Tree Farm Licence 37

Timber Supply Analysis Report for Sustainable Forest Management Plan 9

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EXECUTIVE SUMMARY

This report describes the timber supply analysis for Tree Farm Licence 37 (TFL 37), held by Canadian Forest Products, and is a supporting document for Sustainable Forest Management (SFM) Plan 9. Timber supply analysis examines the availability of wood volume for harvesting over time. The analysis involves the testing and reporting of a variety of assumptions and management strategies using the approved resource inventory of the 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 (AAC) determination.

The following analyses are described in this report:

- **Base Case harvest forecast**—an attempt to model current management and tree growth in TFL 37.
- **Sensitivity analyses**—used to assess the risk associated with Base Case assumptions.
- **Comparison with the previous timber supply analysis**—a description and explanation of the differences between the Base Cases for Management Plan 8 (MP8) and SFM Plan 9.

BASE CASE HARVEST FORECAST

The SFM Plan 9 Base Case harvest forecast (Figure 1) indicates that there is insufficient merchantable volume on TFL 37 to maintain the current AAC beyond the year 2005. A 10% drop in harvest levels is required in 2006 to sustain the long-term harvest level of 780,000 m^3/yr without reductions in the medium term. Beyond the second period, the harvest level declines by 5% every five years until the long-term harvest level is reached in the year 2032.

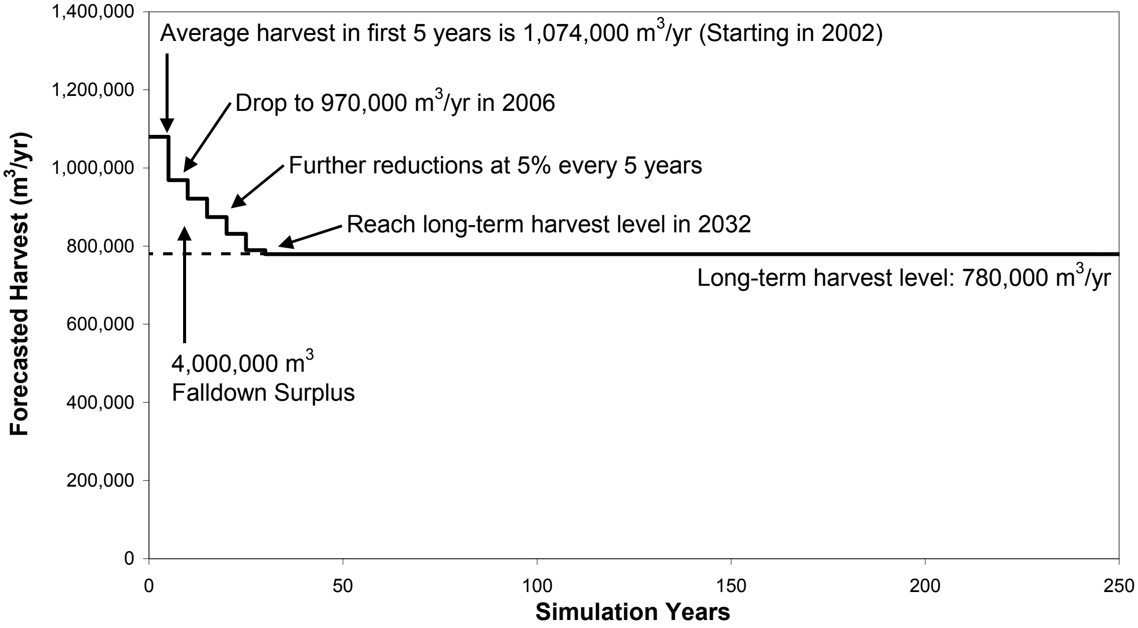

Figure 1: Harvest forecast of the TFL 37 SFM Plan 9 Base Case

SUMMARY OF SENSITIVITY ANALYSES

The sensitivity analyses indicate that the Base Case short-term is robust. Adjustment of the medium-term harvest level can compensate for major reductions in the THLB or yields. Timber supply crashes associated with changes to assumptions almost exclusively occur in the long-term. The following key conclusions were drawn from the sensitivity analyses:

- **Marbled murrelet reserves, old growth management areas, and northern goshawk territories** collectively reduce the harvest in the short and medium-terms by 4 million m^3 (6.6%). The short-term impact of these reserves is considerably greater than their impact in the long-term (4.4%) because they contain higher-than average amounts of standing volume.
- The Base Case is dependent on areas identified for **helicopter logging**. In the absence of "hembal-heli" sites, not economically viable in the foreseeable future, the short-term harvest level must be reduced by 6.8% to 904,000 m^3/yr in 2006.
- **Partitioning harvest from all helicopter-operable areas** further reduces the overall short-term harvest level by 1.7% to 888,000 m^3/yr in 2006.
- Modeling **40-80 year old stands** with TIPSY instead of VDYP produces a 2.2 million m^3 (3.5%) increase in the harvestable volume in the short and medium-terms. This surplus volume could support an 8.7% increase in the short-term harvest level or a 5.5% increase in the medium-term.
- Yield effects of **partial harvesting**, as modeled in the Base Case, reduce the long-term harvest level by 3.8%, with minor impacts in the medium-term and no impact in the short-term. The yield effects of partial harvesting appear to be less important to timber supply than direct loss of harvestable volume due to internal retention.
- Productivity assumptions for **existing managed stands in the CWHvm2** appear to be conservative. Using inventory site index instead of the elevation model allows a 10.7% increase in the short-term harvest level.
- **Regeneration delay** is important to timber supply in TFL 37. A one-year increase in regeneration delay causes a 1.3% harvest reduction in the medium-term and a 2.3% reduction in the long-term.
- **Visual quality objectives** are a minor (0.2%) constraint to harvesting in the Base Case.
- **Mature-plus-old objectives** in special management zones are not constraining to timber supply.

COMPARISON WITH THE PREVIOUS TIMBER SUPPLY ANALYSIS (MP8)

Compared to the timber supply analysis for Management Plan 8, harvest levels forecasted in this analysis are reduced by 7.5% in the short term, 25% in the medium term, and 33% in the long term (Figure 2). This reduction in forecasted harvest is due to more conservative analysis assumptions as well as changes in forest management on TFL 37, as discussed below.

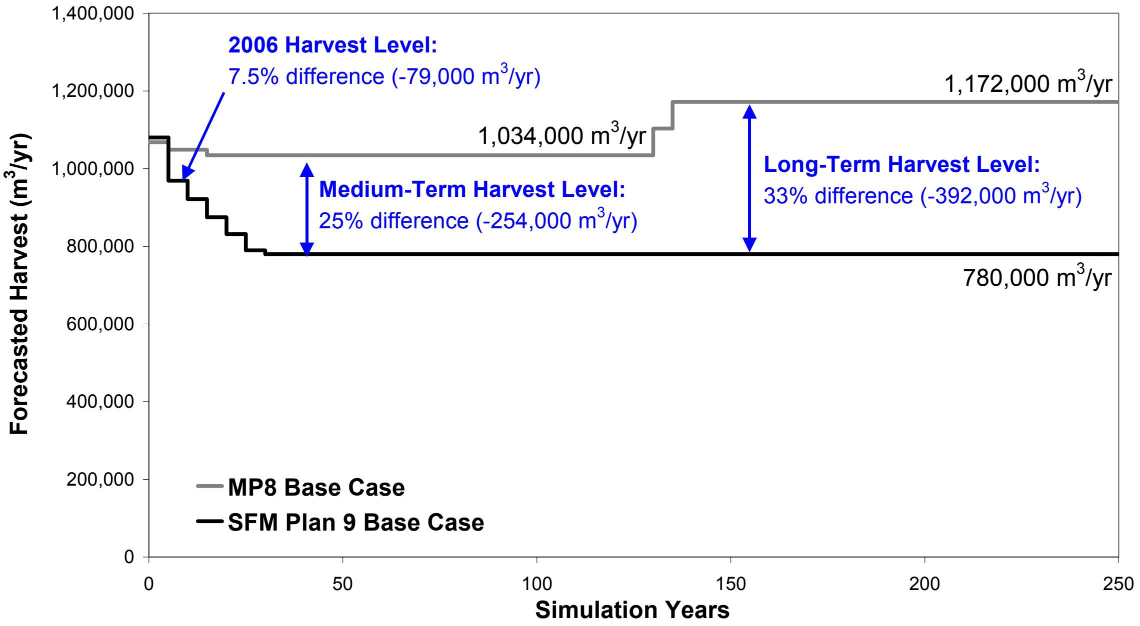

Figure 2: Comparison of the Base Case harvest forecasts for MP8 and SFM Plan 9.

Changes to forest management

Several changes to forest management have been implemented on TFL 37 during the course of Management Plan 8. The key management changes that affect timber supply are:

- A network of reserves designed to protect northern goshawk territories, marbled murrelet nesting habitat, and a representative distribution of old growth forest. These reserves cover approximately 5,000 ha of land that would otherwise be in the timber harvesting land base.
- Harvesting avoidance of areas underlain by sensitive karst geology, totalling 1,000 ha that would otherwise be timber harvesting land base.
- Partial harvesting regimes consistent with ecosystem management objectives, which reduce the area available for harvesting by 5,600 ha (5.8%) and the growth of regenerating stands by 3.5%.

The short-term harvest level is dependent on harvesting of old growth forest. The new removals from the timber harvesting land base are almost exclusively from old growth forest. As a result, the effect of these changes is greater in the short term than it is in the long term.

Changes to timber supply analysis assumptions

This timber supply analysis also incorporates new spatial and inventory data and new assumptions about tree growth. These changes have a profound influence on timber supply, especially in the long term. The key changes to assumptions that affect timber supply are:

- A localized site index conversion was used for western redcedar (Cw) and yellow cypress (Yc) in mixed species stands. The standard methodology applied in MP8 assigned the leading species site index to secondary components of Cw/Yc. This new method reduced the assumed productivity of future managed stands by 12%.
- SIBEC calibration was removed from the calculation of site indices in the CWHvm2 variant. A modified elevation model was also applied in this variant. These changes further reduced the overall assumed productivity of managed stands by approximately 5%.

- Updated mapping and classification of roads and streams that resulted in an additional 2,500-3,000 ha net removal from the timber harvesting land base.

RECOMMENDATIONS FOR FURTHER STUDY

The following areas of uncertainty have direct implications for short-term timber supply:

- Growth and yield of 40-80 year old stands;
- Location and economic operability of areas accessible by helicopter; and
- Site index of managed stands in the higher elevation areas of the TFL (CWHvm2 and MHmm1).

Measures should be taken during the course of SFM Plan 9 to reduce these uncertainties in preparation for the next timber supply analysis.

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1 INTRODUCTION

Canadian Forest Products Ltd. (Canfor) is currently preparing a sustainable forest management (SFM) plan 9 under section 2.08 of its Tree Farm Licence 37 (TFL 37) agreement and SFM certification for the Nimpkish defined forest area (DFA). Under section 2.22 of the agreement, Canfor is responsible for preparing a timber supply analysis showing the long-term harvest forecast for the land base. To make timber supply analysis compatible with the SFM Plan the Nimpkish DFA is the land base for this analysis report. The Nimpkish DFA is comprised of TFL 37 and all parks within the Upper and Lower Nimpkish landscape units, but excludes other forest tenures within these landscape units. Forest Ecosystem Solutions Ltd. (FESL) conducted this timber supply analysis on Canfor's behalf.

1.1 TIMBER SUPPLY ANALYSIS

This report describes the timber supply analysis process for TFL 37. 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. The timber supply analysis provides the Chief Forester of British Columbia with information about the relationship between of current management and 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 (AAC) 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 the long-term stability of growing stock and therefore the perpetual availability of timber for harvest. No attempt is made in this analysis 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 TIMBER SUPPLY FORECASTS

The complexity of timber supply means that a single forecast is not sufficient to portray the timber supply dynamics of TFL 37. There are many uncertainties about how well the assumptions of the analysis reflect the realities of timber supply on TFL 37. Also, there are many options for setting harvest levels in response to the timber supply dynamics of the TFL. Several forecasts are developed in this analysis to account for these uncertainties and opportunities. The purpose of presenting forecasts is to build a layered understanding of the timber supply dynamics of TFL 37. The following forecasts are presented in this report:

Base Case: The Base Case is the standard against which other forecasts are compared. In most timber supply analyses, the Base Case reflects the best available knowledge about current management activities and forest development in TFL 37.

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

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 Base Case harvest levels and assumptions presented in the Analysis Report. The Twenty-Year Plan report and maps are submitted as a separate document.

2 DESCRIPTION OF THE LAND BASE

TFL 37 is located in the Nimpkish valley on North-Central Vancouver Island. The TFL is bounded by the Strathcona Timber Supply Area to the west, TFL19 to the south, TFL 39 to the east, and TFL 47 to the north. Communities within or near the TFL include Woss, Port McNeill, and Sayward. TFL 37 was awarded to Canadian Forest Products Ltd. (Canfor) in 1960, and is located within the Ministry of Forest's North Island Central Coast Forest District. The TFL is a contiguous unit covering an area of 196,725 ha, of which 91,325 ha is currently available for harvesting. The current standing timber volume for TFL 37, based on the inventory projected to January 1, 2002, is 36.5 million m^3.

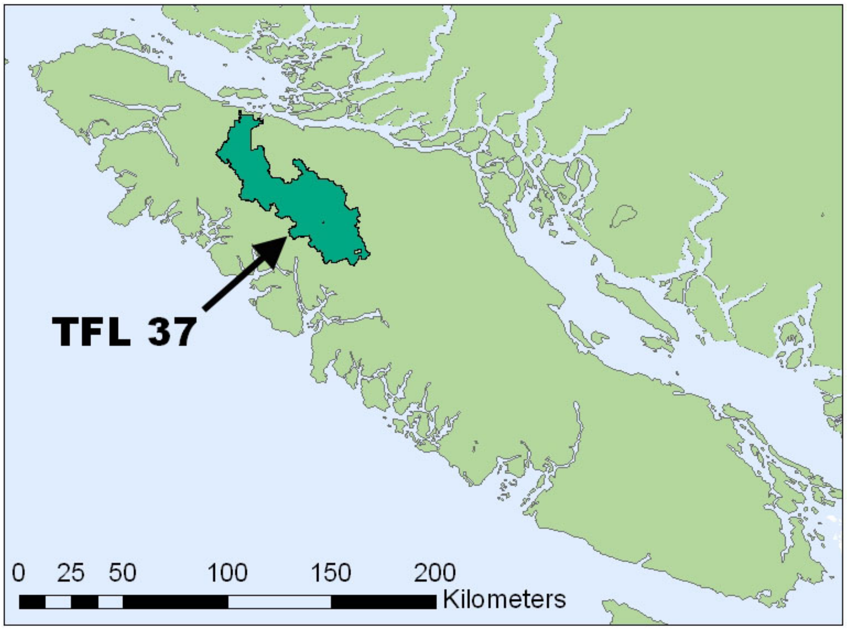

Figure 3: Location of TFL 37

Climate

Climates of TFL 37 are maritime variants of the Coastal Western Hemlock (CWH), Mountain Hemlock (MH), and Alpine Tundra (AT) biogeoclimatic zones (Figure 4).

Figure 4 refers to the non-productive, non-harvestable, and timber harvesting land bases. The non-productive land base (NPLB) is composed of areas that cannot support harvestable forests (e.g. highways, wetlands, water bodies). The non-harvestable land base (NHLB) is composed of productive forest that is constrained from harvest due to inoperability or management objectives (e.g. riparian reserves, OGMAs, and uneconomic forest). The ATc and MHmmp variants are assumed to be entirely non-productive for timber harvesting and regeneration, and are also considered ineligible to contribute to forest cover constraints on the productive land base. The non-harvestable portion of the productive land base is evenly distributed partly through the representative design of the old growth management area system for TFL 37.

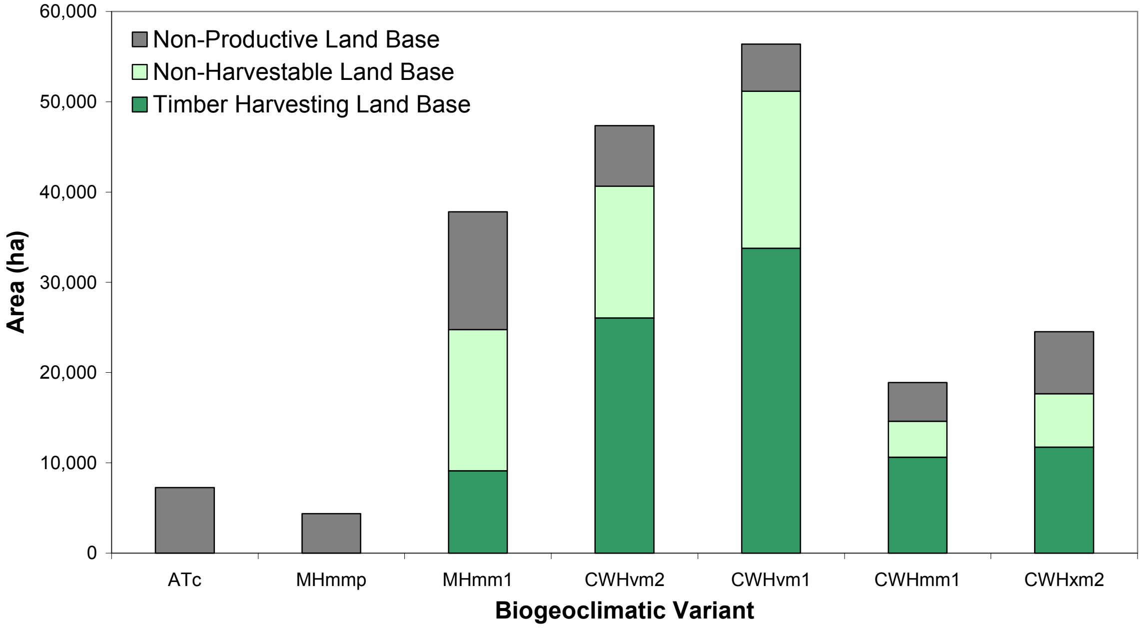

Figure 4: Biogeoclimatic variants of TFL 37

Age Structure

The age structure of forests in TFL 37 is bimodal, with 37% of the productive land base in young forest less than 41 years old and 46% in old forests greater than 250 years old. Eleven percent of the productive forest area is between 41 and 80 years old, while only 4% is between 80 and 250 years old.

More than half of the old forest in TFL 37 is non-harvestable. Furthermore, 62% of the non-harvestable portion of the productive land base is old growth forest.

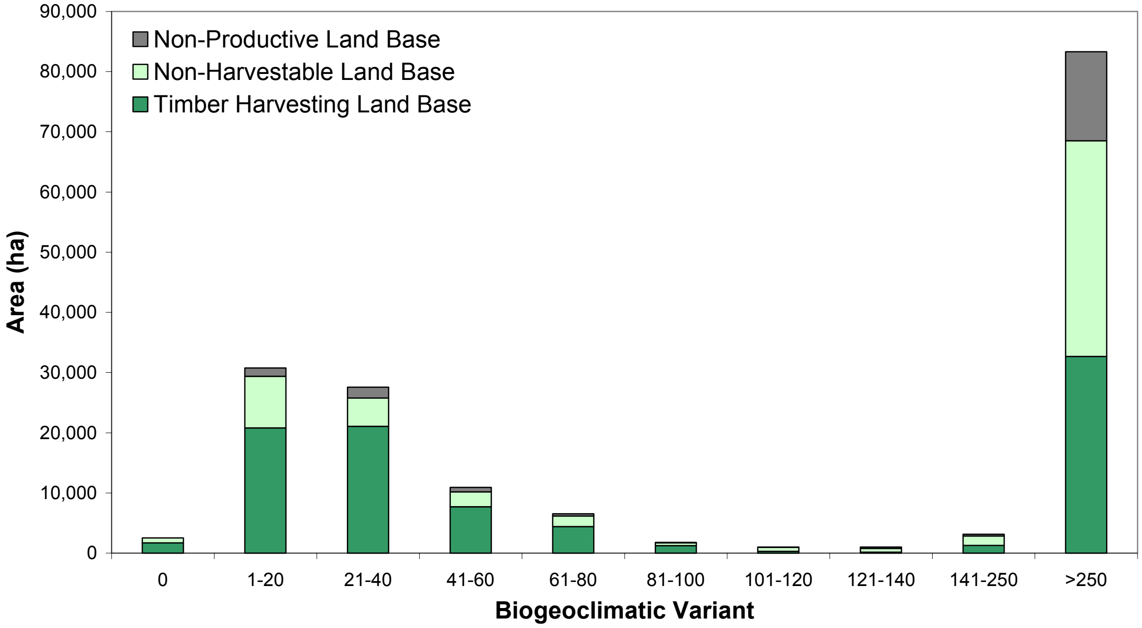

Figure 5: Age structure of TFL 37

Tree Species

The species profile of the THLB is dominated by "hembal"—western hemlock (*Tsuga heterophylla*), mountain hemlock (*T. mertensiana*), and pacific silver fir (*Abies amabilis*)—which occupies 53% of the net area and 66% of the net volume of the TFL. Other major species include Douglas-fir (*Pseudotsuga menziesii*, 23% of the THLB area), western redcedar (*Thuja plicata*, 8% of the THLB), and yellow cypress (*Chamaecyparis nootkatensis*, 7% of the THLB). Minor species are lodgepole pine (*Pinus contorta*), Sitka spruce (*Picea sitchensis*) and deciduous species (3%). Species labels are not available 6% of the THLB that was logged since the forest cover inventory was completed in 1996.

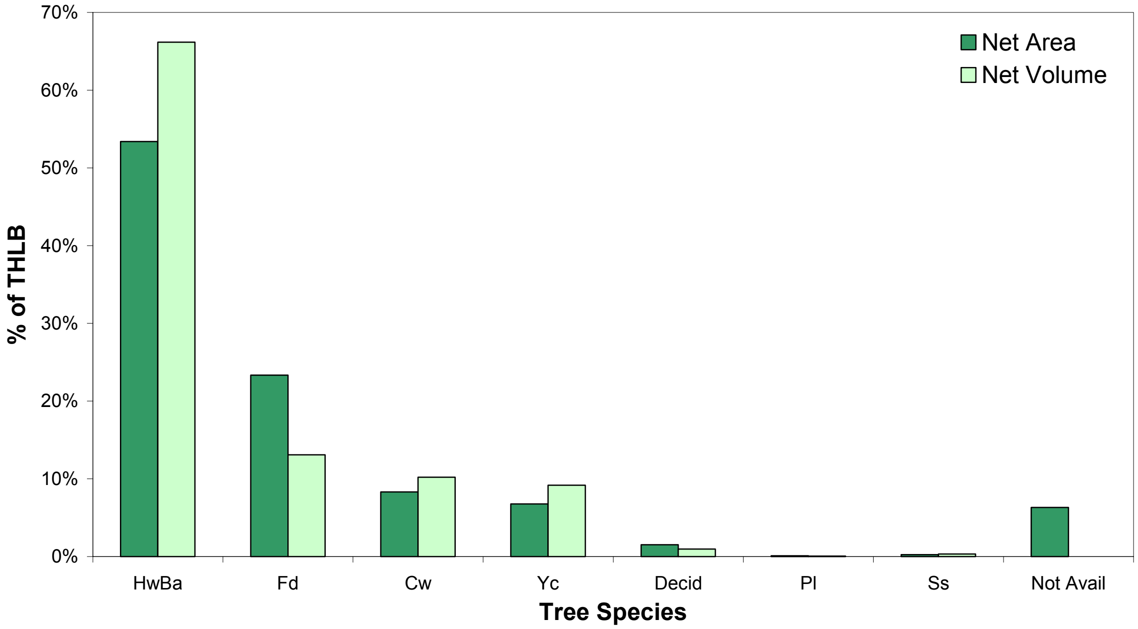

Figure 6: Species composition of the timber harvesting land base

Stand productivity

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 TFL 37 limits the utility of site index as a comparative measure of site productivity. Figure 7 shows the distribution of predicted productivity of future managed stands. Since the growth of these stands is modeled using potential site index, "potential" culmination MAI is used to indicate productivity.

Distributions of potential stand productivity in the harvestable and non-harvestable land bases are not substantially different. Both land bases show a bimodal distribution, with large areas in very low and very high productivity sites, and an even distribution of area in intermediate productivity classes. The non-harvestable land base is slightly skewed towards lower productivity sites, relative to the timber harvesting land base.

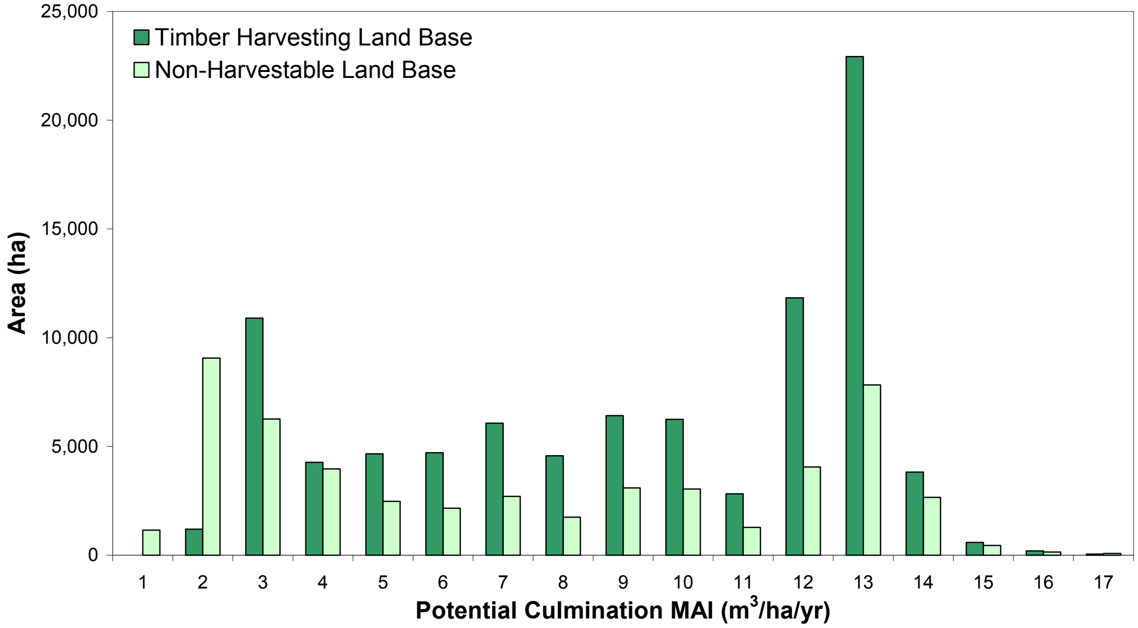

Figure 7: Stand productivity of the productive land base.

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 37 SFM Plan 9 Information Package.

3.1 TIMBER SUPPLY MODEL

All analysis presented in this report was conducted using Forest Simulation and Optimization System (FSOS) a proprietary forest estate model developed by Forest Ecosystem Solutions Ltd. Although FSOS has both simulation and heuristic (psuedo-optimization) capabilities, the time-step simulation mode was primarily used in this analysis. Time-step simulation grows the forest based on growth and yield inputs and harvests units of land area based on user-specified harvest rules and constraints that cannot be exceeded. Using "hard" constraints and harvest rules instead of targets (as would be applied in the heuristic mode of FSOS) gives results that are repeatable and more easily interpreted.

3.2 FOREST COVER INVENTORY

The Nimpkish DFA forest cover inventory is based on 1:15,000 colour aerial photography flown in 1995, and the effective scale is 1:5,000. Age, height, and volume are updated for disturbance and projected to January 1, 2002.

Vegetation Resources Inventory (VRI) Phase II sampling and adjustment was completed by J.S Thrower and Associates in July 2003 and updated for new data in June 2004. This process calculates statistical adjustments for age, site index, and volume based on comparisons of species composition, basal area, height, volume, and age between plot data and the photo-interpreted estimates. J.S Thrower and Associates also calculated net volume adjustment factors (NVAF) in June 2004.

Addendum: error in forest cover depletions.

After completing the base case harvest forecast and sensitivity analyses, an error in the inventory was discovered. Eight cutblocks were fully depleted in the inventory even though all or some of their area was actually logged after January 1, 2002 (Table 1). Consequently, volume harvested from these blocks in 2002 did not contribute to the first period harvest in the forecasts presented in this analysis (base case and sensitivity analyses). The volume harvested from these blocks in 2002 totals 148,725 m^3, or 5,000 m^3/yr spread over 30 years. As a result of this error, harvest forecasts shown in this analysis report should be 5,000 m^3/yr (0.5%) higher for the first 30 years of the planning horizon.

Table 1: Cutblocks that were depleted in the inventory even though they were logged after 2001.

