a simple linear relationship between these harvest levels can be developed. This equation can be used to predict the medium term harvest level for any short term harvest level between 187,000 and 267,000 m^3/yr. This information can then be used to determine alternative short and medium-term harvest levels without performing additional timber supply simulations.

In this relationship the duration of the short and medium terms is held constant at 15 and 55 years, respectively. A more complex relationship (not shown here) can be developed allowing prediction of equivalent harvest flows for variable durations of the short term.

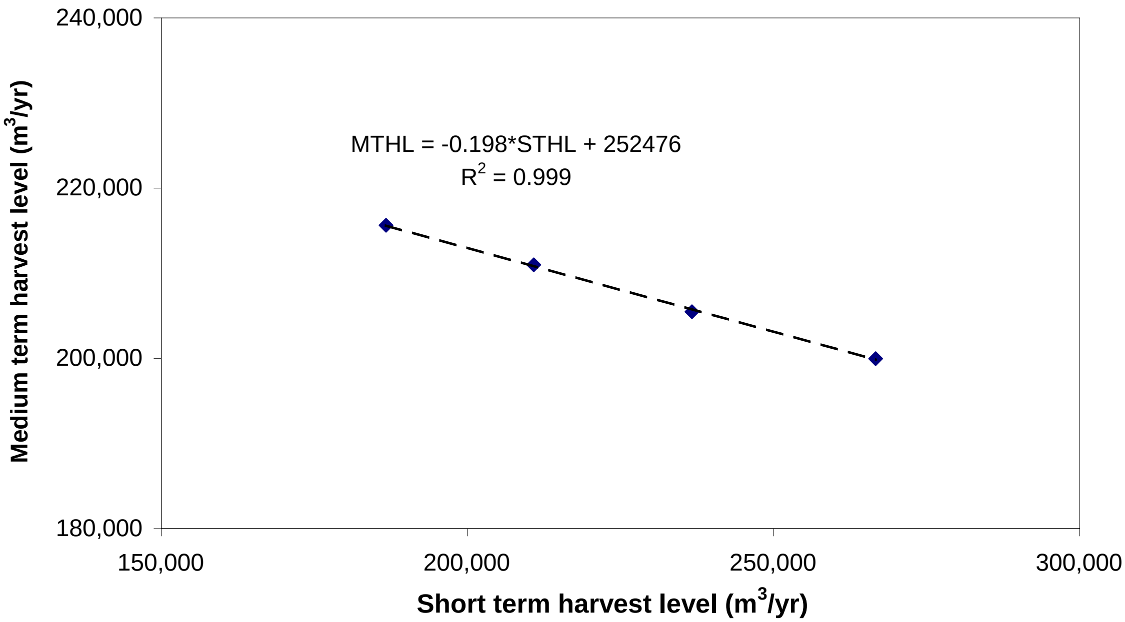

Figure 11: Scatterplot illustrating the linear relationship between the short- and medium-term harvest levels.

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4.2 Description of the Base Case

The Base Case is the point of comparison for all other sensitivity analyses and scenarios, so it is important to understand the dynamics of the Base Case in detail. The purpose of this section is to comprehensively describe and interpret the attributes of Base Case. The emphasis is on the development of attributes over the first 250 years of the 500-year planning horizon.

4.2.1 Timber Flows

The alternative harvest flows presented in Figure 9 demonstrate that short- and medium term harvest levels are essentially interchangeable. Canfor is likely to pursue an AAC increase as a means to respond to the current mountain pine beetle infestation in TFL 18. In light of the perceived necessity for salvage of beetle-affected stands, the short term in the Base Case is higher than the medium term harvest level. A short-term harvest level of 237,000 m^3/yr was chosen for the Base Case. This requires a medium term harvest level of 205,500 m^3/yr. Harvest levels throughout the planning horizon are substantially higher than the current AAC of 177,500 m^3/yr. The reasons for these differences are investigated in Section 5.13.

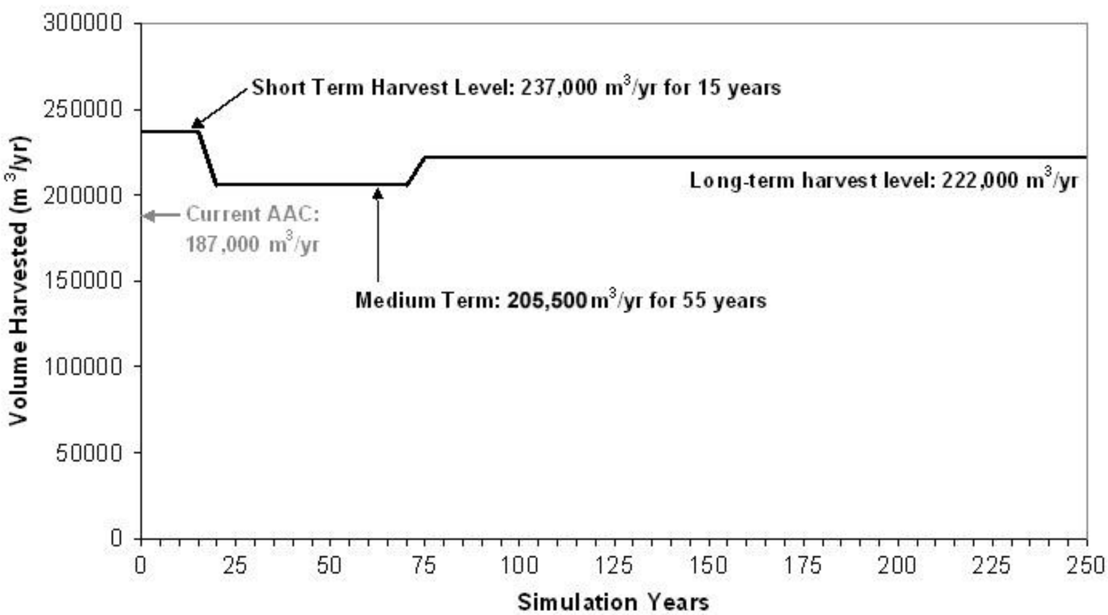

Figure 12: Timber Flows of the Base Case for TFL 18 Management Plan #10.

4.2.2 Age Structure

The development of the age structure of the productive land base is shown in Figure 13. The first 55 years of the planning horizon are characterized by a conversion of older forest into younger age classes. Between years 55 and 70, the focus of harvesting has shifted to younger second growth stands. The age structure is in equilibrium beyond year 70 of the planning horizon. This equilibrium is a good definition of the "long term" for the purposes of timber supply analysis.

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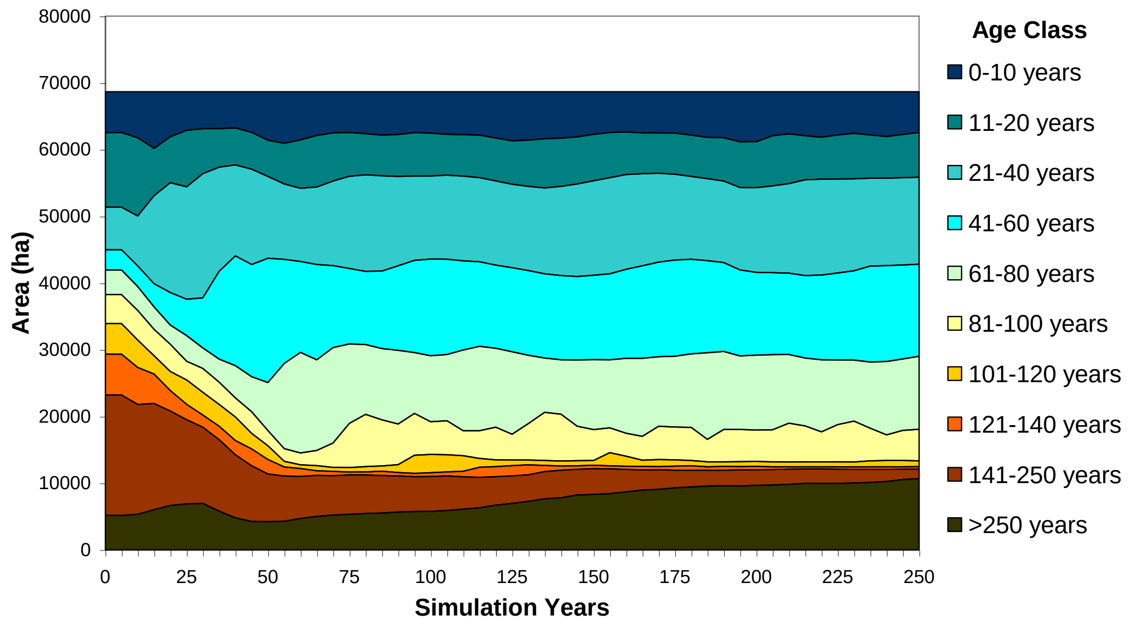

Figure 13: Age Structure of the productive forest land base over the planning horizon.

4.2.3 Species composition of harvest

Figure 14 shows the contribution of major tree species to volume harvested over the planning horizon. Pine dominates harvest in the first 15 years, due to the explicit strategy of allocating short-term harvest priority to stands with a large component of pine. This strategy displaces the harvest of spruce and balsam into the medium term.

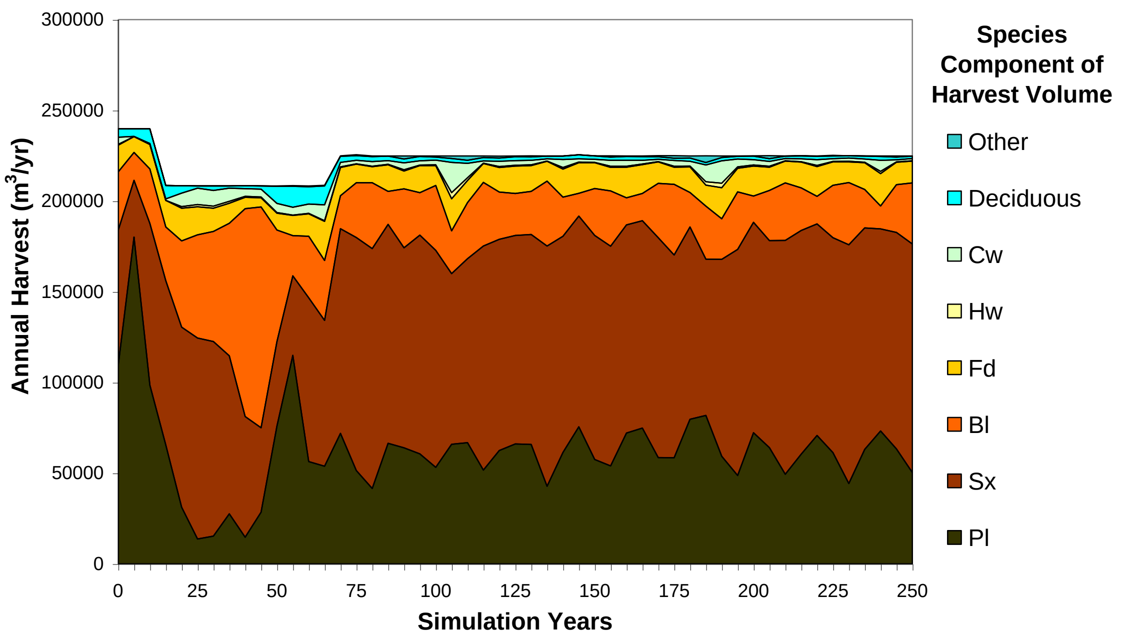

Figure 14: Species component of harvest for the first 150 years of the planning horizon.

The disproportionate harvest of subalpine fir ("balsam") in the 25-50 year period is partly associated with the harvest of IU Balsam stands during this period. Douglas-fir contributes an average of 5.5% of

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the harvest volume over the planning horizon. Western redcedar and deciduous species together make up the final 5% of the Base Case harvest in the first 90 years, but make much smaller contributions in the long term. Hemlock and other species contribute less than 1% of harvested volume in any given period. Species composition of harvest reaches equilibrium at 70 years, which corroborates the observation from the age structure diagram that the long term begins at 70 years.

4.2.4 Yield populations

Yield curves were developed by dividing the stands of TFL 18 into yield populations. Harvest from selected yield populations is shown in Figure 15. Harvest from natural stands (NSYTs) is primarily confined to the first 55 years of the planning horizon. Small volumes from natural stands are harvested throughout the long term. These stands are likely located in OGMAs or other highly constrained areas. Natural stands are subdivided in Mature, Immature, Constrained, IU Balsam, or deciduous NSYTs, based on their condition in 2004. Mature NSYTs, which are currently >80 years old, dominate harvest in the first 40 years. This is mainly because the "relative poorest first" harvest scheduling rule prioritizes stands that are growing slowly relative to their site potential. Mature NSYTs are generally at or close to the "zero-growth" stage of their yield curve, and so are targeted for harvest under this rule. Harvest from IU Balsam stands is localized in the 40-60 year period. Existing managed stands are the dominant source of volume between 55 and 75 years, but continue to contribute to harvest well into the long term. Future managed stands become a significant source of harvest at the start of the long term.

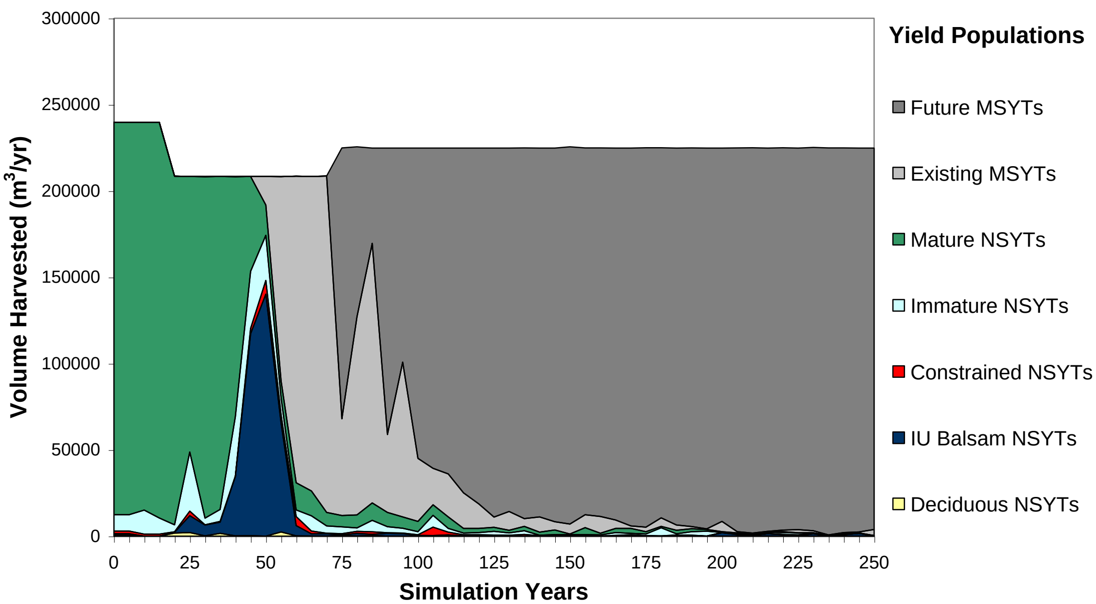

Figure 15: Contribution of volume from selected yield populations (stand types)

4.2.5 Stand volume at harvest

Under the assumptions of this analysis, stands become available for harvest once they attain a minimum volume of 125 m^3/ha. In practice, most harvests on TFL18 occur in stands that are greater than 200 m^3/ha. Figure 16 demonstrates that the harvests projected in the Base Case are consistent with these harvest practices. Harvests from stands with volumes of 125-150 m^3/ha average 0.5% of the total harvest in the short and medium terms (first 70 years), and never exceed 1.5% in any period. Harvests from stands with volumes of 150-200 m^3/ha average 1.4% and never exceed 5.6%. These results demonstrate that the Base Case is not highly dependent on harvest from low-volume stands.

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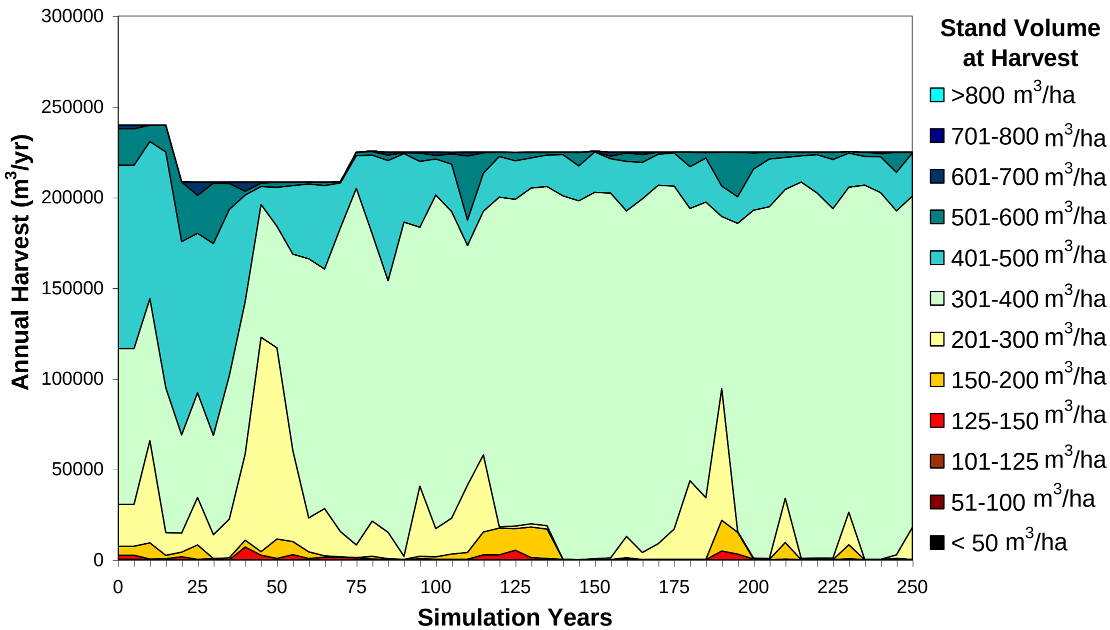

Figure 16: Stand volume at harvest for the first 250 years of the planning horizon

4.2.6 Harvest in constrained areas

Contribution of volume from constrained areas is of interest especially in light of uncertainties about these constraints. Figure 17 demonstrates that timber supply from constrained areas is stable throughout the planning horizon. OGMAs contribute an average 2,500 m^3/yr, or about 1.3% of the total harvest. In contrast, VQO polygons and riparian management zones are an important component of the Base Case, making up 9.2% and 10.3% of the total harvest level, respectively.

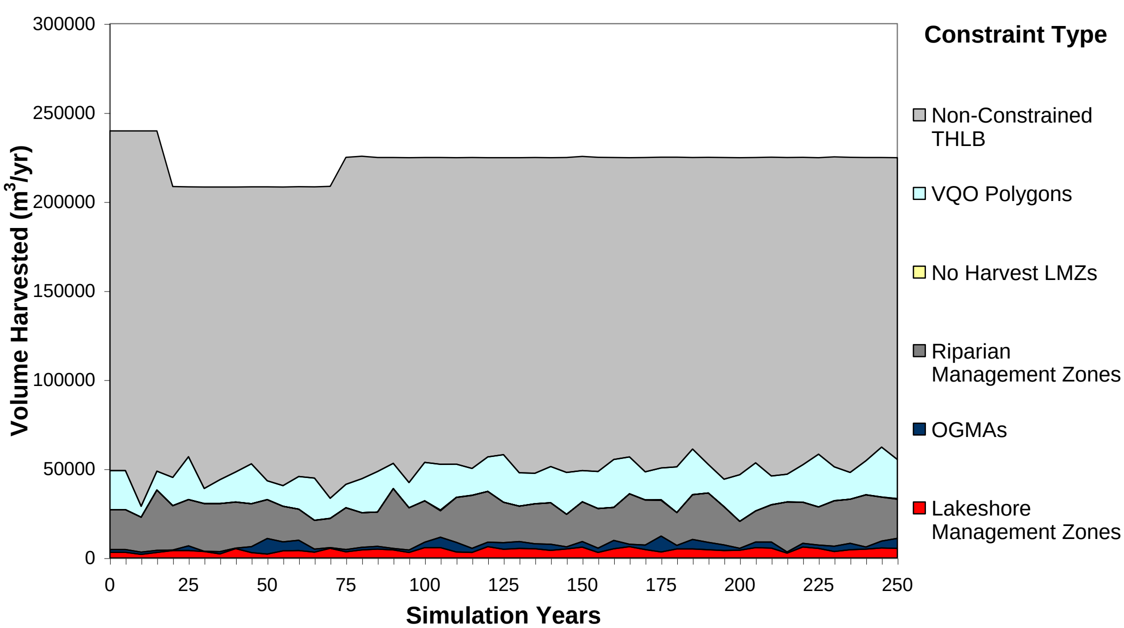

Figure 17: Harvest from constrained areas during the first 150 years of the planning horizon.

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4.2.7 Role of harvest scheduling rules

There are three harvest rules used to determine the timing and location of harvests in the Base Case. The role of these harvest rules is evident in Figure 18. Almost all of the harvest during the first 5-year period comes from development plan blocks that have been fixed into the harvest schedule. Between 5 and 30 years harvest priority is given to stands with a high component of pine. Once the available pine stands have been harvested, harvests proceed primarily according to the relative poorest first rule. However, some pine stands were constrained from harvest (in OGMAs, VQOs, etc…) during the short term and these stands are harvested throughout the medium and long terms.