Block	2002			
	From	To	Harvest area (ha)	Harvest volume (m^3)
CT059	Mar	Jul	37.2	28,000
CU039	Jun	Sep	13.8	11,600
CU041	Jun	Sep	32.5	25,800
KA014	Mar	Jun	12.6	9,700
NI022	Mar	Jun	36.7	28,300
NI024	Mar	Jun	19.5	14,800
NI046	Mar	Jun	14.4	10,400
WE001		Feb	30.8	19,675
Total			**197.5**	**148,275**

3.3 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 2 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.

The area of TFL 37 is 196,725 ha, of which 148,720 ha is productive forest. The current THLB is 91,325 ha. Proposed and future road reductions are not deducted from the current THLB 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 THLB is 90,221 ha. The current and future THLB are 15ha smaller than stated in the information package due to a small change to the Old Growth Management Areas.

Table 2: Timber harvesting land base determination.

Land Classification	**Total Area (ha)** [1]	**Net Reduction**	
		Area (ha)	**Volume ('000s m^3)**
Nimpkish DFA		**196,725**	**67,529**
Highway 19	198	198	0
Non-forest and Non-productive forest	31,713	31,523	560
TEM NP	36,363	13,314	4,000
Roads and railway	3,180	2,970	740
Total NP reductions		48,005	5,300
Total Productive Forest		**148,720**	**62,229**
Protected Areas	18,479	11,943	4,152
Physically inoperable	45,685	15,144	6,184
Avalanche track	4,235	89	44
Riparian reductions	9,329	7,092	3,245
Class IV Terrain	17,121	2,818	1,439
Karst areas	1,300	1,122	415
Campsites/recreation areas	38	20	10
Ungulate Winter Range	6,195	4,885	3,557
Goshawk WHAs (Draft)	2,778	1,611	1,089
Marbled Murrelet WHA (OIC)	322	65	65
Marbled Murrelet WHA (Draft)	9,454	2,444	1,663
OGMAs (Draft)	16,339	1,595	996
Uneconomic forest	20,455	2,933	786
Wildlife tree retention (Area VRAF)	8,569	5,634	2,073
Total Reductions to Productive Forest		57,395	25,718
Current THLB		**91,325**	**36,511**
Proposed roads	218	167	**n/a**[2]
Future roads	2,805	937	**n/a**[2]
Long-term THLB		**90,221**	**n/a**[2]

[1] Total area of TFL 37 covered by a given land classification.

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

3.4 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, average tree diameter (quadratic mean DBH), and species composition. Many 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 species composition, site productivity, regeneration method, and operational adjustment factors. There are four major populations of stands that were given distinct growth and yield assumptions:

1. **Old Natural Stands** (current age >80 years old)—modelled with the Variable Density Yield Prediction (VDYP) model based on adjusted inventory attributes;
2. **Transitional Natural Stands** (current age 41-80 years old or deciduous)—Modeled using the same method as Old stands, but kept separate due to distinct implications for timber supply;
3. **Existing Managed Stands** (current age 6-40 years old)—Modeled with Table Interpolation Program for Stand Yields (TIPSY) using inventory data for species composition and potential site index for productivity. OAF1=10% and OAF2=5%;
4. **Future Managed Stands** (current age 0-5 years old)—Modeled with TIPSY using inventory ecosystem-based regeneration assumptions and potential site index for productivity. Genetic gain is applied to selected species. OAF1=10% and OAF2=5%. Future yields are reduced by a variable retention adjustment factor (VRAF) to account for reduced growth associated with partial retention in cutblocks established after 1996. All sites regenerate to future managed stands following harvest.

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, cutblock adjacency, and visual quality by specifying target stand height and age distributions. Table 3 is a summary of modelling assumptions for forest cover targets in TFL 37.

Table 3: Forest cover objectives – Base Case forecast

			Applied to:	
Resource	**Criteria**	**Cover requirement**	**Zone**	**Cover type**
Landscape green-up	Green-up height	No more than 33% of stands can be less than 3 meters in height in Special and General Management Zones, and 1.3 m in the Enhanced Forestry Zone	SMZ, GMZ, and EFZ	THLB outside visual polygons
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 land base
Landscape Level Biodiversity	Mature + old seral cover	A specified percentage of each variant must be greater than the designated mature seral age.	BEC variants in SMZs	Productive forest land base

3.6 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 37 are insect infestations, windthrow, and fire.

Although unsalvaged losses are stochastic and difficult to predict, an average volume loss of 9,874 m^3/year is assumed for TFL 37. Harvest levels in this report are net of unsalvaged losses, meaning that actual simulated harvest is 9,874 m^3/yr greater than what is reported in this report.

3.7 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.

3.8 MINIMUM HARVEST AGES

Minimum harvest age is the age at which stands become eligible for harvest within the timber supply model. Minimum harvest ages can have a profound effect on harvest levels by creating acute timber supply shortages ("pinch points"). Minimum harvest ages in this analysis are calculated based on the age at which each stand reaches general minimum merchantability criteria for TFL 37. In areas accessible through ground harvesting systems, these criteria are a minimum volume of 250 m^3/ha and minimum mean tree diameter (mean DBH) of 25 cm. In areas harvested with cable or helicopter systems the minimum merchantability criteria are 350 m^3/ha and 30cm mean DBH.

4 BASE CASE HARVEST FORECAST

The Base Case is the basis for comparison between timber supply forecasts. "Base Case assumptions" are described in the information package, including the THLB, growth & yield, forest cover requirements, and harvesting rules. Together, the Base Case assumptions create a picture of how TFL 37 will respond to the current management regime over time. The purpose of the Base Case is to understand the implications of current management for future timber supply, rather than to actually predict what will happen in the future. This section describes the Base Case, first by showing how sustainable harvest levels are determined, and then by describing the development of selected attributes of the TFL associated with one of these sustainable harvest levels.

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 harvest 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 directly related to how the modeller defines minimum harvest ages, and so may not reflect "true" constraints on timber supply.

Pinch points are only useful as indicators of sustainability if minimum harvest ages are close to culmination age. When minimum harvest ages are set close to culmination age, pinch points indicate that the model is harvesting below culmination age, Pinch points are less effective indicators of sustainability when minimum harvest ages are set using other criteria. 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. Consequently, pinch points are not an effective indicator of sustainability in this case. Long-term growing stock is the sole indicator of sustainability in this timber supply analysis. Short- and medium-term harvest levels are considered sustainable if they do not compromise growing stock in the long-term.

4.1.2 Determining the maximum even flow harvest level

Figure 8 shows the effect of different even flow harvest levels on growing stock. Growing stock becomes stable when the rate of harvest equals the rate of growth. At low harvest levels, stands get harvested after their culmination age and growing stock accumulates until a stable equilibrium is reached. 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 can sustain a stable growing stock. In the absence of constraints, this harvest rate would equal the average culmination MAI of the land base. However, the presence of forest cover constraints such as VQOs can limit the ability of the model to harvest stands at culmination age. As a result, long-term harvest levels are typically somewhat lower than the maximum possible growth rate of the forest.

All even flows shown in Figure 8 initially result in a large decline in total growing stock, associated with harvest of slow-growing, high-volume old growth stands. After 30 years, even flow harvest levels of 776,000 m^3/yr and lower allow accumulation of growing stock, indicating that the harvest rate is less than the growth rate of the forest. Even flow harvest of 792,000 m^3/yr results in accelerating decline of growing stock. This harvest level eventually crashes at 375 years because there is no longer sufficient merchantable growing stock to support the even flow. A harvest level of 780,000 m^3/yr produces a stable and slightly declining growing stock. This slight decline is desirable attribute of the long-term harvest level for the Base Case because it indicates that the harvest level is at a maximum and that there will be little room to absorb unsustainable harvest levels in the short-term. The slight decline also ensures that the Base Case will be responsive to sensitivity analyses.

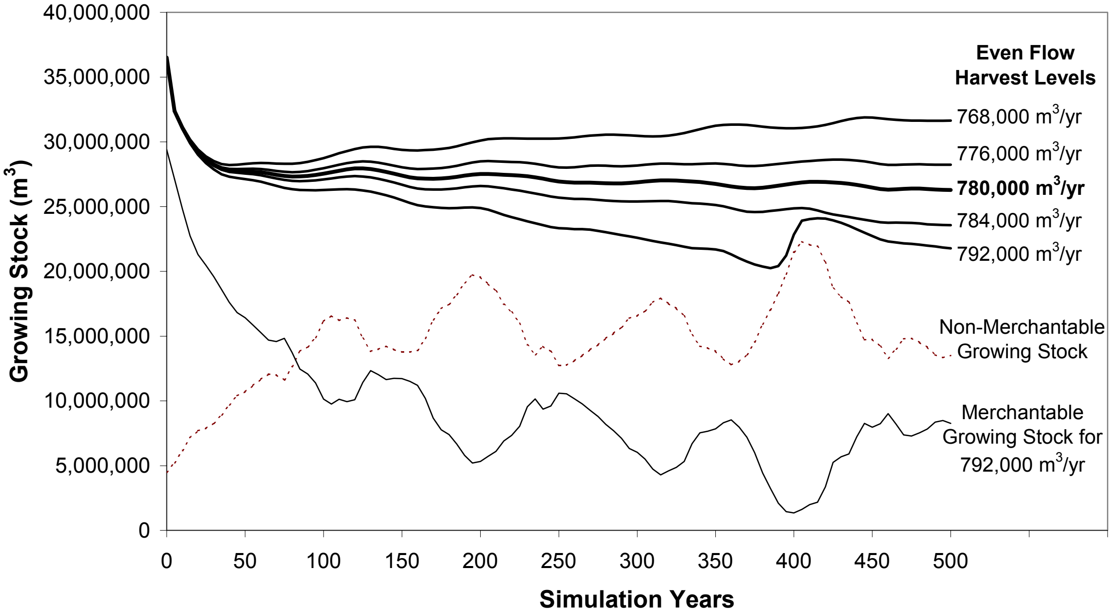

Figure 8: Effect of even-flow harvest levels on growing stock.

4.1.3 Precision of harvest forecasts

Figure 8 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 4,000 m^3/yr (0.5%) 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 harvest forecasts presented in this analysis report were tested on a 500-year planning horizon. The minimum resolution of harvest forecasts is 4,000 m^3/yr (0.5%) in the long-term and 10,000 m^3/yr (1.25%) in the short and medium-terms.

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. 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.

Based on Figure 8, the Base Case long-term harvest level was established as 780,000 m^3/yr, which is considerably lower than the current AAC. This situation necessitates a decline in harvest levels during the short-term. The process of determining a sustainable short-term harvest level and the appropriate decline is demonstrated in Figure 9 and Figure 10. The rate of decline was held constant at 5% every 5 years. Since the first 5-year period occurs mostly within the duration of the current Management Plan (MP8: 2001-2005), determining the sustainable short-term harvest level involves finding the appropriate harvest in the second period (2007-2012). The maximum second-period harvest level will result in stable growing stock in the long-term. Figure 9 shows harvest flows associated with different second-period harvest levels. Figure 10 shows the response of the total growing stock to these harvest flows.

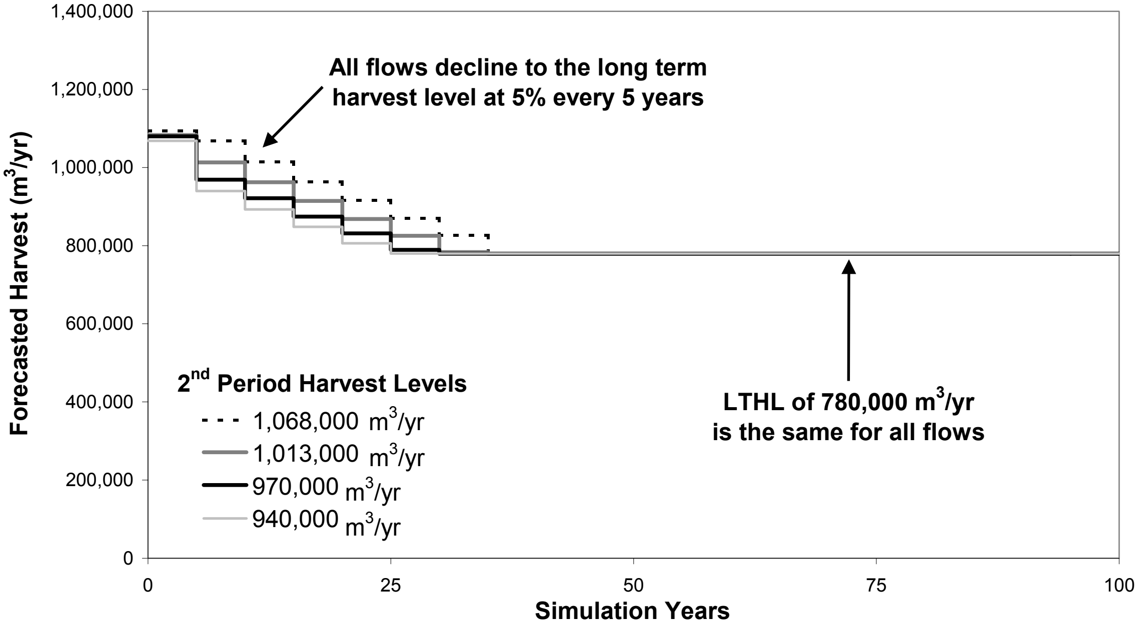

Figure 9: Harvest flows used to find the appropriate harvest level for the year 2006.

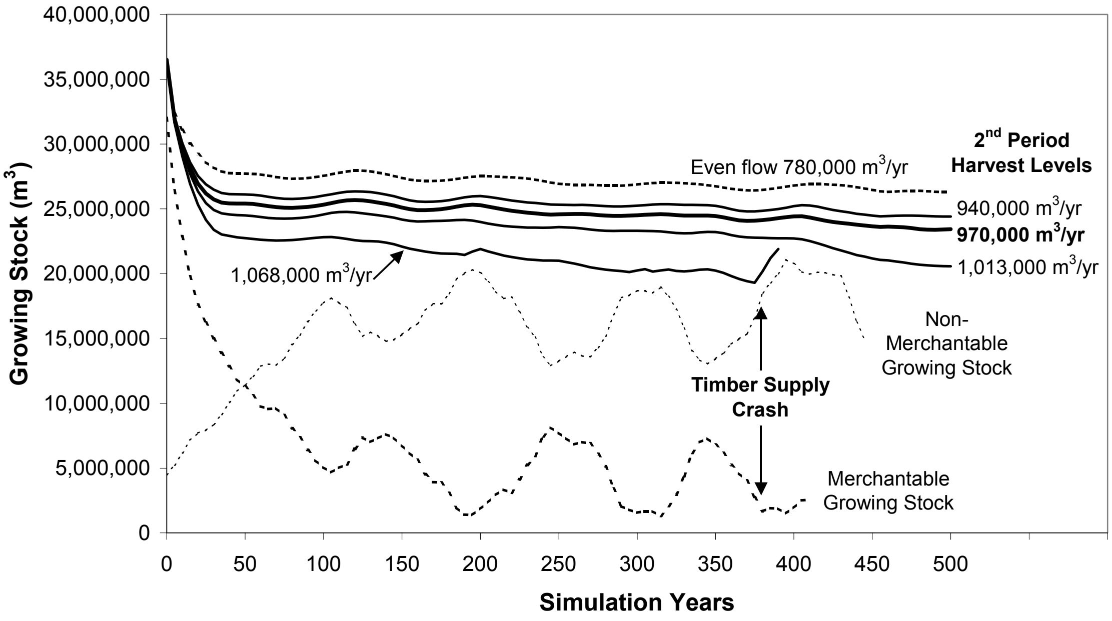

Figure 10: Long-term growing stock produced by different harvest levels in the medium-term.

The initial effect of different short-term harvest levels is to reduce growing stock proportionally at the end of the short-term. Despite these differences in the amount of growing stock, the development of growing stock is similar in all runs between 30 and 100 years of the planning horizon. Beyond 200 years, however, the result of over-harvesting in the short-term is detectable as accelerating decline in total growing stock.

Maintaining the current AAC (1,068,000 m^3/yr) in the second period creates a decline in total growing stock and a major timber supply crash at 375 years, when there is insufficient merchantable growing stock to sustain the long-term harvest level. A 2nd period harvest level of 970,000 m^3/yr produces a stable growing stock.

The total growing stock associated with a second period harvest level of 1,013,000 m^3/yr does not crash but is in a clearly unsustainable decline at the end of the planning horizon. This example illustrates that the effects of over-harvesting in the short-term may not be detectable until well into the long-term, and may not create timber supply crashes within the planning horizon. For this reason, the decline of long-term growing stock, not the associated timber supply crash, is used as the definitive indicator of sustainability in this analysis.

4.1.5 Alternative harvest flows

The maximum sustainable long-term harvest level for the TFL 37 SFM Plan 9 Base Case is 780,000 m^3/yr. However, the legacy of high-volume old growth forests remaining in the THLB allows harvest levels in the short-term that are higher than the long-term harvest level ("taking a falldown"). The extra harvest in the short-term is called the "falldown surplus." The falldown surplus is flexible and can generally be taken as a large amount over a short period or a small amount over a longer period. Despite this flexibility, deferring harvest of the falldown surplus into the medium-term generally reduces the falldown surplus slightly due to mortality in old stands and delayed conversion to faster-growing managed stands.

This Base Case harvest flow produces a falldown surplus of 4 million m^3. This falldown surplus can be allocated in ways other than declining by 5% per period. For example, it could be used to sustain a harvest of 946,000 m^3/yr for 15 years over periods 2-4 before immediately dropping to the long-term harvest level. Alternately, it could sustain a harvest of approximately 880,000 m^3/yr for 30 years. These alternative options are shown in Figure 11. All three flows are equally sustainable in terms of timber supply, so the choice between them is purely a management decision.

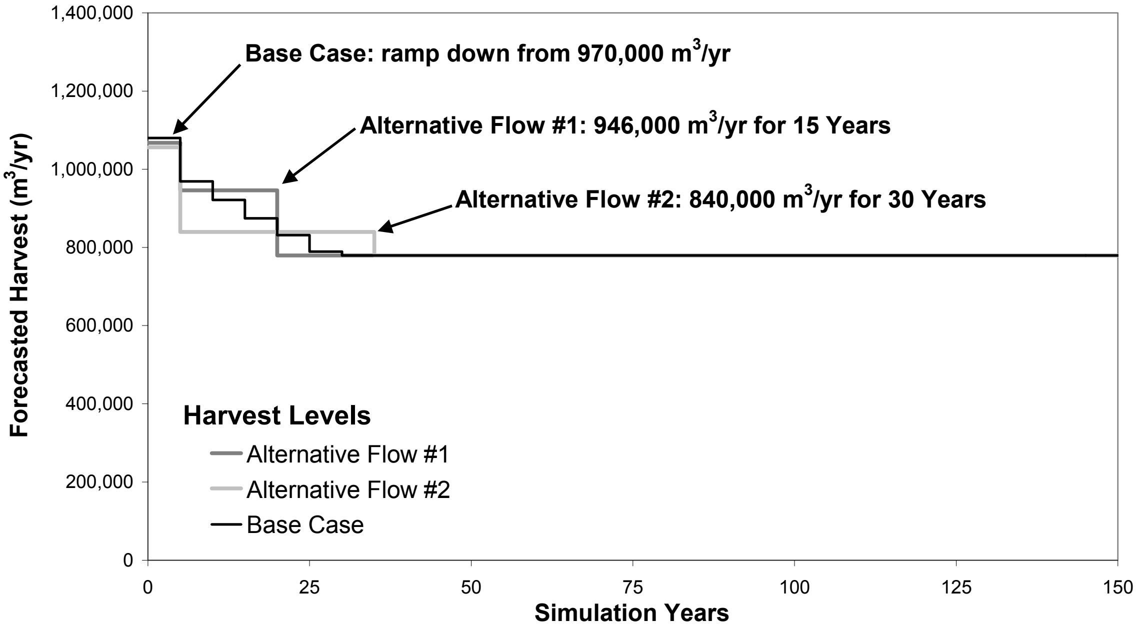

Figure 11: Alternative harvest flows using different harvest levels in the short-term.

The growing stock for these alternative harvest flows is shown in Figure 12. The total volume harvested in the first 30 years of the planning horizon is the same, even though the harvest levels may be different in a given 5-year period. Beyond 30 years, the Base Case and the Alternative Flows are all harvesting 780,000 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.

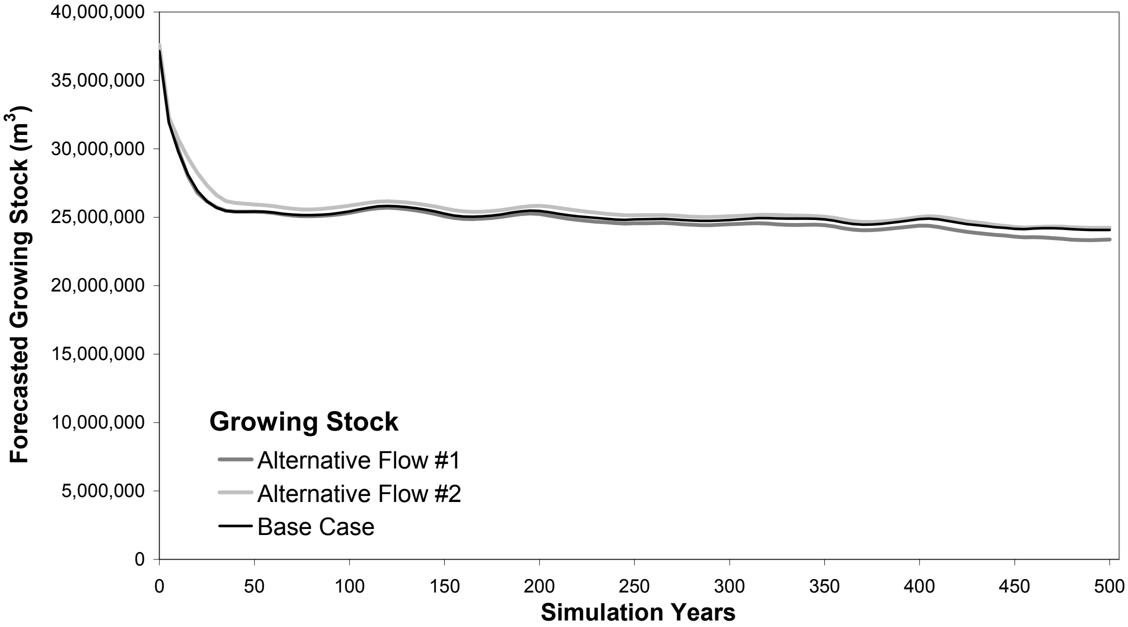

Figure 12: Equivalent harvest flows that sustain the same growing stock in the long-term.

4.2 DESCRIPTION OF THE BASE CASE

The Base Case is the point of comparison for all sensitivity analyses, 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 the Base Case. The emphasis is on the development of attributes over the first 250 years of the 500-year planning horizon.

4.2.1 Harvest forecast

The Base Case harvest forecast (Figure 13) indicates that there is insufficient volume to maintain the current AAC beyond the first period. A 10% drop in harvest levels is required after the first period in order to sustain the long-term harvest level of 780,000 m^3/yr. Beyond the second period, the harvest level declines by 5% every five years until the long-term harvest level is reached in the year 2032.

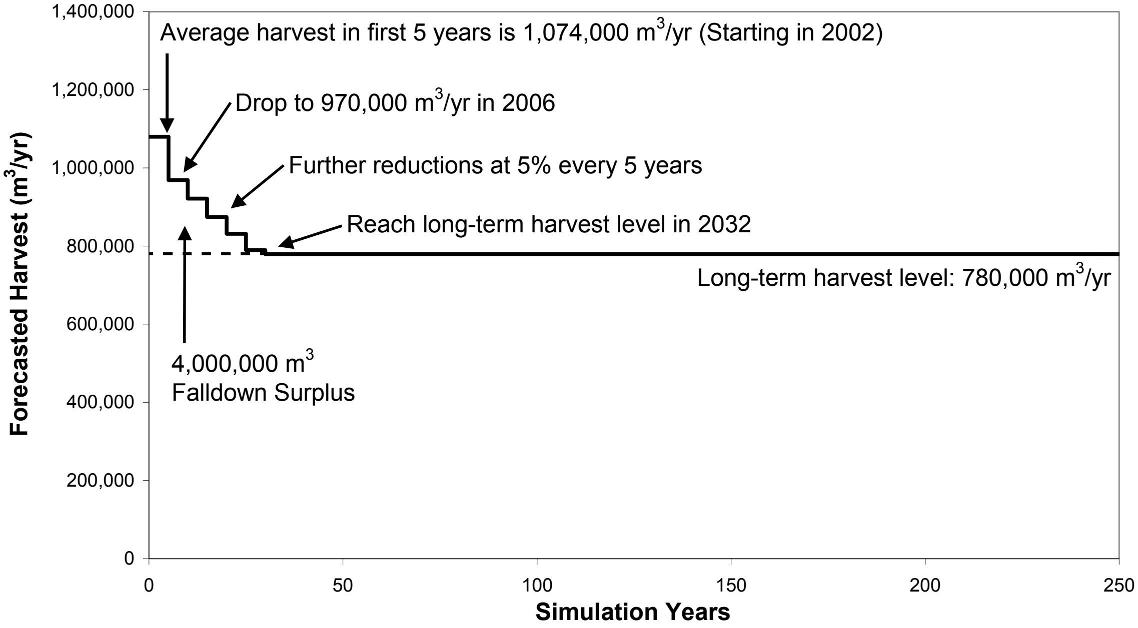

Figure 13: Harvest forecasts of the SFM Plan 9 Base Case.

4.2.2 Explanation of the initial harvest level

The current Management Plan (MP8) and the associated AAC of 1,068,000 m^3/yr came into effect January 1, 1999 and expires December 31, 2005. However, the inventory used in the SFM Plan 9 timber supply analysis is projected and updated to January 1, 2002. This means that the first period of the analysis must be 2002-2006. The harvest levels of the first and second periods in the timber supply analysis are designed to compensate for the 1-year lag with the AAC cut-control periods (Table 4).

Although the second period of the timber supply analysis begins in 2007, Base Case harvest levels incorporate an assumption that the second period harvest level will be adopted in 2006. The initial harvest rate is the average of actual and projected harvest levels during the period 2002 and 2006. This approach ensures that the timber supply analysis harvest levels are consistent with the commencement of a new AAC in 2006.

Table 4: Rationale for first and second period harvests in the SFM Plan 9 proposed Base Case.

Year	Cut-Control Periods	Timber Supply Analysis Periods	Annual Harvest (m^3/yr)	Average Harvest (m^3/yr)	
				Cut Control Periods	Timber Supply Analysis
2001	MP8	n/a	919,701*	1,064,533	n/a
2002		Period 1	1,202,231*		1,074,593
2003			1,025,033*		
2004			1,106,699*		
2005			1,069,000**		
2006	SFM Plan 9		970,000***	970,000	
2007		Period 2	970,000		970,000
2008			970,000		
2009			970,000		
2010			970,000		
2011	SFM Plan 10		970,000		
2012		Period 3	921500		921,500
2013			921500		
2014			921500		
2016			921500		
2016	…		921500		

*Total harvest for Englewood TFL 37 (includes BCTS harvest)

**Estimated total harvest for Englewood TFL 37 (includes First Nations and BCTS harvest)

***Sustainable harvests projected by SFM Plan 9 timber supply analysis

4.2.3 Harvest profile for yield populations

Yield curves were developed by dividing the stands of TFL 37 into yield populations. Harvest from these yield populations is shown in Figure 14. Old natural stands, which are currently >80 years old, dominate harvest in the first 45 years. This reflects the current dependence on old-growth stands in TFL 37, but is also a result of the "relative poorest first" harvest scheduling rule prioritizing stands that are growing slowly relative to their site potential. Old natural stands are generally at or close to the "zero-growth" stage of their yield curve, and are consequently targeted for harvest under this rule. Transitional stands (second growth stands between 41 and 80 years old), form a small portion (9%) of harvest during the first 20 years of the planning horizon, but in the subsequent 20 years are a major source of volume, contributing 35% of the harvest during this period. Existing managed stands are the dominant source of volume between 40 and 75 years, but continue to contribute to harvest well into the long-term. By definition, the long-term begins when future managed stands become the dominant source of harvest.