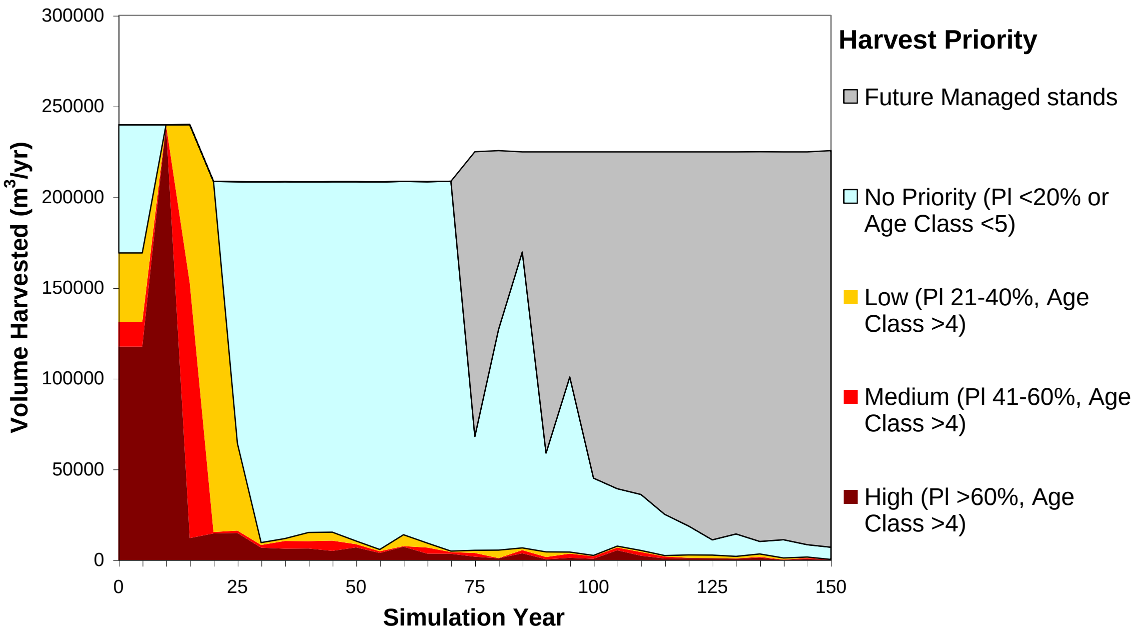

Figure 18: The role of harvest priority in harvest scheduling. Harvest priority is allocated to stands associated with high expected levels of mortality due to mountain pine beetle.

4.2.8 Forest cover objectives

Figure 19 shows the average status of constraints relative to their targets. OGMA, LMZ, and VQO constraints are all violated during the first 20-25 years of the planning horizon, indicating that the legacy of harvesting before these forest cover objectives were imposed. Beyond this point the model has configured harvests such that the constraints are never violated, but are maintained at or close to the target condition. Riparian management zones are always in excess of the required condition, indicating that they are never constraining to timber supply.

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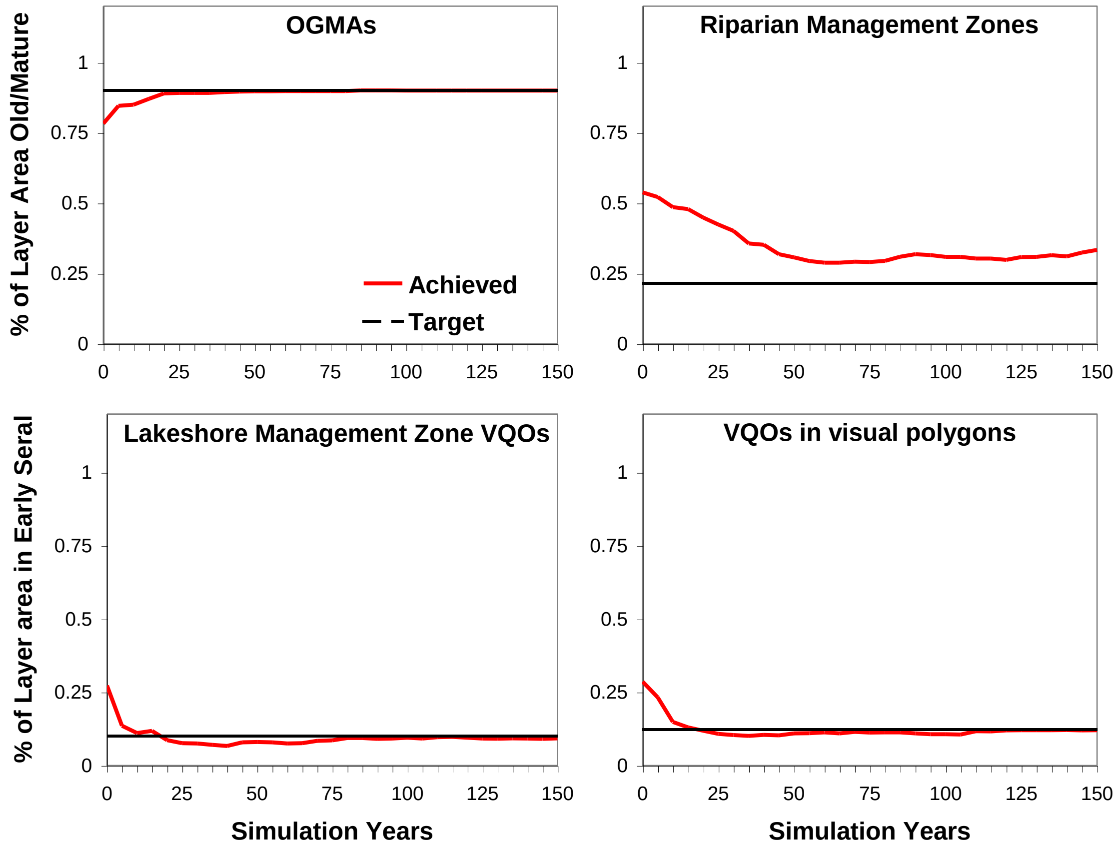

Figure 19: Average status of forest cover constraints in the first 150 years of the planning horizon. OGMAs and RMZs are minimum constraints, while VQOs are maximum constraints.

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5 Sensitivity Analyses

Sensitivity analyses have several functions in timber supply analysis. First, they give an understanding of the contribution of specific assumptions to the timber supply dynamics of the Base Case. They also verify that the model is applying the harvesting constraints correctly. Finally, they provide the Chief Forester with an indication of the risk associated with short-term harvest levels in the context of major uncertainties. Sensitivity analyses are described in this document to investigate issues associated with yield tables, OGMAs, VQOs, and minimum harvest ages.

Objective measures for comparison with the Base Case are necessary for sensitivity analyses to be meaningful. The long-term harvest level is set objectively, and changes in the long-term harvest level are a good measure of sensitivity in the long term. In contrast, there are many different ways of setting harvest levels in the short and medium terms, as illustrated by the alternative harvest flows described in Section 4.1.5. The subjectivity of harvest levels in the short and medium terms limits their utility as indicators of sensitivity. The possible harvest responses were limited in the following ways to facilitate objective comparisons with the Base Case:

1. As described in section 3.6, the duration of the short-, medium-, and long-terms is fixed and harvest levels are uniform within these planning terms.
2. Where possible, the response to changes in assumptions was limited to the medium term. By fixing the short-term harvest level at 237,000 m3/yr, the emphasis in most sensitivity analyses is on the risk associated with the Base Case short term harvest level.
3. The total volume harvested over the first 70 years of the planning horizon is used as the definitive measure of sensitivity in the short and medium terms. When the total harvest is below the Base Case harvest, it is expressed as a negative number.

The long-term harvest level and the total short/medium-term harvest are the primary measures of sensitivity used in this report. Changes in the short and medium-term harvest levels are reported as secondary descriptive measures.

Table 4: Summary of harvest level impacts of sensitivity analyses.

		Change in harvest levels (m^3/yr)			Change in short/medium term harvest (m^3)
Section	**Sensitivity Analysis**	**Short term**	**Medium term**	**Long term**	
5.1	"Relative oldest first" harvest scheduling	0	-2,500	-500	-150,000
5.2	Exclude sanitation harvests from OGMAs	0	-2,000	-3,000	-120,000
5.3	Remove OGMA Constraints	0	9,000	15,000	540,000
5.4	Remove netdown for wildlife tree retention	0	2,000	2,000	120,000
5.5	Apply RMZs as a netdown reduction	0	-5,500	-4,000	-330,000
5.6	Standard VDYP yields for young deciduous	0	-1,500	0	-90,000
5.7	Exclude deciduous volume from harvest	0	-5,000	-2,000	-300,000
5.8	Reduce NSYTs by 10%	0	-19,500	0	-1,170,000
5.9	Inventory site index for managed stands	0	-37,500	-54,000	-2,250,000
5.10	Standard VDYP yields for IU Balsam stands	0	-25,000	0	-1,500,000
5.12	Remove visual quality constraints	0	16,500	15,000	990,000

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5.1 Harvest Scheduling and Minimum Harvest Ages

Sensitivity Analysis	Use "relative oldest first" scheduling instead of "relative poorest first"
Rationale	"Relative poorest first" scheduling is an innovative method that has not been used in other timber supply analyses. This sensitivity analysis benchmarks the new rule against the more established "relative oldest first" harvest rule, which schedules stands in order of the ratio of stand age to minimum harvest age.
Methods	The relative oldest first algorithm was activated in the simulation model. Minimum harvest ages were increased to 90% of culmination age to avoid persistent harvesting of stands below culmination.
Results and discussion	Using relative poorest first scheduling created downward pressures of 2,500 m^3/yr on the medium term and 500 m^3/yr in the long term. Even when harvest is adjusted below Base Case harvest levels, a reduction in total growing stock is observable beyond 55 years into the planning horizon. This reduction indicates that "relative poorest first" scheduling is more efficient at realizing the productive potential of the land base.

Table 5: summary of the sensitivity analysis: "relative oldest first" harvest scheduling

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	203,000	-2,500	-1.2%	11,165	-138	-1.2%
Long-term (>70 years)	221,500	-500	-0.2%		n/a	
Total short/medium term harvest		n/a		14,720	-138	-0.9%

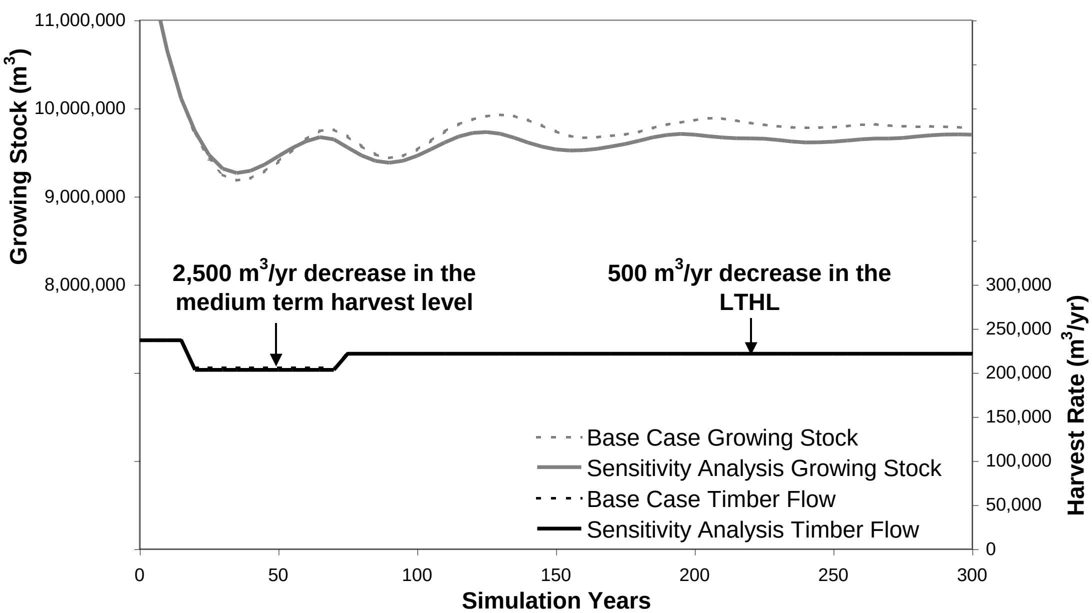

Figure 20: Sustainable harvest levels and growing stock: relative oldest first rule scheduling.

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5.2 Old Growth Management Areas (OGMAs)

Sensitivity Analysis	Exclude sanitation harvests from OGMAs
Rationale	The OGMA strategy for the Clearwater Landscape Unit allows up to 10% of OGMA area to be harvested for forest health reasons. These sanitation harvests were modeled in the Base Case by allowing 10% of the OGMA area in each BGC variant to be younger than old seral. The purpose of this sensitivity analysis is to test the dependence of Base Case harvest levels on harvest in OGMAs.
Methods	No harvesting was permitted in OGMAs.
Results	Growing stock is stabilized when harvest is reduced by 2,000 m^3/yr (1.3%) in the medium term and 3,000 m^3/yr (1.3%) in the long term. This result is consistent with the observation in Figure 17 that OGMAs contribute an average harvest of 2,500 m^3/yr to the Base Case.

Table 6: summary of the sensitivity analysis: Exclude sanitation harvests from OGMAs

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	203,500	-2,000	-1.0%	11,193	-110	-1.0%
Long-term (>70 years)	219,000	-3,000	-1.4%		n/a	
Total short/medium term harvest		n/a		14,748	-110	-0.7%

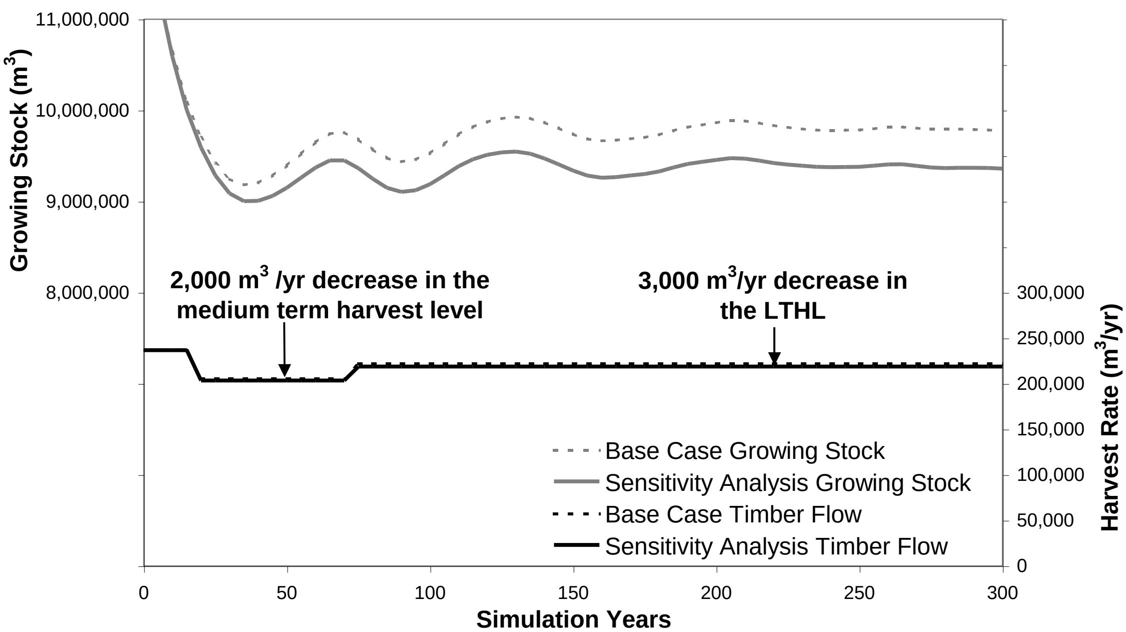

Figure 21: Sustainable harvest levels and growing stock: Exclude sanitation harvests in OGMAs

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5.3 Old Growth Management Areas

Sensitivity	Remove OGMA Constraints
Rationale	This sensitivity analysis tests the overall timber supply impact of OGMAs.
Methods	OGMA requirements were removed from the entire land base. Other constraints that overlap with OGMAs were maintained.
Results	OGMAs have two effects on timber supply: (1) they reduce the long-term harvest level by imposing very long rotations within their boundaries; and (2) they reduce the total harvest in the short and medium terms by tying up an amount of mature volume that is disproportionate to their area. These effects are evident in the results of this sensitivity analysis. In the absence of OGMA constraints, the long-term harvest level is 15,000 m^3/yr (6.8%) higher than the Base Case.

Table 7: summary of the sensitivity analysis: Remove OGMA Constraints

Planning Term	Harvest Levels Rate (m^3/yr)	Change (m^3/yr)	% Change	Volume Harvested Total (000s m^3)	Change (000s m^3)	% Change
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	214,500	9,000	4.4%	11,798	495	4.4%
Long-term (>70 years)	237,000	15,000	6.8%		n/a	
Total short/medium term harvest		n/a		15,353	495	3.3%

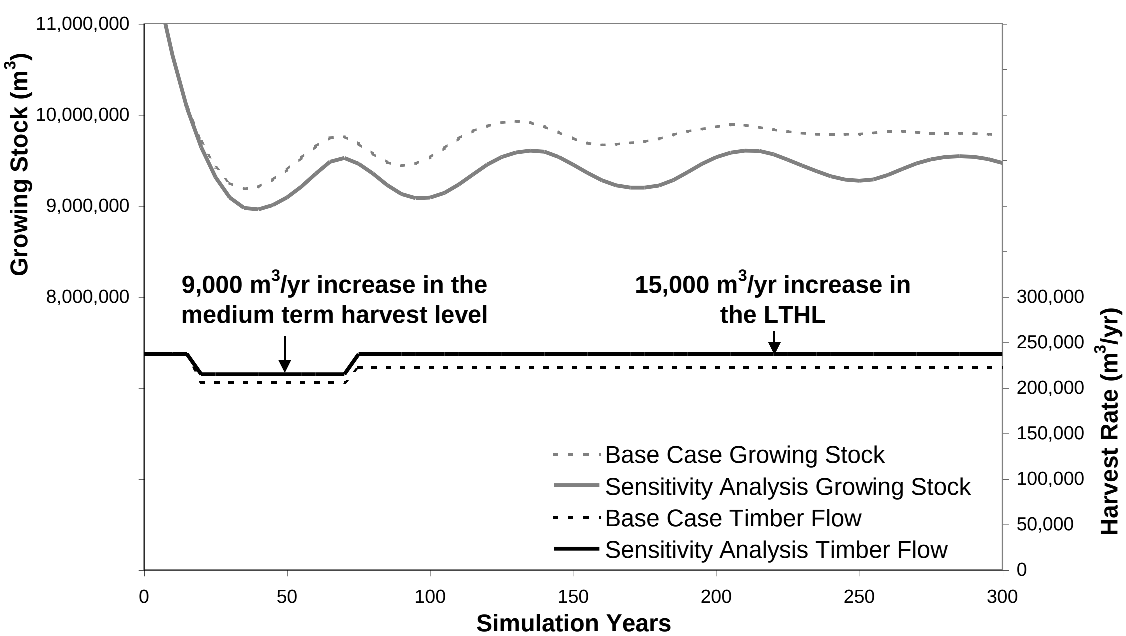

Figure 22: Sustainable harvest levels and growing stock: Remove OGMA Constraints

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5.4 Wildlife Tree Retention Targets

Sensitivity	Remove netdown for wildlife tree retention
Rationale	There is uncertainty about how Draft WTR targets for the Clearwater LU provided by MSRM will be applied within TFL18. Also, the specified contribution from the THLB is not yet determined. The purpose of this sensitivity analysis is to determine the relationship between the WTR netdown and sustainable harvest levels
Methods	The netdown was redone without the 496-hectare reduction for WTR.
Results	The netdown for WTR is a percentage reduction applied to THLB polygons, so their removal from the netdown essentially increases the harvestable volume in each polygon. The calculated LRSY effect of the WTR netdown is 1,888 m^3/yr, implying a 1-1 relationship between LRSY and LTHL responses to WTR. This result indicates that harvest levels can be adjusted based on LRSY estimates should the final WTR targets be substantially different from those used in the Base Case

Table 8: summary of the sensitivity analysis: Remove netdown for wildlife tree retention

Planning Term	Harvest Levels Rate (m^3/yr)	Harvest Levels Change (m^3/yr)	% Change	Volume Harvested Total (000s m^3)	Volume Harvested Change (000s m^3)	% Change
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (15-70 years)	207,500	2,000	1.0%	11,413	110	1.0%
Long-term (>70 years)	224,000	2,000	0.9%		n/a	
Total short/medium term harvest		n/a		14,968	110	0.7%

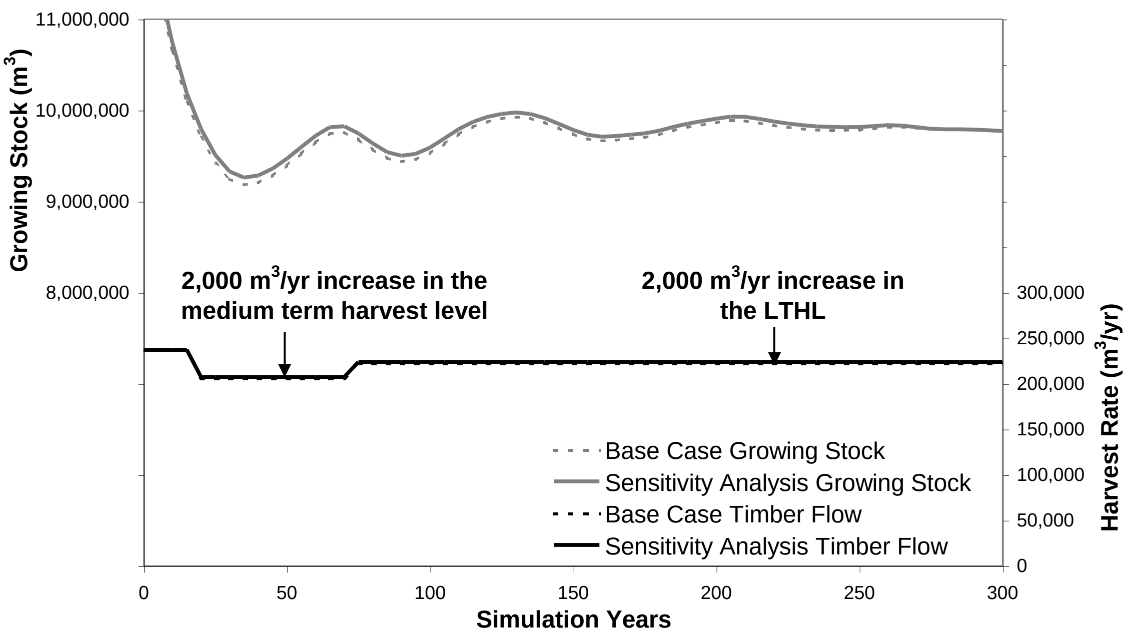

Figure 23: Sustainable harvest levels and growing stock: Remove netdown for WTR

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5.5 Riparian Management Zones

Sensitivity	Apply RMZs as a netdown reduction instead of as a forest cover requirement
Rationale	Stem retention in RMZs is modelled as a mature seral forest cover requirement in the Base Case to reflect the spatially and temporally dynamic nature of retention in the RMZs of TFL18. RMZ retention is usually modelled in timber supply analyses as a partial netdown reduction. This sensitivity analysis provides a comparison between the two approaches.
Methods	The mature seral requirement for RMZs was turned off and the THLB area of RMZs was reduced by 5-50%, depending on the riparian class. These reductions correspond to a 1,742 reduction in the THLB.
Results	Applying a netdown for RMZs has a downward pressure on timber supply throughout the planning horizon. Harvest levels are reduced by 5,500 m^3/yr in the medium term and 4,000 m^3/yr in the long term. The LRSY impact of the RMZ netdown is 4516 m^3/yr, corroborating the observation in Figure 19 that RMZ forest cover requirements are not constraining on the Base Case. The disproportionate impact on the medium term is a compensation for fixing the short term at the Base Case harvest level.