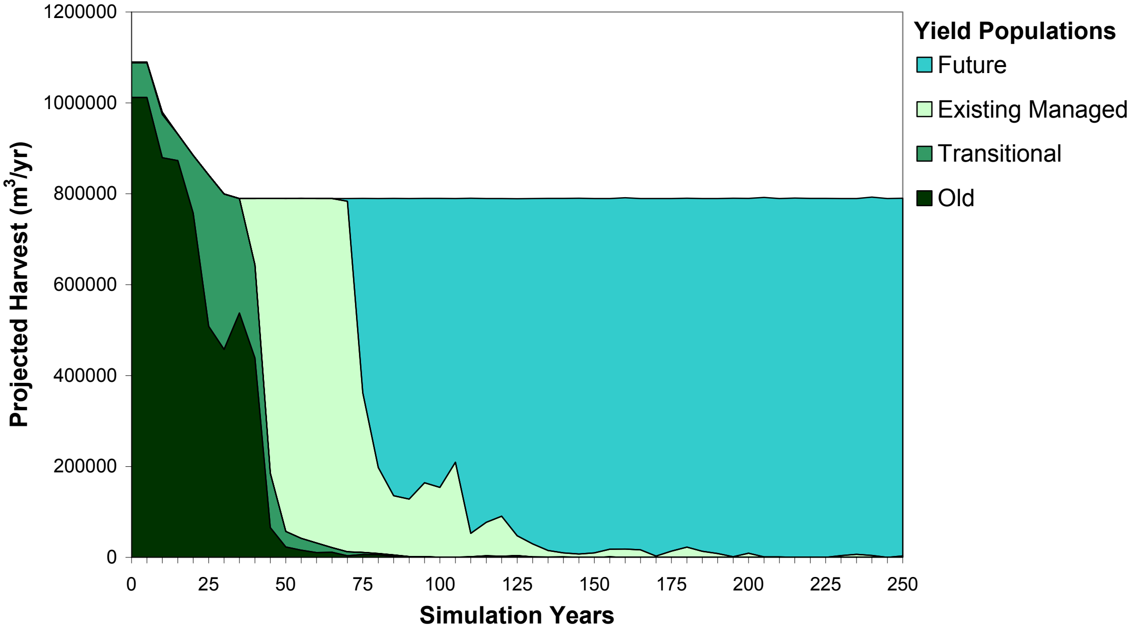

Figure 14: Harvest profile of the major yield populations

The associated growing stock of yield populations is shown in Figure 15. Old and transitional stands in the THLB are entirely harvested at the end of the medium-term, and existing managed stands are depleted at 225 years. The full depletion of growing stock in existing stands indicates that no THLB stands are being "locked up" due to inflexibilities created by forest cover constraints.

Figure 15: Growing stock profile of the major yield populations

4.2.4 Harvest profile for species composition

Figure 16 shows the contribution of major tree species to volume harvested over the planning horizon. The species composition of harvest is stable during the first 35 years, and reflects the species composition of old stands (70% HwBa, 10% Fd, 9% Cw, 10% Yc, 1% Deciduous). The species profile changes suddenly at year 35 as second-growth (transitional and existing managed) stands become a major contributor of volume. Between 35 and 60 years, Douglas-fir becomes the dominant species harvested while harvest of all other species is reduced. Notably, there is almost no harvest from yellow cypress (Yc) in the medium-term. The medium-term harvest profile is the legacy of planting practices between 1960 and 1996.

The long-term species profile is dominated equally by Fd and HwBa (37% each), with a significant harvest of western redcedar (19%) and minor components of yellow cypress and Sitka spruce (6% and 2%, respectively). Note that while the species composition of volume harvested from natural and existing managed stands is based on the forest cover inventory, the future species profile reflects general assumptions about current regeneration and planting practices on TFL 37. The species profile for the first 75 years of the planning horizon is therefore more reliable than in the long-term.

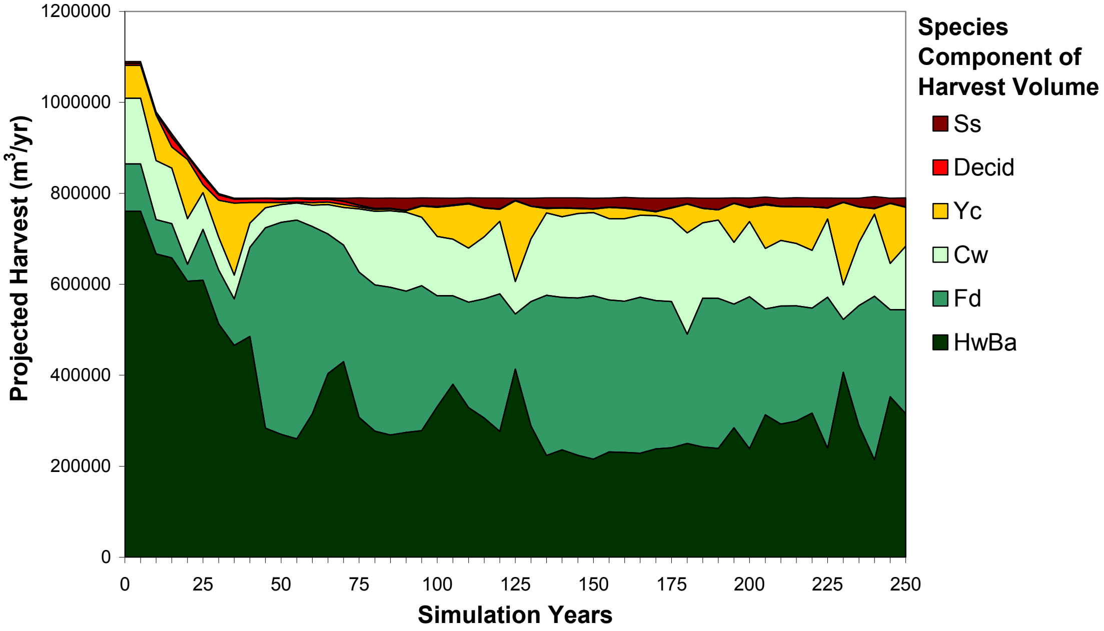

Figure 16: Species composition of harvest.

4.2.5 Harvest profile for stand age

The age of stands at the time they are harvested is shown in Figure 17. Throughout the planning horizon, harvest volume comes exclusively from stands greater than 60 years old. The exceptions to this rule occur in the short-term and at 200 years. Harvest of young (41-60 year old) stands in the short-term results from stands in the "transitional" yield population where the VDYP yield table has been calibrated to high inventory volumes. The harvest of young stands at 200 years coincides with a "pinch point"—a temporary shortage of merchantable volume—that forces the model to harvest stands below their culmination age in order to maintain the long-term harvest level. Harvesting future managed stands before culmination reduces the average productivity of the forest over the planning horizon, and is an indicator of over-harvesting. The presence of sub-culmination harvesting in the Base Case indicates that harvest levels are near the limit of long-term sustainability.

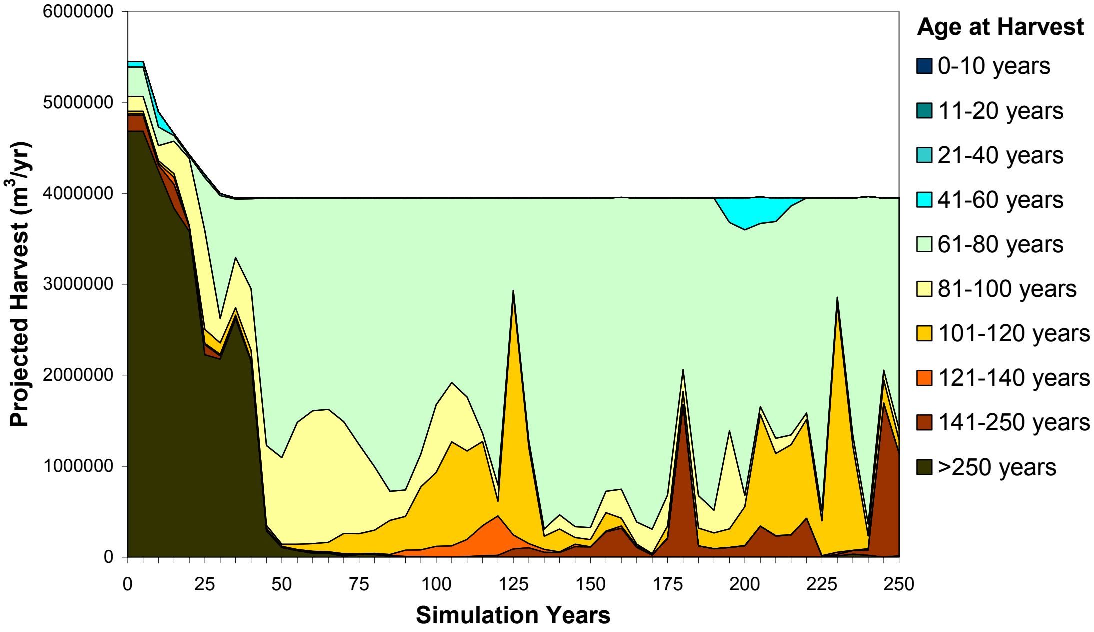

Figure 17: Stand age at harvest.

4.2.6 Age structure

The development of age structure of the productive land base is shown in Figure 18. The age structure achieves relative equilibrium beyond year 75 of the planning horizon, corroborating the use of 75 years as the threshold for the long-term. Nevertheless, the age structure of mature stands continues to be dynamic during the 250 years shown in the graph. The prominent dynamic during the long-term is the recruitment of stands into age class 8 (141-250 years old). This recruitment is primarily associated with regeneration of stands with poor site productivity that are not merchantable until they reach age class 8. The forecasted long-term equilibrium age class structure differs from the current age class structure of the TFL in the following ways:

- The area of old stands (age >250 years) is limited to the non-harvestable land base, and is 51% of the current area of old stands;
- Stands aged 40-100 years old become a substantial component of the land base.

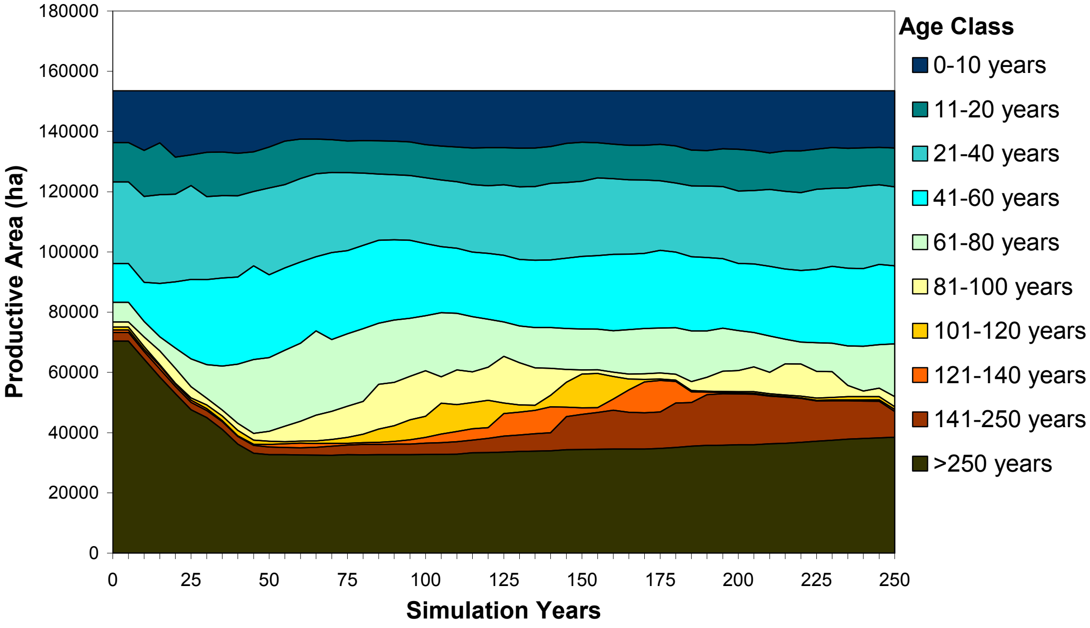

Figure 18: Age structure of the productive forest land base over the planning horizon.

4.2.7 Harvest profile for stand volume

Under the assumptions of this analysis, stands become eligible for harvest once they attain a minimum volume of 250 m^3/ha (ground harvesting) or 350 m^3/ha (cable/helicopter harvesting). In practice, harvest in TFL 37 typically occurs in stands that are greater that 350 m^3/ha. Figure 19 demonstrates that the harvests projected in the Base Case are consistent with these harvest practices: volume from stands with <300 m^3/ha averages 0.1% of total harvest and never exceeds 1% in any period. These results demonstrate that the Base Case is not highly dependent on harvest from low-volume stands.

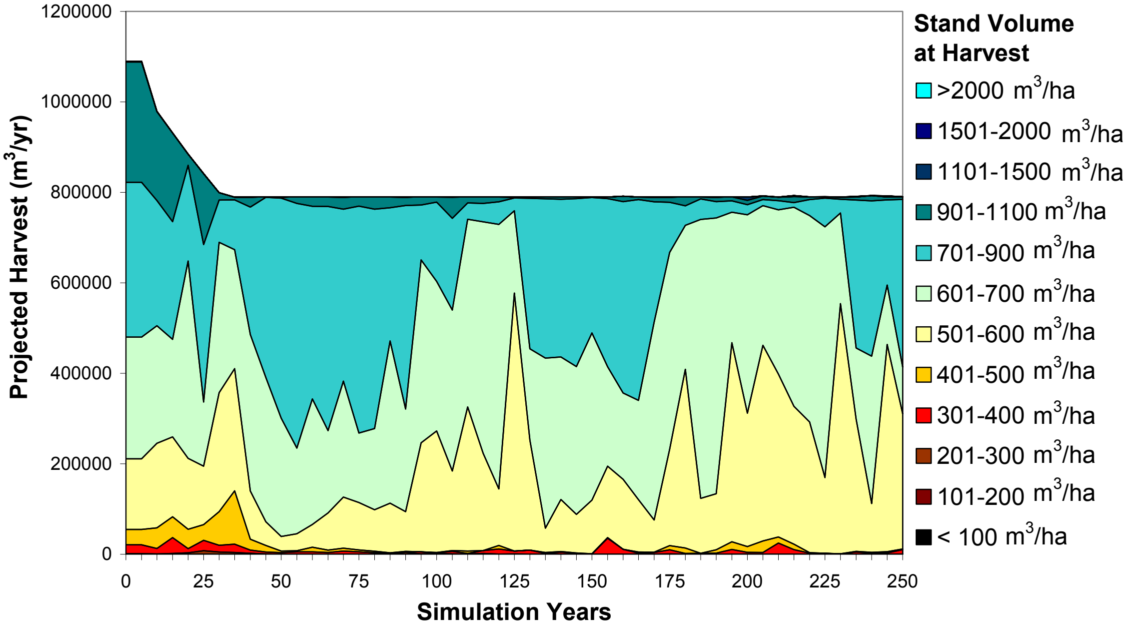

Figure 19: Stand volume at harvest

4.2.8 Harvest profile for harvesting systems

Data used for this analysis was stratified into areas deemed appropriate for ground, cable, and helicopter harvest systems. The harvest profile from stands associated with these strata of the THLB is shown in Figure 20. On average, 54% of the harvest comes from stands currently operable with ground systems, a 37% from ground systems, and the remaining 9% from helicopter harvesting. The major exception to this pattern occurs between years 10 and 40, when 24% of the harvest comes from areas that are mapped as operable by helicopter systems. Harvest from helicopter-operable areas is sporadic in the long term, and varies between 1% and 28% of the harvest in any given period.

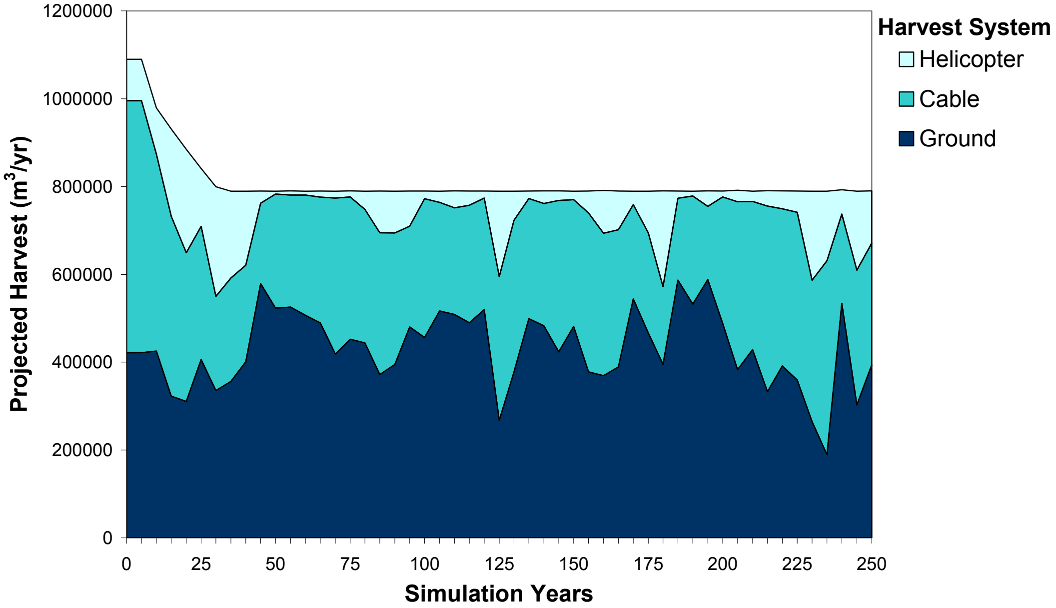

Figure 20: Projected harvest by logging system.

4.2.9 Visual quality objectives

Contribution of harvest volume from constrained areas is interesting especially in light of uncertainties about the constraints. Figure 21 demonstrates that timber supply from visually sensitive areas is stable throughout the planning horizon. Harvest from areas with VQOs contributes an average of 126,000 m^3/yr, or 16% of the total harvest. Slightly more than half of the harvest from VQO polygons comes from polygons with a recommend visual quality class of Partial Retention (PR).

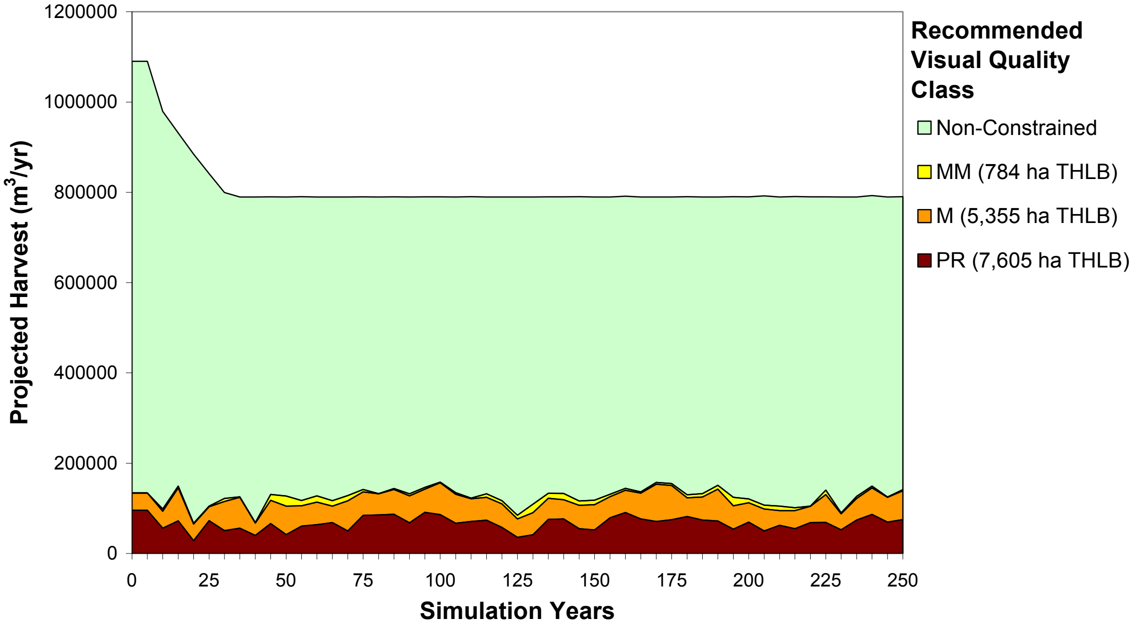

Figure 21: Harvest from visual quality polygons

There are 66 scenic polygons in which visual quality objectives are applied. Figure 22 shows the status of three of the larger VQO polygons to demonstrate the range of responses to the constraint. Although VQOs are typically expressed in terms of the proportion of productive area that is below visually effective green-up, this analysis uses an equivalent clearcut area (ECA) approach often associated with watershed management. The ECA approach allows stands to progressively recover towards a visually effective green-up condition after harvest. VQO Polygon 100 is an example of a polygon where harvest is constrained throughout the planning horizon. Harvest of a Category "A" FDP cutblock in the second period violates the constraint slightly. For the rest of the planning horizon, this polygon is consistently at the maximum percent denudation, indicating that more harvest would occur from this polygon if it were not constrained by the VQO. Polygon 122 is an example of a polygon that is unconstrained by the VQO. The equivalent clearcut area is always below the maximum, indicating that harvest from this polygon would be the same in the absence of the constraint. Polygon 111 is an example of polygons that are periodically constrained by the VQO.

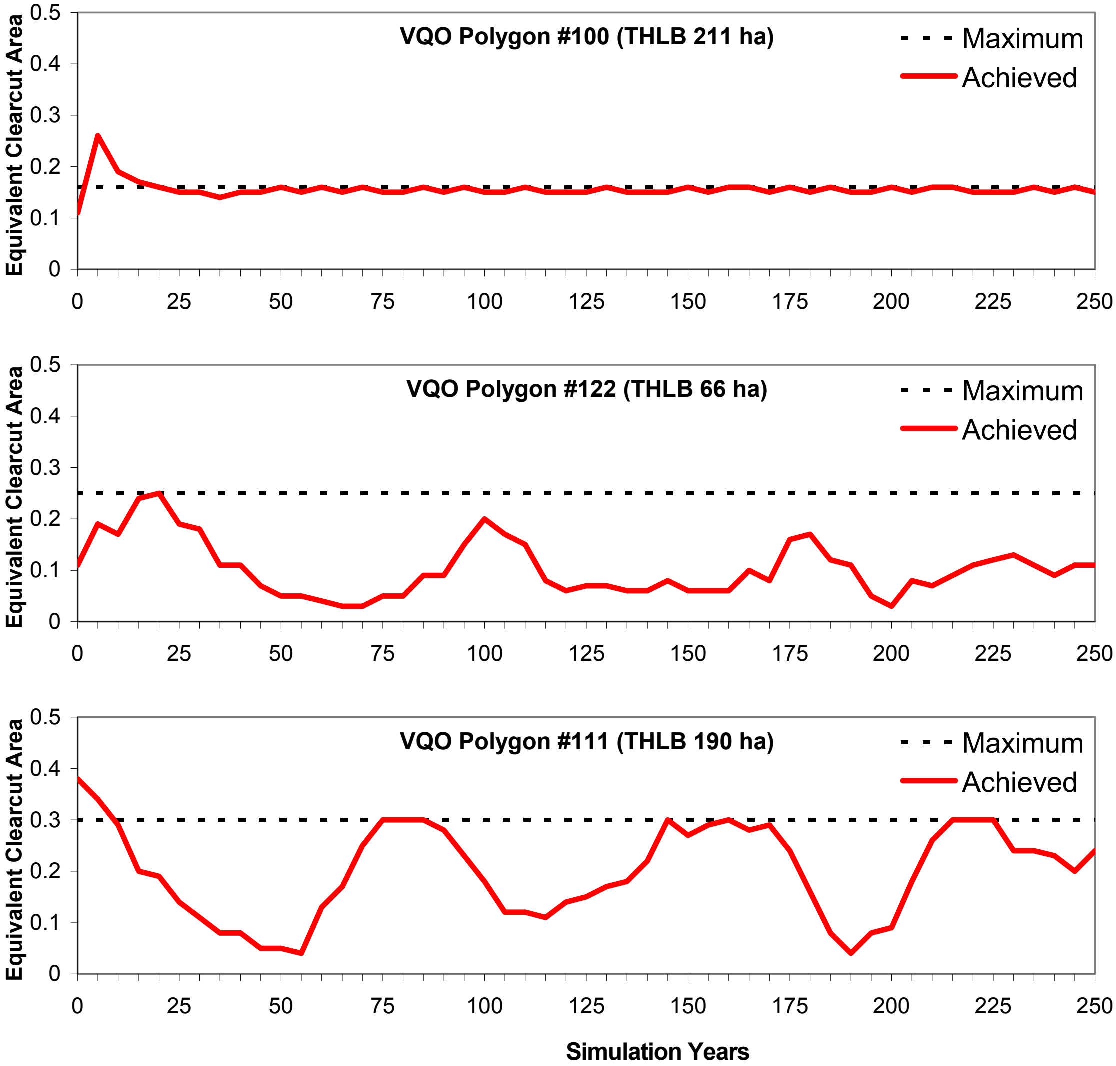

Figure 22: Sample of VQO polygons demonstrating the range of effects of VQOs on harvesting.

4.2.10 IRM green-up

As specified in the VILUP HLPO, the green-up height is 1.3 metres in EFZs and 3 meters in SMZs and GMZs. Like the Forest Service Simulator (FSSIM), the simulation mode of FSOS is unable to effectively model spatial adjacency because it cannot strategically sequence harvests with respect to this constraint. A landscape green-up constraint is applied in the Base Case as a surrogate for spatial adjacency constraints. This constraint specifies that no more than 33% of the THLB area of each type of resource management zone (RMZ) may be below green-up height at any given time. This constraint excludes areas managed for visual quality objectives. As shown in Figure 23, this constraint is achieved throughout the planning horizon. The achieved levels never reach 33%, indicating that the objective is not constraining to timber supply and never influences the harvest schedule.

Figure 23: Proportion of the non-constrained THLB below green-up height in each Resource Management Zone, relative to the IRM green-up constraint.

4.2.11 Mature-plus-old forest cover requirements

VILUP HLPO Section II A 1 (a) specifies that a minimum of 25% of the forested area in each SMZ must be >80 years old in the CWH biogeoclimatic zone and greater than 120 years in the MH zone. Figure 24 shows the proportion of mature-plus-old forest achieved for each SMZ relative to the target.

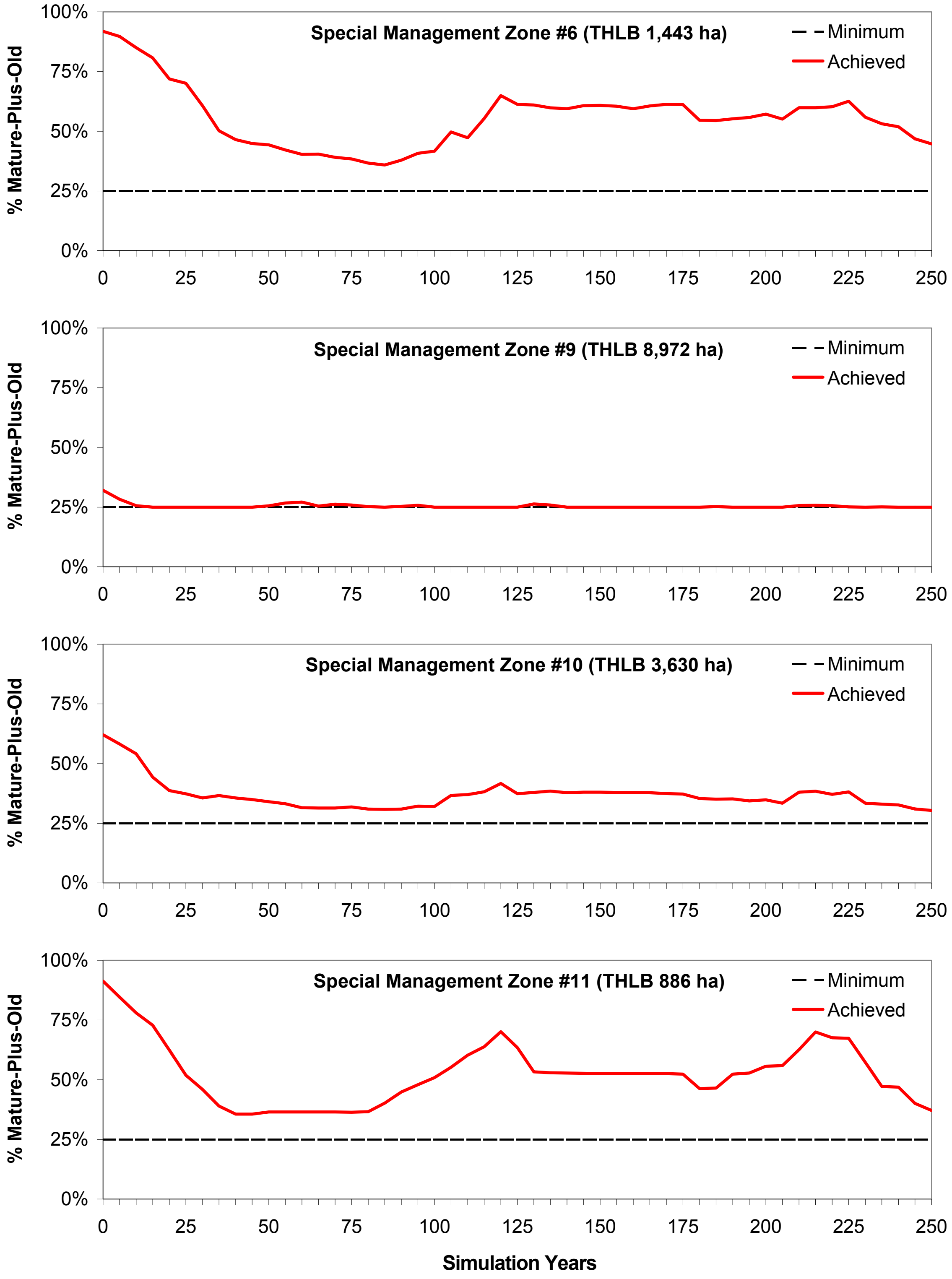

Figure 24: Mature-plus-old forest within SMZs relative to targets

Within SMZs 6, 10, and 11, mature-plus-old requirements are met by existing reserves (e.g. OGMAs and MAMU WHAs). Consequently, timber supply is not constrained in these zones and the proportion of mature-plus-old forest is always greater than the 25% target. Existing reserves make up only 19% of SMZ 9, meaning that an additional 6% of the THLB must be mature in order to satisfy the mature-plus-old requirement. The proportion of mature-plus-old in SMZ 9 rarely exceeds the minimum, implying that this target is affecting the harvest schedule and may be constraining to timber supply.