Table 9: summary of the sensitivity analysis: Apply RMZs as a netdown reduction

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	200,000	-5,500	-2.7%	11,000	-303	-2.7%
Long-term (>70 years)	218,000	-4,000	-1.8%		n/a	
Total short/medium term harvest		n/a		14,555	-303	-2.0%

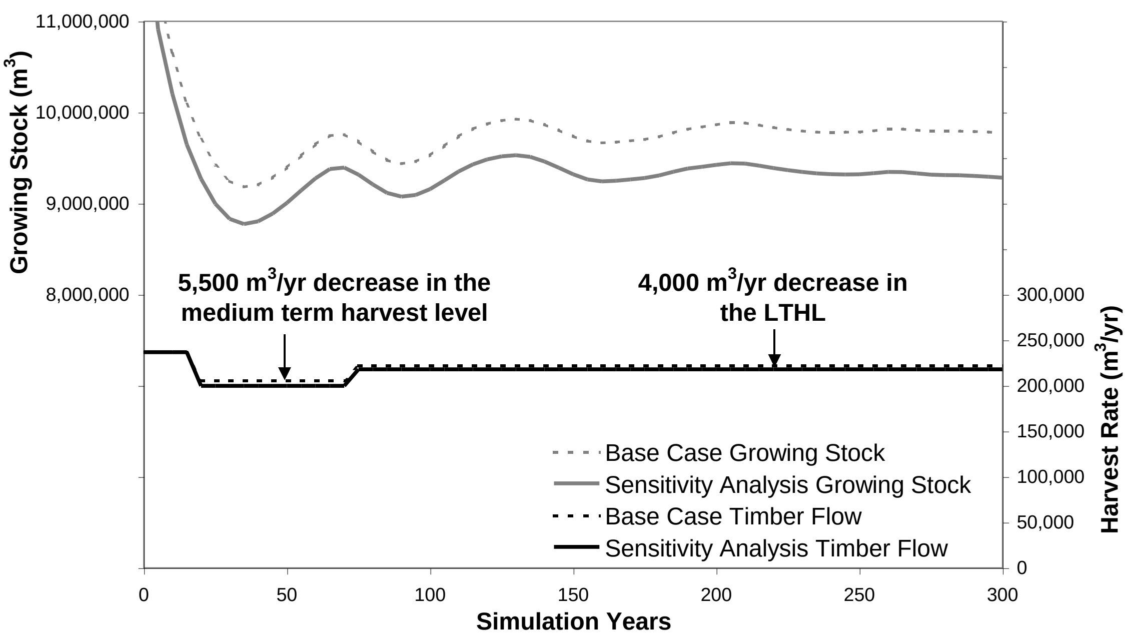

Figure 24: Sustainable harvest levels and growing stock: Apply RMZs as a netdown reduction

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5.6 Growth and yield for young deciduous stands

Sensitivity	Revert stands young deciduous stands to standard VDYP yield tables.
Rationale	As noted in Section 8.5.4 of the data package, Canfor is required by law to establish free-growing coniferous stands on cutblocks harvested during and after 1987. Although the inventory may report leading deciduous cover, 602 ha of deciduous-leading stands were modeled using a conifer-leading TIPSY yield table. The purpose of this sensitivity analysis is to test the timber supply impact associated with these impacts.
Methods	Deciduous-leading polygons that had been assigned to the "existing_mixed_managed" MSYT were reverted to their inventory VDYP curves.
Results	Modeling deciduous-leading stands with conifer MSYTs in the Base Case theoretically introduces several upward pressures on the medium-term timber supply: (1) It reduces the stand component of deciduous species, which have lower productivity when managed on a harvest rotation designed for conifers; (2) Potential site index instead of inventory site index is applied; and (3) TIPSY generally produces higher yields than VDYP. The small reduction in the medium term harvest demonstrates that these upward pressures are present but subtle in the Base Case for TFL 18.

Table 10: summary of the sensitivity analysis: Growth and yield for young deciduous stands

Planning Term	Harvest Levels Rate (m^3/yr)	Change (m^3/yr)	% Change	Volume Harvested Total (000s m^3)	Change (000s m^3)	% Change
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	204,000	-1,500	-0.7%	11,220	-83	-0.7%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		14,775	-83	-0.6%

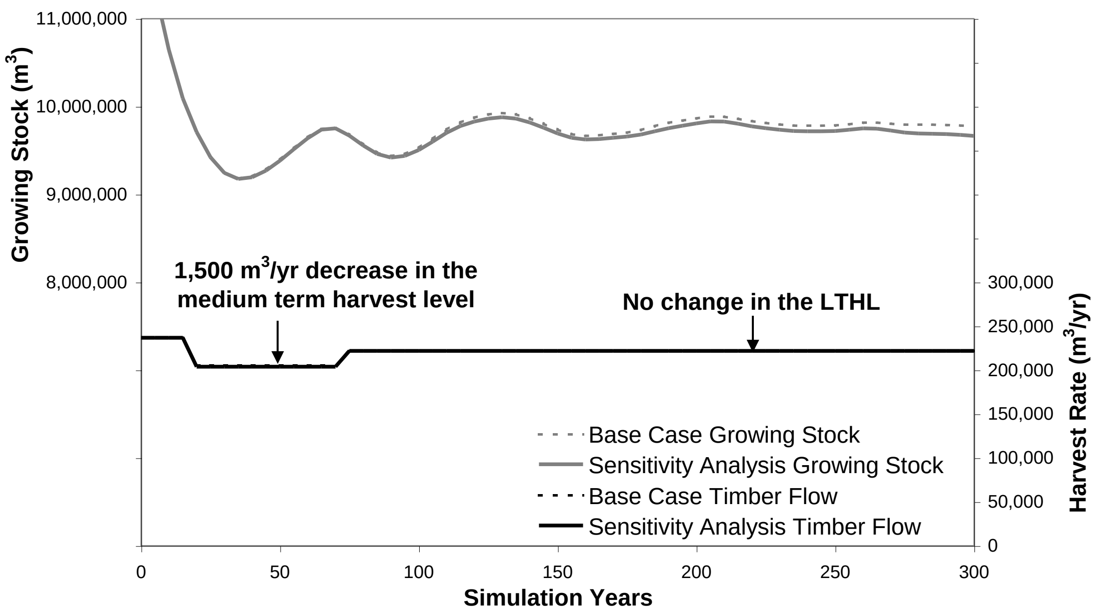

Figure 25: Sustainable harvest levels and growing stock: standard VDYP for young deciduous.

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5.7 Utilization of deciduous volume

Sensitivity	Exclude deciduous volume from harvest
Rationale	Canfor utilizes deciduous volume from merchantable conifer stands, and the Base Case utilized all deciduous volume from stands with >125 m^3/ha of merchantable volume. This sensitivity analysis tests the dependence of Base Case harvest levels on deciduous volume.
Methods	The deciduous component was removed from all yield tables (NSYTs and MSYTs). Minimum harvest ages were increased accordingly. Because deciduous volume is non-merchantable in this sensitivity analysis, it is not included in growing stock summaries.
Results	Rendering deciduous volume non-merchantable reduces the medium-term harvest level by reducing the legacy of mature volume that contributes to harvest from natural stands. It also reduces the long-term harvest level by reducing the production of merchantable volume in future MSYTs. Considering that 387,000 m^3 of deciduous volume are harvested in the first 70 years of the Base Case, the 275,000 m^3 reduction in the total harvest during this period is slightly less than would be expected. This is likely due to the faster conversion of NSYTs to future managed stands in the short term, creating an upward pressure on the medium term. Long term harvest of deciduous volume averages 1,700 m^3/yr in the Base Case, indicating a proportional response to the removal of this volume from harvest.

Table 11: summary of the sensitivity analysis: Exclude deciduous volume from harvest

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	200,500	-5,000	-2.4%	11,028	-275	-2.4%
Long-term (>70 years)	220,000	-2,000	-0.9%		n/a	
Total short/medium term harvest		n/a		14,583	-275	-1.8%

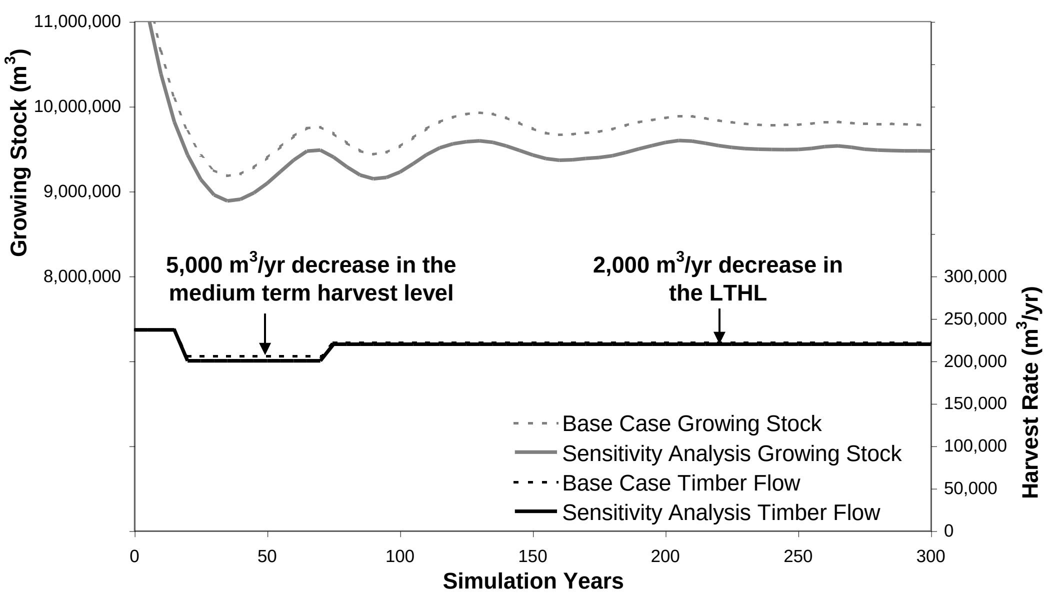

Figure 26: Sustainable harvest levels and growing stock: Exclude deciduous volume from harvest

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5.8 Natural Stand Yields

Sensitivity Reduce NSYTs by 10%

Rationale The 1997 Resource Information Branch Inventory Audit found no significant difference between the inventory and the audit sample with 95% confidence, indicating that standard VDYP volumes are appropriate for use in the Base Case. However, the audit reported average sample volume that was 10% less than the average inventory volume for stands 60 years and older. Due to the standard error of the audit, a sensitivity analysis is warranted to test the proportional risk associated with an overestimation of inventory volumes.

Methods Height/volume of all NSYTs was multiplied by 90%. MHAs were increased accordingly.

Results This change in assumptions affects harvest levels by (1) reducing the pool of growing stock available for harvest; and (2) slowing the height growth of stands and thereby increasing VQO and greenup constraints in the short and medium term. Consequently, a response of greater than 10% would be expected to the medium term harvest level. When the short term is maintained, the medium term must be reduced by only 19,500 m^3/yr (9.5%) in order to accumulate sufficient growing stock for sustainability in the long term. It is likely that increasing the rate of conversion to future managed stands in the short term reduces the downward pressure on the medium term.

Table 12: summary of the sensitivity analysis: Reduce NSYTs by 10%.

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	186,000	-19,500	-9.5%	10,230	-1,073	-9.5%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		13,785	-1,073	-7.2%

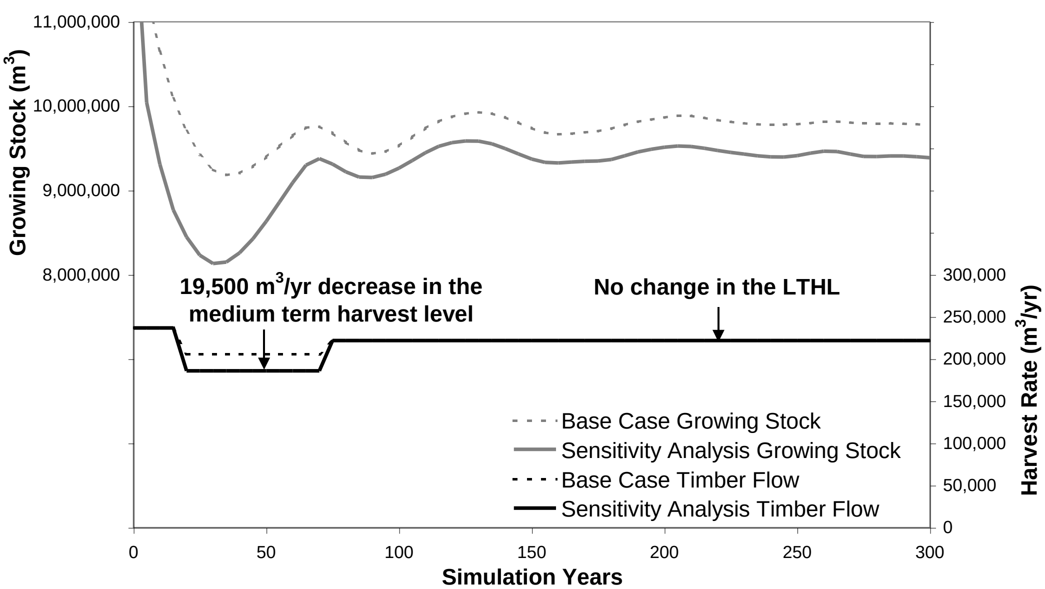

Figure 27: Sustainable harvest levels and growing stock: Reduce NSYTs by 10%

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5.9 Managed Stand Yields

Sensitivity	Use inventory site index for managed stand yield tables
Rationale	The use of potential site index (PSI) for managed stand yield tables is a major change to the Base Case assumptions. The purpose of this sensitivity analysis is to quantify the upward pressure created by these new site index assumptions.
Methods	New managed stand yield tables were created in WinTIPSY for existing managed and future managed stands. The stands assigned to each Base Case yield table were maintained, and the area-weighted average site index was calculated within these populations. Site index was assigned to each species in the yield table based on the average site index of stands where those species are leading within each population (MoF site index conversion equations were not used). Similar to the Base Case methods, TIPSY MSYTs for future stands were created at the TEM decile level for future stands, and then clustered into 10 analysis units for timber supply modeling.
Results	The medium and long term harvest levels were independently determined to be 168,000 m^3/yr. The short term harvest level was maintained at Base Case harvest levels. This timber flow is a "falldown" type timber flow, where the legacy of mature volume at the beginning of the planning horizon allows short term harvests above the long term harvest level. A reduction in the short term harvest level would allow a higher medium term harvest, but it would not increase the long term harvest level. This result indicates that—all other things being equal—the short term harvest level is independent of the site index assumptions for existing and future managed stands. In other words, the large upward pressure exerted on the medium and long terms by the use of potential site index does not "trickle down" to the short term. However, potential site index may indirectly affect the short term through interactions with other Base Case assumptions.

Table 13: summary of the sensitivity analysis: inventory site index for managed stand yield tables

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	168,000	-37,500	-18.2%	9,240	-2,063	-18.2%
Long-term (>70 years)	168,000	-54,000	-24.3%		n/a	
Total short/medium term harvest		n/a		12,795	-2,063	-13.9%

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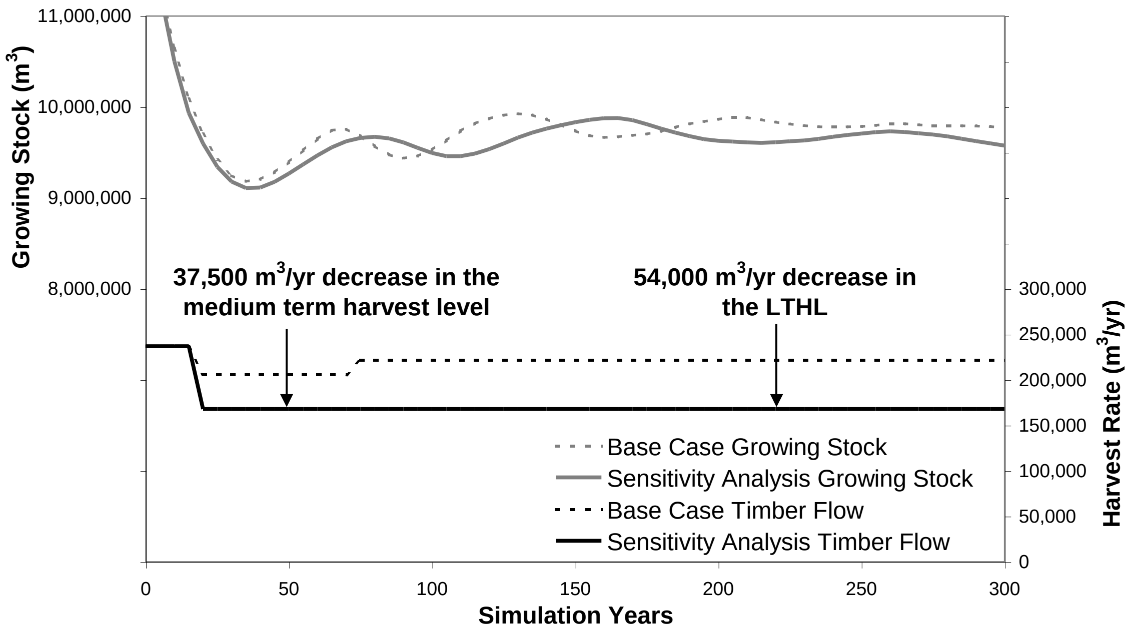

Figure 28: Sustainable harvest levels and growing stock: inventory site index for managed stand yield tables

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5.10 Harvest Scheduling of IU Balsam Stands

Sensitivity Regulate harvest of IU Balsam so that it does not exceed 25% of harvest in any period.

Rationale Base Case harvest of IU Balsam stands in the base case primarily occurs between 40 and 60 years into the planning horizon, where it forms greater than 50% of the harvest in one period (Figure 15). It is unlikely that harvesting such a large component of IU Balsam in a short period would be economically feasible. The purpose of this sensitivity analysis is to test whether there is a timber supply impact of distributing the IU Balsam harvest evenly over the short and medium terms.

Methods Harvest of IU Balsam was constrained to between 10% and 25% in each period for the short and medium terms.

Results Average harvest of IU Balsam was 14% and it took 55 years to harvest all the available IU Balsam during this period. Disruption of relative poorest first scheduling resulted in lower growing stock during the medium term, but this growth was recovered by the beginning of the long term and no changes in harvest levels were required. Scheduling of IU Balsam stands does not appear to affect sustainable harvest levels using all other base case assumptions

Table 14: summary of the sensitivity analysis: regulate harvest of IU Balsam

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (15-70 years)	205,500	0	0.0%	11,303	0	0.0%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		14,858	0	0.0%

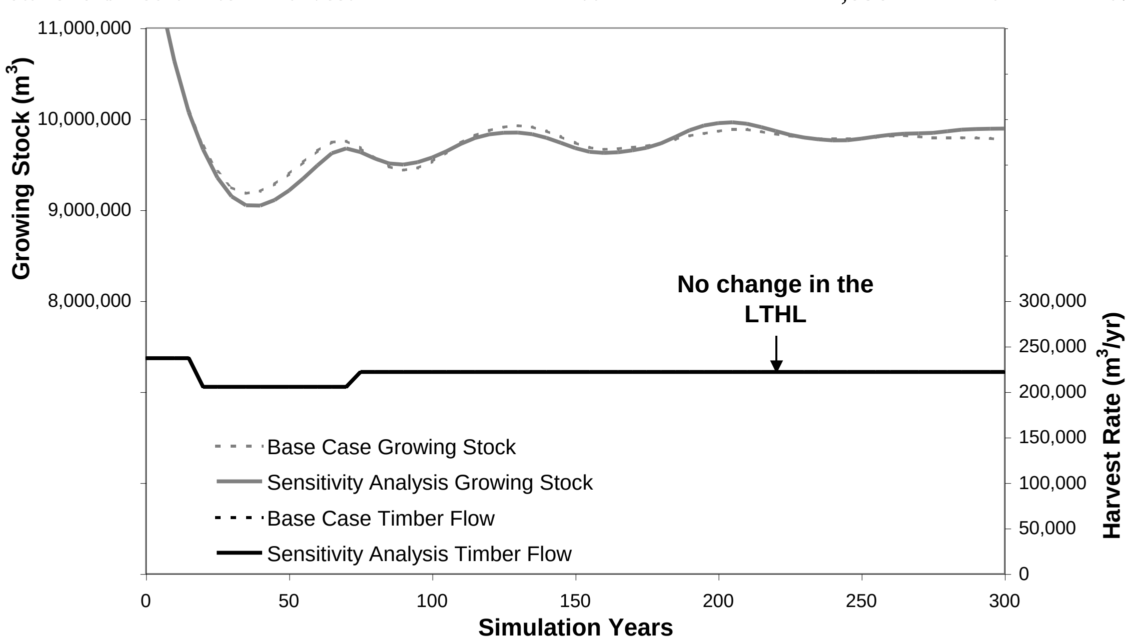

Figure 29: Sustainable harvest levels and growing stock: Regulate harvest of IU Balsam

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5.11 Yield tables for IU Balsam Stands

Sensitivity	Standard VDYP Yield tables for IU Balsam Stands
Rationale	The IU Balsam project addressed a concern that the standard VDYP modeling did not create realistic yield assumptions for IU Balsam stands on TFL 18. This sensitivity analysis tests the effect of the custom IU Balsam yield tables on timber supply.
Methods	Standard VDYP curves were assigned to IU Balsam polygons using the same method used to create NSYTs for all other natural stands. Polygon curves were clustered into 12 aggregates based on curve shape and magnitude. Two alternative harvest flows were tested. The first tests the risk to the medium term associated with maintaining the short-term harvest level. The second allows both the short and medium terms to be adjusted.
Results	When the short term is maintained (Alternative Flow #1), the medium term must be reduced by 24,983 (12.2%) in order to accumulate sufficient growing stock for sustainability in the long term. If the short term and medium term are adjusted together (Alternative Flow #2), the medium term impact is reduced by about a third at the expense of a 20% reduction in the short-term harvest level. By maintaining the strategic conversion to future managed stands in the shot term, Alternative Flow #1 reduces the impact on the total harvest volume by 250,000 m^3 relative to Alternative Flow #2. The magnitude of the harvest level response in this sensitivity analysis is similar to that of the general 10% NSYT volume reduction sensitivity analysis. However, the yield reduction associated with replacing the yields for IU Balsam stands is confined to a small portion of the natural stands (8,192 ha or 12.8% of the natural stands). The volume harvested from IU Balsam stands in the sensitivity analysis is only 721,000 m^3 less than the Base Case. This is only 52% of the 1,375,000 harvest reduction observed in Alternative Flow #1, indicating that there is a disproportionate sensitivity of timber supply to changes in IU Balsam yields.

Table 15: summary of the sensitivity analysis: Standard VDYP Yields for IU Balsam Stands. Alternative Flow #1: Maintain the short-term harvest level

Planning Term	Harvest Levels: Rate (m^3/yr)	Harvest Levels: Change (m^3/yr)	Harvest Levels: % Change	Volume Harvested: Total (000s m^3)	Volume Harvested: Change (000s m^3)	Volume Harvested: % Change
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	180,500	-25,000	-12.2%	9,928	-1,375	-12.2%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		13,483	-1,375	-9.2%

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Table 16: summary of the sensitivity analysis: Standard VDYP Yields for IU Balsam Stands. Alternative Flow #2: Reduce the short-term harvest level

Planning Term	Harvest Levels Rate (m^3/yr)	Change (m^3/yr)	% Change	Volume Harvested Total (000s m^3)	Change (000s m^3)	% Change
Short-term (0-15 years)	189,000	-48,000	-20.3%	2,835	-720	-20.3%
Medium-term (16-70 years)	189,000	-16,500	-8.0%	10,395	-908	-8.0%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		13,230	-1,628	-10.9%

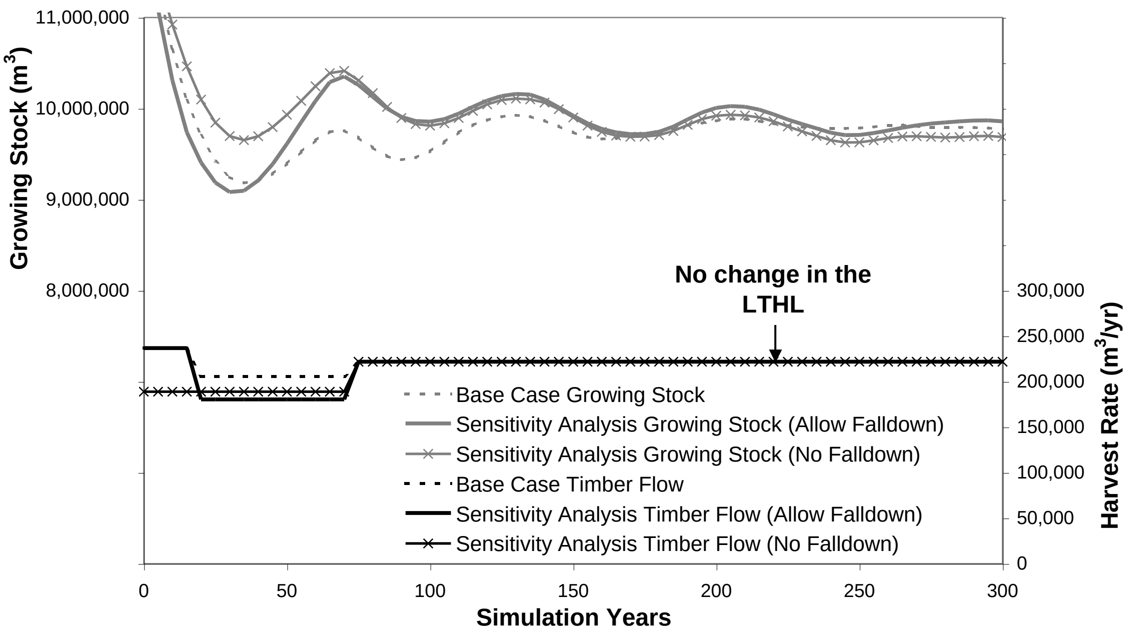

Figure 30: Sustainable harvest levels and growing stock: Standard VDYP Yields for IU Balsam Stands

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5.12 Visual Quality Objectives

Sensitivity	Remove visual quality constraints
Rationale	Standard TSR sensitivity analysis
Methods	Forest cover requirements for visual quality objectives were turned off. Visual quality objectives within Lakeshore Management Zones were maintained as a constraint.
Results	Removal of visual quality constraints allowed harvest increases of 16,500 m^3/yr in the medium term and 15,000 m^3/yr in the long term. The larger impact on the medium term is partly due to transferring the upward pressure from the short term, however, there is also likely some additional upward pressure exerted on the medium term created by greater opportunities to increase the overall productivity of the land base through strategic harvesting of stands with slow growth relative to potential site productivity.

Table 17: summary of the sensitivity analysis: Remove visual quality constraints

Planning Term	Harvest Levels: Rate (m^3/yr)	Harvest Levels: Change (m^3/yr)	Harvest Levels: % Change	Volume Harvested: Total (000s m^3)	Volume Harvested: Change (000s m^3)	Volume Harvested: % Change
Short-term (0-15 years)	237,000	0	0.0%	3,555	0	0.0%
Medium-term (16-70 years)	222,000	16,500	8.0%	12,210	908	8.0%
Long-term (>70 years)	237,000	15,000	6.8%		n/a	
Total short/medium term harvest		n/a		15,765	908	6.1%

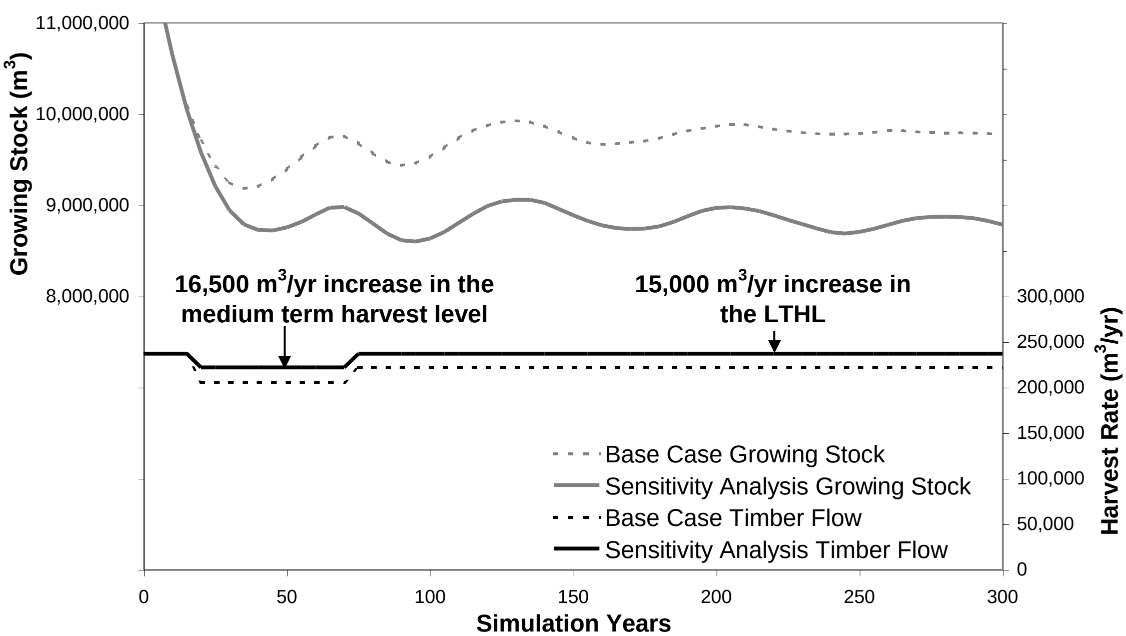

Figure 31: Sustainable harvest levels and growing stock: Remove visual quality constraints

5.13 Comparison with MP9

The MP10 Preliminary Base Case is substantially higher than the MP9 Base Case throughout the planning horizon. The sensitivity analyses provide some insight on the major reasons for these differences. The purpose of this section is to describe the differences between the MP9 and MP10 Base Case volume flows and to describe the probable causes of these differences.

5.13.1 Volume Flows of the MP9 and MP10 Base Cases

Volume flows for the MP9 and MP10 Base Cases are compared in Figure 32. Note that year 0 in this figure is 2004, and the MP9 flow begins at –5 simulation years. The initial harvest rate in MP9 was 187,000 m^3/yr. This harvest immediately declined to 162,000 m^3/yr after the first period, however, meaning that there is a 75,000 m^3/yr (50%) difference between the MP9 and MP10 harvest levels in the short term. The scale of this difference is carried into the medium and long terms.

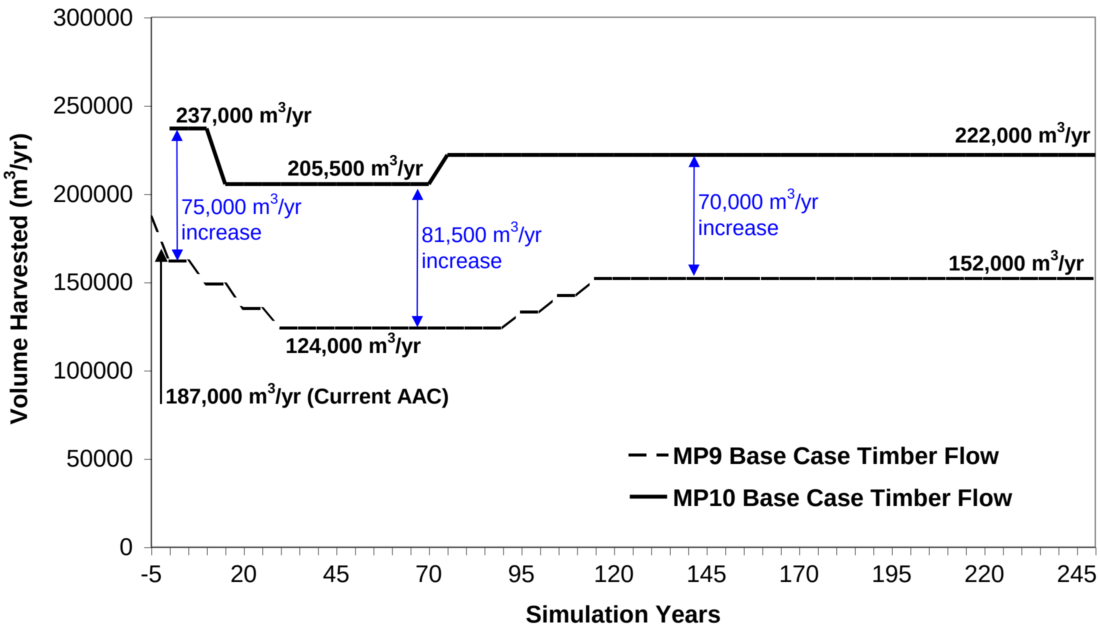

Figure 32: Comparison of the volume flows of the MP9 and MP10 Base Cases

5.13.2 Explanation of the Differences between MP9 and MP10 volume flows

The changes in assumptions relative to MP9 introduce both upwards and downwards pressures on timber supply. These pressures can be roughly differentiated between those that affect the medium term harvest level (MTHL) and those that affect the long term harvest level (LTHL). The table below summarizes the pressures exerted by the MP10 assumptions on harvest levels, relative to MP9. Some pressures are unquantified but are still identified because their general direction is known.

The cumulative impact of removing these pressures would be a 35% downward pressure on the MTHL and a 29% downward pressure on the LTHL. These translate into harvest levels of 135,000 m^3/yr and 159,000 m^3/yr, respectively. It is likely that further pressures associated with minimum harvest ages are sufficient to account for the remaining difference between the harvest levels.

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The major assumptions that are leading to higher harvest levels in MP10 are:

- MP 9 used a fully spatial run for the Base Case and sensitivity analysis. MP 10 returns to using a non-spatial timber supply analysis. As noted in the analysis report for MP 9, this caused the significant decline in the short term harvest level.
- Custom VDYP curves for IU Balsam stands—These curves increase the current volume and also the growth rate of IU Balsam stands. The extra volume harvested from these stands is available at a time when harvest is transitioning to existing managed stands and where there would otherwise be a significant timber supply shortage. Consequently the impact of IU Balsam stands is disproportionate to their volume production. These new assumptions introduce a 12% upward pressure on the medium term, but have no effect on the long term harvest level
- MP9 used an average OAF2 of 14% for managed stand yield tables, while MP10 used the standard 5% OAF2. This translates approximately to a 9% increase in the LTHL in MP10.
- Potential site index is the single most important change in assumptions. The impact of this assumption is greatest in the long term. However, it is important to the medium term, due to the ability of faster-growing existing managed and future managed stands to offset the timber supply shortage at 50 years.

Table 18: Estimate of key upward and downward pressure on MP10 timber flows associated with the differences between MP9 and MP10 timber supply assumptions.

			Pressure on Harvest	
Assumption	**MP9**	**MP10**	**MTHL**	**LTHL**
Deciduous	Deciduous-leading stands removed from the THLB. Minor deciduous component excluded from harvest	Utilize all deciduous volume	2.4%	0.9%
Harvest Rules	Oldest First	Relative poorest first	1.2%	0.2%
IU Balsam Yields	Standard VDYP tables	Customized VDYP Tables	12.2%	0.0%
Long-term THLB (excludes OGMAs)	60,272	56,927	0.0%	-5.5%
OAF2	15% (Sx/Fd), 14% (Pl), 5% (others)	5%	4.0%	9.0%
Riparian Management Zones	Partial netdown reduction by Riparian Management Guidebook guidelines	Forest cover requirement	2.7%	1.8%
Site index for managed stands	Inventory SI (current age <141 years); OGSI adjustment (>140 years old)	Inventory SI (elevation >1550m); PSI adjustment (<1550m)	18.2%	24.3%
Unsalvaged losses	1400	3000	-1.5%	-1.5%
Watershed ECAs	<22% <36yrs	None	? (up)	
Minimum Harvest Ages	>80 yrs & >120 m^3/ha (Pl, Fd), >100 yrs & >150 m^3/ha (other spp.)	>125 m^3/ha	? (up)	

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6 Management Scenario: Mountain Pine Beetle Infestation

This section examines the timber supply implications of the mountain pine beetle infestation and several harvest strategies that could be used to respond to it. This section is designed to answer the following questions:

- What effect do short-term harvest levels have on the timber supply impact of the beetle attack?
- How do short term harvest levels influence the effectiveness of salvage operations?
- What is the range of uncertainty associated with the beetle attack assumptions?

This analysis uses a range of assumptions (conservative/optimistic/pessimistic) and a range of harvest levels to provide a picture of the trade-offs and uncertainties associated with salvage harvesting in TFL 18. Sensitivity analyses provide additional information about the effect of forest cover constraints and IU Balsam yield assumptions.

6.1 Starting Condition (January 1, 2004)

6.1.1 Regional Context

TFL 18 is located at the leading edge of a mountain pine beetle epidemic that has spread through the adjacent 100 Mile House timber supply area. (Figure 33; Maclauchlin et al. 2004). The infestation is expected to spread throughout the TFL in the next 5 years (Lorraine Maclauchlin, Forest Entomologist, MoF, pers. comm., November 17, 2004).

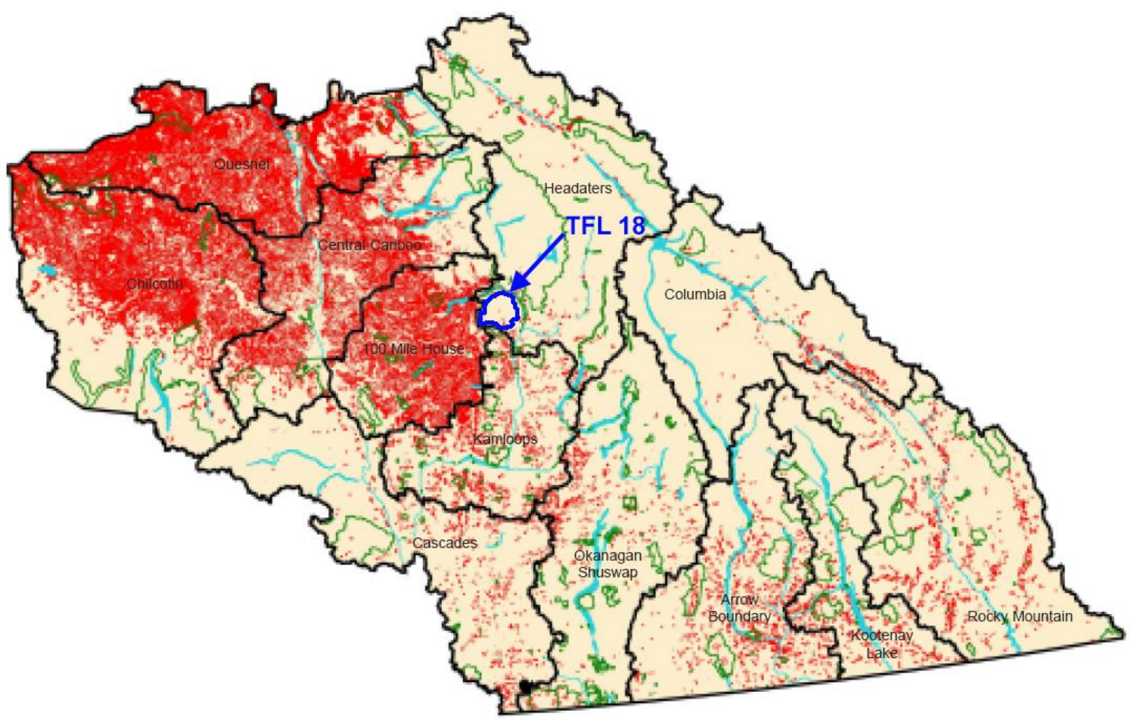

Figure 33: Mountain pine beetle infestations mapped during the 2004 southern interior aerial overview surveys (adapted from Maclauchlin et al. 2004)

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6.1.2 Management Objectives

Figure 34 summarizes the basic management considerations driving harvests on TFL 18 between 2002 and 2004. Salvage and pre-emptive harvest of stands susceptible to mountain pine beetle are currently the primary factor in harvest scheduling. Salvage of spruce bark beetle-affected stands is also a major consideration in harvest scheduling, making up more than a quarter of the total harvest area in 2004.

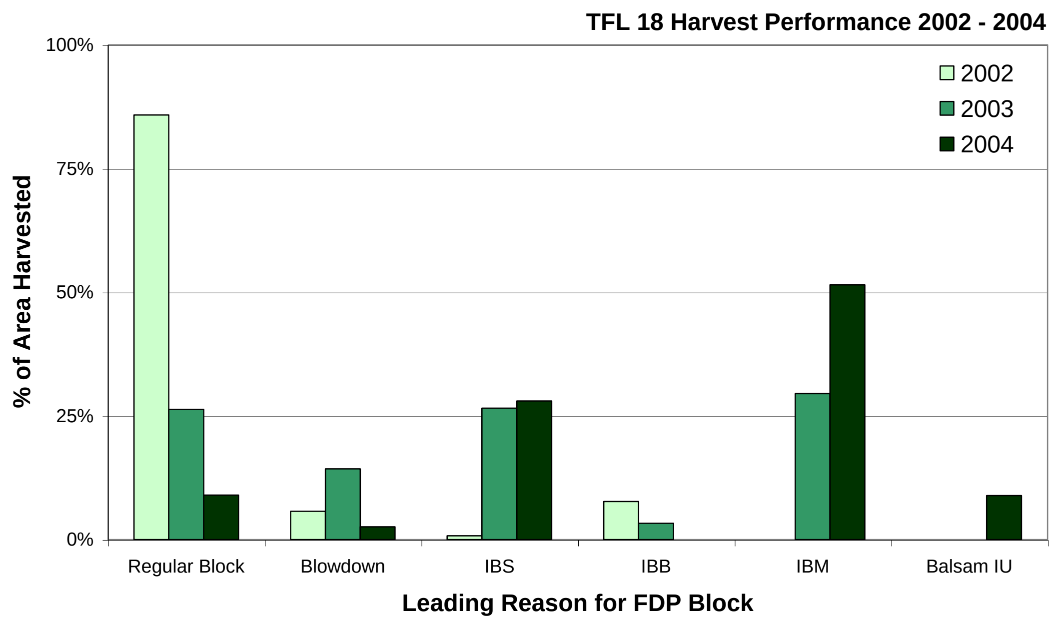

Figure 34: Leading reason for harvest over the years 2002-2004.

The extensive road network and currently low level of attack on TFL 18 allow a pre-emptive harvest strategy. This approach attempts to minimize anticipated losses by prioritizing harvest of stands where the consequence of infestation is high, regardless of the current level of attack in the stand. The pre-emptive strategy prioritizes harvest based on the proportion of pine in susceptible stands. Although stands as young as 60 years old are considered susceptible, Canfor is concentrating harvest priority on stands >80 years old due to merchantability considerations.

6.1.3 Susceptible Stands

Pine-leading stands make up a minority of the area of all age classes in TFL18 (Figure 35). On average, 28% of the standing volume is pine (Table 19), and 99% of the total pine volume is considered susceptible to mountain pine beetle attack (>60 years old and >10% pine). A majority (57%) of the susceptible pine volume is growing in pine-leading stands.