5 SENSITIVITY ANALYSES

Sensitivity analyses have several functions in timber supply analysis. First, they illustrate 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 the short-term harvest level in the context of major uncertainties.

The sensitivity analyses in this report test uncertainties associated with four major categories of timber supply assumptions: (1) harvest rules; (2) THLB; (3) growth & yield; and (4) forest cover constraints. In all cases, sensitivity analyses determined sustainable harvest levels using methods described in Section 4.1. The sensitivity analyses are listed in Table 5.

Table 5: List of sensitivity analyses.

Section	Sensitivity Analysis
	Harvest Rules
5.3.1	Remove DBH criteria for minimum merchantability
5.3.2	Set minimum harvest ages at 90% culmination age
5.3.3	Relative oldest first scheduling
5.3.4	Random harvest scheduling
	Timber Harvesting Land Base
5.4.1	Remove hembal-heli stands
5.4.2	Partition the helicopter-operable land base
5.4.3	Remove marginally economic stands
5.4.4	Remove conditionally operable
5.4.5	Return MAMU reserves to THLB
5.4.6	Return MAMU reserves and OGMAs to THLB
5.4.7	Return MAMU/OGMAs/NOGO territories to THLB
	Growth and Yield
5.5.1	Reduce natural stand volumes by 10%
5.5.2	Reduce existing managed stand volumes by 10%
5.5.3	Inventory site index for CWHvm2 stands
5.5.4	TIPSY for transitional stands
5.5.5	Increase OAF1 to 15%
5.5.6	Increase OAF2 to 7%
5.5.7	Remove yield reductions for partial harvesting
5.5.8	Increase regeneration delay by 1 year
	Forest Cover Constraints
5.6.1	Reduce IRM green-up to 25%
5.6.2	Remove VQO constraints
5.6.3	Absolute VEG for VQOs
5.6.4	Standard TSR visual constraints
5.6.5	Remove mature-plus-old constraints

5.1 MEASURES OF SENSITIVITY

For sensitivity analyses to be meaningful, objective measures are necessary for comparing results to the Base Case. Changes in the long-term harvest level are a good measure of sensitivity because there is only one long-term harvest level for any set of assumptions. 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 the short and medium term harvest levels limits their utility as indicators of sensitivity. To compensate for this subjectivity, harvest responses in the sensitivity analyses were limited in the following ways:

1. The medium-term ends—and the long-term begins—at 75 years in all the sensitivity analyses.
2. Where possible, the response to changes in assumptions was limited to the medium-term. By fixing the short-term harvest level, the emphasis in most sensitivity analyses is on the risk associated with setting the AAC at the Base Case harvest level.
3. The total volume harvested over the first 75 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 volume 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.

5.2 GUIDE TO INTERPRETING THE SENSITIVITY ANALYSIS GRAPHS

Most of the information about the sensitivity analyses is contained in the graphs. Discussion of each sensitivity analysis is limited to a brief explanation of the major observations and their implications. The intent of this approach is to provide a concise analysis that also allows the reader to pursue a deeper understanding of the implications of each sensitivity analysis if desired. This section explains the layout and some of the basic interpretations of the graphs presented in each sensitivity analysis.

Two graphs are shown in each sensitivity analysis: A "Harvest Levels" graph and a "Growing Stock" graph. An example of each is shown in Figure 25 and Figure 26. Both graphs contain a dashed black line, a grey line, and a solid black line. The dashed line shows the results for the Base Case and is the same in each sensitivity analysis. The grey line shows the results of a run where the timber supply model has been changed for the sensitivity analysis, but the base case harvest levels have been maintained. The solid black line shows final results of the sensitivity analysis, where harvest levels have been adjusted to compensate for the change in assumptions. Together, these three lines provide a complete picture of the basic dynamics of the sensitivity analysis.

5.2.1 The Harvest Levels graph

The Harvest Levels graph illustrates when the effects of the sensitivity analysis are expressed as an acute timber supply shortage, and the scale of the adjustments to harvest levels that must be made to prevent such a shortage from occurring. Although the harvest forecasts are tested over a period of 500 years, the Harvest Levels graphs show only the first 250 years.

Sensitivity analyses can put "upward" or "downward" pressures on timber supply. Upward pressures result from a change in assumptions that increase the volume available for harvest over time, such as an increase to the size of the THLB. Upward pressures allow an increase in harvest levels relative to the Base Case. Downward pressures result from a change in assumptions that reduce the volume available for harvest. Downward pressures require a reduction in harvest levels. If the base case harvest level is attempted despite a downward pressure, the forest is being cut faster than the rate that it is growing. Eventually, the supply of mature volume is entirely depleted, forcing a large reduction in the harvest level for a period of time. This acute timber supply shortage resulting from over-harvesting is called a timber supply "crash."

The grey line in the Harvest Levels graph shows the crash associated with maintaining base case harvest levels in the sensitivity analysis. The size of the crash indicates the consequences associated with the uncertainty being tested by the sensitivity analysis. The timing of the crash indicates the amount of time available to respond to better information about the uncertainty. In this way, the Harvest Levels graph provides an indication of the *risk* and the *consequences* of uncertainties in the base case assumptions.

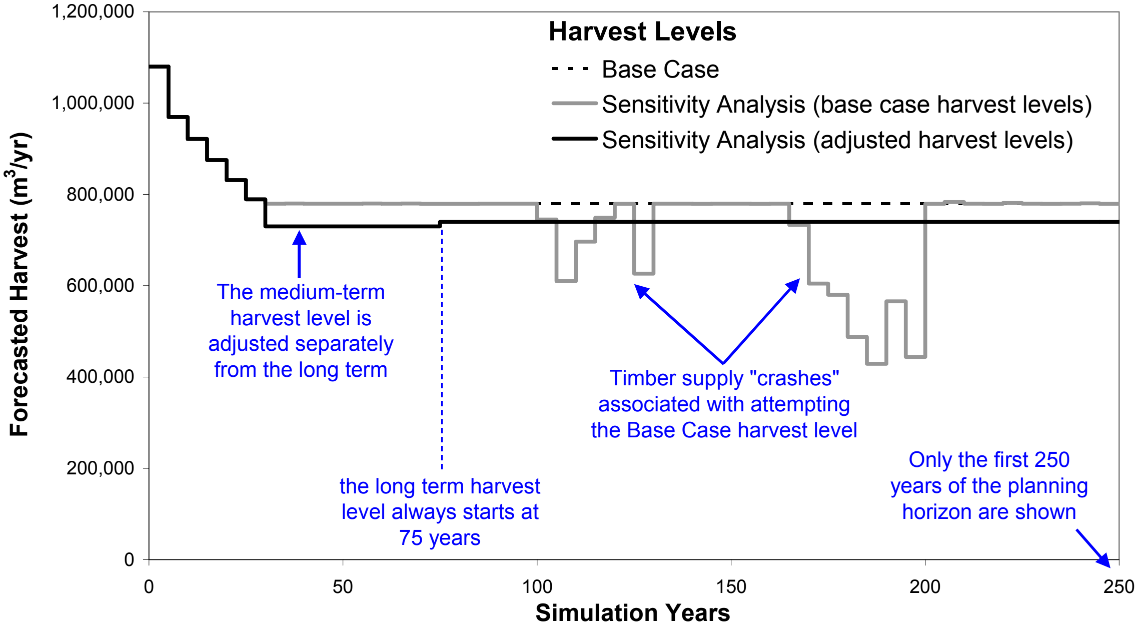

Figure 25: Explanation of the Harvest Levels graph shown in each sensitivity analysis

5.2.2 The Growing Stock graph

The Growing Stock graph is a "behind-the-scenes" look at the underlying causes and effects of the harvest levels. The causes of a timber supply crash are foreseeable in the development of growing stock, and the effects of changes in the harvest level are shown as a stabilization of growing stock. Unlike the Harvest Levels graph, the full length of the 500-year planning horizon is shown in the Growing Stock graph.

Growing stock is the wood volume existing on the TFL at any given point in time. There are two types of growing stock shown in the Growing Stock graph: "merchantable growing stock" and "total growing stock." Merchantable growing stock is the volume of wood in stands that are above minimum harvest age. Total growing stock is the sum of merchantable and non-merchantable growing stock.

The Growing Stock graph shows the interaction between the growth of the forest and the rate at which it is being harvested. When the harvest rate is slower than the growth of the forest, the total and merchantable growing stock will accumulate. When the harvest rate is faster than the growth rate, growing stock will decline. Unsustainable harvest rates deplete merchantable growing stock until it approaches zero, as shown by the grey line example in Figure 26. At this point, there is insufficient merchantable growing stock to sustain the target harvest level and a timber supply crash occurs. In the example provided in Figure 25, the timber supply crashes between 100 and 200 years depicted in the Harvest Levels graph are also visible in the Growing Stock graph (Figure 26), when merchantable growing stock is at a minimum. Merchantable growing stock never reaches zero in any of the sensitivity analyses because some mature stands are being withheld from harvest to satisfy visual quality objectives.

Sustainable harvest levels are indicated by stable and non-declining total growing stock. Merchantable growing stock fluctuates more readily depending on the relative maturity of fast-growing or slow-growing stands on the land base at any given point in time.

The growing stock associated with the adjusted harvest level (solid black lines) allows the reader to evaluate the effectiveness of the harvest levels adjustment in the sensitivity analysis. Sometimes it is clear from the Growing Stock graph that the adjusted harvest level should be slightly higher or lower than what was actually reported in the sensitivity analysis. These imperfections are due to adherence to the precision of the timber supply analysis (explained in Section 4.1.3).

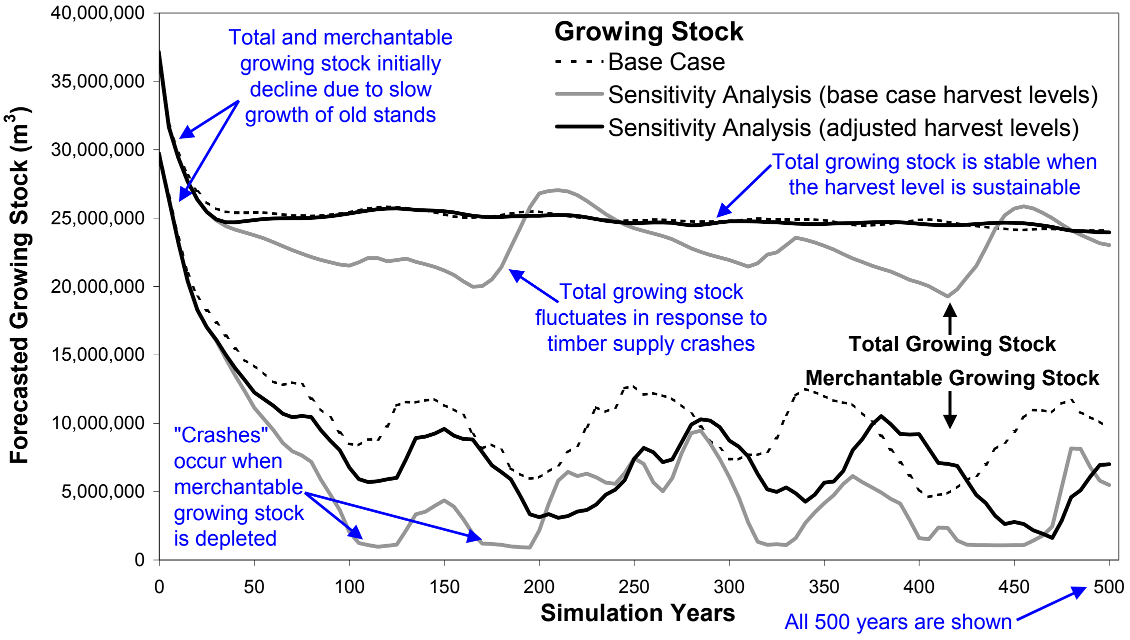

Figure 26: Explanation of the Growing Stock graph shown in each sensitivity analysis

5.3 HARVEST SCHEDULING RULES

5.3.1 Remove DBH criteria for minimum harvest age

Sensitivity	Remove mean diameter criteria for minimum merchantability so that minimum harvest age reflects only minimum stand volume.
Rationale	Minimum harvest age (MHA) is the age at which stands become eligible for harvest. MHAs in the Base Case reflect current merchantability limits on TFL 37 and were defined using minimum stand volume (ground systems 250 m^3/ha; cable/heli systems 350 m^3/ha) and minimum average tree diameter (ground systems 25 cm; cable/heli systems 30 cm). The diameter criteria result in MHAs older than culmination age in some stands. This can constrain timber supply because if stands are consistently harvested above culmination age the average stand growth over the planning horizon will be reduced. The purpose of this sensitivity analysis is to test the extent to which the diameter criteria constrain timber supply.
Methods	Minimum harvest age was recalculated for each yield table using only the minimum volume criteria for minimum merchantability

Table 6: Summary of the sensitivity analysis—Remove DBH criteria for MHAs.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Total short/medium-term harvest (000's m^3)	62,415	62,415	0	0.0%

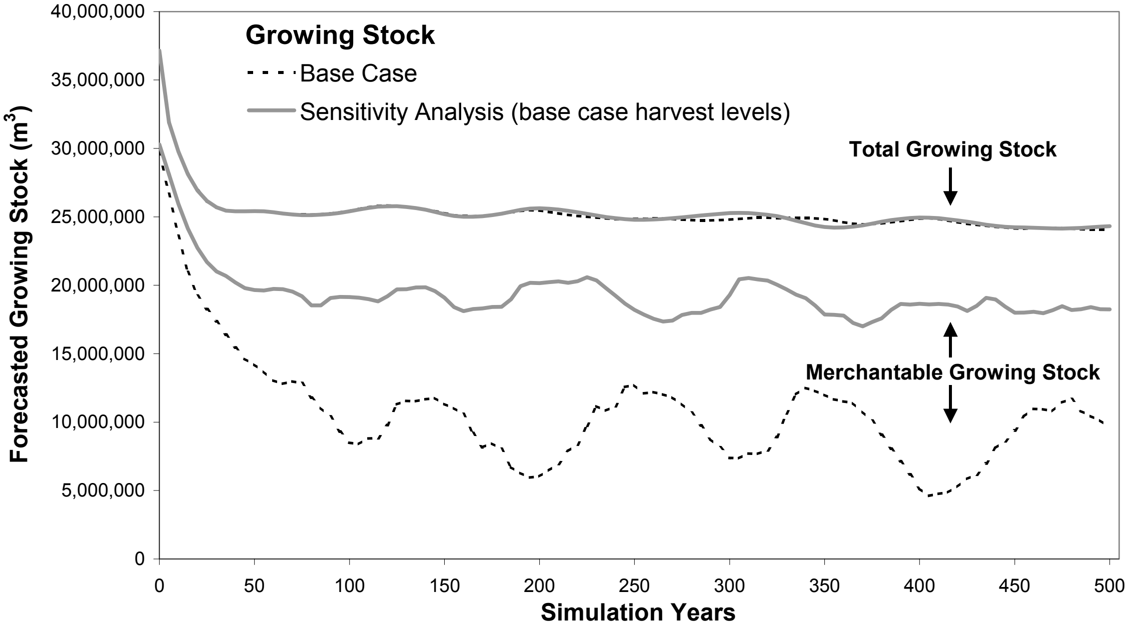

Figure 27: Sensitivity analysis growing stock—Remove DBH criteria for MHAs.

Discussion

This sensitivity analysis has no effect on sustainable harvest levels. The net effect of removing the DBH criteria is a reduction of minimum harvest ages. This effect is reflected in the higher levels of merchantable growing stock throughout the planning horizon. However, the total growing stock is unchanged from the Base Case, indicating that the DBH criteria are not constraining to timber supply.

5.3.2 Set minimum harvest ages at 90% of culmination age

Sensitivity	Set minimum harvest ages at 90% of culmination age
Rationale	Unlike "relative poorest first" scheduling, traditional harvest scheduling rules such as "oldest first" and "relative oldest first" scheduling cannot detect when a stand is at culmination age. As a result, timber supply analyses that use these rules generally set minimum harvest age close to culmination age to ensure that timber supply is not compromised by consistently harvesting stands well below culmination age. The sensitivity analysis in section 5.3.3 tests the impact of using the "relative oldest first" harvest scheduling rule, which also requires setting MHAs at 90% of culmination age. The purpose of this sensitivity analysis is to isolate the effect of the change to minimum harvest ages so that the sensitivity to changes in harvest scheduling rules can be effectively tested.
Methods	Minimum harvest ages for all yield tables were recalculated as 90% of the age at which stands reach maximum mean annual increment (culmination of MAI)

Table 7: Summary of the sensitivity analysis—Set MHAs at 90% of culmination age.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Total short/medium-term harvest (000's m^3)	62,415	62,415	0	0.0%

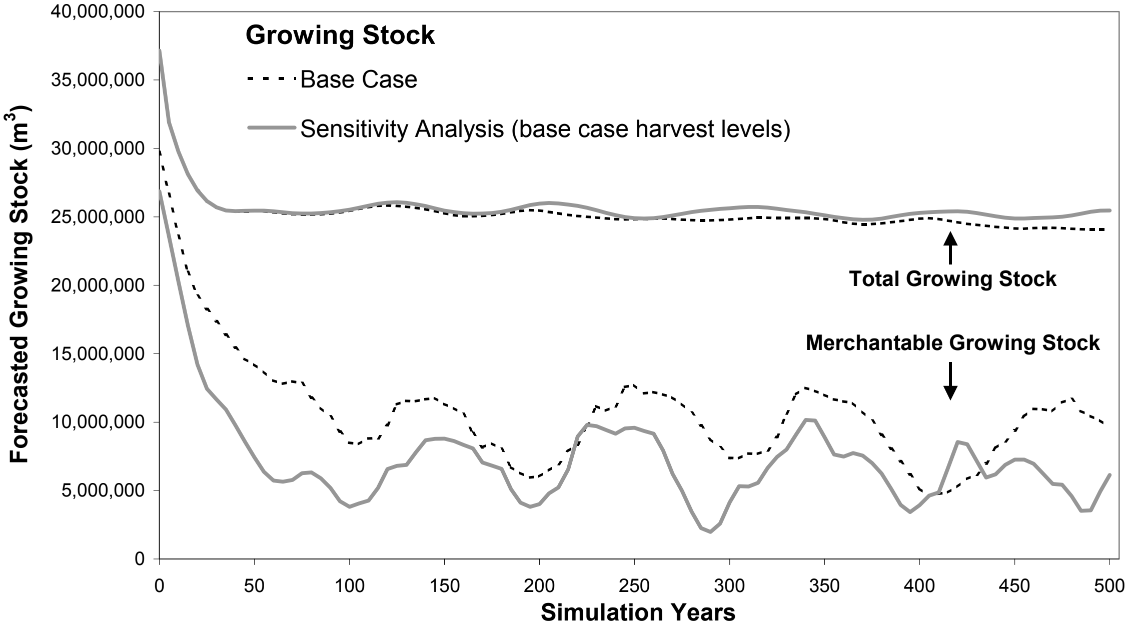

Figure 28: Sensitivity analysis growing stock— Set MHAs at 90% of culmination age.

Discussion

The merchantable growing stock for the sensitivity analysis is considerably lower than for the Base Case, indicating that the sensitivity analysis results in more constraining minimum harvest ages. Nevertheless, the change in minimum harvest age has no effect on sustainable harvest levels over the 500-year planning horizon. Total growing stock for the sensitivity analysis is slightly higher than the Base Case, which implies that the Base Case relies on harvesting of some stands below culmination. This effect is subtle, though, and the overall result is that the Base Case is not sensitive to reasonable changes in minimum harvest ages.

5.3.3 Relative oldest first harvest scheduling

Sensitivity	Change the harvest scheduling rule to "relative oldest first" scheduling
Rationale	In any given period of the planning horizon, thousands of polygons are unconstrained and available for harvesting. Harvest scheduling rules are the means by which a timber supply simulation model decides which polygons should be harvested first. The order that polygons are harvested affects the development of growing stock and is potentially important to timber supply, especially in the transition from the medium-term to the long-term. The purpose of this sensitivity analysis is to determine the role of harvest scheduling rules in the Base Case. "Relative oldest first" scheduling is in this sensitivity analysis because it is the most sophisticated of the scheduling rules that are commonly used in the British Columbia timber supply review.
Methods	The harvest scheduling rule in FSOS simulation mode was changed to "relative oldest first" scheduling. Minimum harvest ages were changed to 90% of culmination age to prevent persistent harvest below culmination age that could otherwise occur using this rule.

Table 8: Summary of the sensitivity analysis— Relative oldest first harvest scheduling.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	750,000	-30,000	-3.8%
Total short/medium-term harvest (000's m^3)	62,415	61,102	-1,313	-2.1%

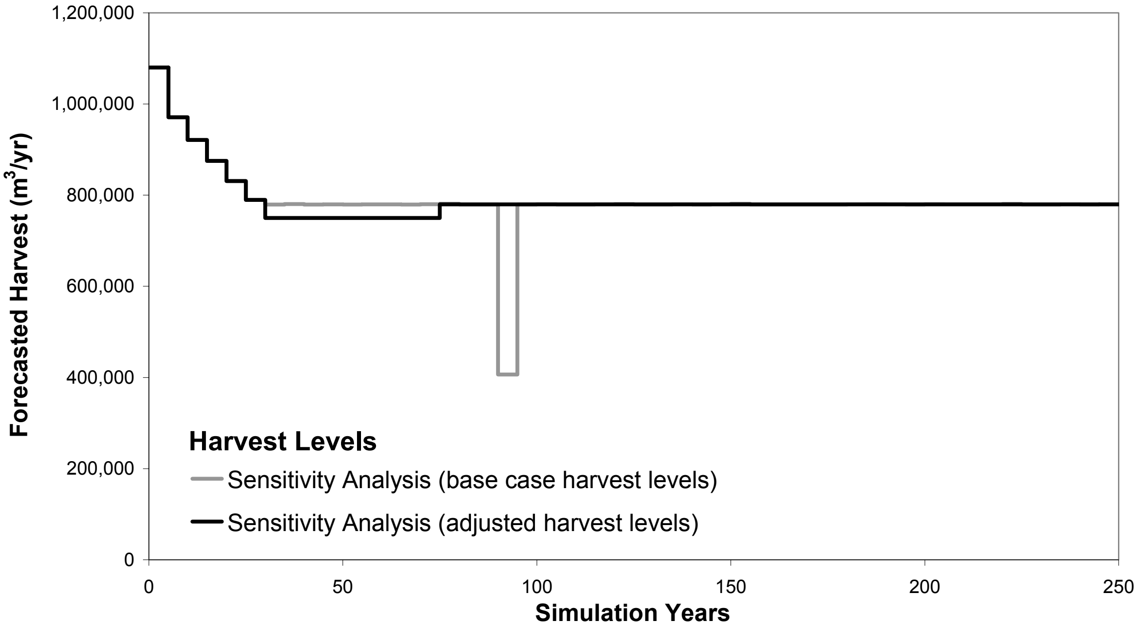

Figure 29: Sensitivity analysis harvest levels— Relative oldest first harvest scheduling.

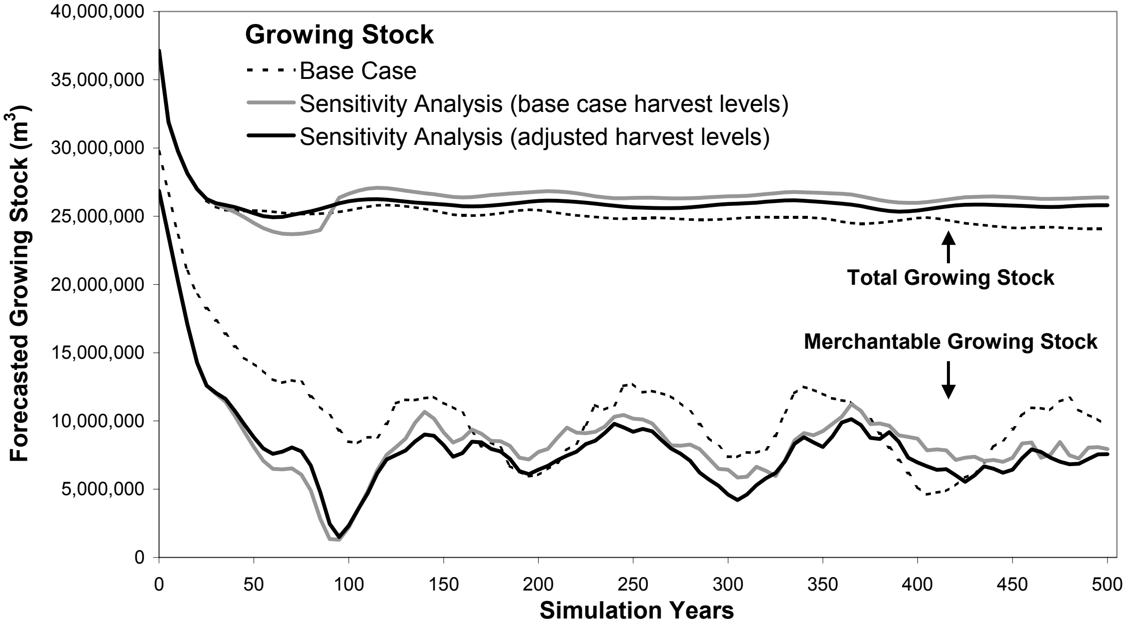

Figure 30: Sensitivity analysis growing stock— Relative oldest first harvest scheduling.

Discussion

Relative poorest first scheduling gives harvest priority to stands that are growing slowest relative to the stand that will replace them after they are harvested. This strategy results in faster accumulation of growing stock in the medium-term. “Relative oldest first” scheduling gives harvest priority to stands that are old relative to their minimum harvest age.

At Base Case harvest levels, relative oldest first scheduling results in a timber supply crash at 90 years into the planning horizon. Total growing stock is drawn down during the medium-term at a faster rate than the Base Case while merchantable growing stock declines sharply. At 90 years, merchantable growing stock is depleted beyond a level that can support the Base Case harvest level. The timber supply crash reduces harvest, allowing total growing stock to be replenished. Beyond the pinch point the Base Case harvest levels can be supported for the remainder of the planning horizon.

The medium-term harvest level was adjusted to reduce the depletion of merchantable growing stock. This leaves enough merchantable growing stock at the 90-year pinch point that a timber supply crash is avoided. In essence, a small reduction in harvest over 50 years in the medium-term has replaced a large reduction at 90 years.

The Base Case long-term harvest level can be sustained in this sensitivity analysis, indicating that the relative oldest first harvest rule has little effect on the long-term harvest level.

5.3.4 Random harvest scheduling

Sensitivity	Change the harvest scheduling rule to random scheduling
Rationale	The previous sensitivity analysis demonstrated that medium-term harvest levels are sensitive to the order in which stands are harvested. Actual harvest scheduling in TFL 37 does not follow simple rules used in simulation models, and may be closer to a random schedule than to relative poorest first or relative oldest first rules. The purpose of this sensitivity analysis is to provide further understanding of the degree to which harvest scheduling can affect timber supply in the short and medium-term.
Methods	Polygons eligible for harvest were harvested in order of their identification number. This approach is not truly random since polygons are labelled from northwest to southeast. Nevertheless, the effect is sufficient for this sensitivity analysis. Minimum harvest ages were set at 90% of culmination age.