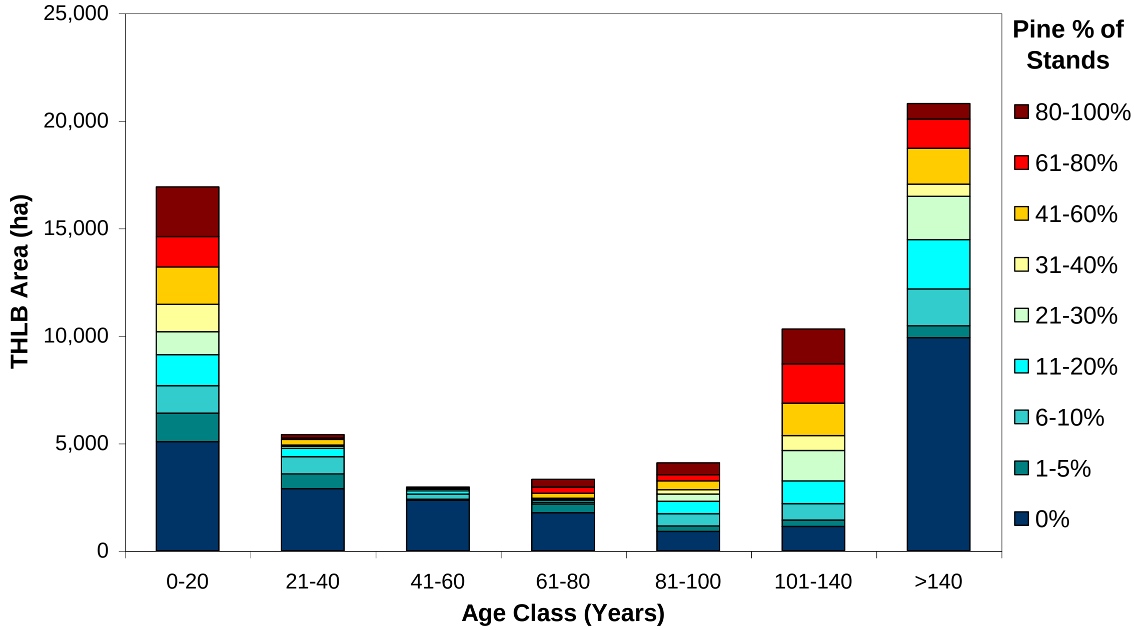

Figure 35: The proportion of pine in TFL18 stands, by age class.

The criteria and distribution of mountain pine beetle harvest priority classes are shown in Table 19. The THLB area of susceptible stands is 22,789 ha, or 36% of the total THLB area. However, susceptible stands contain 7.6 million cubic metres (all species), which is a majority (61%) of the total THLB volume of THLB. On average, susceptible stands are composed of 45% pine by volume.

Table 19: Area and volume summary of mountain pine beetle harvest priority classes

Harvest Priority Class	Criteria	THLB Area (ha)	THLB Volume (m^3)	THLB Volume of Pine (m^3)	% Pine by volume	% Of Susceptible Volume
Non-susceptible	Pl <10% or Age <61	41,024	4,896,547	40,103	1%	n/a
None	Pl 10-20% or Pl >20%, Age 61-80	5,117	1,463,625	300,145	21%	9%
Low	Pl 20-40%, Age >80	7,010	2,496,745	656,434	26%	19%
Medium	Pl 40-60%, Age >80	3,076	1,125,102	530,251	47%	15%
High	Pl >60%, Age >80	7,586	2,570,378	1,973,810	77%	57%
Total		**63,813**	**12,552,398**	**3,500,744**	**28%**	
Total Susceptible		22,789	7,655,851	3,460,640	45%	100%

6.1.4 Current Mortality

The location of 2004 mountain pine beetle red-attack in TFL18 is shown in Figure 36. These data were identified using colour air photos flown in 2004. They indicate that mountain pine beetle is distributed across the entire TFL. While the development of attack in individual stands can be expected to vary, it is likely that the attack will proceed uniformly at the landscape level.

A forest health reconnaissance survey was conducted for TFL18 in the spring of 2005. The survey population was 1,572 ha (408,000 m^3) of stands that were identified as a priority for pre-emptive harvest in 2006 and 2007 (Table 20). This survey estimated that the average attack level is between 2% and 9%, with possible attack up to 46% in one stand. All stands surveyed were in the green attack phase.

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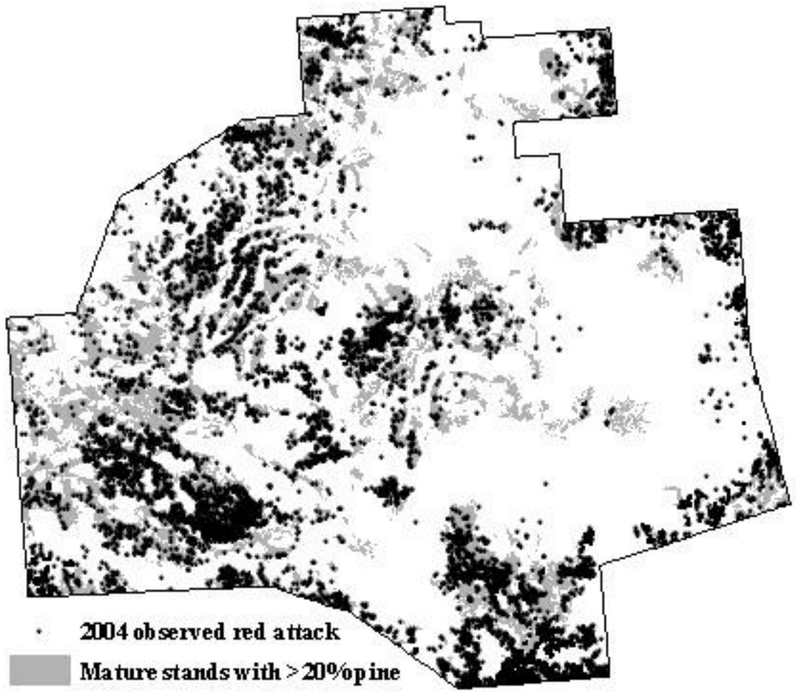

Figure 36: Mountain Pine Beetle red attack observed at the end of the 2004 growing season. Individual observation points represent one tree.

Table 20: Summary of spring 2005 reconnaissance of priority 20 Year Plan blocks.

Mapsheet	Location	Recce #	Block	Gross ha	Harvest (m^3)	Attack%	Attack/Ratio
92P078	Sicily Lake	DR002	D134	37	8,658	1%-8%	Green, 4:1:0
92P078	Sicily Lake	DR003	D135	63	17,325	1%-5%	Green, 2:1:0
92P078	Double Lakes	DR004	D136	132	33,000	2%-3%	Green, 3:1:0
92P078	Patricia Lake	DR005	D137	40	11,000	7%	Green, 5:1:1
92P078	Frank's Farm	DR006	Hold off	48	13,920	1%-2%	Green, 3:1:1
92P078	Deube Lake	DR007	D115	10	2,750	10%	Green, 3:1:2
92P078	Windy Lake North	DR008	D130	187	50,490	2%-10%	Green, 3-5:1:0
92P079	Coldscaur Lake	DR009	D131	17	4,675	3%-4%	Green, 5:1:1
92P079	Coldscaur Lake	DR010	D132	28	7,700	5%	Green, 7:1:1
92P079	Coldscaur Lake	DR011	D133	13	3,250	2%	Green, 3:1:1
92P089	Maury Lake	IR001	I117	103	30,900	2%-3%	Green, 4:1:1
92P089	Ejas Lake North	IR003	I118	38	7,476	1%-46%	Green,3:1:1
92P089	Ejas Lake North	IR004	I119	37	6,875	3%	Green, 3:1:1
92P089	East Maury Lake	IR005	I120	22	6,050	3%	Green, 4:1:1
92P089	Maury Lake West	IR006	I121	208	52,000	1%-3%	Green, 3-4:1:0
92P089	Ejas Lake	IR008	I107	53	15,675	1%-3%	Green, 2:1:0
92P089	Italia Lake	IR009	I116	30	8,250	2%	Green, 3:1:1
92P078	Herby lake	MR015	D130	113	30,245	1%-7%	Green,3:1:0
92P078	Neil Lake	MR016	M105	66	18,150	10%	Green, 7:1:1
92P078	Herby Lake	MR017	D130	213	53,664	3%-30%	Green,4-7:1:0
92P078	Grizzly Lakes North	MR018	M158	57	11,678	1%	Green, 2:1:0
92P079	Mann Creek	MR020	M157	50	12,375	1%-2%	Green,3-4:1:0
92P069	Moose Creek		M151	7	1,950	1%-10%	Green,2-6:1:1
Total				**1,572**	**408,056**	**2%-9%**	

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6.2 Methods

6.2.1 Beetle attack assumptions

There is considerable uncertainty about the behaviour of the mountain pine beetle infestation and the ecological response of affected stands in TFL 18. The projected impact of the beetle on timber supply depends on some key variables:

- Current state of the forest
- Criteria for stand susceptibility to beetle attack
- Duration of attack
- Mortality within attacked stands
- Shelf life of beetle-killed wood
- Stand dynamics following attack
- Strata for beetle assumptions
- Management Strategy

This section briefly describes the rationale for the assumptions around each of these variables, and how they are incorporated into timber supply analysis. Where local information was not available, assumptions are consistent with direction provided in the ongoing Provincial Level Projection of the Current Mountain Pine Beetle Outbreak (Eng et al. 2004; Eng et al. 2005).

Current State

Consistent with the observed stand level attack of 2-9% pine in spring 2005, a conservative assumption for forest-level attack in susceptible stands is 5% of pine volume in 2004. Optimistic and pessimistic assumptions of 2% and 10% attack will be applied in the optimistic and pessimistic scenarios.

Susceptibility

The most widely used general rule for stand susceptibility to MPB attack is stands greater than 60 years old and not in AT, BWBS, CDF, CWH, SWB biogeoclimatic zones (Eng et al. 2004; BC MoF 2004). The Beetle scenario for the recently completed timber supply analysis for the Cranbrook TSA specified this age minimum, but assumed that attack would not occur in the ESSF zone (Foresite 2004). There is currently no information indicating that MPB will not attack stands in the ESSF subzones in TFL18 (Maclauchlin, pers. comm.; Eng, pers. comm.; Dobi, pers. comm.). Mountain pine beetle has recently been reported to attack managed stands younger than 60 years (Westfall 2004, 15-16; Maclauchlin et al. 2004), although the potential for such infestations in TFL 18 is not known.

Provincial-level projections for TFL18 assume no difference in susceptibility with different % pine components in the stand, including stands with 1-20% pine (Eng, 2004). Nevertheless, Canfor staff think that stands with less than 10% pine by volume will show negligible volume losses due to the ability of non-pine trees to capture the canopy space vacated by beetle-killed pine. It is possible that stands with low pine component (<20% pine by volume) will not be severely attacked by mountain pine beetle due to the intervention of non-host trees.

Duration

A summary of Year 1 BCMPB Results for TFL18 was provided by Marvin Eng on November 15, 2004. The provincial-level projection shows the mountain pine beetle epidemic in TFL18 peaking in the years 2010 and 2011. The reliability of this forecast is considered low due to poor inventory data and starting condition (Marvin Eng, Pers. comm., November 12, 2004). Lorraine MacLauchlin (Pers.

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comm., November 17, 2004) believes that this projection is too delayed, and that the infestation is likely to peak and decline in TFL18 within 5 years, starting in lower elevation stands with lots of pine, spreading into stands with less pine, and ending in ESSF stands. The base (“conservative”) assumptions for analysis are that all attack will occur between 2004 and 2008. The Optimistic scenario uses an assumption that the attack will proceed evenly over ten years between 2004 to 2013. The pessimistic assumption is the same as the conservative assumption (5-year spread).

Mortality

Existing timber supply analyses have modeled mortality rates of susceptible stands between 50% (Foresite 2004) and up to 100% (BC MoF 2004). In the discussion of the Provincial Level Projection for TFL18, Eng et al. (2005) comment:

> The suggestion from beetle researchers is that beetles rarely kill more than 90% of the volume in a stand… Researchers from the CFS suggest that, in pure pine stands subject to heavy beetle pressure, 70% of the stems and 90% of the standing volume might be killed by beetles. Over the whole landscape, they suggest the average is probably closer to 50-60% of the stems and 60-70% of the volume (T. Shore, pers. Comm.).

Eng (Pers. comm., November 12, 2004) also noted work by Shore, Sefranyk and Riel indicating that age and percent pine can affect the *rate* of mortality within a stand, but under epidemic attack the total *amount* of mortality will be high in any stand that contains pine. This guidance suggests that it is reasonable to model uniform mortality rates for all susceptible stands.

Shelf life

The merchantability of beetle-killed wood remains an important uncertainty for projecting the timber supply impact of the MPB epidemic. The status quo shelf life assumption in most timber supply analyses to date have assumed 100% retention of merchantability for 10 years, after which the volume is no longer usable (BC MoF 2004; Foresite 2004). However, the year 2 BCMPB assumptions indicate that 10 years is probably an optimistic shelf life assumption for TFL18. They provided “pessimistic”, “conservative”, and “optimistic” shelf life assumptions for “Dry”, “Moist”, and “Wet” groups of BGC subzones (Figure 37). TFL18 is almost all in the “moist” climate category. An important distinction was made between shelf life for sawlogs and “alternative” volume (pulp, OSB, fuel, etc.). The conservative assumption is that all volume is available for sawlogs and alternative uses for 3 years after attack. No volume is available for sawlogs after 5 years, but decreasing volumes for alternative uses are available for 13 years after attack. Canfor anticipates that utilization of dead wood for alternative uses will be feasible (Dave Dobi, Canfor, pers. comm., November 17, 2004).

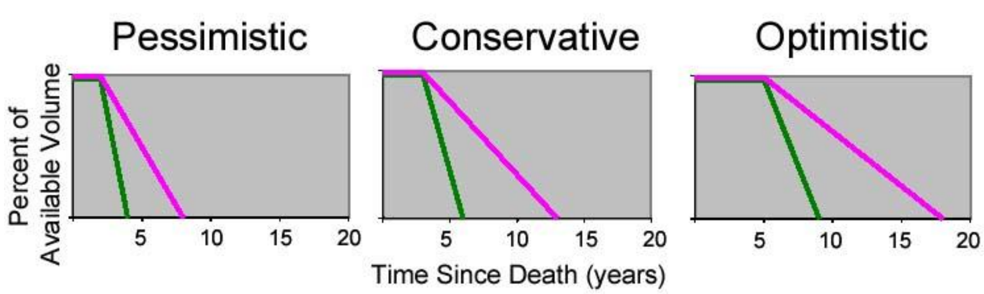

Figure 37: BCMPB shelf life assumptions for moist climates. Shelf life is differentiated between sawlogs (green) and alternative products (red).

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Stand dynamics

The growth and yield of beetle-affected stands is uncertain, partly because of limited data, but also because the response is highly variable. A possible response in mixed-species stands would be non-pine species may capture some of the mortality by occupying the canopy positions vacated by beetle killed pine. Dave Coates (Pers. comm., November 12, 2004) stated that this response is unlikely to be substantial in natural stands of the SBS and ESSF. Volume recovery of 30% is optimistic, and it is possible that there will be no compensating response from non-pine trees.

6.2.2 Synthesis of beetle attack assumptions

The assumptions described above are summarized in Table 21. optimistic and pessimistic scenarios are used to test the boundaries of uncertainty associated with the assumptions.

Table 21: Assumptions used to model the timber supply impacts of the mountain pine beetle.

Category	Central Question	Conservative	Optimistic	Pessimistic
Susceptibility	Which stands will get attacked by beetle?	>60 years old and >10% Pine Volume	>60 years old and >20% Pine Volume	>40 years old and >10% Pine Volume
Current State	What % of the pine volume in TFL18 is attacked in Jan 1, 2004?	5% of pine volume currently killed	2% of pine volume currently killed	10% of pine volume currently killed
Duration	How long for the beetle to spread through susceptible stands?	End of attack in 2008.	End of attack in 2013.	End of attack in 2008.
Shelf life	How long will beetle-killed wood remain merchantable?	No loss for 3 years after attack, then linear decrease in merch pine volume until 13 years after attack.	No loss for 5 years after attack, then linear decrease in merch pine volume until 18 years after attack.	No loss for 2 years after attack, then linear decrease in merch pine volume until 8 years after attack.
Mortality	How much of the pine volume in susceptible stands will be killed?	70% of the pine volume in susceptible stands killed by beetle.	60% of the pine volume in susceptible stands killed by beetle.	90% of the pine volume in susceptible stands killed by beetle.
Stand Dynamics	How will stands develop after beetle attack?	Pine volume is removed from yield tables. No yield recovery after attack.	Pine volume is removed from yield tables. 30% yield recovery after attack.	Pine volume is removed from yield tables. No yield recovery after attack.
Regen Age	What happens to stands with a high proportion of pine mortality?	Stands with >60% pine break up naturally after shelf life and regenerate to the same NSYT with a 20-year regeneration delay.	Stands with >60% pine break up naturally after shelf life and regenerate to the same NSYT with a 5-year regeneration delay.	Stands with >60% pine break up naturally after shelf life and regenerate to the same NSYT with a 30-year regeneration delay.

Combining the assumptions from Table 21 results in conservative, optimistic, and pessimistic forecasts of merchantable pine volume remaining in TFL18 (Figure 38). The pine volume in the yield tables of susceptible stands is multiplied by these curves to model the progressive decay of beetle-killed pine over the next 30 years. The conservative assumptions are used as the base for most harvest forecasts.

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Optimistic and pessimistic assumptions are used to test the uncertainty associated with the recommended harvest level.

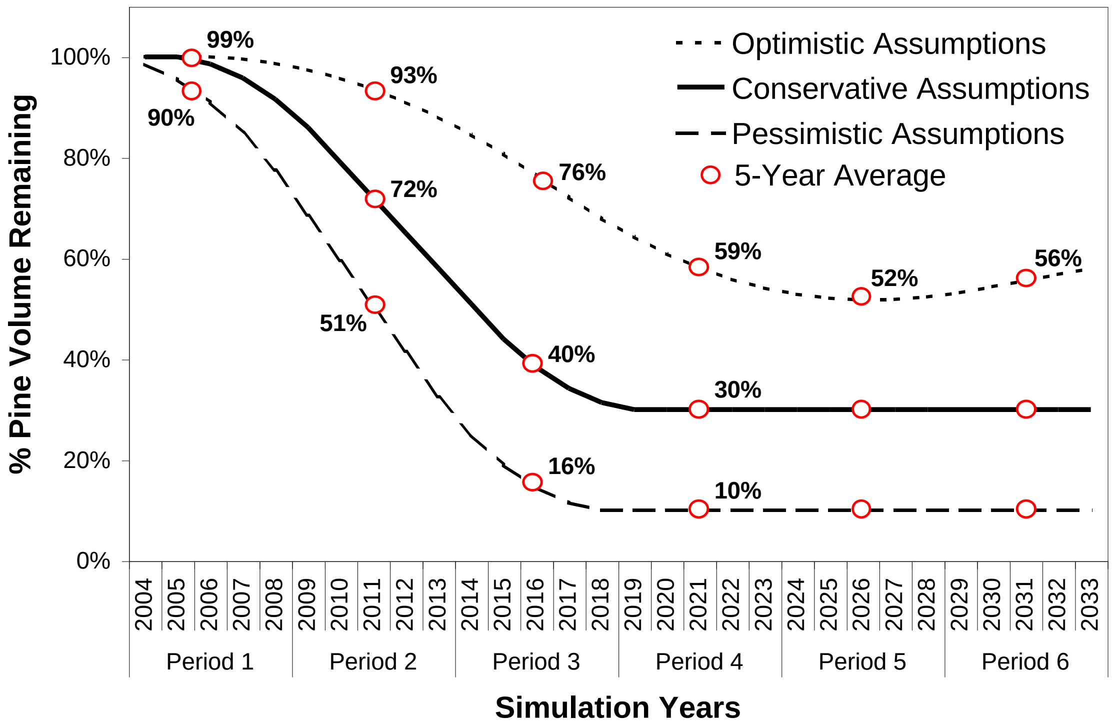

Figure 38: Yield adjustment curves used in the "conservative", "optimistic", and "pessimistic" scenarios.

The yield adjustment curves shown in Figure 38 are applied to the yield tables of susceptible stands. Figure 39 gives an example of how this is done, using the "conservative" yield adjustment curve. The hypothetical stand in this example contains a minority component of pine. It is 70 years old in 2004 (the start of the analysis). The yield adjustment for mountain pine beetle attack is 99% in 2004, meaning that the pine component of the stand is reduced by 1%. At age 75, the merchantability of some of the pine volume in the stand has begun to decrease, and the yield adjustment has dropped to 72% of the original merchantable pine volume. By 2019, at age 85, the shelf life of the attacked wood in the stand has passed, and the 30% pine component that is assumed to be unattacked continues to grow normally from this point on. The adjusted yield table would look different for a stand that is 100 years old in 2004, because the successive reductions to the yield table would begin at 100 years rather than at 70 years stand age.

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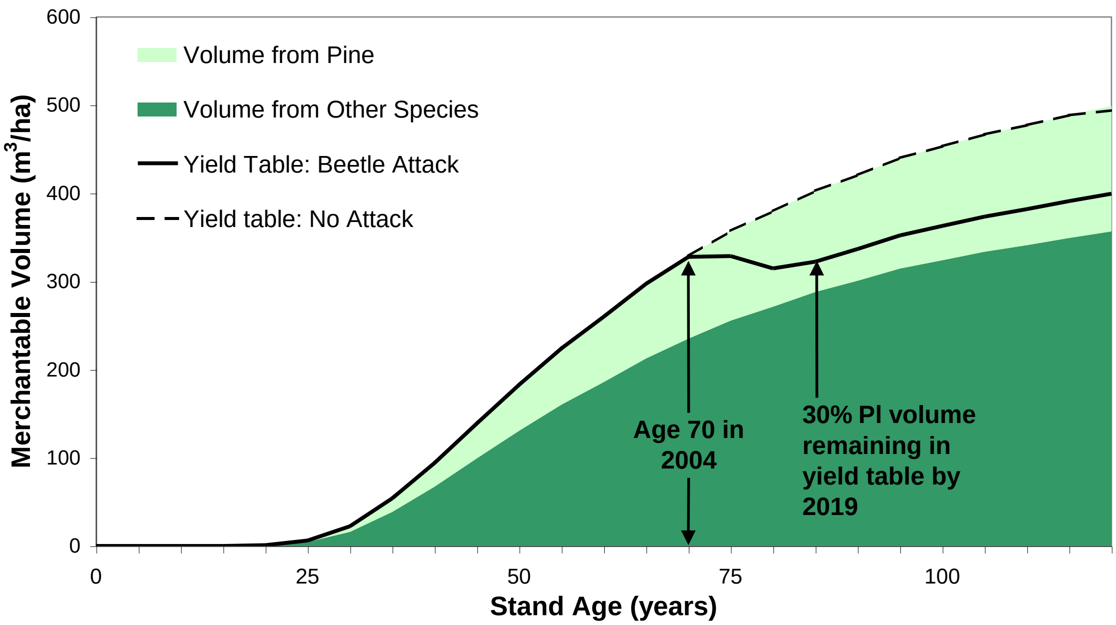

Figure 39: example of how the yield adjustment curves are applied to the yield tables of susceptible stands in the timber supply analysis.