Table 9: Summary of the sensitivity analysis— Random harvest scheduling.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	765,000	-15,000	-1.9%
Total short/medium-term harvest (000's m^3)	62,415	61,751	-663	-1.1%

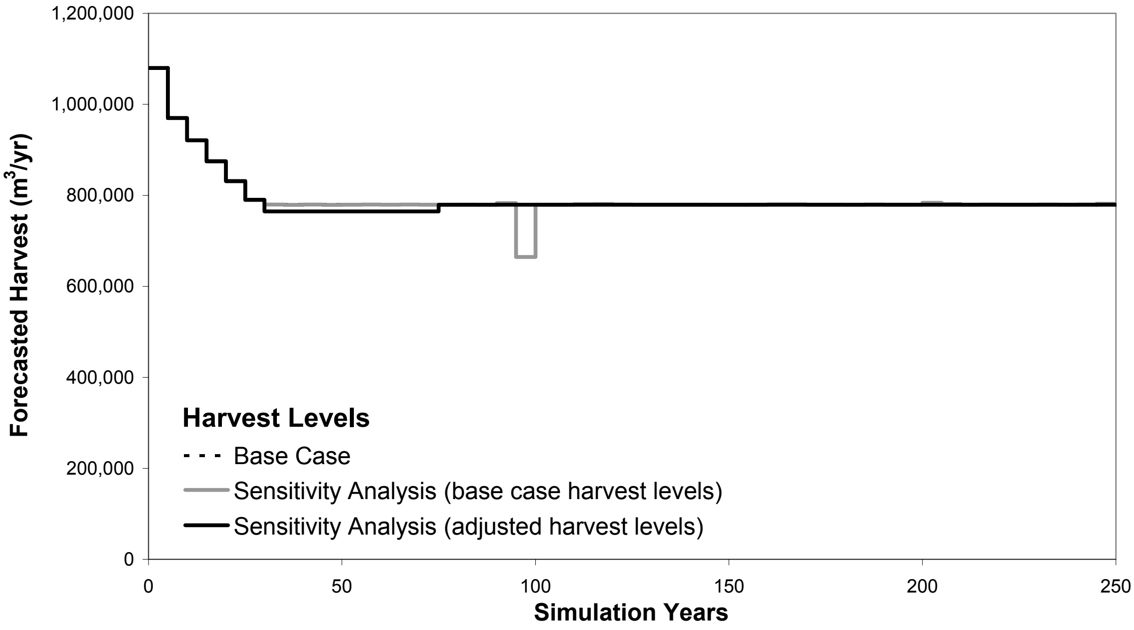

Figure 31: Sensitivity analysis harvest levels— Random harvest scheduling.

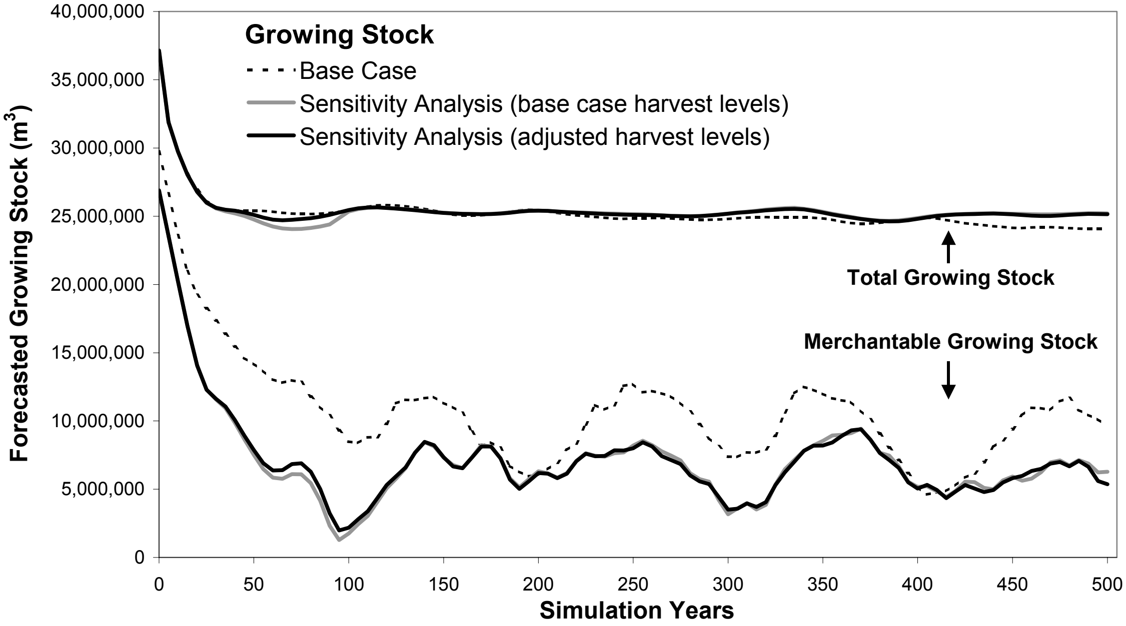

Figure 32: Sensitivity analysis growing stock—Random harvest scheduling.

Discussion

Similar to the "relative oldest first" sensitivity analysis, random scheduling produces a rapid decline of merchantable growing stock during the first 95 years of the planning horizon, and an associated crash at the end of this period. This pattern is not as pronounced in this sensitivity analysis as it was under "relative oldest first" scheduling. This result suggests that—in the case of TFL 37—the stands prioritized by "relative oldest first" scheduling occurs on site series with poorer-than-average potential site index.

5.4 TIMBER HARVESTING LAND BASE

5.4.1 Remove low-profit helicopter-operable stands ("hembal-heli")

Sensitivity	Remove helicopter-operable stands with low economic viability from the THLB.
Rationale	Canfor staff have indicated that some areas of the helicopter-accessible land base are unlikely to become merchantable in the foreseeable future, mostly due to dominance of lower value tree species (western hemlock and pacific silver fir). This sensitivity analysis tests the timber supply impact of removing these "hembal-heli" stands from the timber harvesting land base.
Methods	Helicopter-operable stands with a Douglas-fir/cedar/cypress component of less than 30% were also removed from the THLB (5689 net ha). Also, stands greater than 1000 metres from current and proposed roads were removed from the timber harvesting land base (786 net ha). These areas are eligible to contribute to VQO and mature-plus-old targets, but not to IRM green-up constraints.

Table 10: Summary of the sensitivity analysis— Remove hembal-heli stands from the THLB

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	744,000	-36,000	-4.6%
Medium-term harvest level (m^3/yr)	780,000	744,000	-36,000	-4.6%
2006 harvest level (m^3/yr)	970,000	904,000	-66,000	-6.8%
Total short/medium term harvest (000's m^3)	62,415	59,342	-3,073	-4.9%

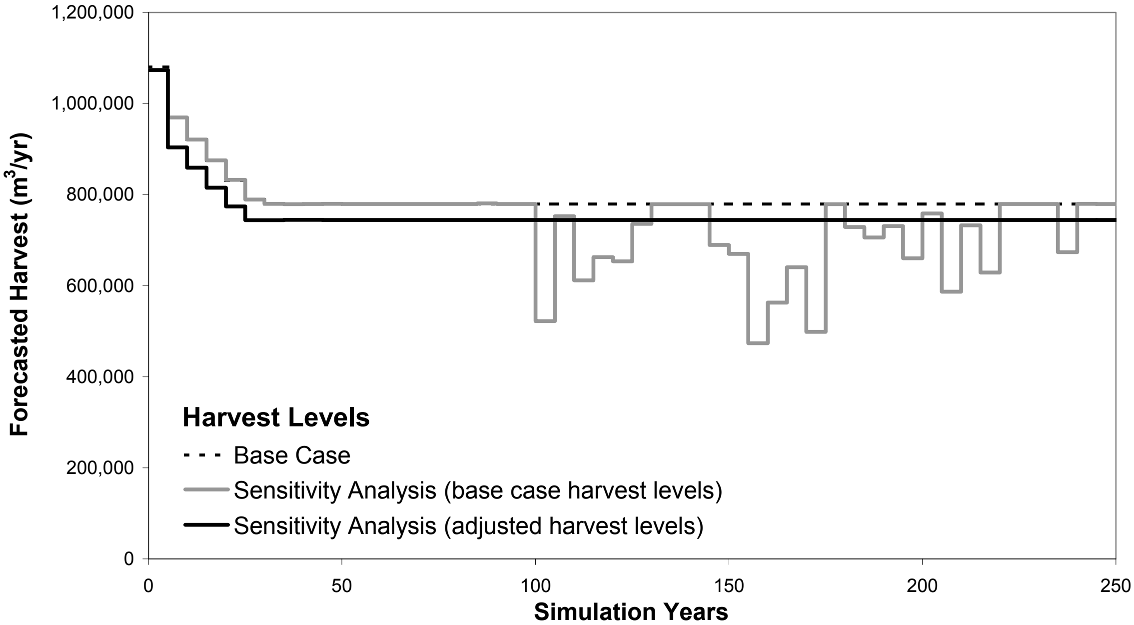

Figure 33: Sensitivity analysis harvest levels— Remove hembal-heli stands from the THLB.

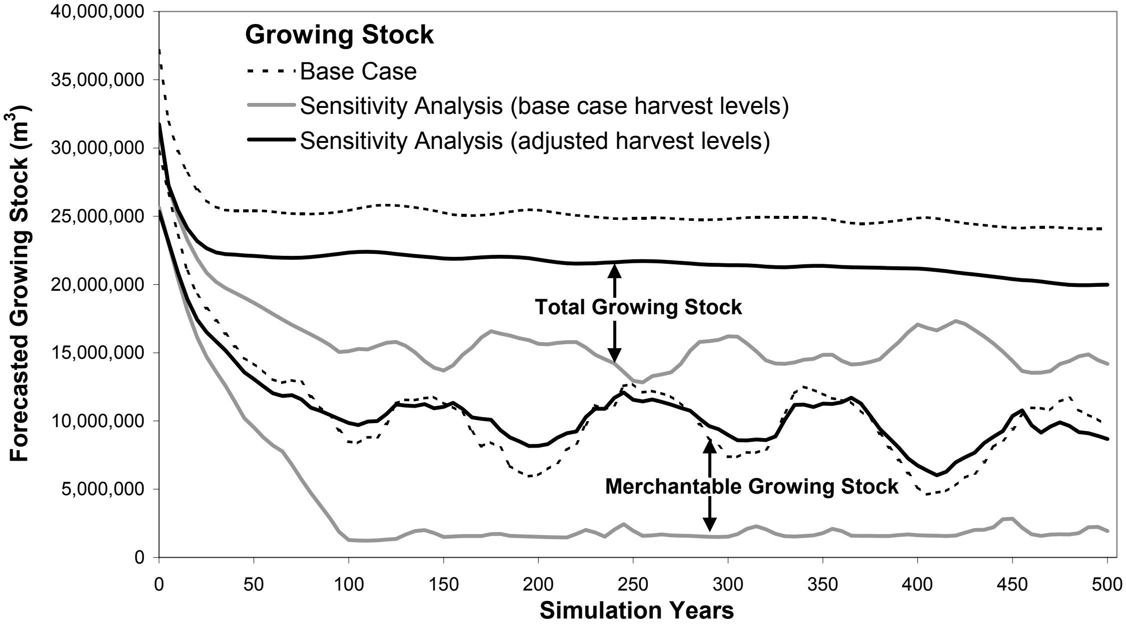

Figure 34: Sensitivity analysis growing stock— Remove hembal-heli stands from the THLB.

Table 11: Summary statistics for changes associated with the sensitivity analysis

	Base Case	Remove Hembal-Heli	Change	Change
Current THLB (ha)	91,294	84,819	-6,475	-7.1%
Future THLB (ha)	90,190	83,948	-6,242	-6.9%
Current Volume (000's m^3)	36,508	31,758	-4,750	-13.0%
Future CMAI (m^3/ha/yr)	8.9	9.1	0.2	2.8%
LRSY (m^3/yr)	803,883	768,062	35,821	-4.5%

Discussion

Removal of hembal-heli stands reduces the current and future THLB by 7% (Table 11). The standing volume removed in this sensitivity analysis is almost double the area removed, indicating the importance of hembal-heli to the short term in the base case. Removing hembal-heli also increases the average productivity of the THLB by 2.8% indicating that the potential site productivity of these stands is lower than the rest of the TFL. The increase in average productivity offsets some of the THLB reduction on the long-run sustainable yield (LRSY).

The harvest forecast for the sensitivity analysis reflects these changes to the size and productivity of the THLB. The short-term harvest level must be reduced by 6.8% (904,000 m^3/yr in 2006). The medium and long terms must be reduced by 4.6%, approximately in proportion to the predicted reduction in LRSY.

5.4.2 Partition helicopter-operable areas

Sensitivity	Regulate harvest from helicopter-operable areas separately from the rest of the TFL.
Rationale	The previous sensitivity analysis (Section 5.4.1) removed helicopter-operable areas with low economic viability. After these removals, 4,383 ha (5%) of the THLB are still considered economically viable using helicopter logging systems. Operability of these areas is especially susceptible to changes in fibre markets, and their contribution to future harvest is uncertain. The risk associated with setting allowable harvest levels can be reduced by separating ("partitioning") the harvest forecast of the helicopter land base from the land base currently accessible through conventional harvest systems. The purpose of this analysis is to determine the timber supply impact of partitioning the currently feasible (non-hembal) helicopter land base. **All comparisons are made to the previous sensitivity analysis (Section 5.4.1) rather than the Base Case**, because both sensitivity analyses exclude hembal-heli from the THLB.
Methods	Separate timber supply runs were performed for the conventional and helicopter land bases. The helicopter land base in this analysis does not include hembal-heli stands removed from the THLB in the previous sensitivity analysis.

Table 12: Summary of the sensitivity analysis— Partition helicopter-operable areas.

	No Partition	Convent-ional	Heli-copter	Total	Change*	% Change
Long-term harvest level (m^3/yr)	745,000	715,000	25,500	**740,500**	-4,500	-0.6%
Medium-term harvest level (m^3/yr)	745,000	704,000	25,500	**729,500**	-15,500	-2.1%
2006 harvest level (m^3/yr)	906,000	852,000	36,000	**888,000**	-18,000	-2.0%
Total short/medium-term harvest (000's m^3)	59,342	56,121	2,278	**58,399**	-943	-1.6%

*Change is measured against the harvest forecast from Sensitivity 5.4.1, not the Base Case

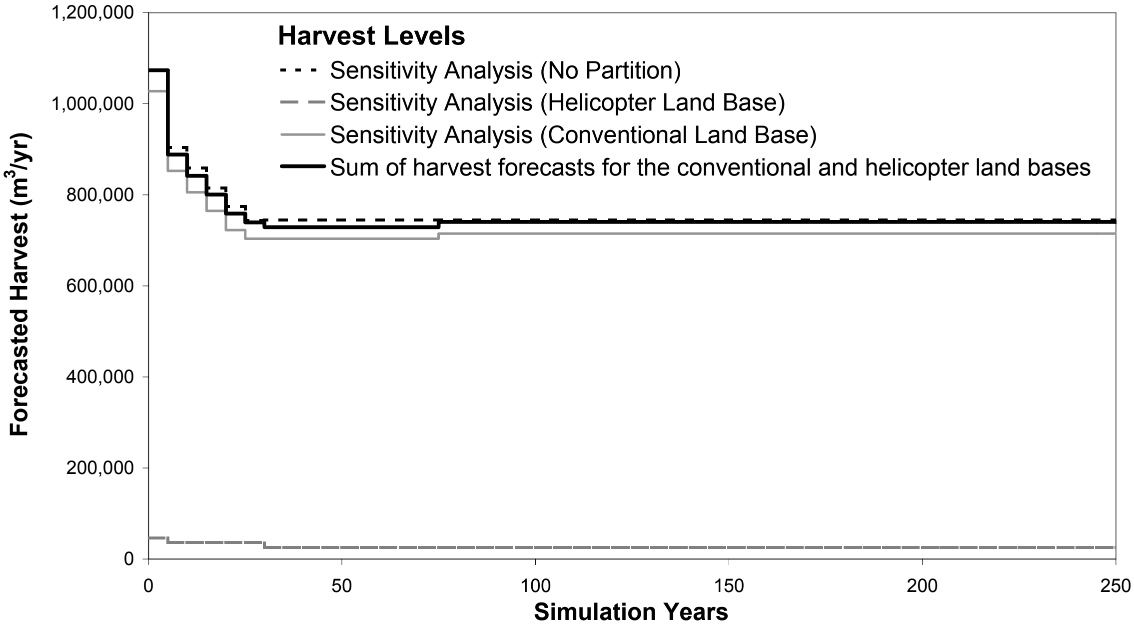

Figure 35: Total harvest forecast resulting from partition of helicopter-operable areas. "No Partition" is the harvest forecast from Sensitivity analysis 5.4.1.

Discussion

The sum of the partitioned harvest forecasts does not add up to the non-partitioned harvest forecast. The harvest reduction associated with partition is greatest in the short and medium terms, but is also present as a small (0.6%) reduction in the long-term harvest level.

Helicopter-operable areas cover 5% of the THLB, contain 8% of the standing inventory of wood volume, and contribute only 3.6% of the Base Case long-term harvest level (Table 13). These results imply that helicopter-operable areas have higher-than-average mature volume and lower-than average site productivity. These attributes make helicopter-operable areas disproportionately important to the short term.

Table 13: Comparison of the conventional and helicopter-operable land bases

	Conventional	Helicopter
Current THLB volume	92%	8%
THLB area	95%	5%
Contribution to the long-term harvest level	96%	4%

Figure 36 illustrates the role of the partition in regulating timber supply. In the absence of controls on how much volume can be harvested from helicopter-operable areas, the harvest in these areas fluctuates considerably. Harvest is high in the first 30 years of the planning horizon, followed by very low harvest between years 30 and 70.

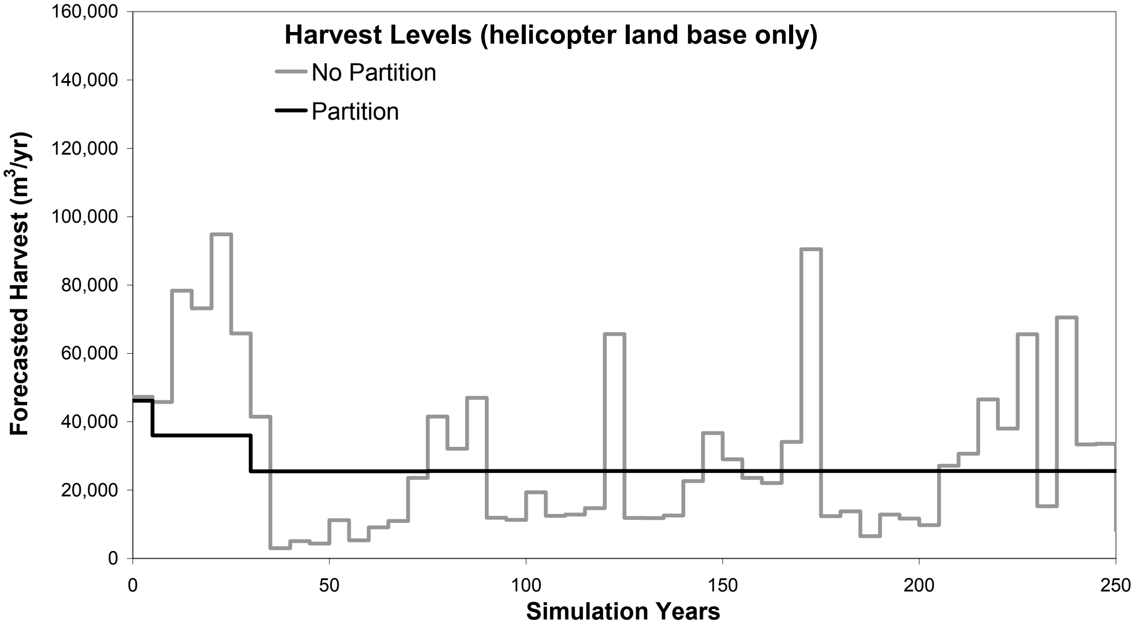

Figure 36: Harvest from the economically viable helicopter land base—partition vs. no partition

The partition reduces harvest in the short term in order to raise the harvest in the medium term. Due to some inflexibility in this transfer, the results indicate a reduction in the total harvest achievable when the timber supply is partitioned. This effect is more subtly expressed in the long term.

5.4.3 Remove marginally economic stands

Sensitivity	Remove areas with marginal economic operability from the THLB.
Rationale	Economic operability is based on the attributes of the existing stands, while physical operability (Section 5.4.4) is determined by factors of access, slope stability, and feasibility of regeneration. The economic operability determination for TFL 37 involved dividing mature stands into Operable and Inoperable stands. This economic operability classification also specified an intermediate operability class for areas that would be operable only under favourable markets. Marginally operable areas were included in the Base Case THLB, and occupy a net area of 6,569 ha (7.2% of the THLB). The purpose of this sensitivity analysis is to test the role of these marginally operable areas to timber supply.
Methods	Marginally operable areas of the THLB were reclassified as non-harvestable land base (NHLB). These areas are eligible to contribute to VQO and mature-plus-old targets, but not to IRM green-up constraints.

Table 14: Summary of the sensitivity analysis— Remove marginally economic stands.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	749,000	-31,000	-4.0%
Medium-term harvest level (m^3/yr)	780,000	749,000	-31,000	-4.0%
Total short/medium-term harvest (000's m^3)	62,415	60,902	-1,512	-2.4%

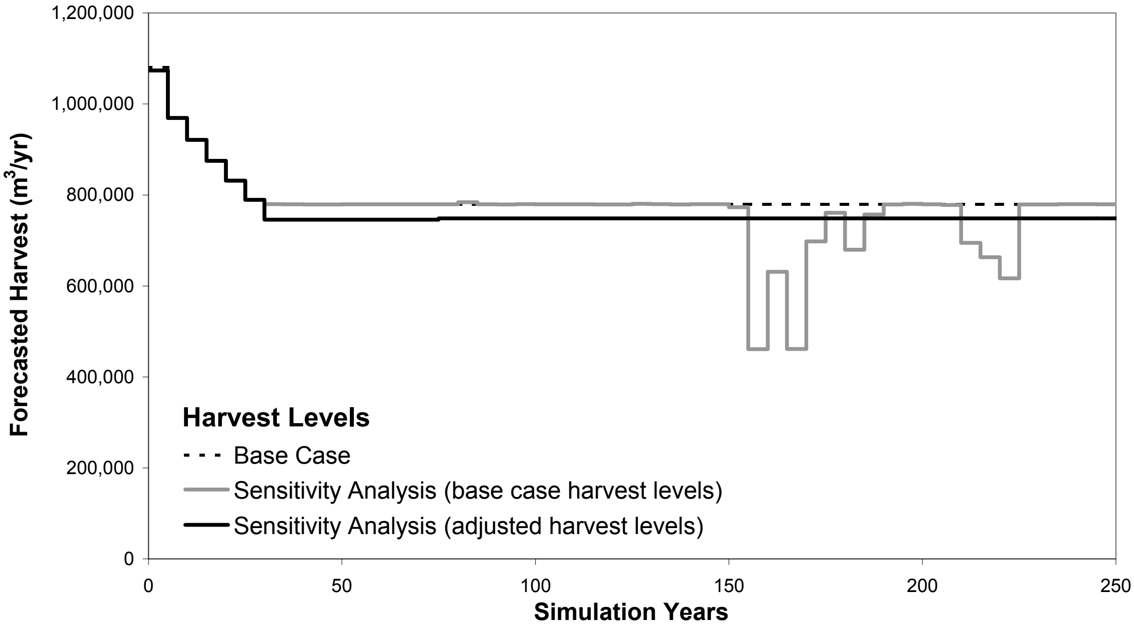

Figure 37: Sensitivity analysis harvest levels— Remove marginally economic stands.

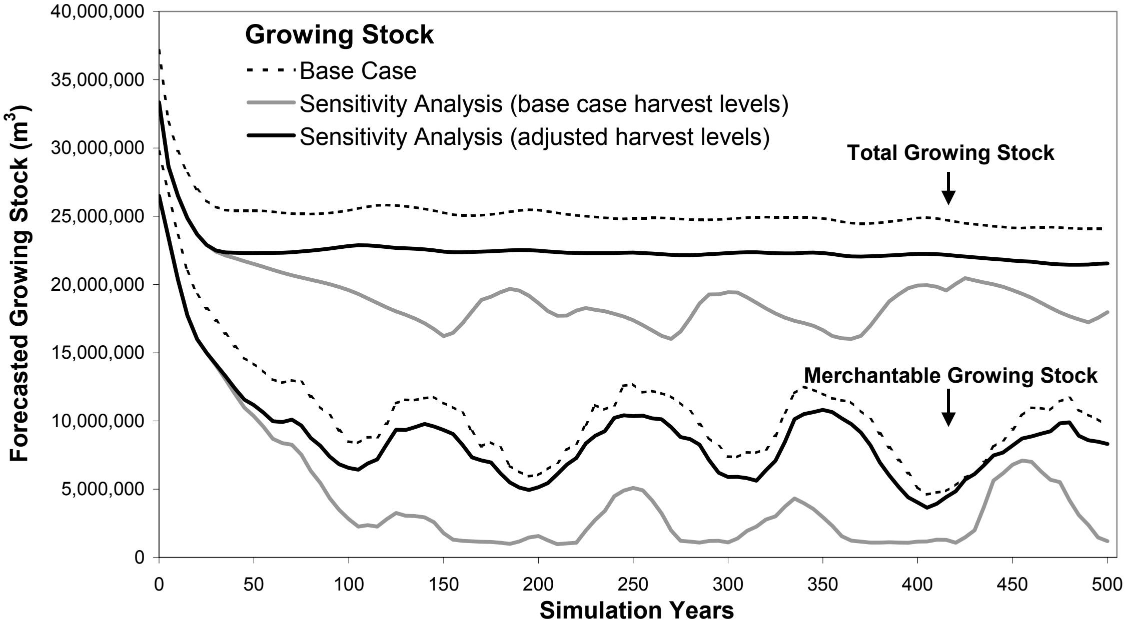

Figure 38: Sensitivity analysis growing stock— Remove marginally economic stands.

Discussion

Excluding marginally economic stands from the THLB produces decline of total and merchantable growing stock, and a large timber supply crash at 150 years that reoccurs periodically throughout the rest of the planning horizon at 100-year intervals. A 4% reduction in the medium and long-term harvest levels is sufficient to stabilize harvest in the long-term. This corresponds to a 2.4% reduction in the total volume harvested over the next 75 years.

5.4.4 Remove conditionally operable

Sensitivity	Remove areas with "conditional" operability from the THLB.
Rationale	The operability determination for TFL 37 involved dividing the land base into Operable and Inoperable areas based on slope, ecology, plantable sites, and terrain stability. This classification also specified an intermediate "conditional" operability class for ecologically sensitive sites that are conditionally available to harvest methods with a softer footprint. Conditionally operable areas were included in the THLB for the Base Case, and occupy a net area of 2,300 ha (2.5% of the THLB). The purpose of this sensitivity analysis is to test the role of these conditionally operable areas to timber supply.
Methods	Conditionally operable areas were reclassified as non-harvestable land base (NHLB). These areas are eligible to contribute to VQO and mature-plus-old targets, but not to IRM green-up constraints.

Table 15: Summary of the sensitivity analysis— Remove conditionally operable.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	770,000	-10,000	-1.3%
Medium-term harvest level (m^3/yr)	780,000	770,000	-10,000	-1.3%
Total short/medium-term harvest (000's m^3)	62,415	61,926	-489	-0.8%

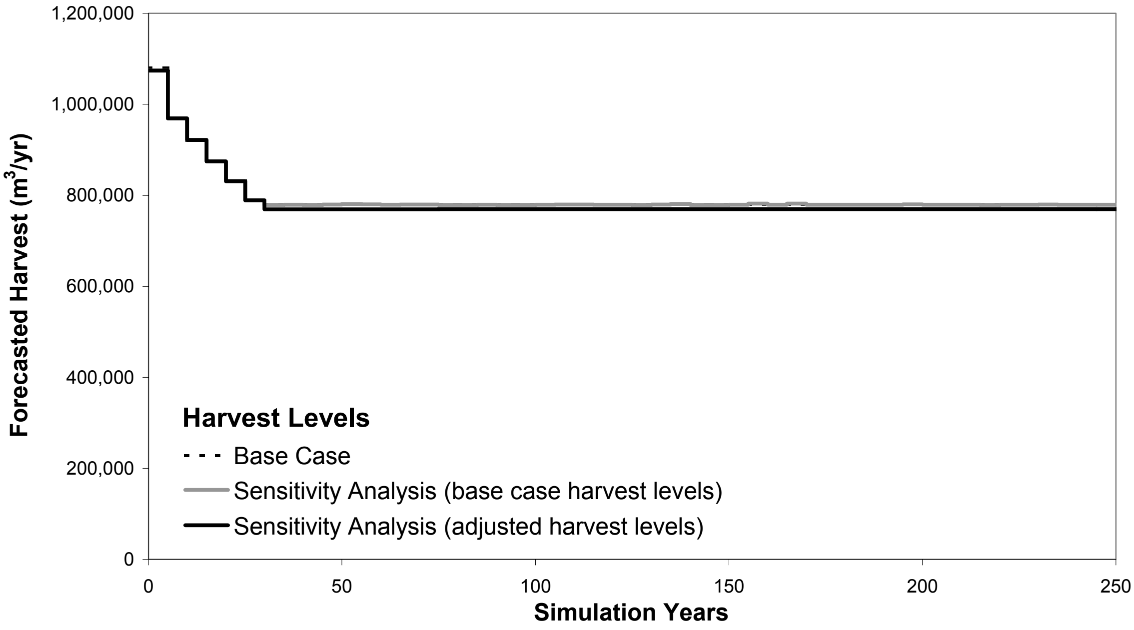

Figure 39: Sensitivity analysis harvest levels—Remove conditionally operable.