6.2.3 Management Assumptions

Beetle management strategy

The road network in TFL 18 is extensive, and short-term access to susceptible stands is good. The short-term accessibility to almost all stands in the TFL allows Canfor to adopt a "pre-emptive" strategy to manage the pine beetle infestation. This approach attempts to minimize anticipated losses by prioritizing harvest of stands where the consequence of infestation is high, as well as improving value recovery before the beetle introduces blue stain regardless of the current level of attack in the stand. The pre-emptive strategy prioritizes harvest based on the proportion of pine in susceptible stands.

Forest Cover Constraints

Canfor – Vavenby is currently operating under an approved Forest Development Plan. In the Forest Practices Code of BC Act, section 37(4) of the Operational and Site Planning Regulation, a visual impact assessment is not required unless requested in writing by the District Manager. To date this section has been utilized when developing Mountain Pine Beetle infested and susceptible stands in scenic areas. While visual resource management strategies are employed in developing these stands, it is recognized that the scale of the disturbance will not be consistent with meeting any visual quality objective other than modification.

In the currently approved Forest Development Plan Canfor has committed to follow Section 3.3 items 31 and/or 32 of the Lakes LRUP document in the event a variance from the guideline standard is required for operational planning purposes. This approach is current practice, and management of operations within a number of LMZ's on TFL 18 have varied from the standard to allow for aggressive management of Mountain Pine Beetle infestations.

Figure 40 shows the THLB area of susceptible stands over the short and medium term of the planning horizon (Base Case results are shown). Two-thirds of the area of susceptible stands is available for

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harvest in the first twenty years, as indicated by the steady decline of the area of these stands in this period. However, the remaining third of the original area of susceptible stands is constrained, and most of this area persists into the long term (>70 years). The original profile of susceptible stands is well represented in these constrained areas, with medium and high susceptibility stands making up between 50 and 55% of the total area of susceptible stands.

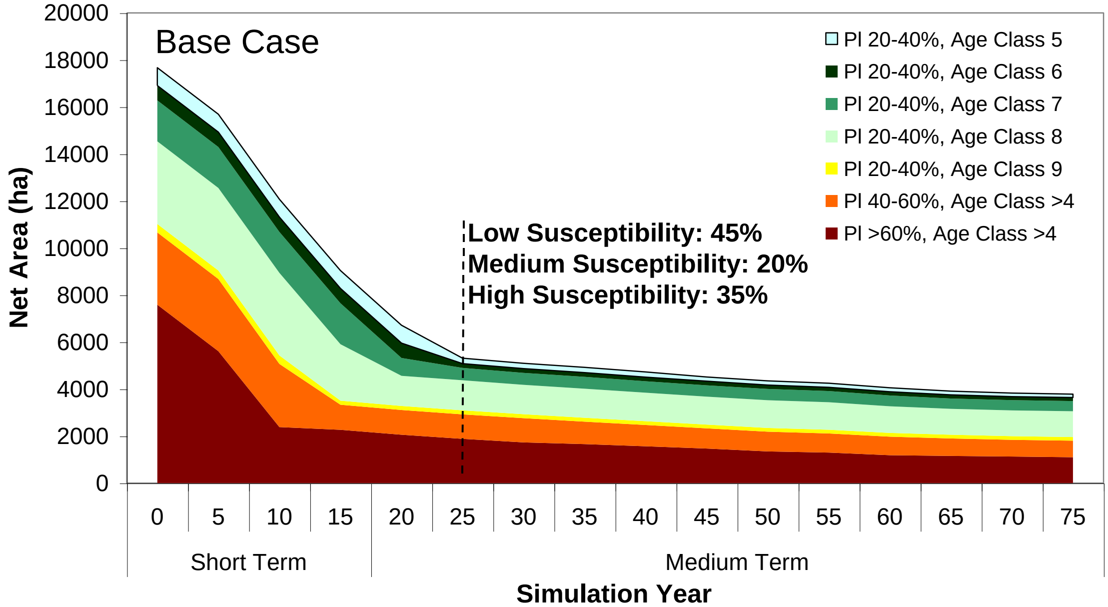

Figure 40: Area of Susceptible stands during the short and medium terms. About a third of the original area of susceptible stands is constrained and 25% persists into the long term.

Figure 41 elaborates on Figure 40, showing the relative importance of various constraints to the persistence of susceptible stands through the medium term. Non-constrained areas form the majority of susceptible stands at the start of the planning horizon. At the end of the 4th period (20 years), these non-constrained stands have been completely harvested. Likewise, riparian management zones (RMZs) are shown to be non-constraining from the perspective of pine liquidation, since very few susceptible stands in RMZs persist beyond 20 years. The primary constraints on susceptible stands are OGMAs and VQOs, with LMZs playing a significant but minor role.

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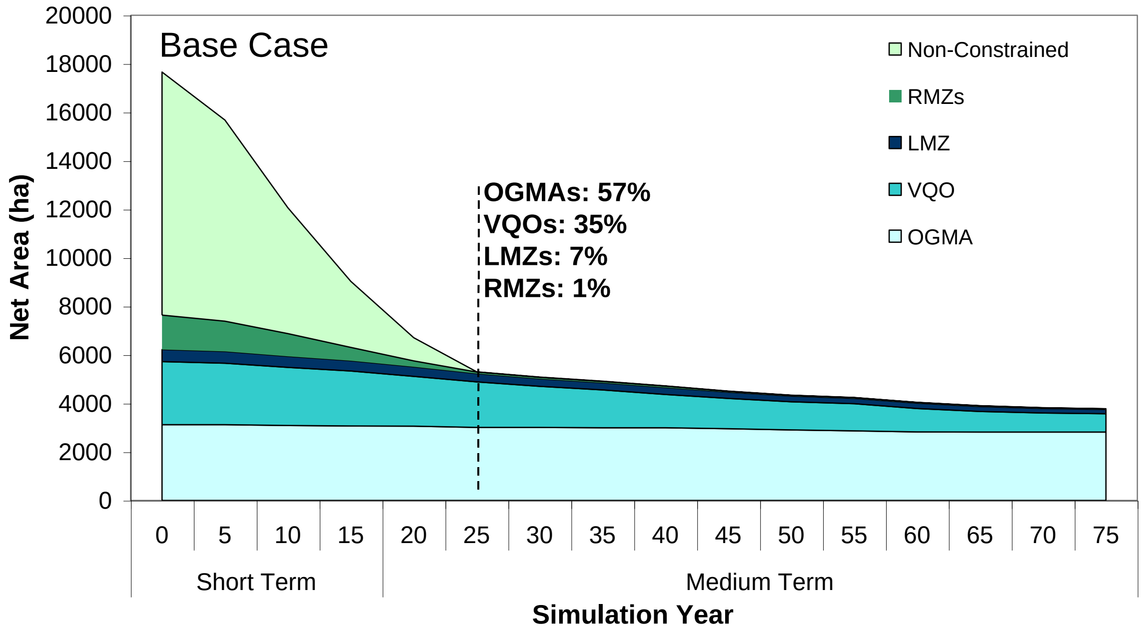

Figure 41: Area of susceptible stands in constrained areas in the short and medium terms.

Harvest scheduling based on the Twenty-Year Plan

The mountain pine beetle is different from most other factors in timber supply analysis because the period over which it occurs, and the window for a management response, are limited to the short term. Harvesting of susceptible stands is the primary management response modeled in this analysis. It is important that harvesting in the short term is as close to operational reality as possible.

Based on preliminary analysis of beetle impacts and salvage opportunities, Canfor developed a twenty-year plan using a 15-year short-term harvest level of 267,000 m^3/yr. This plan is a "best guess" at how harvesting will proceed over the short term and incorporates the "conservative" beetle attack assumptions outlined above. The twenty-year plan provides a good base for harvest scheduling in the beetle management scenarios because it balances salvage priorities against operational considerations and other management priorities.

The twenty-year plan began with a preliminary simulation using "conservative" beetle attack assumptions. The simulated harvests were manually grouped into operationally realistic cutblocks and additional blocks were created for short-term harvest objectives that were not incorporated into the timber supply assumptions (e.g. salvage of trees killed by spruce bark beetle). New simulations were used to schedule the harvest of these blocks during the first twenty years of the planning horizon. Canfor staff made final manual refinements to this harvest schedule so that it reflects their operational perspective. This final twenty-year harvest schedule was then incorporated into a 500-year planning horizon, and the appropriate medium term harvest level was determined. This methodology creates a timber supply scenario that integrates a semi-operational spatial harvest plan with simulated long-term timber flows.

The sequencing in the twenty-year plan differs from the base case in the following ways:

- Although harvesting is generally driven by the mountain pine beetle salvage priority, non-susceptible stands are sometimes incorporated to create operationally feasible cutblocks;

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- Areas with higher levels of current attack were subjectively given priority in scheduling;
- Some short-term harvest was allocated to non-susceptible areas to allow for other forest management objectives (e.g. salvage of spruce beetle infected stands).

Harvest priority was based on the twenty-year plan in all the beetle scenarios outlined in this section. I.e. the timber supply model gives highest priority to polygons that were harvested in the first period of the twenty-year plan.

6.2.4 Timber supply runs

The basic analysis involves finding the sustainable medium-term harvest level for the following timber supply runs:

Harvest ranging runs—Short-term harvest levels of 177,000 m^3/yr (current AAC); 207,000 m^3/yr; 237,000 m^3/yr; 267,000 m^3/yr; 297,000 m^3/yr; 327,000 m^3/yr; and 357,000 m^3/yr. Conservative assumptions.

Assumptions ranging runs—Optimistic and pessimistic assumptions, Short-term harvest levels of 267,000 m^3/yr.

Sensitivity Analysis—Standard VDYP yields for IU Balsam stands

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6.3 Results

6.3.1 Impact of mountain pine beetle attack on timber supply

The impact of applying beetle attack assumptions is shown in Figure 42. The decay of beetle-killed pine volume during the first 20 years of the planning horizon reduces growing stock below a level that can sustain the Base Case harvest rate. In order to sustain Base Case harvest levels, the model starts to harvest stands before they reach culmination age. This process reduces the rate of volume production on those stands and results in accelerating decline of growing stock until the harvest crashes at 125 years into the future. It is important to note that the beetle attack as modeled here does not create an acute timber supply shortage in the near future. Nevertheless, a short-term response is required in order to ensure sustained timber supply in the long term.

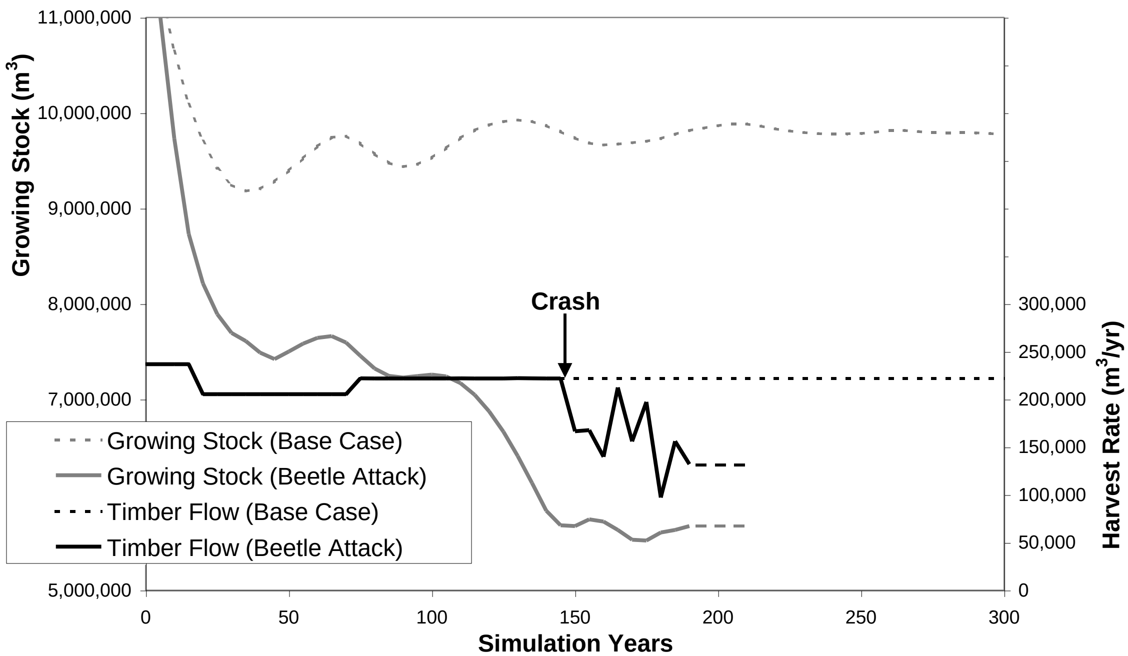

Figure 42: Effect of beetle attack on growing stock when Base Case harvest levels are attempted

6.3.2 Effect of different short-term harvest levels on timber supply impacts

There are many ways of using harvest levels to respond to the downward pressures on timber supply created by the beetle infestation. The simplest approach is to reduce both the short and medium-term harvest levels by whatever amount is necessary to achieve long-term sustainability. Another approach is to maintain or increase short-term harvest levels as a means of salvaging beetle-killed wood and thereby reduce the downward pressure on timber supply.

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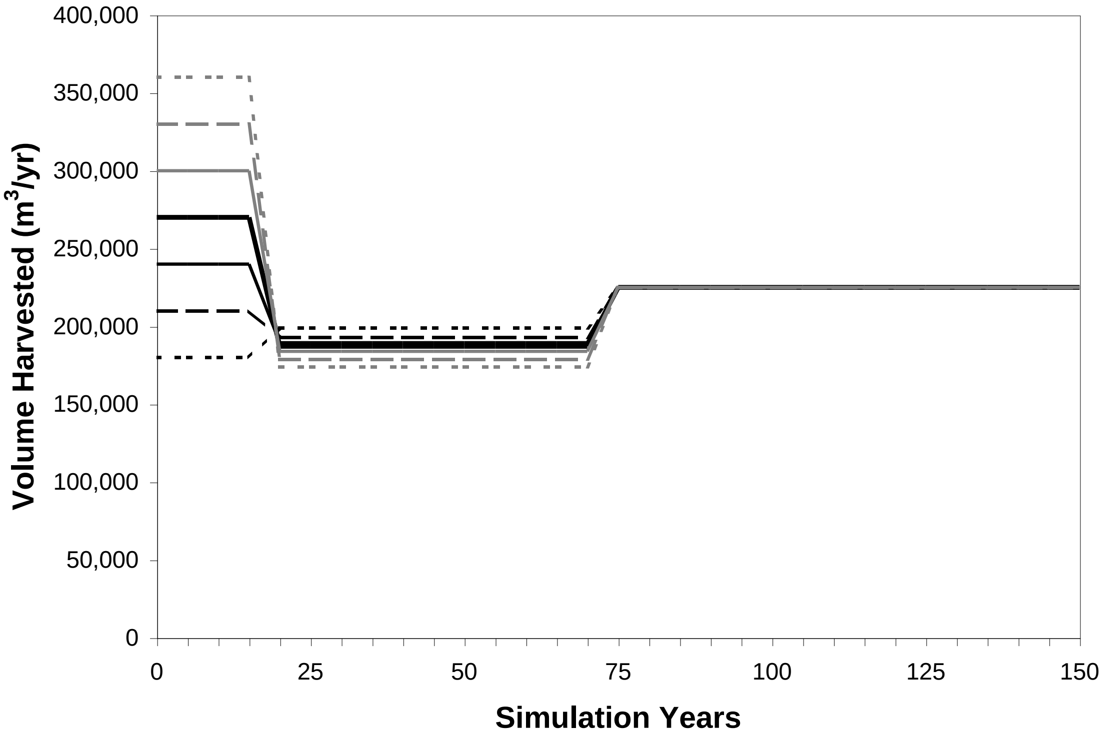

Figure 43: response of the medium term harvest level to increases in the short-term harvest level, using conservative beetle assumptions.

The medium-term response to a range of short-term harvest levels is shown in Figure 43. The minimum short-term harvest level shown is 177,000 m^3/yr, equivalent to the current AAC. The associated medium term harvest level is 199,000 m^3/yr. Doubling the current AAC to 357,000 m^3/yr requires a 25,000 m^3/yr (12.5%) reduction in the medium term harvest level. This corresponds to a 2.7 million m^3/yr increase in the total volume harvested over the short term and a 1.38 million m^3/yr decrease in the total volume harvested over the medium term. On average, a two cubic meter increase in the short term harvest requires a reduction of only 1 cubic meter in the medium term. These results imply that there is a net timber supply gain associated with increasing the short-term harvest level by as much as double the current AAC.

There are two main reasons why this net timber supply gain will occur. The first is the increase in average forest productivity created by accelerated conversion of slow-growing natural stands to fast-growing managed stands. The second reason is that higher harvest levels allow faster salvage of beetle-affected stands, thereby increasing the merchantable volume that can be recovered from these stands.

The relationship between the medium term and short-term harvest volumes is not constant, as shown in Figure 44. The proportional medium-term timber supply impact declines as the short-term harvest level increases up to 267,000 m^3/yr. Beyond 267,000 m^3/yr, the proportional impact remains the same at approximately 50%.

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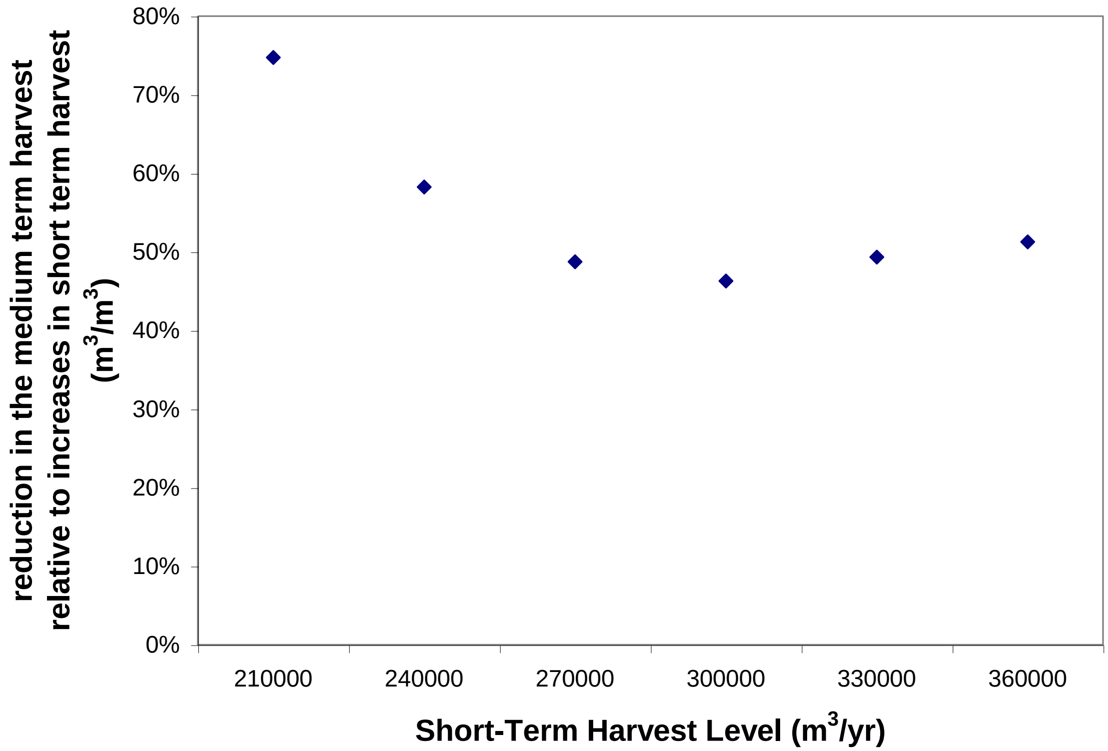

Figure 44: relative reduction in the total medium term harvest necessitated by increases in the short-term harvest.

The beetle scenarios do not affect the long term harvest level. Therefore, the sum of all volume harvested over the short and medium terms (the first 75 years of the planning horizon) is a good measure of total timber supply impact. Using “conservative” beetle assumptions, a short term harvest level of 177,000 m^3/yr has a 1.6 million m^3 (10.8%) timber supply impact relative to the MP10 base case (Figure 45). This impact decreases at higher harvest levels due to the net volume gain associated with increasing the short term harvest level (Figure 44). Increasing the short-term harvest level to 357,000 m^3/yr reduces the impact to 0.3 million m^3 (2.0%). In other words, the timber supply impact of the beetle can be partially mitigated by raising harvest levels in the short term. This benefit comes at the cost of creating a large differential between the short term and the medium term harvest levels.

The effect of the optimistic and pessimistic assumptions on total timber supply impact is substantial, though not as great as the impact of initial harvest levels. The optimistic and pessimistic scenarios indicate that, at a short term harvest level of 267,000 m^3/yr, the total impact could be as little as 0.4 million m^3 (3%) or as much as 1.4 million m^3 (9%). This range of uncertainty would likely be narrower at higher short term harvest levels because faster salvage rates would reduce the role of beetle assumptions in the timber supply forecasting.

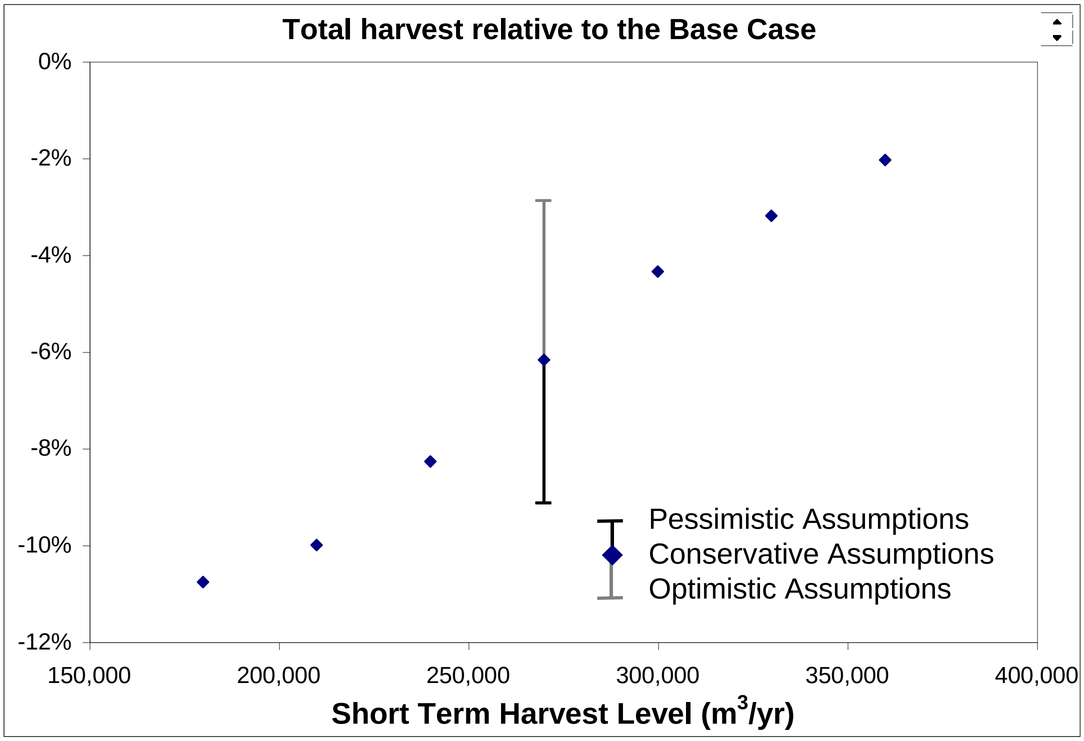

Figure 45: Total harvest relative to the Base Case for a range of short-term harvest levels and beetle assumptions. This proportion is the volume harvested over the first 75 years (combined short- and medium-term harvest), divided by the base case harvest over the same period.

6.3.3 Salvage Effectiveness

The following measures are used to compare the results of different short-term harvest levels and beetle assumptions:

Salvage completion—The proportion of the total area of medium and high-priority stands (>40% pine) that have been harvested by the end of the short term (first 15 years of the planning horizon).

Salvage success—The proportion of the total harvested susceptible pine volume that is merchantable at the time of harvest (measured over the first 25 years).

Incidental Harvest—the proportion of the harvest volume from susceptible stands that is non-pine (measured over the first 25 years).

Salvage completion

Salvage completion indicates whether the short-term harvest level is high enough to allow salvage of higher priority stands. At, salvage completion increases with the harvest level until short-term harvest levels less than 267,000 m^3/yr, beyond which there is little additional improvement. Salvage completion does not reach 100% in any run because some pine stands are in OGMAs or other unharvestable areas.

The uncertainty associated with assumptions is small compared to the role of havest levels in controlling salvage completion. Optimistic assumptions show lower salvage completion because there is more merchantable volume per hectare in attacked stands, and therefore it takes longer to complete the salvage of priority stands at a given harvest level.

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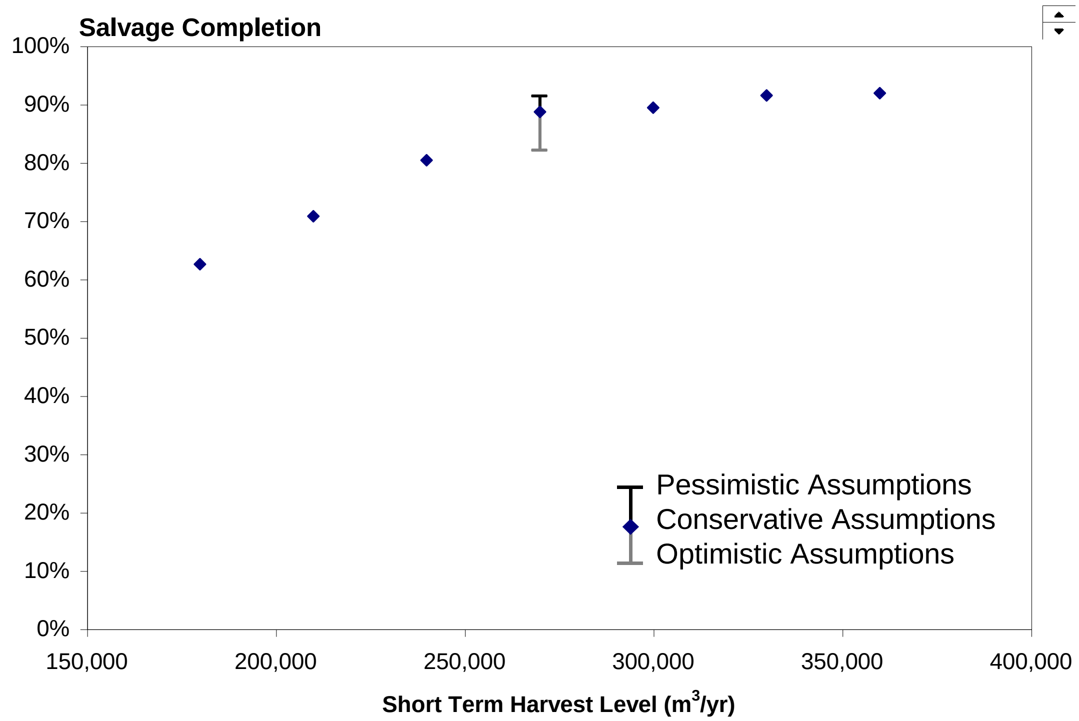

Figure 46: Salvage Completion for a range of short-term harvest levels and beetle assumptions

Salvage Success

Salvage success, in contrast to salvage completion, continues to increase at harvest levels above 267,000 m^3/yr. This occurs because higher initial harvest levels allow more stands to be harvested in the first period, where almost all beetle-attacked volume remains merchantable. Salvage success appears to taper off slightly at the higher harvest levels.

Salvage success of the optimistic and pessimistic scenarios exceeds the range of Salvage success created by variation of the initial harvest level. This result suggests that the behaviour of the beetle infestation and its effect on merchantability may be more important to timber supply than the rate at which stands are salvaged.

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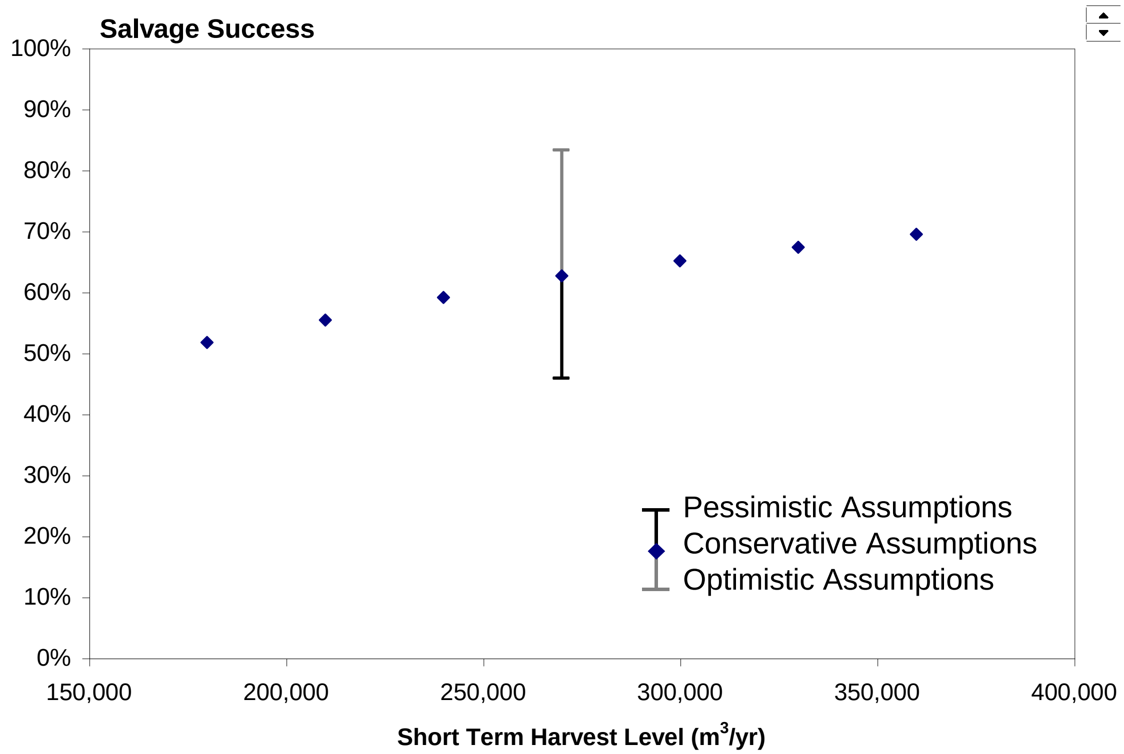

Figure 47: Salvage success for a range of short-term harvest levels and beetle assumptions

Incidental Harvest

Incidental harvest is a measure of the efficiency of salvage. When clearcutting is used for salvage operations, the non-susceptible component of the stand is also harvested. Although it is inevitable in some cases, the incidental harvest can reduce salvage rates and exacerbate the medium-term timber supply impacts of an AAC Uplift. Incidental harvest is an important consideration in the choice of management strategies for salvage, including the choice of initial harvest level.

Incidental harvest decreases slightly with increasing initial harvest levels, from 62% at 177,000 m^3/yr to 58% at 357,000 m^3/yr. This change is small relative to the response of salvage success to harvest levels. This dampened response is likely due to two counteracting factors: (1) Higher harvest levels allow more low-priority (20-40% pine) stands to be harvested, which increases the incidental harvest; (2) Higher harvest levels allow earlier salvage of stands, when merchantable pine forms a greater proportion of the stand volume, which reduces the incidental harvest. Similar to salvage success, the response of incidental harvest to beetle assumptions is much greater than the response to harvest levels.

The reduction in incidental harvest caused by an increase in short term harvest levels is due to the definition of incidental harvest. In this case, it refers to the proportion of non-pine volume in susceptible stands harvested over the first 25 years of the planning horizon. Another measure of incidental harvest is the proportion of non-pine in the total harvest (Figure 49). This must be measured over the first ten years of the planning horizon to ensure that the results are not obscured by the effect of non-susceptible harvest that occurs after the salvage window. This measure decreases between harvest levels of 177,000 and 267,000 m^3/yr, which is the effect of raising the harvest but keeping the non-susceptible harvest (e.g. for spruce beetle salvage blocks) fairly constant. At harvest levels above 267,000 m^3/yr the proportion of non-pine volume in the harvest increases due to increasing harvest of susceptible stands with low pine content (20-40% Pl).

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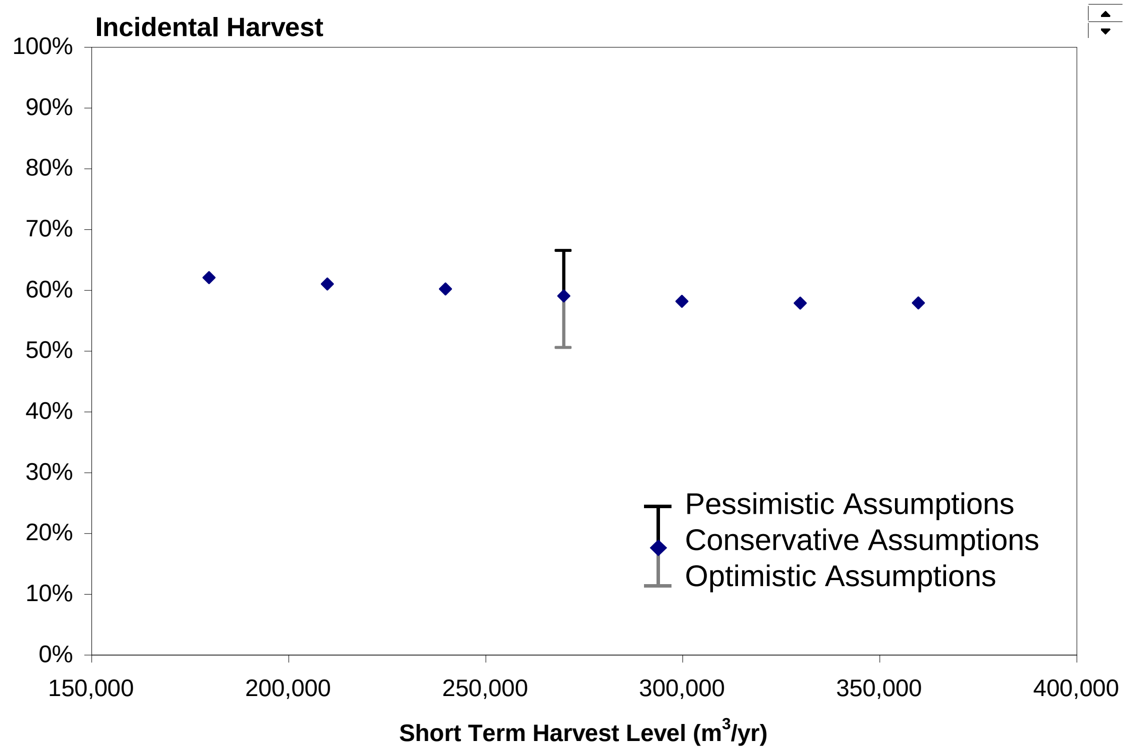

Figure 48: incidental harvest for a range of short-term harvest levels and beetle assumptions

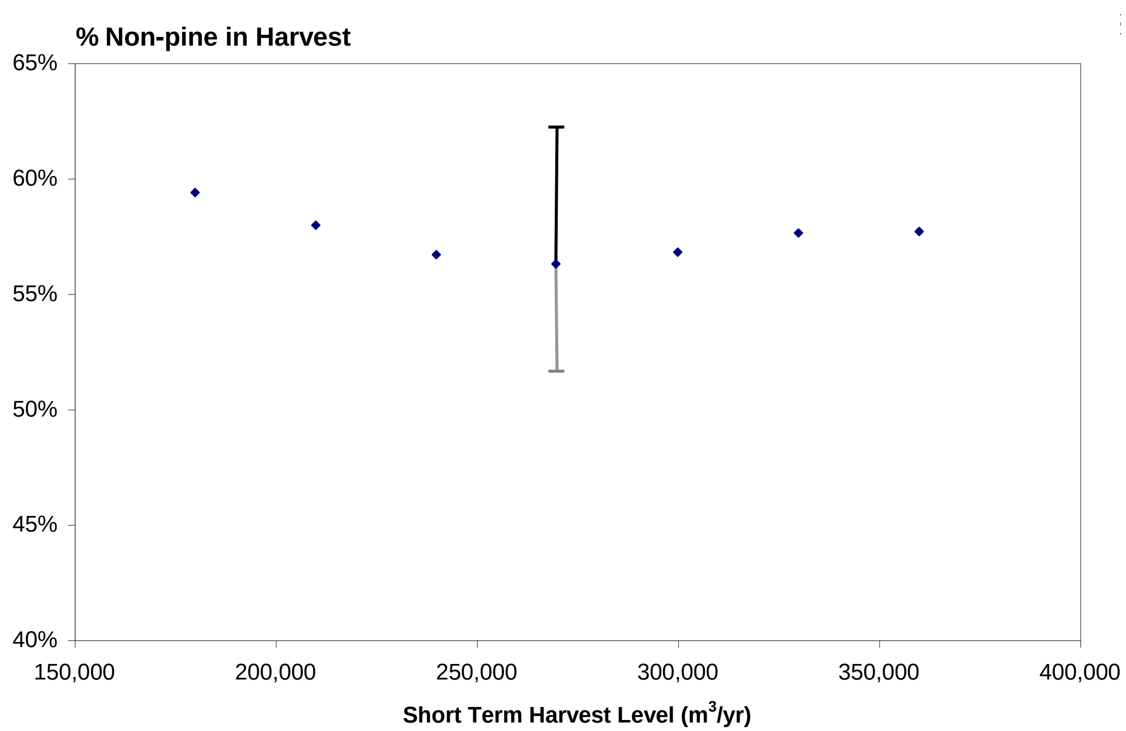

Figure 49: proportion of the total harvest in the first ten years that is non-pine species.

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6.4 Synthesis

The following key conclusions can be drawn from the results above to answer the central question o of the Beetle Management Scenario: "What are the likely effects of a beetle infestation on timber supply, and how can these impacts be mitigated through harvest strategies?"

- Beetle-associated volume losses do not appear to cause acute timber shortages in the short term. However, they require adjustments in the short and medium-term harvest levels to maintain long-term sustainable timber supply.
- Within the assumptions of the analysis, it appears that the anticipated timber supply impact of the mountain pine beetle infestation can be mitigated by a large increase in the short term harvest level. However, this increase requires a reduction in the medium-term harvest level. The reduction in the medium term relative to the short term increase is constant at short term harvest levels of 267,000 m^3/yr and above.
- Uncertainties about the behaviour and outcome of the infestation (optimistic vs. pessimistic assumptions) are by some measures more important than the variations in harvest levels in terms of timber supply impacts.

Although this analysis demonstrates that there are timber supply benefits of higher short tem harvest levels, this analysis does not point to a single harvest level that offers significant advantages over other harvest levels. Canfor prefers an initial harvest level of 267,000 m^3/yr to accomplish their management objectives, for the following reasons:

- A short term harvest level of 267,000 m^3/yr will allow Canfor to harvest most of the high and medium susceptibility stands within 15 years, which is the approximate window for responding to the mountain pine beetle infestation.
- Harvest levels higher than 267,000 m^3/yr are subjectively associated with higher risk to the medium term.
- 267,000 m^3/yr is a subtle pivot point in most of the measures considered, where the benefits of raising the short term harvest level begin to taper off;
- 267,000 m^3/yr is an intermediate response. It leaves room for future determinations to adjust the response depending on how the mountain pine beetle infestation progresses.

6.5 Sensitivity Analysis—Yield assumptions for IU Balsam

The sensitivity analyses described in Section 5.10 showed that the medium term timber supply is highly sensitive to yield assumptions for IU Balsam stands. IU Balsam stands are harvested during a timber supply shortage in the rest of the TFL and the higher productivity modeled by the custom VDYP curves plays an crucial role in reducing the effect of this timber supply shortage on the medium term harvest level. Given this role, it is important to investigate the interactions between IU Balsam assumptions and beetle attack assumptions. This sensitivity analyses tests the impact of using standard VDYP curves in addition to "conservative" beetle attack assumptions at a short term harvest level of 267,000 m3/yr.

The results of these sensitivity analyses are shown in Table 22 and Figure 50. The impact of the IU Balsam sensitivity on the Base Case (Section 5.10) was 1,375,000 m^3 (9.6%). The response when beetle assumptions are used is slightly greater: 1,485,000 m^3 (10.4%). This result indicates that the timber supply shortage that creates the disproportionate response to IU Balsam is exacerbated by the assumptions of beetle attack. However, the response is only 10% greater, indicating that the risk associated with yield assumptions for IU Balsam stands is not substantially greater in the beetle scenarios than it was in the Base Case.

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Table 22: summary of the sensitivity analysis: Standard VDYP Yields for IU Balsam Stands. "Conservative" beetle assumptions at a short-term harvest level of 267,000 m^3/yr

	Harvest Levels			Volume Harvested		
Planning Term	**Rate (m^3/yr)**	**Change (m^3/yr)**	**% Change**	**Total (000s m^3)**	**Change (000s m^3)**	**% Change**
Short-term (0-15 years)	267,000	0	0.0%	4,005	0	0.0%
Medium-term (16-70 years)	159,000	-27,000	-14.5%	8,745	-1,485	-14.5%
Long-term (>70 years)	222,000	0	0.0%		n/a	
Total short/medium term harvest		n/a		12,750	-1,485	-10.4%

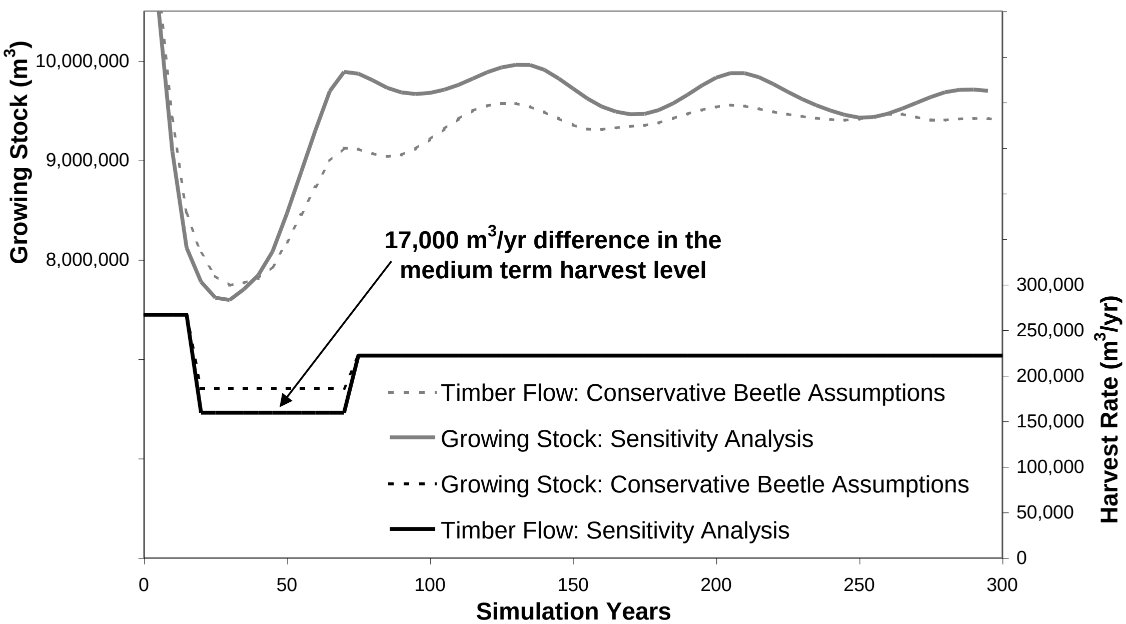

Figure 50: Sustainable harvest levels and growing stock: Standard VDYP Yields for IU Balsam Stands

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7 Canfor Preferred Scenario

The Base Case in timber supply analyses for Tree Farm Licenses typically represent the licensee's best guess about the relationship between timber supply and management objectives. In that sense, the Base Case is the final product of many timber supply analyses. In TFL18, the complexities and uncertainties associated with the mountain pine beetle infestation create the necessity for a more layered approach. The purpose of this section is to synthesize the information provided in the Base Case, the sensitivity analyses, and especially the Beetle Management Scenarios into a scenario that represents Canfor's perspective on how their management objectives can be met within the limitations and opportunities of timber supply on TFL18. This "proposed management option" incorporates the Twenty Year Plan into a full 500-year planning horizon, and is equivalent to the "conservative" beetle management scenario at a short term harvest level of 267,000 m^3/yr.