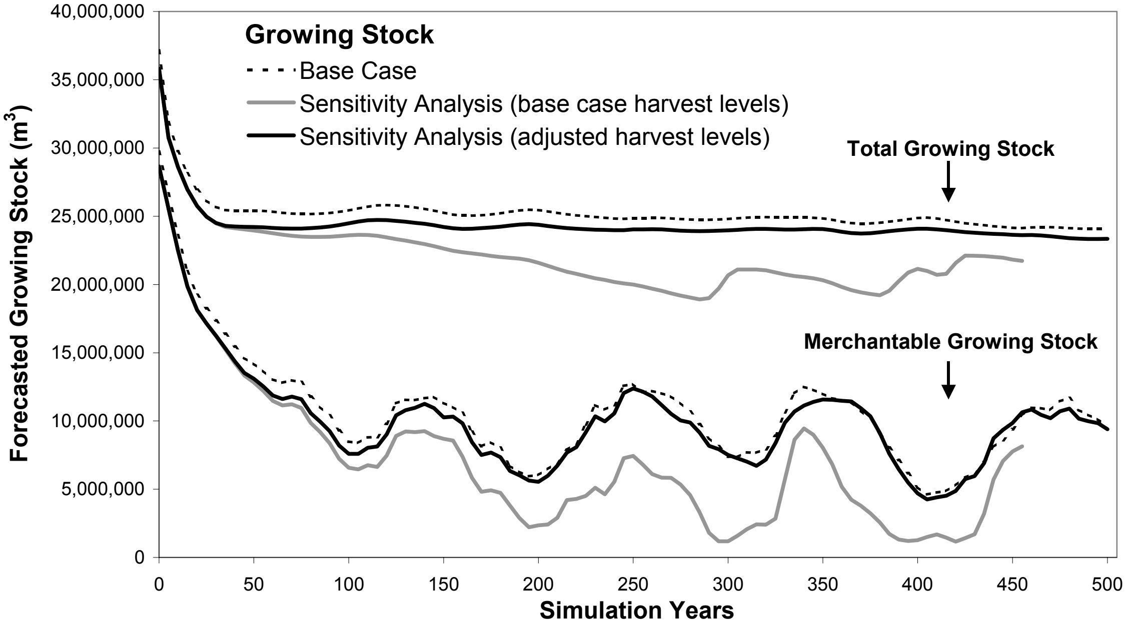

Figure 40: Sensitivity analysis growing stock—Remove conditionally operable.

Discussion

Removing conditionally operable areas creates a decline in total and merchantable growing stock, but does not result in a timber supply crash until 300 years into the planning horizon. A 10,000 m^3/yr reduction in the medium- and long-term harvest level is sufficient to stabilize growing stock throughout the planning horizon.

5.4.5 Return MAMU reserves to THLB

Sensitivity	Return proposed marbled murrelet (MAMU) wildlife habitat areas to the THLB
Rationale	A network of reserves and wildlife habitat areas is being developed in TFL 37 to achieve fine-filter (i.e. species-specific) and coarse-filter (general) biological diversity conservation objectives. The primary reserves are ungulate winter ranges (UWR), northern goshawk (NOGO) territories, old growth management areas (OGMAs), and MAMU nesting habitat. Where possible, these reserves were designed to overlap in order to minimize impacts to the THLB. The integrated nature of this network means that each type of reserve cannot be considered separately for sensitivity analyses. Instead, the impact of the reserves can be assessed by sequentially removing them from the land base. The following three sensitivity analyses demonstrate timber supply impacts by sequentially removing MAMU, OGMA, and NOGO reserves from the THLB.
Methods	The netdown was redone without any removals for MAMU reserves. Other land base removals within MAMU reserves still apply.

Table 16: Summary of the sensitivity analysis— Return MAMU reserves to THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	787,000	7,000	0.9%
Medium-term harvest level--Alternative 1 (m^3/yr)	780,000	798,000	18,000	2.3%
Year 2006 harvest level--Alternative 2 (m^3/yr)	970,000	993,000	23,000	2.4%
Total short/medium-term harvest (000's m^3)	62,415	63,272	857	1.4%

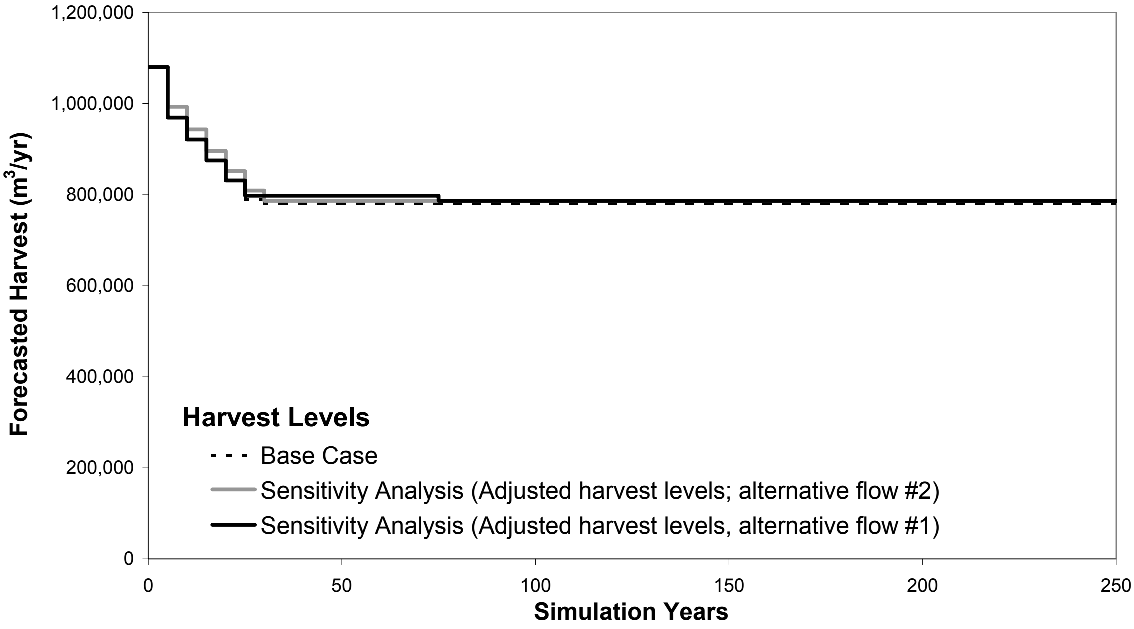

Figure 41: Sensitivity analysis harvest levels— Return MAMU reserves to THLB.

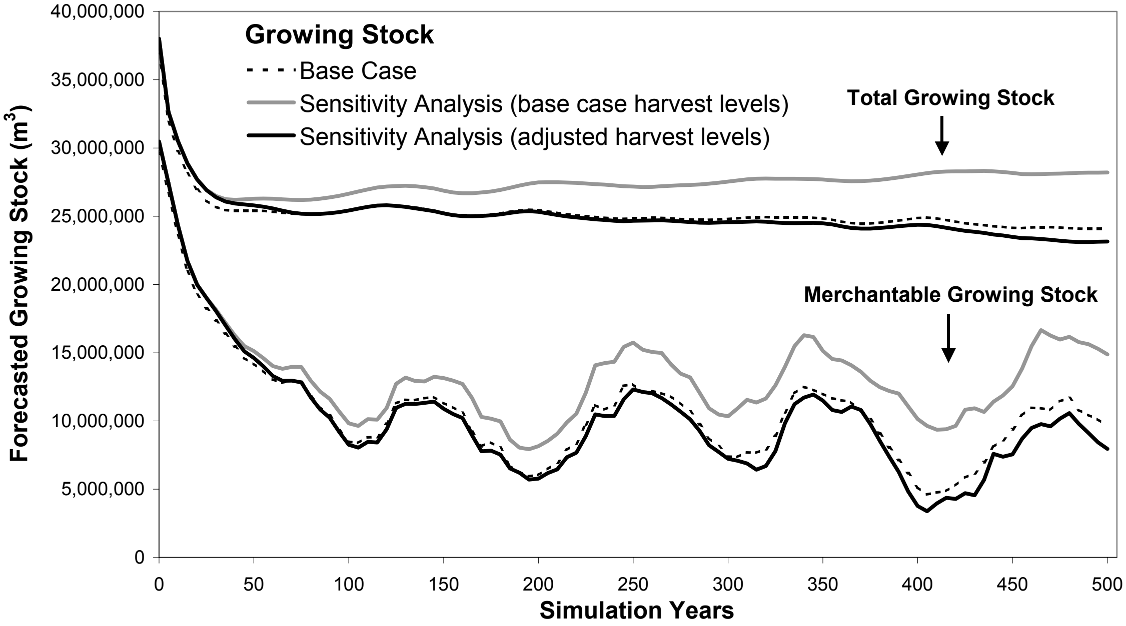

Figure 42: Sensitivity analysis growing stock— Return MAMU reserves to THLB.

Discussion

Returning MAMU reserves to the THLB has the immediate effect of increasing the merchantable growing stock at year zero by 750,000 m^3 (2.6%). At Base Case harvest levels, this surplus persists through the medium-term and then accumulates due to the increased THLB. There is no “pinch point” (acute shortage of merchantable volume) in the short and medium-terms, so the surplus volume can be harvested at any point during this period. It can be used to raise the medium-term harvest level by 2.3% to 798,000 m^3/yr (alternative flow 1), or it can be used to raise the 2006 harvest level by 2.4% to 993,000 m^3/yr (alternative flow 2). The total volume harvested in the short and medium-terms is greater than the initial increase in growing stock (857,000 m^3 vs. 750,000 m^3) because future stands regenerated from harvested MAMU habitat displace existing managed stands towards the present and thereby allow higher harvest in the medium-term. Returning MAMU reserves to the THLB allows a 0.9% increase in the long-term harvest level.

Timber harvesting in the short-term is largely supported by the legacy of volume in old growth stands. Despite the slow growth of natural stands, high harvest levels are possible in the short-term because these stands have high volumes. Because they are entirely composed of old growth and mature stands, MAMU reserves have an importance to the short and medium-terms that is disproportionate to their area. This observation also applies to OGMAs and northern goshawk reserves.

The network of reserves designed to protect marbled murrelet nesting habitat is extensive, and covers a total area of 9,454 ha. Much of this network is also designated as OGMAs, however, and only 11% of this area would otherwise be THLB. As a result, the net timber supply impact of this sensitivity analysis is small compared to the total area of MAMU reserves.

5.4.6 Return MAMU reserves and OGMAs to THLB

Sensitivity Analysis	Return both MAMU reserves and OGMAs to THLB
Rationale	See rationale in section 5.4.4
Methods	The netdown was redone without any removals for OGMAs and MAMU reserves. Other land base removals within these reserves still apply.

Table 17: Summary of the sensitivity analysis— Return MAMU reserves and OGMAs to THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	801,000	21,000	2.7%
Medium-term harvest level--Alternative 1 (m^3/yr)	780,000	836,000	56,000	7.2%
Year 2006 harvest level--Alternative 2 (m^3/yr)	970,000	1,046,000	76,000	7.8%
Total short/medium-term harvest (000's m^3)	62,415	65,193	2,778	4.5%

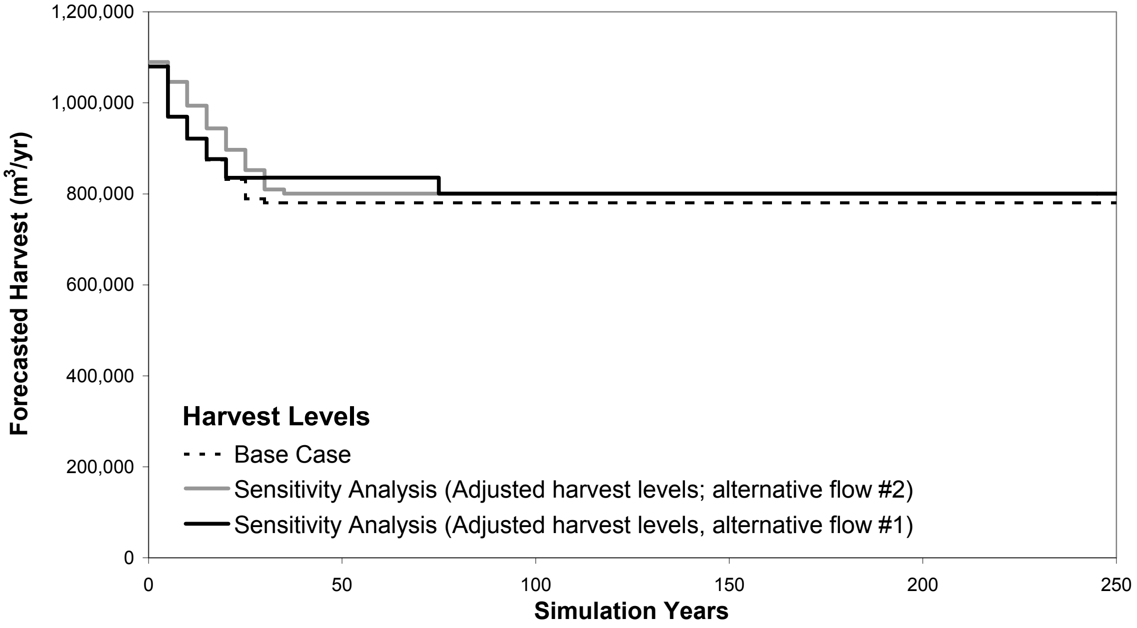

Figure 43: Sensitivity analysis harvest levels— Return MAMU reserves and OGMAs to THLB.

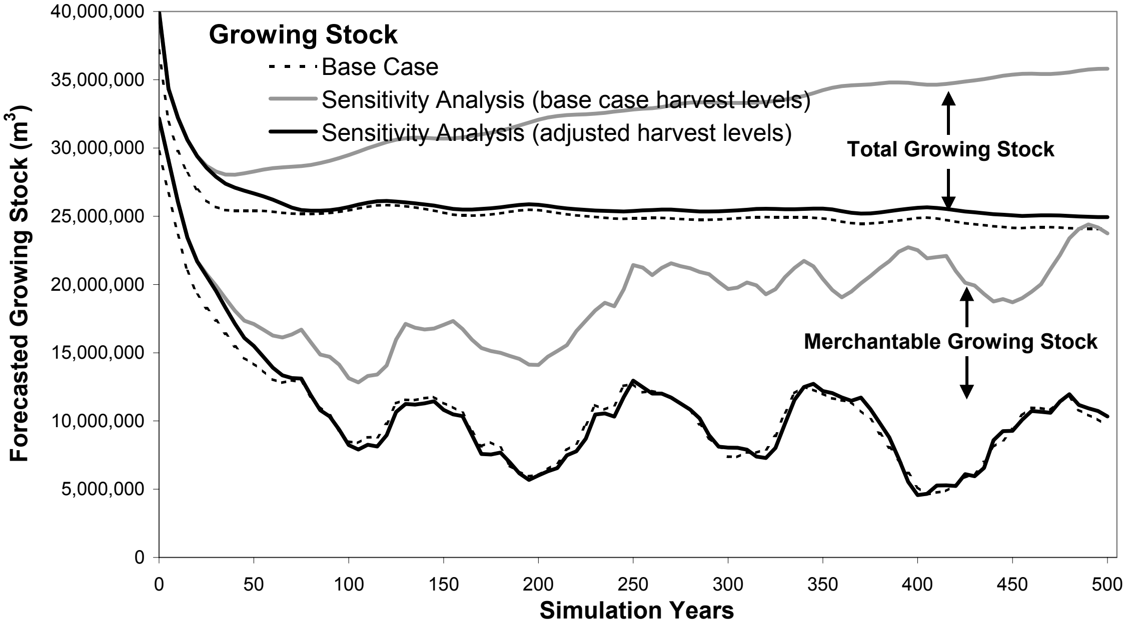

Figure 44: Sensitivity analysis growing stock— Return MAMU reserves and OGMAs to THLB.

Discussion

Returning both MAMU and OGMA reserves to the THLB has the immediate effect of increasing the total and merchantable growing stock at year zero by 2,400,000 m^3 (8.6%). At Base Case harvest levels, this surplus persists through the medium-term and then accumulates due to the increased THLB. Similar to the previous sensitivity analysis, the surplus volume can be used to raise the medium-term harvest level by 7.2% to 836,000 m^3/yr (alternative flow 1), or it can be used to raise the 2006 harvest level by 8.1% to 1,046,000 m^3/yr (alternative flow 2). Similar to the previous sensitivity analysis, the total volume harvested in the short and medium-terms is greater than the initial increase in growing stock (2.8 million m^3 vs. 2.4 million m^3) because future stands are available sooner, allowing faster harvest of existing managed stands. Returning MAMU and OGMA reserves to the THLB allows a 2.7% increase in the long-term harvest level.

5.4.7 Return MAMU reserves, OGMAs, and NOGO territories to THLB

Sensitivity	Return MAMU reserves, OGMAs, and NOGO territories to THLB
Rationale	See rationale in section 5.4.4
Methods	The netdown was redone without any removals for NOGO territories, OGMAs and MAMU reserves. Other land base removals within these reserves still apply.

Table 18: Summary of the sensitivity analysis—Return MAMU/OGMAs/NOGO to THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	812,000	32,000	4.1%
Medium-term harvest level—Alternative 1 (m^3/yr)	780,000	860,000	80,000	10.3%
Year 2006 harvest level—Alternative 2 (m^3/yr)	970,000	1,068,000	98,000	10.1%
Total short/medium-term harvest (000's m^3)	62,415	66,529	4,115	6.6%

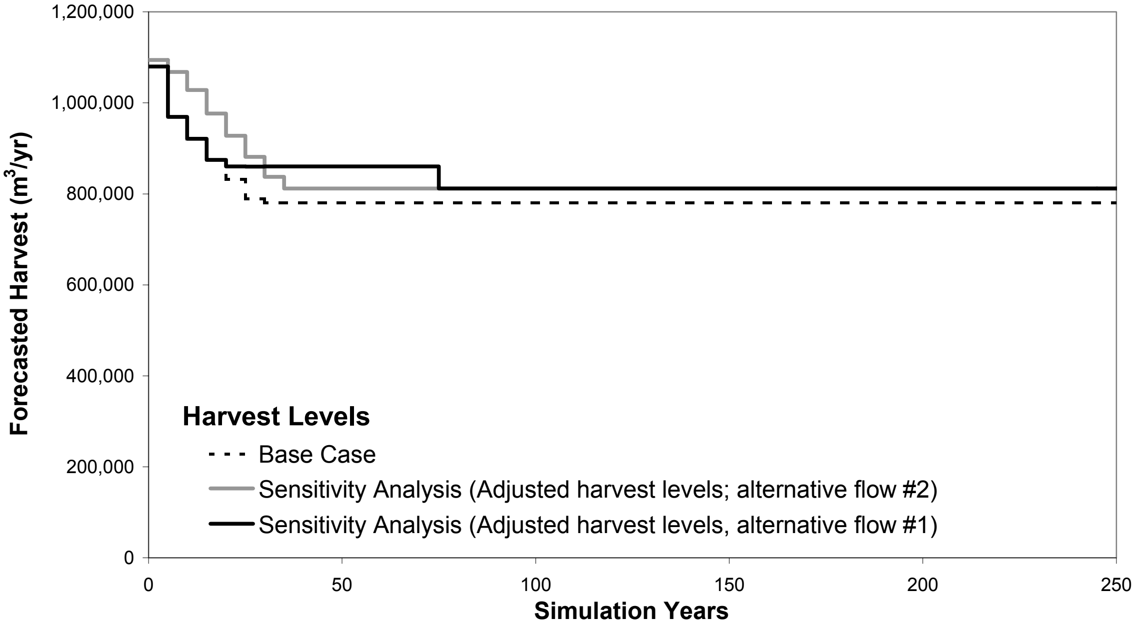

Figure 45: Sensitivity analysis harvest levels— Return MAMU/OGMAs/NOGO to THLB.

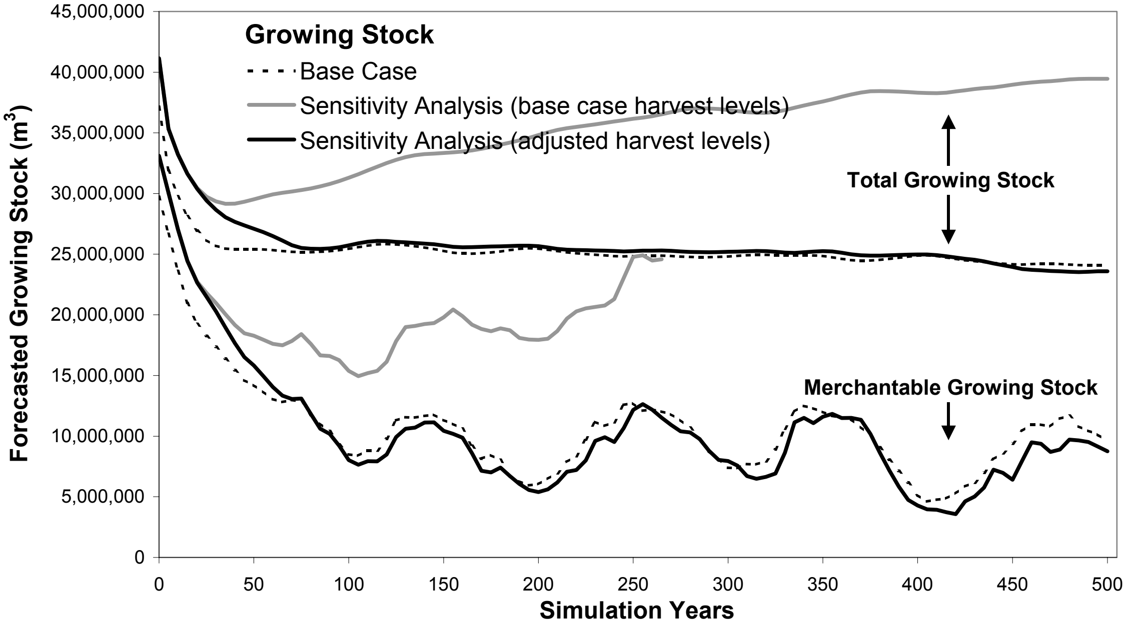

Figure 46: Sensitivity analysis growing stock— Return MAMU/OGMAs/NOGO to THLB.

Discussion

Returning MAMU, OGMA, and NOGO reserves to the THLB increases the merchantable growing stock at year zero by 3,400,000 m^3 (11.9%). At Base Case harvest levels, this surplus accumulates through the medium and long-terms due to the increased THLB. The surplus volume can be used to raise the medium-term harvest level by 10.3% to 860,000 m^3/yr. It can also be used to raise the 2006 harvest level 8.1% to the current AAC of 1,068,000 m^3/yr. Similar to the previous sensitivity analysis, the total volume harvested in the short and medium-terms is greater than the initial increase in growing stock because future stands are available sooner, allowing faster harvest of existing managed stands. Returning MAMU, OGMA, and NOGO reserves to the THLB allows a 4.1% increase in the long-term harvest level.

5.5 GROWTH AND YIELD

5.5.1 Reduce natural stand volumes by 10%

Sensitivity	Reduce natural stand volumes by 10%
Rationale	Current inventory volumes for TFL 37 are estimated by VDYP and adjusted for bias using the Phase II VRI methodology. The purpose of this sensitivity analysis is to test the risk associated with an overestimation in volumes predicted by the vegetation resources inventory.
Methods	Total and species-specific volumes of the yield tables for the Old and Transitional yield populations were multiplied by 0.9. Minimum harvest ages were recalculated accordingly.

Table 19: Summary of the sensitivity analysis— Reduce natural stand volumes by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	710,000	-70,000	-9.0%
Total short/medium-term harvest (000's m^3)	62,415	59,430	-2,985	-4.8%

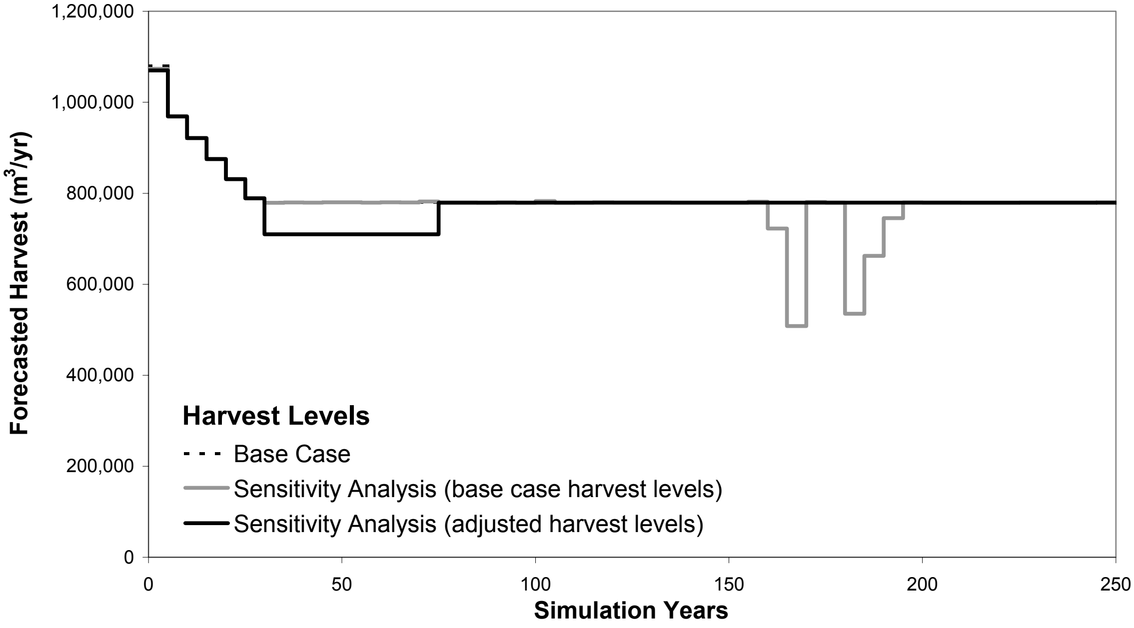

Figure 47: Sensitivity analysis harvest levels— Reduce natural stand volumes by 10%.

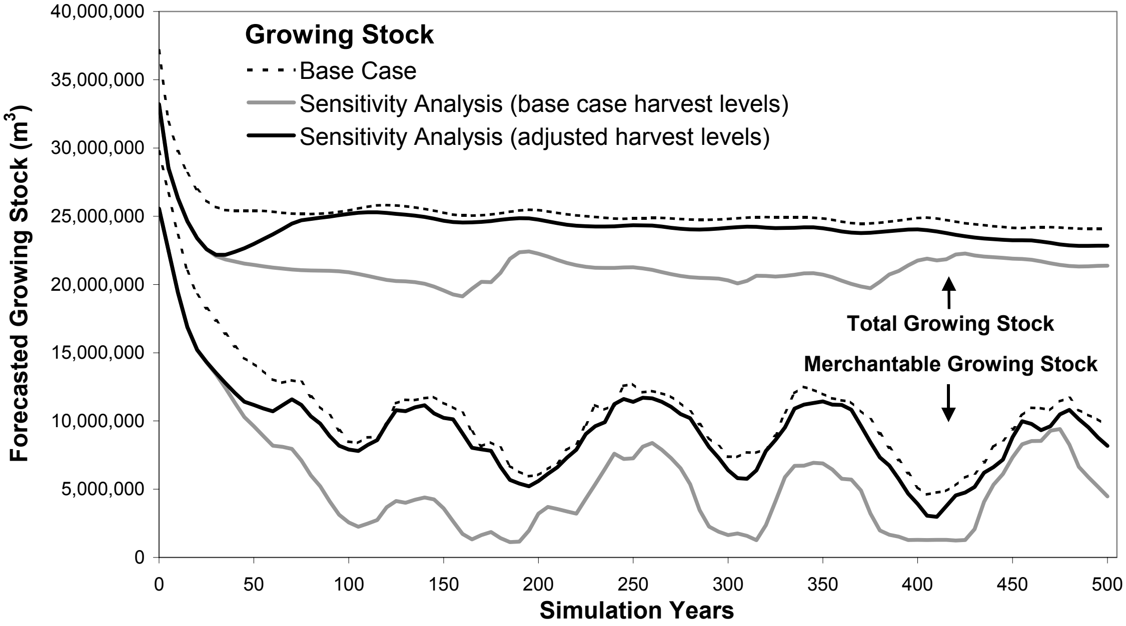

Figure 48: Sensitivity analysis growing stock— Reduce natural stand volumes by 10%.

Discussion

Natural stands make up 51% of the harvest in the short and medium-terms (<75 years into the planning horizon). A directly proportional response to the 10% reduction in natural stand yields would be a 5.1% reduction in volume harvested over the short and medium-terms. However, the sensitivity analysis showed a 4.8% reduction in the volume harvested over this period. This reduced impact is likely a result of maintaining the rate of conversion from natural stands to fast-growing future managed stands, by maintaining harvest levels in the short-term. The 10% reduction is evident in the total growing stock at year zero. Reducing the medium-term harvest level allows the growing stock to recover to Base Case levels by the beginning of the medium-term.

5.5.2 Reduce existing managed stand volumes by 10%

Sensitivity	Reduce existing managed stand volumes by 10%
Rationale	As seen in Section 4.2.3, existing managed stands are not harvested in the short-term, but are the dominant source of volume in the medium-term. The purpose of this sensitivity analysis is to assess the risk associated with an overestimation in the growth of existing managed stands.
Methods	Total and species-specific volumes of the yield tables for the Existing Managed yield population were multiplied by 0.9. Minimum harvest ages were recalculated accordingly.

Table 20: Summary of the sensitivity analysis— Reduce existing MSYTs by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
First 50 years of the long-term (76 to 125 years)	780,000	770,000	-10,000	-1.3%
Medium-term harvest level (m^3/yr)	780,000	725,000	-55,000	-7.1%
Total short/medium-term harvest (000's m^3)	62,415	60,067	-2,348	-3.8%

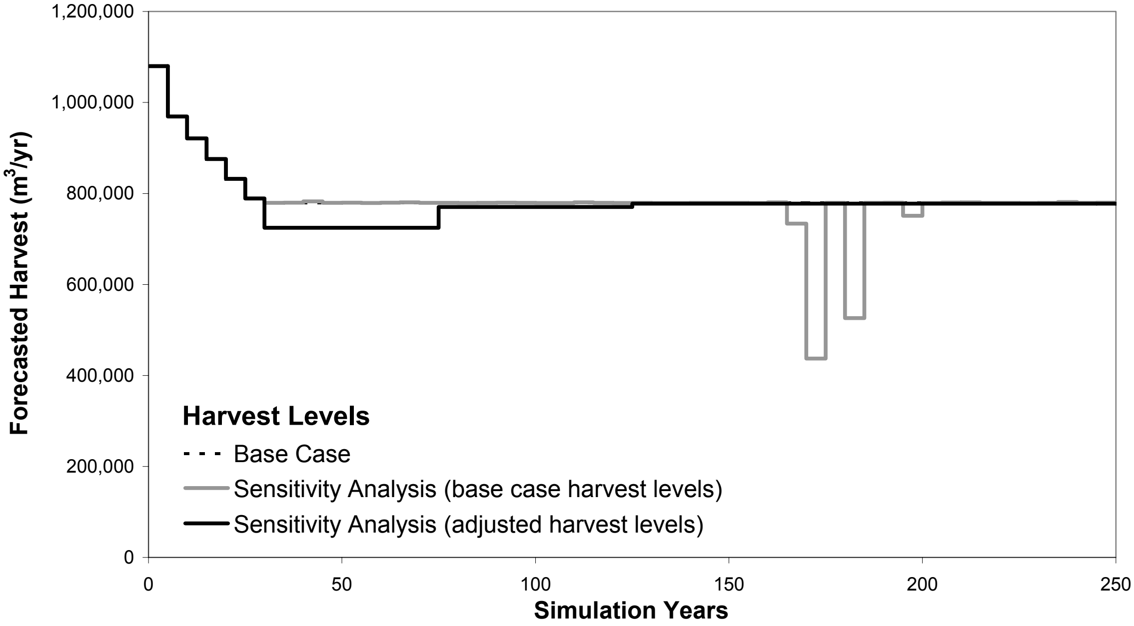

Figure 49: Sensitivity analysis harvest levels— Reduce existing MSYTs by 10%.

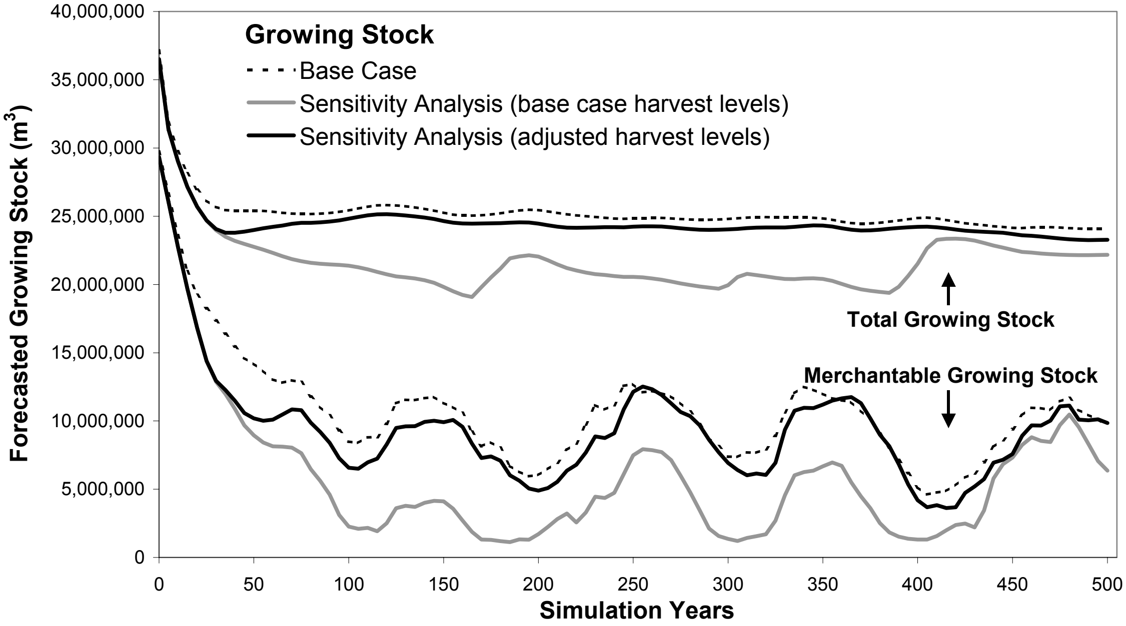

Figure 50: Sensitivity analysis growing stock— Reduce existing MSYTs by 10%.

Discussion

A 10% reduction in existing MSYTs has a very similar effect as the 10% reduction to natural stand yields, and requires similar adjustments to harvest levels. In the previous sensitivity analysis (section 5.5.1) the 10% reduction in natural stand yields was immediately evident as a 10% reduction in the total and merchantable growing stock at year 0 of the planning horizon. A 10% reduction in existing managed stand yields has no effect on growing stock at the beginning of the planning horizon, but at Base Case harvest level it results in a similar deficit of growing stock in the medium-term. Similar to the natural stand sensitivity analysis, a reduction in the medium-term harvest level allows growing stock accumulate back to Base Case levels. However, existing managed stands also make a substantial contribution to the first fifty years of the long-term, and so a small reduction during this period is necessary to achieve equilibrium during the remainder of the planning horizon.

5.5.3 Inventory site index for CWHvm2 managed stand yield tables

Sensitivity	Model the productivity of CWHvm2 managed stands using inventory site index.
Rationale	Performance of managed stands in higher elevation areas of TFL 37 is difficult to assess because few managed stands exist in these areas. Expert opinion indicates that productivity of managed stands in the CWHvm2 decreases with elevation. Base Case site index for managed stands in this BGC variant was estimated using an elevation model. A subjective sample implied that the elevation model provides an unbiased estimate of site index in existing PHR stands. However, statistical confidence cannot be determined for the elevation model because the sample was non-random. While the elevation model provides an educated best guess for site index in the CWHvm2, productivity of managed stands in this BGC variant remains a major uncertainty in timber supply analysis for TFL 37. Traditional TSR assumptions have used photo-interpreted forest cove inventory site index for existing and future managed stands. This sensitivity analysis tests the timber supply effects of using inventory site index for existing and future managed stands in the CWHvm2.
Methods	An additional set of polygon MSYTs was produced by JS Thrower & Associates, using identical assumption as the Base Case MSYTs, but using inventory site index. Minimum harvest ages were recalculated for these MSYTs.

Table 21: Summary of the sensitivity analysis— Inventory site index for CWHvm2 stands.

	Base Case	Sensitivity	Change	% Change
Long-term harvest level (m^3/yr)	780,000	768,000	-12,000	-1.5%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Year 2006 harvest level (m^3/yr)	970,000	1,068,000	98,000	10.1%
Total short/medium term harvest (000's m^3)	62,415	64,978	2,563	4.1%

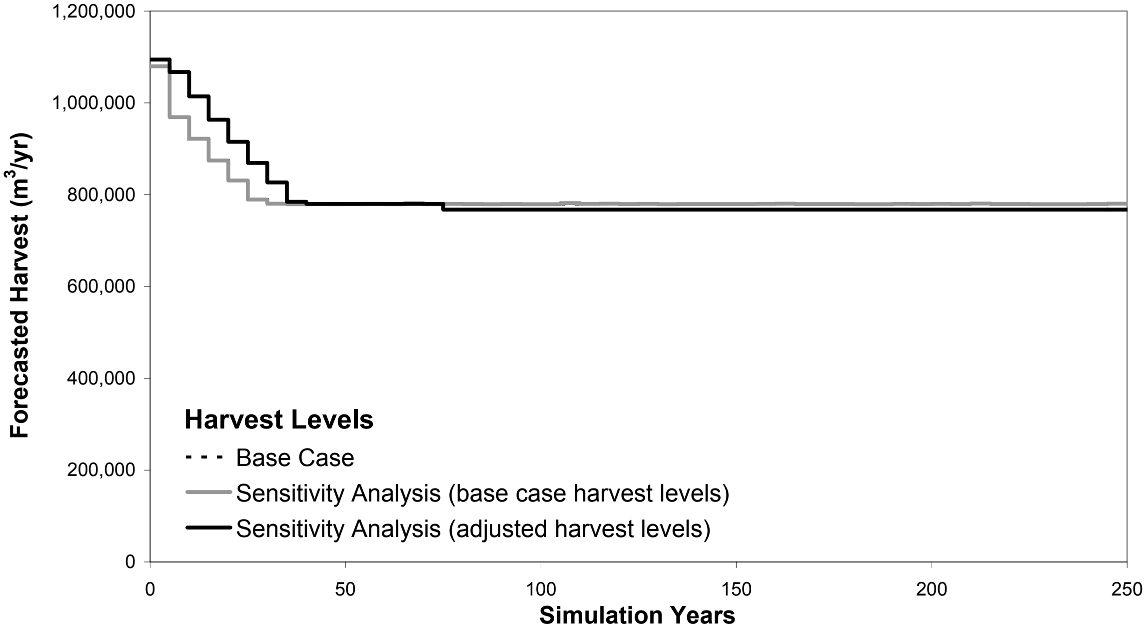

Figure 51: Sensitivity analysis harvest levels— Inventory site index for CWHvm2 MSYTs.

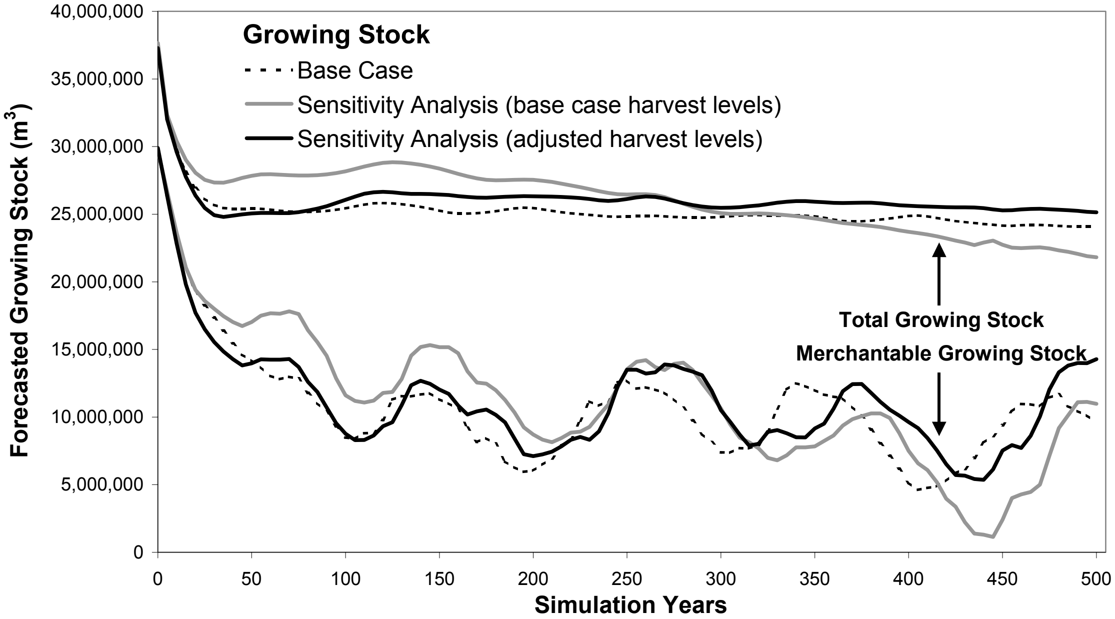

Figure 52: Sensitivity analysis growing stock— Inventory site index for CWHvm2 MSYTs.

Discussion

At Base Case harvest levels, total growing stock accumulates in the medium term but declines unsustainably in the long term. The surplus growing stock in the medium term is approximately 3.5 million m^3. While this surplus could be used to increase the medium term harvest level, it can alternatively support a 10% increase in the short-term harvest level, as shown in Figure 51. The long-term harvest level must be reduced by 1.5%.

These results indicate that inventory site index has increased the productivity of existing MSYTs and reduced the productivity of future MSYTs. Figure 53 verifies this inference: existing and future MSYTs have similar productivity in the Base Case, but differ substantially in the sensitivity analysis. Average inventory site index in the existing managed stands is 33% higher than average elevation model site index. This difference translates to a 75% increase in volume yields at culmination age.

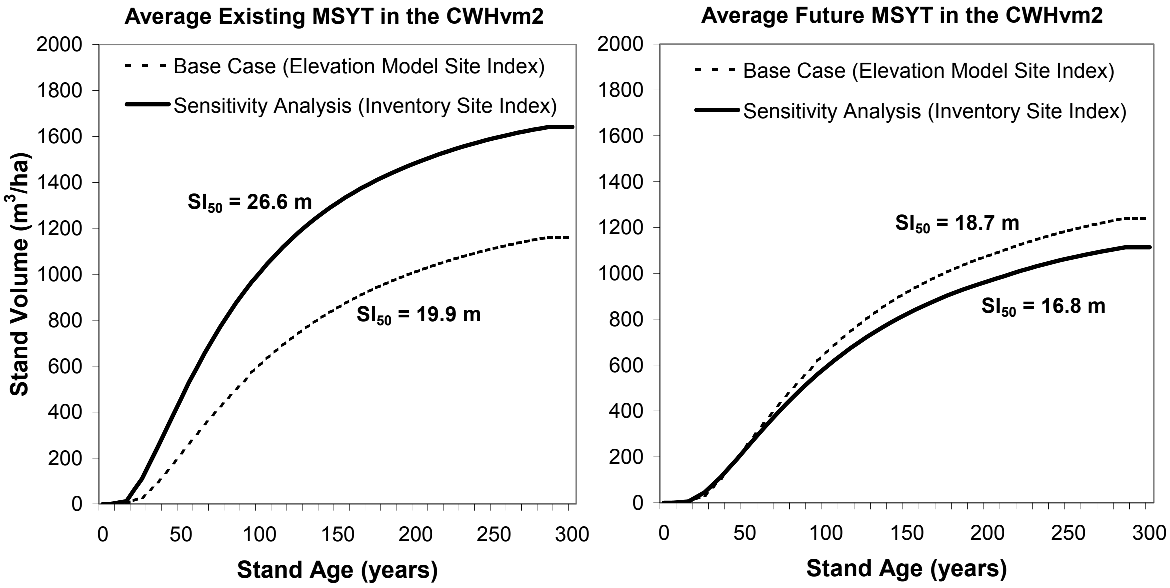

Figure 53: Comparison of the average MSYTs for the Base Case and the sensitivity analysis

Figure 54 shows the harvest timing of CWHvm2 managed stands in this sensitivity analysis. Existing managed stands in the CWHvm2 are projected to be harvested during the first 50 years of the long term (75-125 years into the planning horizon). Nevertheless, the increased volume associated with higher site index in the CWHvm2 existing managed stands allows faster harvest rates of natural stands in the short term. In this way, the growth rate of existing managed stands directly influences the short-term harvest level.

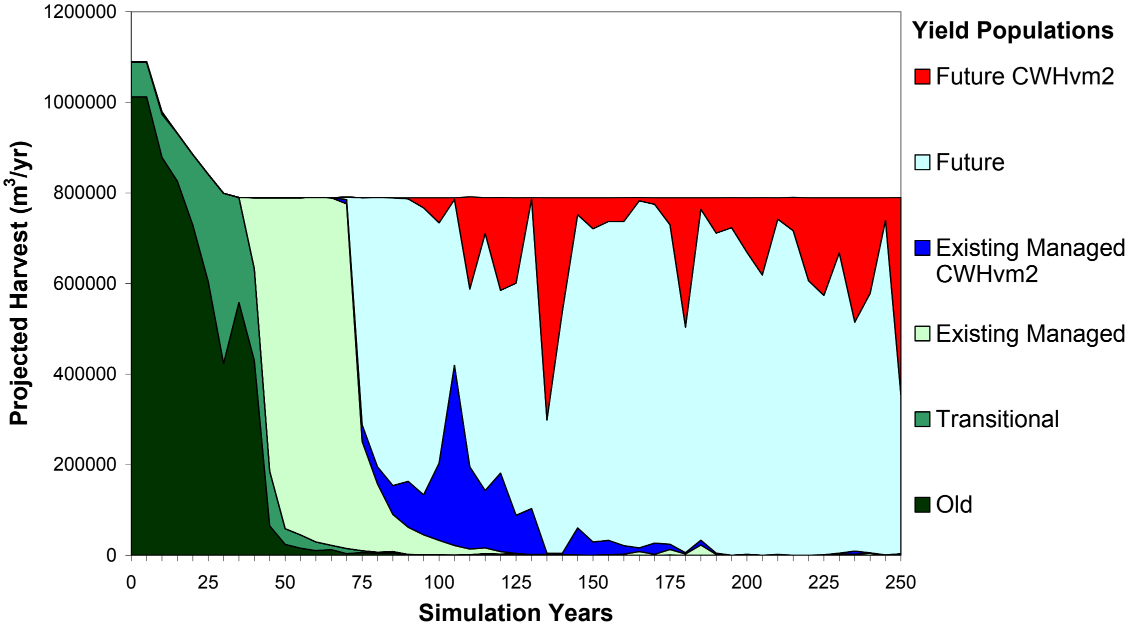

Figure 54: Harvest timing of existing (blue) and future (red) managed stands in the CWHvm2—Inventory site index sensitivity analysis at Base Case harvest levels.

Non-random field measurements on an elevation transect suggest (albeit with no statistical confidence) that the elevation model is not biased for the existing managed population of the CWHvm2. Consequently, the results shown in Figure 53 imply that inventory site index overestimates productivity of existing managed stands in the CWHvm2. For the purposes of setting an AAC, this sensitivity analysis suggests that the elevation model is more conservative than the forest cover inventory as a basis for site index assumptions in the CWHvm2. However, the productivity of managed stands in the CWHvm2 will remain an important uncertainty in timber supply analysis for TFL 37 until a random sample of managed stands can be obtained for this variant.

5.5.4 TIPSY for transitional stands

Sensitivity	Model growth of transitional (41-80 year old) stands with TIPSY instead of VDYP.
Rationale	40-80 year old stands are called "transitional" stands because they represent an intermediate step between natural stands originating from natural disturbance and managed stands originating from modern industrial forestry. They were modeled in the Base Case using VDYP because although they originate almost exclusively from logging, they were not actively regenerated using the silviculture techniques assumed under TIPSY. Several participants in the development of the timber supply assumptions for this analysis felt that transitional stands were atypical of the population for which VDYP is calibrated. Natural regeneration of transitional stands in TFL 37 has generally produced even-aged stands with attributes that are similar to managed stands. The purpose of this sensitivity analysis is to determine the timber supply impacts of modeling transitional stands as managed stands.
Methods	JS Thrower & Associates produced a separate set of yield tables for transitional stands in BatchTIPSY. Assumptions were the same as those used for existing managed stands in the Base Case, except that natural regeneration was assumed. These polygon-specific yield tables were clustered into analysis units using the process described for existing managed stands in the Information package.

Table 22: Summary of the sensitivity analysis— TIPSY for transitional stands.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level—Alternative 1 (m^3/yr)	780,000	823,000	43,000	5.5%
Year 2006 harvest level—Alternative 2 (m^3/yr)	970,000	1,054,000	84,000	8.7%
Total short/medium-term harvest (000's m^3)	62,415	64,580	2,165	3.5%

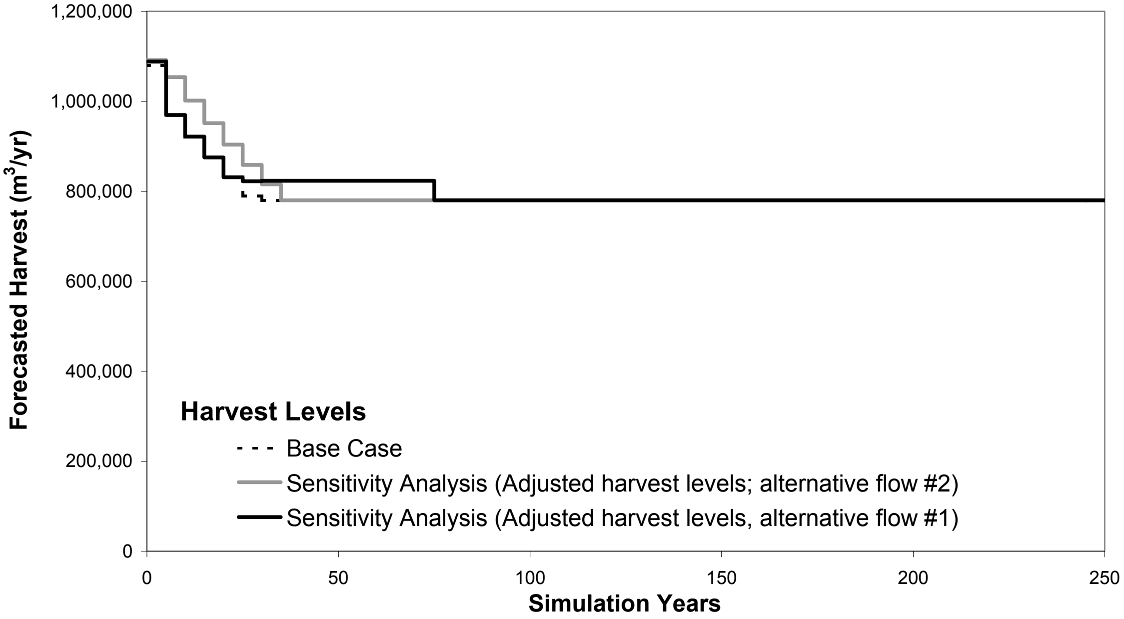

Figure 55: Sensitivity analysis harvest levels— TIPSY for transitional stands.

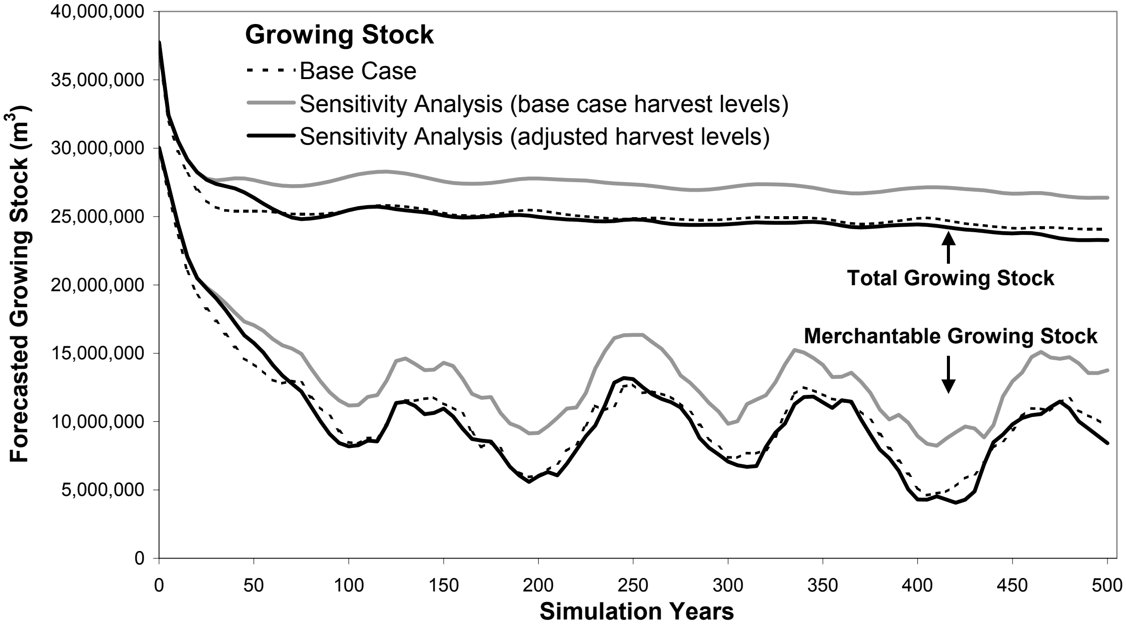

Figure 56: Sensitivity analysis growing stock— TIPSY for transitional stands.

Discussion

Modeling transitional stands with TIPSY has no effect on the initial growing stock, but it results in a progressive accumulation of growing stock during the short-term, relative to the Base Case. This surplus of volume displaces harvest of existing managed stands and eventually future managed stands, which allows the surplus to persist throughout the planning horizon at Base Case harvest levels. Raising the medium-term harvest level 5.5% to 823,000 m^3/yr (Alternative Flow 1) draws down the surplus growing stock to Base Case levels. Following the medium-term, growing stock develops similar to the Base Case. The volume surplus created by higher yields from transitional stands could also support an 8.7% increase in the short-term harvest level (Alternative Flow 2).

5.5.5 Increase OAF1 to 15%

Sensitivity	Increase OAF1 to 15%
Rationale	Instead of the standard 15% typically used in British Columbia timber supply analyses, the managed stand yield tables for the Base Case use an OAF1 of 10% combined with a netdown for non-productive areas mapped by the TEM. Albert Nussbaum (Senior Analysis Forester, MoF Analysis Section) approved this approach for the Base Case (pers. comm. May 29, 2003), on the condition that a sensitivity analysis is run to test the timber supply effects of applying standard OAF1 to the MSYTs. This sensitivity is similar to the previous two analyses (Sections 5.5.1 and 5.5.2) because it is equivalent to testing the sensitivity of the Base Case to a 5% yield overestimation in managed stands.
Methods	Total and species-specific volumes of the yield tables for the Existing Managed and Future yield populations were uniformly multiplied by 0.9525, the reduction factor necessary to increase OAF1 from 10% to 15%. Minimum harvest ages were recalculated accordingly.