7.1 Description of the proposed management option

7.1.1 Timber Flows

The timber flow of the preferred scenario is compared the MP9 and MP10 Base Cases in Figure 51. The short-term harvest level is 2,500 m^3/yr lower than 267,000 m^3/yr, due to inflexibilities created by grouping harvest into operational blocks for the first 20 years of the planning horizon. The medium term harvest level is slightly higher as a result.

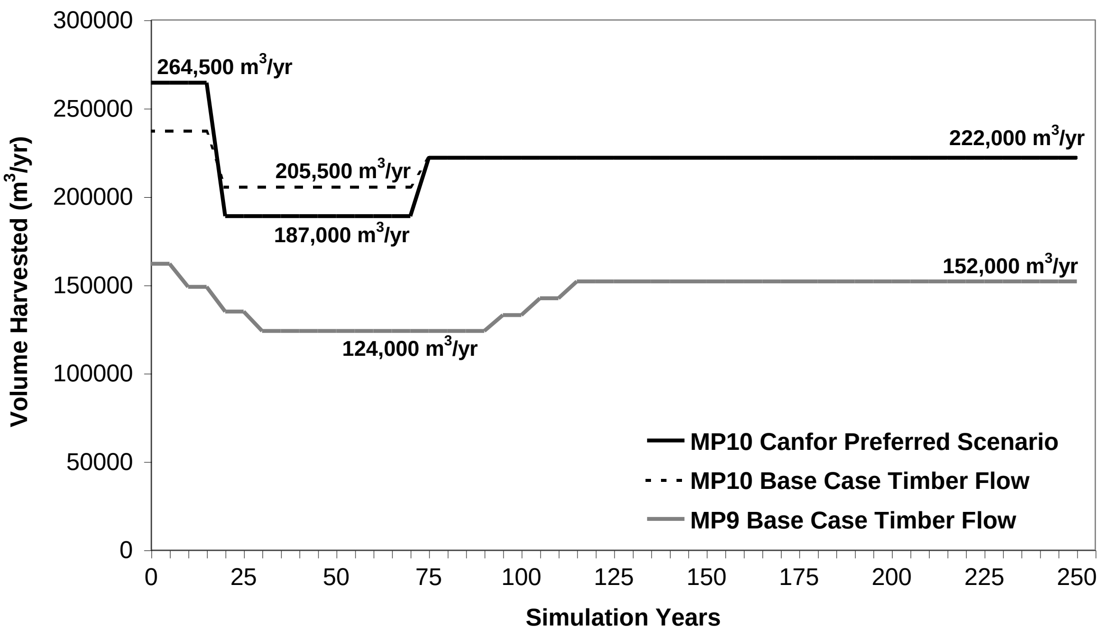

Figure 51: Timber Flows of the Preferred Scenario for TFL 18 Management Plan #10, compared with the MP10 and MP9 Base Case flows.

7.1.2 Age Structure

The general development of the age structure is similar to the Base Case, with achievement of long-term equilibrium condition at 75 years. However, the area of old stands is less than the Base Case

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during the first 160 years of the planning horizon. This result is created by the disturbance and regeneration of stands with >60% pine volume in the non-harvestable land base (primarily OGMAs).

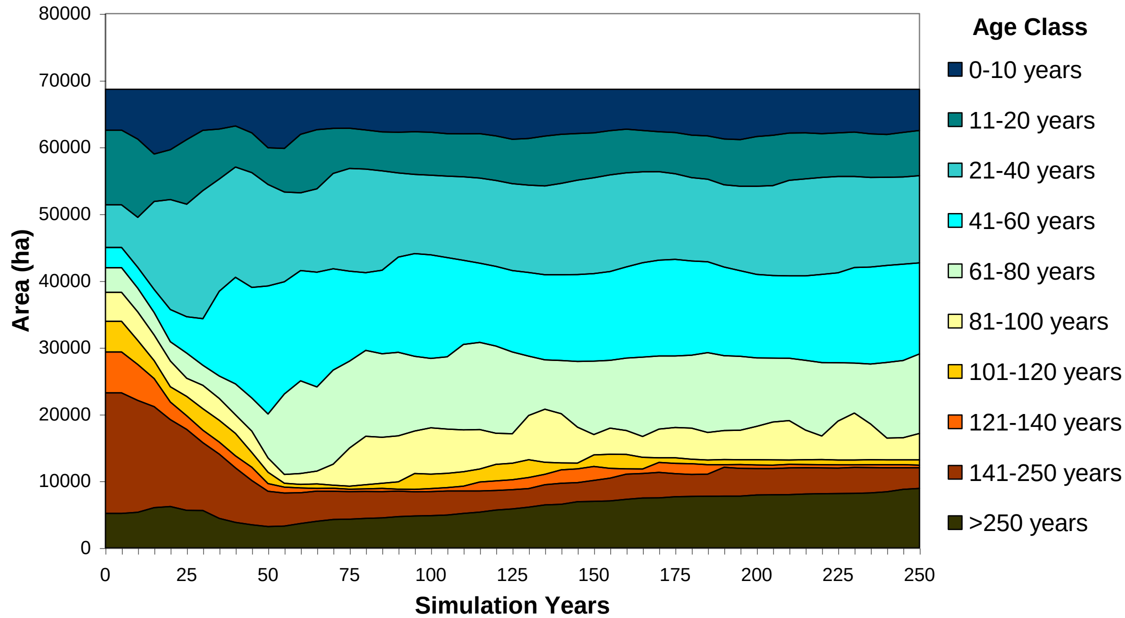

Figure 52: Canfor Preferred Scenario: Age Structure of the productive land base over the planning horizon.

7.1.3 Species composition of harvest

Species composition of harvest is similar to the Base Case, except that pine volume is less dominant during the short term, and never exceeds more than 50% in any period. This result is created by the inclusion in the short term of blocks designed to salvage stands affected by spruce bark beetle.

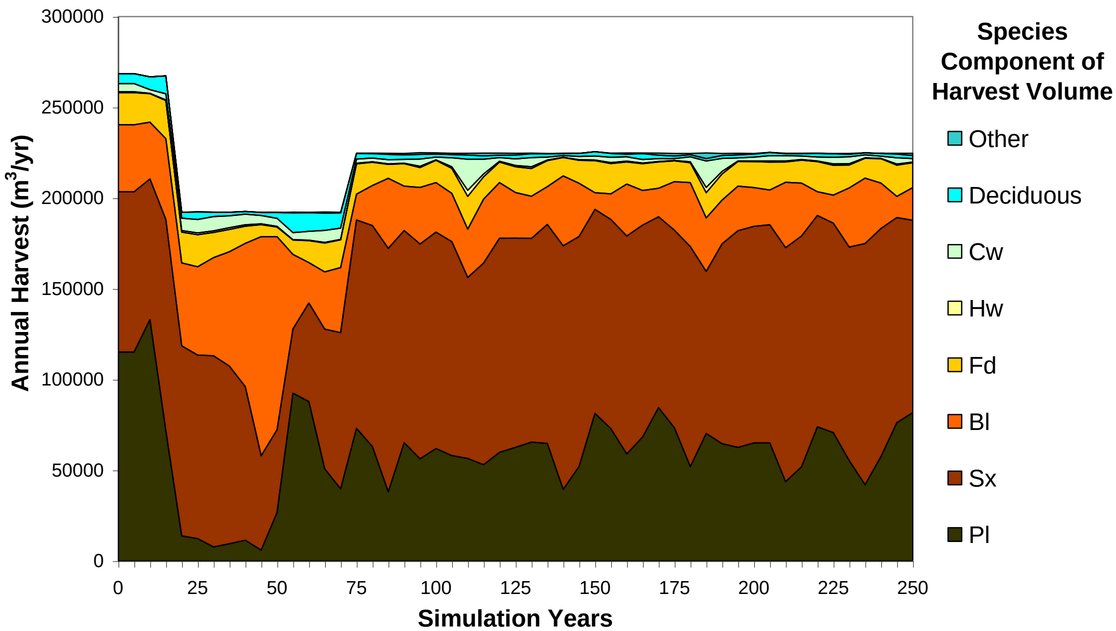

Figure 53: Canfor Preferred Scenario: Species component of harvest over the planning horizon.

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7.1.4 Yield populations

The total harvest of IU Balsam Stands during the short and medium terms is 1,928,000 m^3. This is essentially the same amount as was harvested in the Base Case (1,936,000 m^3), and makes up a similar proportion of the total harvest during this period (13.2% in the Preferred Scenario vs. 12.9% in the Base Case). Total harvest from natural stands is 600,000 m^3 (5%) less than the Base Case, largely due to losses associated with the beetle attack. Like the Base Case, the transition to harvest of future managed stands occurs at the beginning of the long term (75 years).

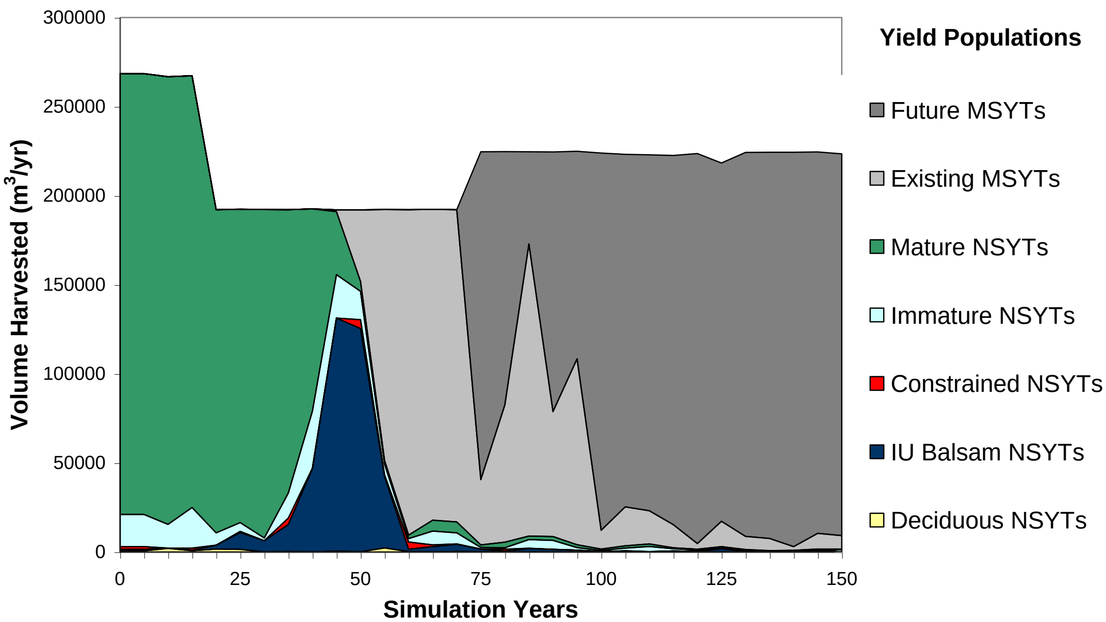

Figure 54: Canfor Preferred Scenario: Contribution of volume from selected yield populations

7.1.5 Harvest in constrained areas

The Base Case harvest in constrained areas was regular. In contrast, harvest in constrained areas—specifically VQOs and LMZs—in the preferred scenario is biased towards the short term, consistent with the "Aggressive Salvage" strategy of allowing constraints to be violated to salvage beetle-affected stands. There is an associated reduction in harvest from these zones during the medium term. The flow of volume from constrained areas is stable throughout the long term.

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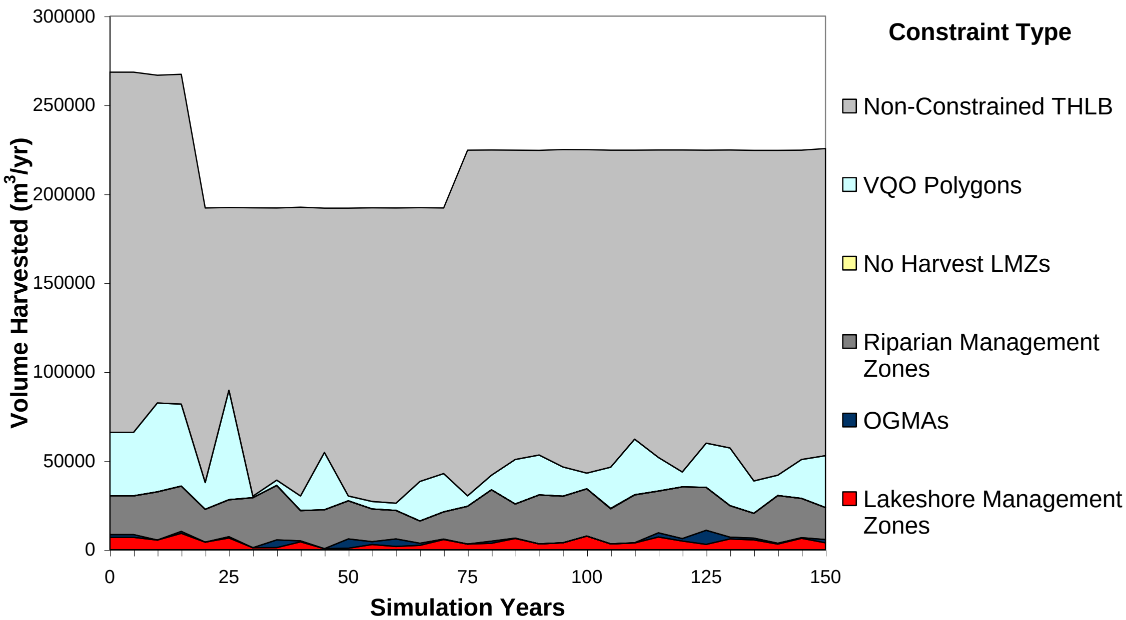

Figure 55: Canfor Preferred Scenario: Harvest from constrained areas during the first 150 years of the planning horizon.

7.1.6 Harvest Priority for Salvage

The salvage priority system used to schedule harvests in the short term of the Base Case was solely designed to reduce volume losses associated with the mountain pine beetle infestation. Current management on TFL18 is also designed to reduce the impacts of other disease agents, primarily spruce bark beetle. These other priorities were incorporated manually into the Twenty-Year Plan harvest sequence that forms the first twenty years of the Canfor Preferred Scenario. Consequently, the harvest of pine stands in the short term of the Canfor Preferred Scenario is relatively "inefficient", with non-susceptible stands averaging 21% of harvested volume in this period.

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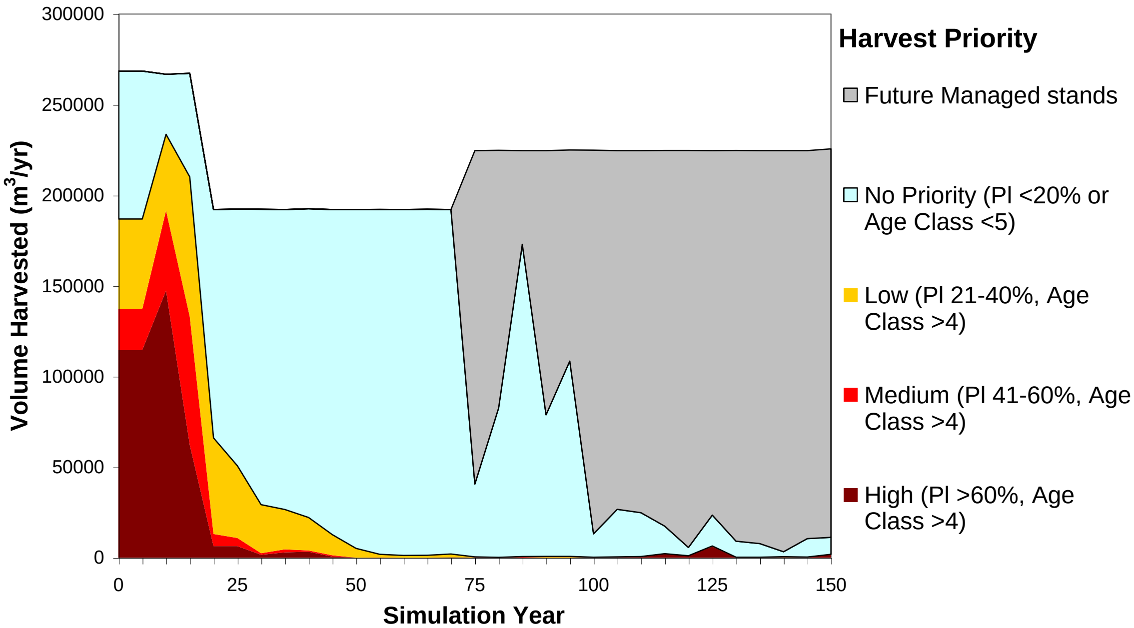

Figure 56: Canfor Preferred Scenario: Harvest Priority based on stand susceptibility to mountain pine beetle

7.1.7 Forest cover objectives

Figure 57 shows the average status of the forest with respect to forest cover objectives. The deficit of old seral forest in OGMAs is slightly greater than the Base Case in the short term due to inclusion of some fixed sanitation harvests in the Canfor Preferred Scenario. However, the major difference from the Base Case in status of OGMAs occurs in the medium term, where the average cover of old seral in OGMAs drops to 81% at 40 years. This sudden decline is not due to harvesting in OGMAs. It is a result of the assumption that unharvested stands susceptible to mountain pine beetle with >60% pine volume will break up naturally and regenerate to a new stand over a 35-year period following beetle attack. For similar reasons, the proportion of mature seral forest in riparian management zones is less than the Base Case during the medium term. Unlike OGMAs, however, the seral condition of riparian management zones is greater than the target on average.

Visual quality objectives are substantially violated in the medium term, due to the "Aggressive Salvage" strategy of violating VQO and LMZ constraints to harvest stands susceptible to mountain pine beetle attack. However, VQO constraints are reinstated at 15 years into the planning horizon, and VQOs are achieved on average by year 30. The violation of LMZ constraints is considerably less than VQOs, and target condition is achieved on average by 30 years into the planning horizon.

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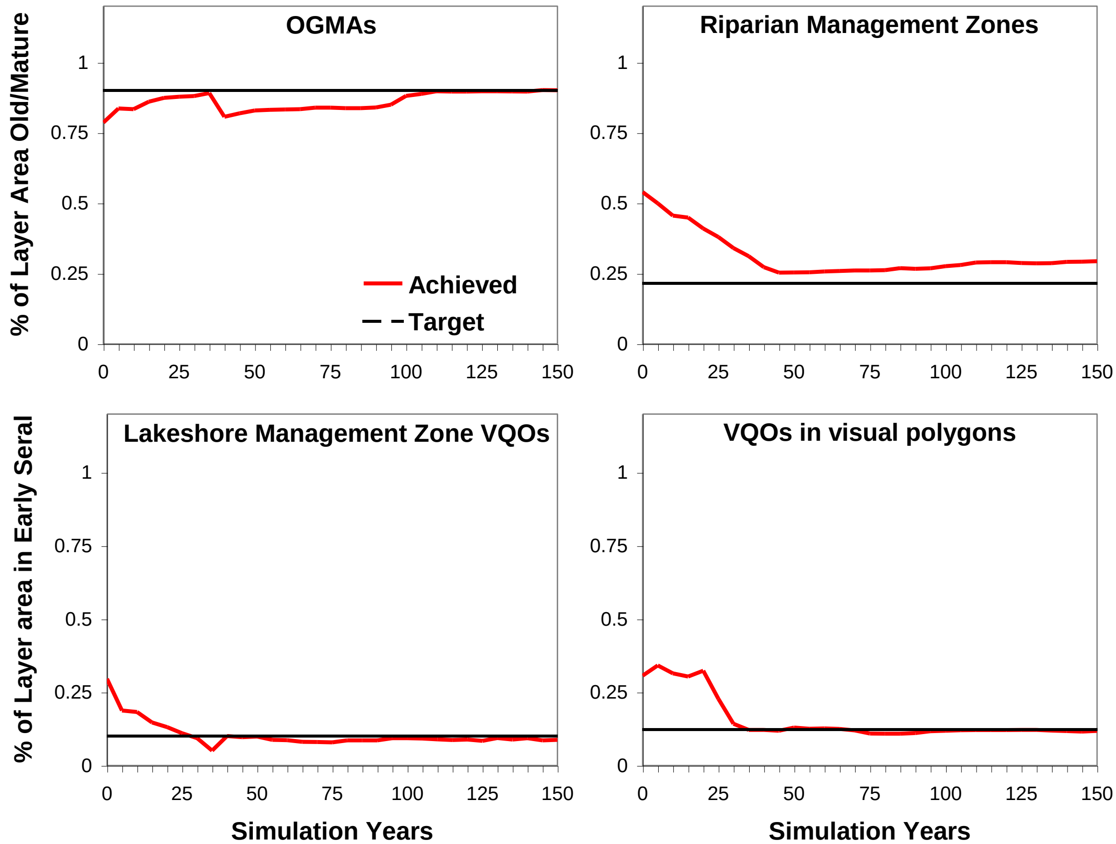

Figure 57: Canfor Preferred Scenario: Average status of forest cover constraints in the first 150 years of the planning horizon.

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