Table 23: Summary of the sensitivity analysis— Increase OAF1 to 15%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	740,000	-40,000	-5.1%
Medium-term harvest level (m^3/yr)	780,000	730,000	-50,000	-6.4%
Total short/medium-term harvest (000's m^3)	62,415	60,264	-2,151	-3.4%

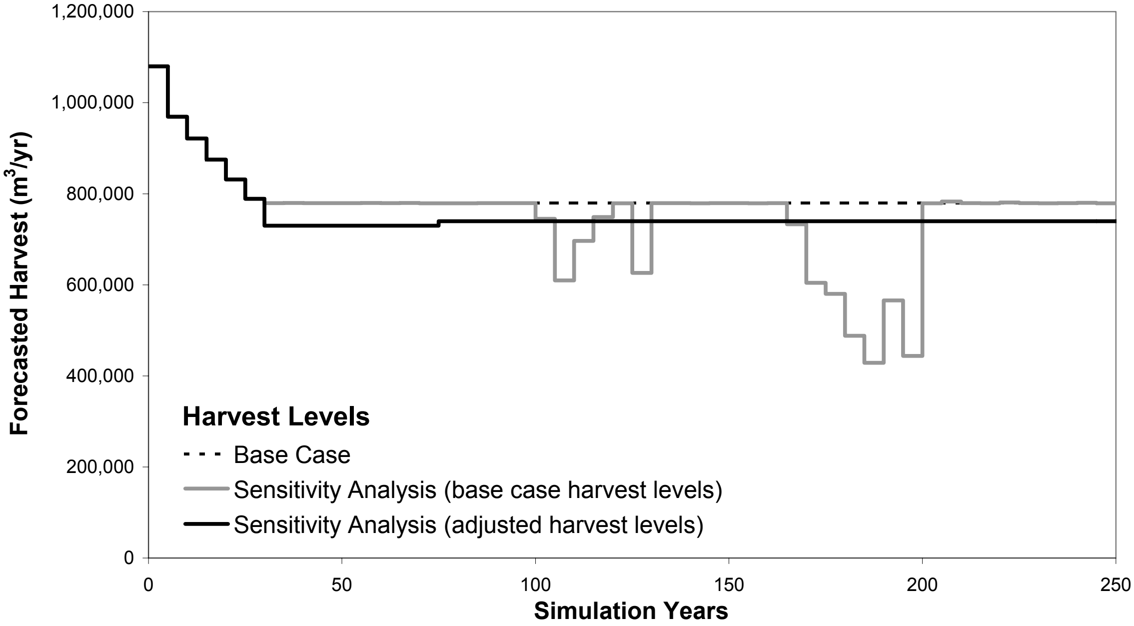

Figure 57: Sensitivity analysis harvest levels— Increase OAF1 to 15%.

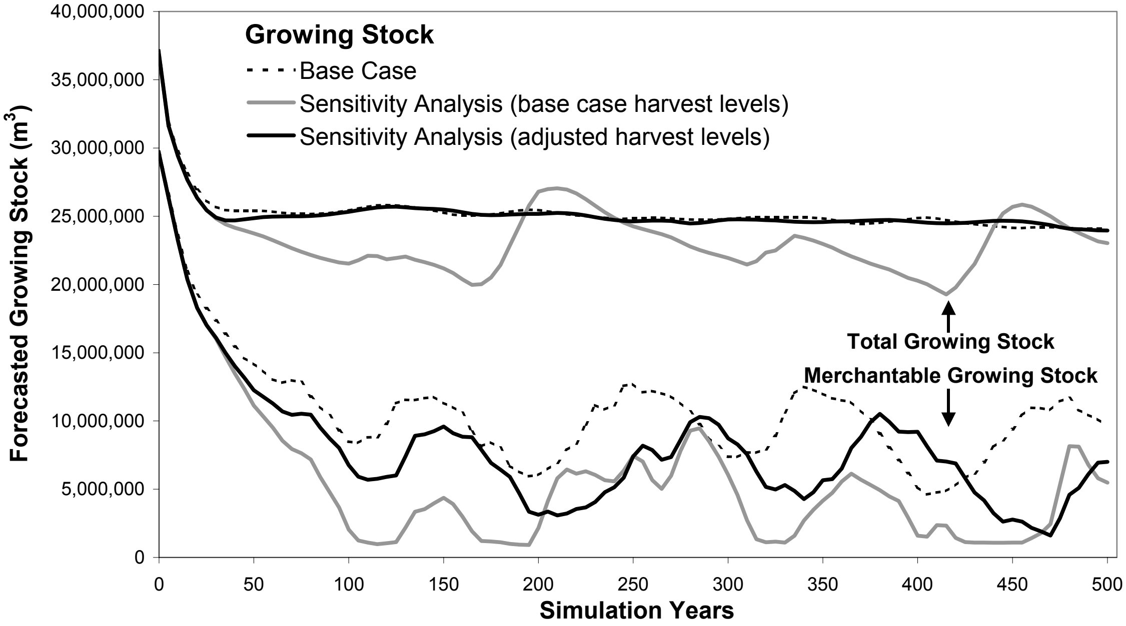

Figure 58: Sensitivity analysis growing stock— Increase OAF1 to 15%.

Discussion

Increasing OAF1 by 5% produces an accelerated decline of growing stock at the beginning of the long-term, resulting in large and persistent timber supply crashes throughout the remainder of the planning horizon. A 5% reduction in the long-term harvest level is sufficient to achieve stability in the growing stock. In other words, the long-term harvest level shows a proportional response to changes in volume yields of future managed stands. This proportionality is typical of land bases that are not heavily constrained by forest cover requirements or severe pinch points in merchantable growing stock.

5.5.6 Increase OAF2 to 7%

Sensitivity	Increase OAF2 to 7%
Rationale	The managed stand yield tables of the Base Case were compiled using an OAF2 of 5%. This value is considered an average for the province, and is associated with a large amount of uncertainty. The purpose of this sensitivity analysis is to test the proportional effect of a 2% underestimation in OAF2.
Methods	A multiplication of 0.979 is required to increase the OAF2 factor from 0.95 to 0.93. Consistent with the definition of OAF2, total and species-specific volumes of the yield tables for the Existing Managed and Future yield populations were multiplied by 0*0.979 at stand age 0 years, 1*0.979 at 100 years, 2*0.979 at 200 years, and 3*0.979 at 300 years with linear interpolation between. Minimum harvest ages were recalculated accordingly.

Table 24: Summary of the sensitivity analysis— Increase OAF2 to 7%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	769,000	-11,000	-1.4%
Medium-term harvest level (m^3/yr)	780,000	769,000	-11,000	-1.4%
Total short/medium-term harvest (000's m^3)	62,415	61,915	-500	-0.8%

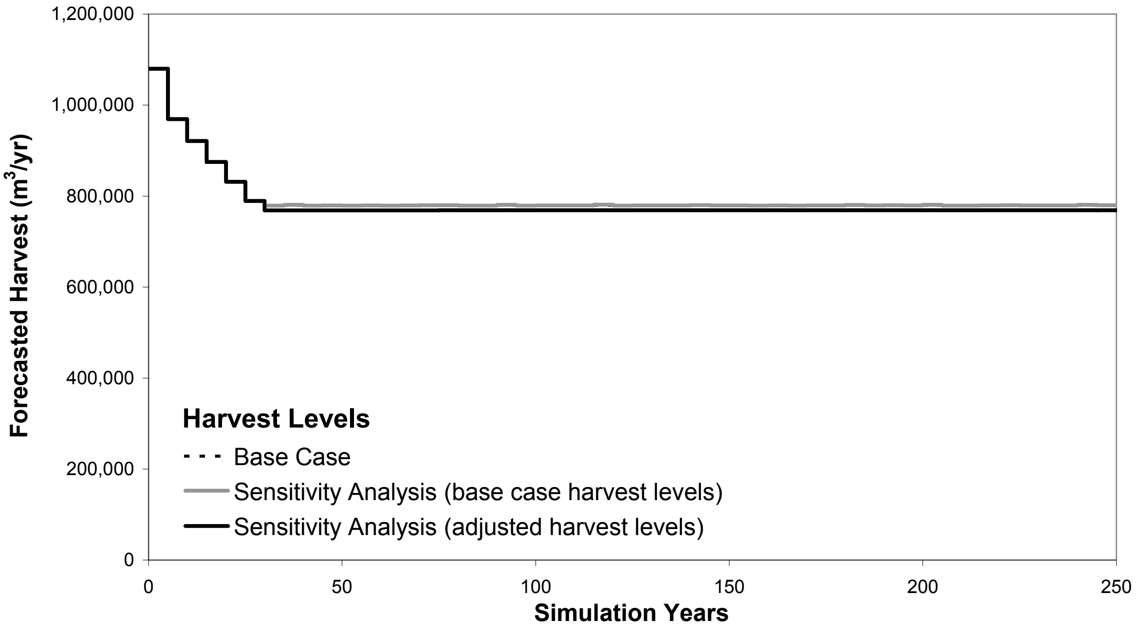

Figure 59: Sensitivity analysis harvest levels— Increase OAF2 to 7%.

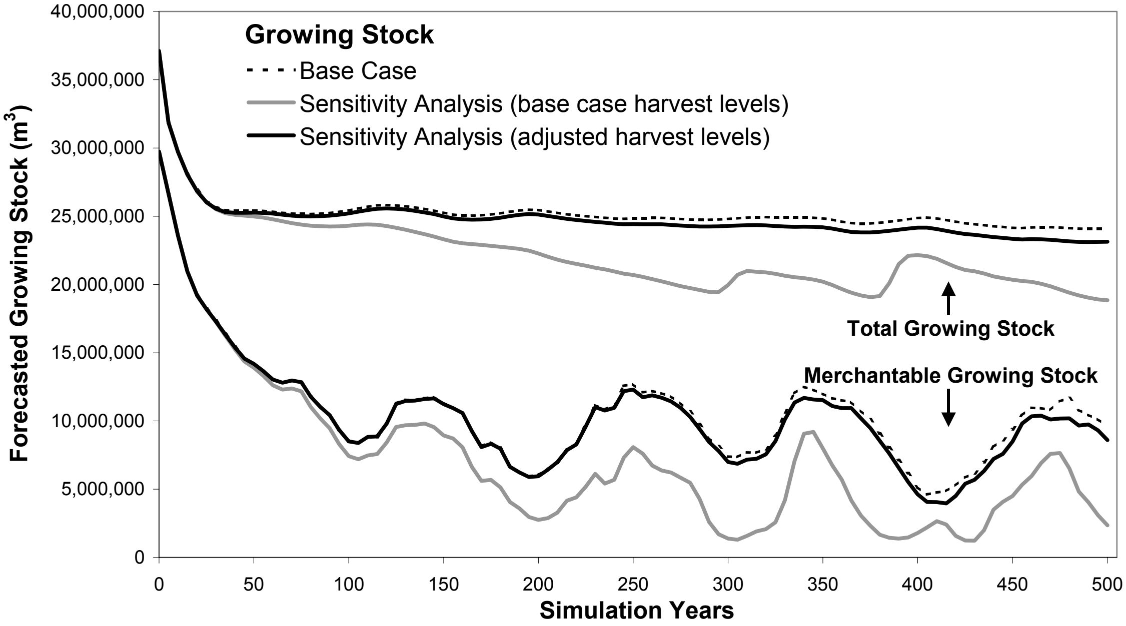

Figure 60: Sensitivity analysis growing stock— Increase OAF2 to 7%.

Discussion

As noted in the methods for this sensitivity analysis, OAF2 is 0 at stand age 0 years, 1*OAF2 at stand age 100 years, 2*OAF2 at 200 years, and so on. The average culmination age of future managed stands is 94 years, so it is expected that the response to this sensitivity analysis would be slightly less than the 2.1% increase in OAF2. The response of existing managed and future managed stands is the same, within the resolution of this analysis.

Recent timber supply analyses for other forest management units on the south coast have used elevated OAF2 values in selected stands to account for higher volume losses associated with root rot in the CWHxm subzone. Stephan Zeglan (Forest Pathologist, MoF Stewardship, Coast Forest Region) suggested applying a 7.5% increase in OAF2 in Fd-leading managed stands >10 years old within the CWHxm subzone in TFL 37. Due to time constraints on the analysis, this suggestion was not directly incorporated into the base case. However, an analysis of the base case harvest volume from the susceptible population of managed stands (2,230 ha) indicates that the total harvestable volume reduction associated with a 7.5% increase in OAF2 would equal approximately 123,000 m^3, primarily between 40 and 100 years into the planning horizon. This reduced volume translates into a 2,700 m^3/yr (0.35%) reduction in the medium term harvest level. The expected timber supply response to root rot is small because the population considered susceptible to root rot is narrowly defined. If root rot were found to be widespread in the CWHmm1 variant, the timber supply response would be more significant.

5.5.7 Remove yield reductions for partial harvesting

Sensitivity	Remove yield reductions for partial harvesting
Rationale	Canfor is retaining dispersed trees and patches of forest in all cutblocks on TFL 37. The timber supply impacts of this partial harvesting were modeled using (1) an area reduction to the THLB to account for internal reserves; and (2) a yield reduction to account for the effect of internal retention on regenerating stands. The yield reductions were modeled using Variable Retention Adjustment Factors (VRAFs) provided by the BC Ministry of Forests. The purpose of this sensitivity analysis is to determine the overall role played by the yield VRAFs in the Base Case.
Methods	Yield VRAFs in the Base Case had been applied similar to an OAF1 directly in the timber supply model. The yield VRAFs were turned off for this sensitivity analysis with no changes to THLB areas.

Table 25: Summary of the sensitivity analysis— Remove yield reductions for partial harvesting.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	810,000	30,000	3.8%
Medium-term harvest level (m^3/yr)	780,000	790,000	10,000	1.3%
Total short/medium-term harvest (000's m^3)	62,415	62,863	448	0.7%

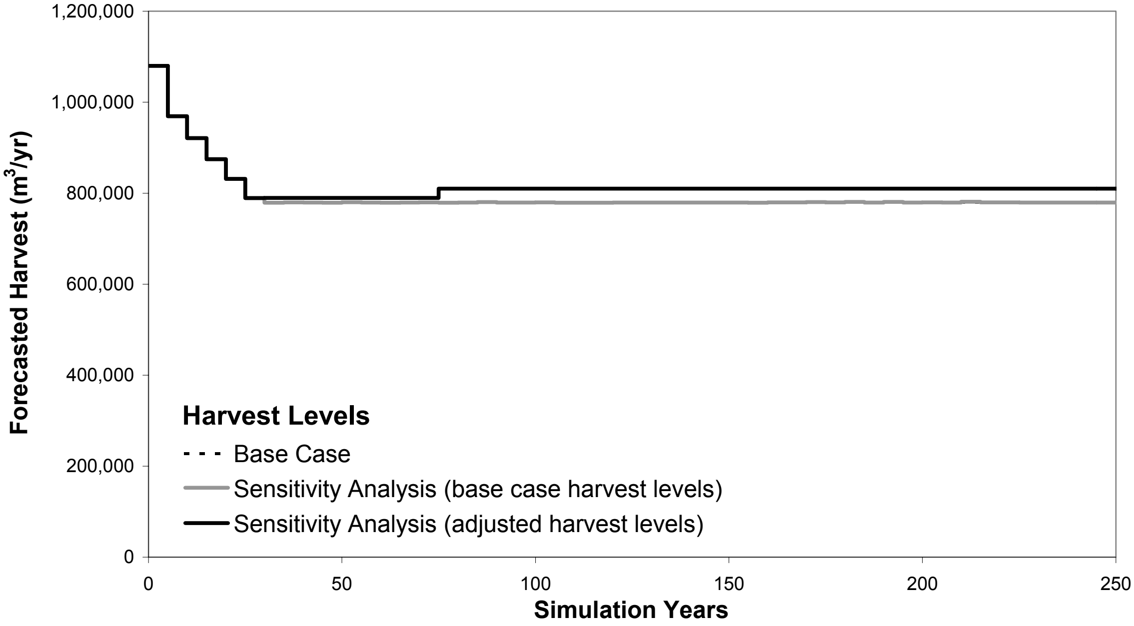

Figure 61: Sensitivity analysis harvest levels— Remove yield reductions for partial harvesting.

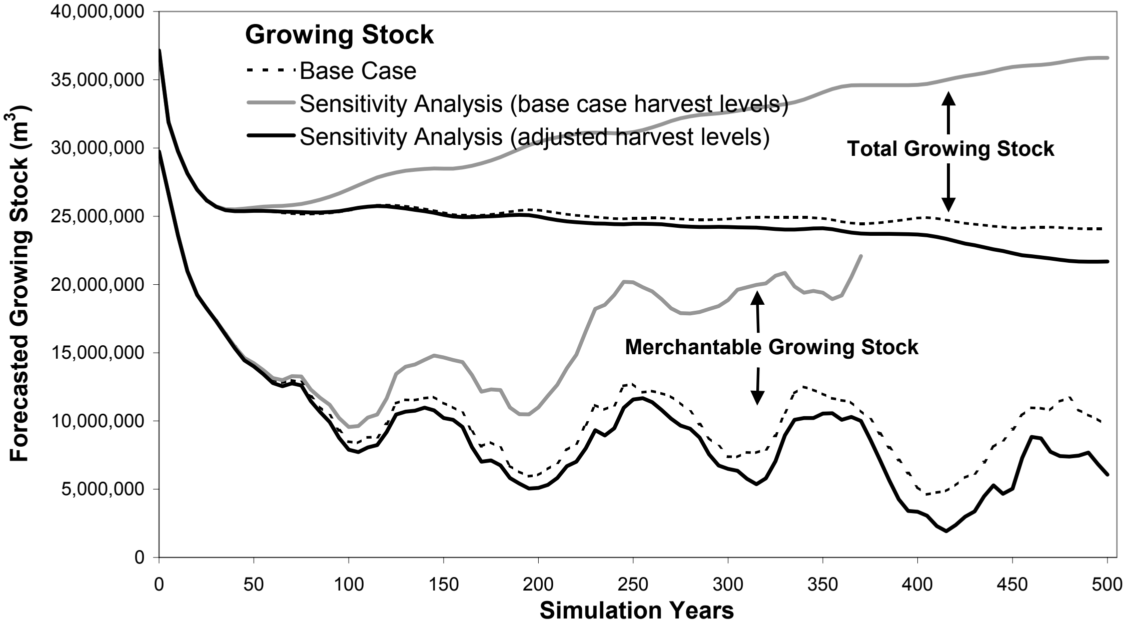

Figure 62: Sensitivity analysis growing stock— Remove yield reductions for partial harvesting.

Discussion

Yield VRAFs reduce volume production of future managed stands, as evidenced by the 3.8% increase in the long-term harvest level when yield VRAFs are turned off. They also delay the rate at which future managed stands become available for harvesting. In the absence of VRAFs, future managed stands are available slightly sooner, meaning that harvest rates in the medium-term can be slightly higher. As noted previously, this extra volume is equivalent to additional falldown surplus and could be transferred to the short-term harvest level.

5.5.8 Increase regeneration delay by 1 year

Sensitivity	Increase regeneration delay by 1 year
Rationale	Cutblocks are planted following harvest within 2 years in the CWH zone, and within 3 years in the MH zone. Canfor plants one-year-old seedling stock, making the effective regeneration delay 1 year in the CWH and 2 years in the MH. Regeneration delay is closely monitored and is one of the least uncertain assumptions in this timber supply analysis. Nevertheless, this sensitivity analysis is performed to demonstrate the role of regeneration delay in timber supply.
Methods	Regeneration delay for future stands was increased by one year.

Table 26: Summary of the sensitivity analysis— Increase regeneration delay by 1 year.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	762,000	-18,000	-2.3%
Medium-term harvest level (m^3/yr)	780,000	770,000	-10,000	-1.3%
Total short/medium-term harvest (000's m^3)	62,415	61,972	-443	-0.7%

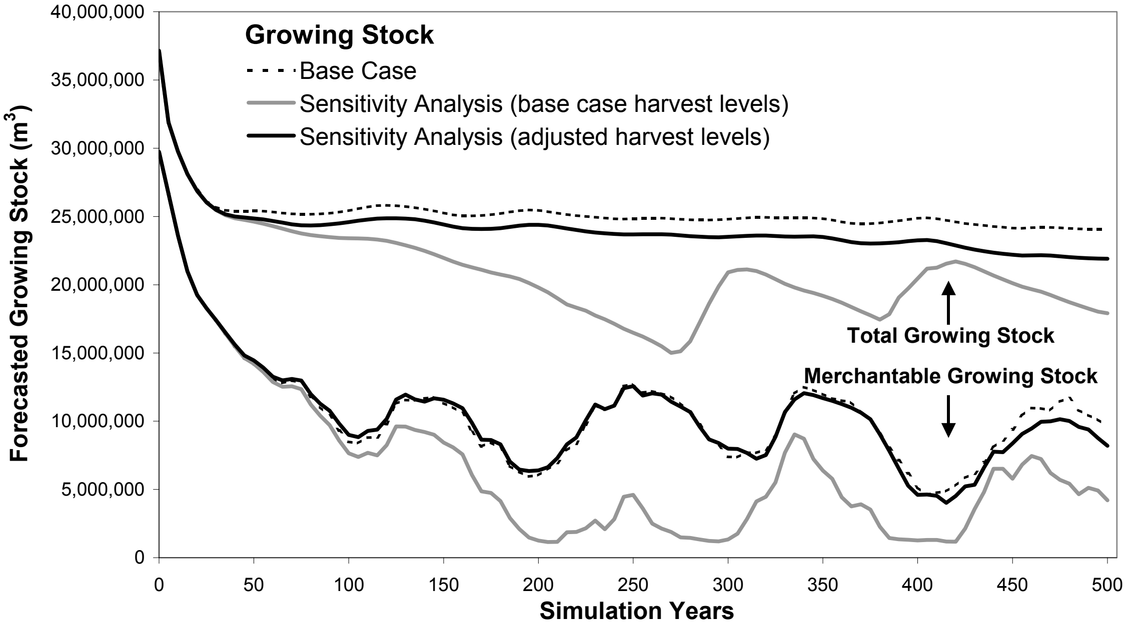

Figure 63: Sensitivity analysis growing stock— Increase regeneration delay by 1 year.

Discussion

Regeneration delay can influence timber supply in two ways: (1) it increases constraints by delaying green-up in constrained areas such as VQOs, and (2) it reduces stand productivity by lengthening rotations. While the former is an important factor in land bases where the THLB is heavily constrained by forest cover requirements, the latter is important in land bases with short rotations.

Figure 63 demonstrates the effect of increased regeneration delay on the development of growing stock. Base Case harvest levels create a reduction in total and merchantable growing stock detectable at 50 years. The decline in total growing stock accelerates until a major timber supply crash occurs at 275 years.

The average culmination age of future stands on TFL 37 is 94 years, incorporating Base Case assumptions of 1-year delay in the CWH and 2-year delay in the MH. Increasing regeneration delay by 1 year amounts to a 1.1% increase in the rotation and a 1.2% reduction in LRSY. Given that the productivity effects of regeneration delay should be proportional to the calculated effect on LRSY, a 1.2% reduction in the long-term harvest level would be expected from productivity effects alone. Stabilization of growing stock required a 2.3% reduction in the long-term harvest level, implying that delayed green-up has a 1% timber supply impact.

5.6 FOREST COVER CONSTRAINTS

5.6.1 Reduce IRM green-up to 25%

Sensitivity	Reduce IRM green-up to 25%
Rationale	A 33% landscape green-up constraint was applied in the Base Case as a surrogate for spatial adjacency constraints. This value is arbitrary, and the purpose of this sensitivity analysis is to test the effect of making IRM green-up more constraining.
Methods	The maximum allowable proportion of the IRM zone (unconstrained THLB) below green-up height was changed from 33% to 25%

Table 27: Summary of the sensitivity analysis— Reduce IRM green-up to 25%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Total short/medium-term harvest (000's m^3)	62,415	62,415	0	0.0%

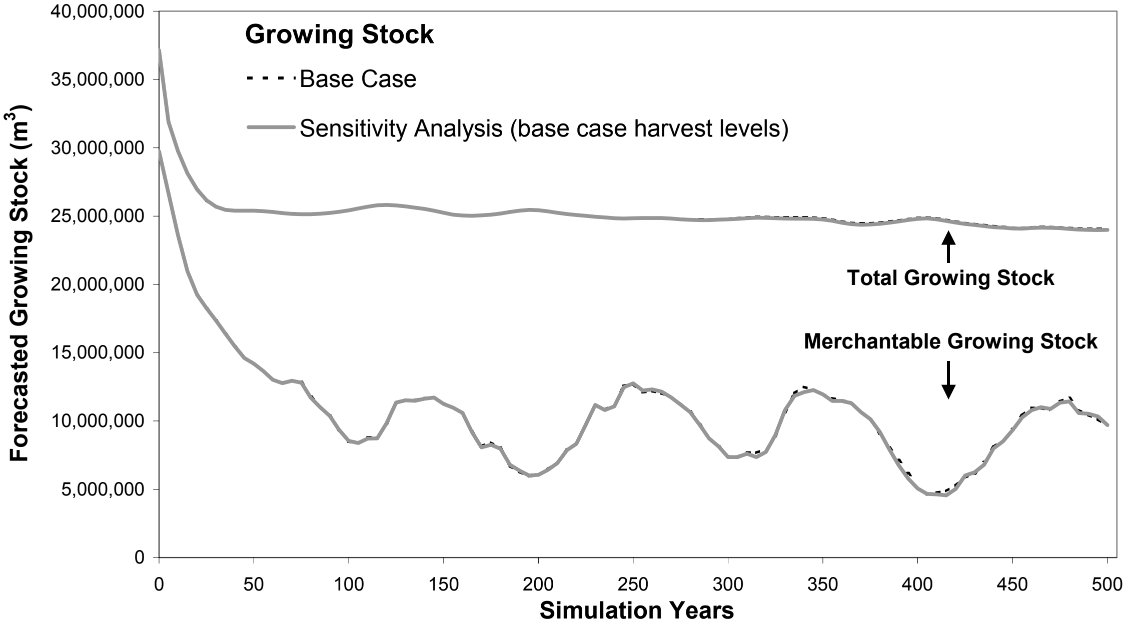

Figure 64: Sensitivity analysis growing stock— Reduce IRM green-up to 25%.

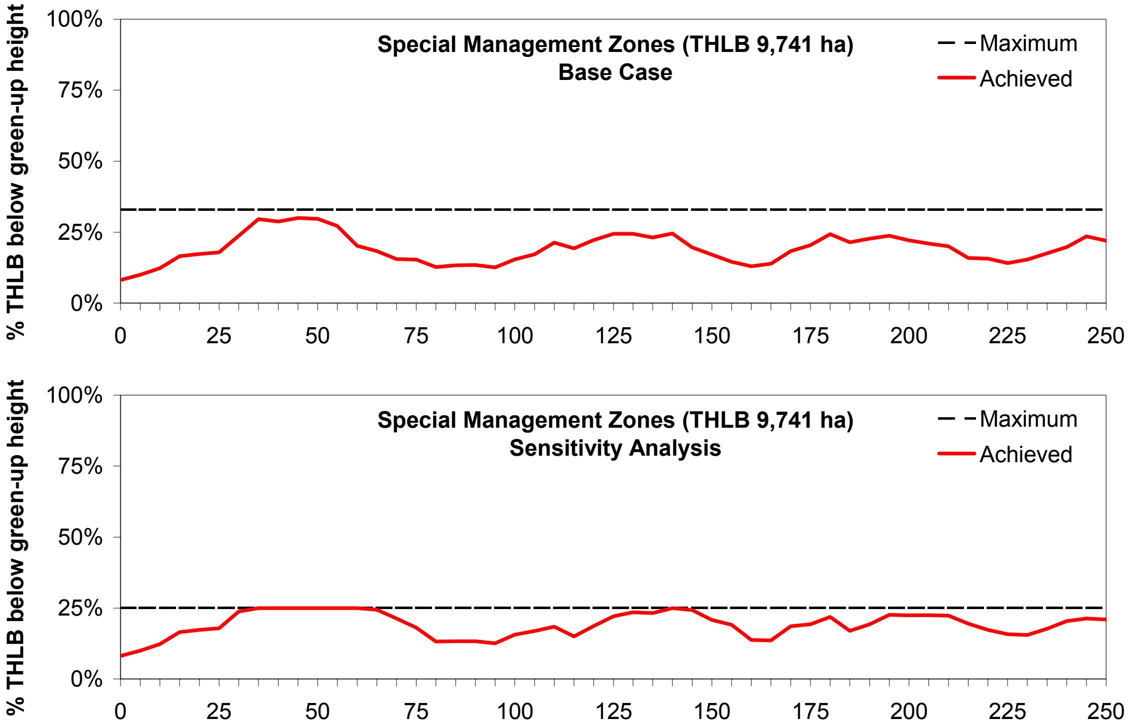

Figure 65: Example of effects of the modified IRM green-up constraint—Special Management Zones

Discussion

Changing the IRM green-up constraint to 25% has no effect on growing stock or harvest levels. Figure 65 is a comparison of the status of one of the three zones in which IRM green-up was applied (SMZs, GMZs, and EFZ). IRM green-up constraints have no effect on harvest in special management zones in the Base Case, because the area below green-up height is always less than the maximum of 33%. In the sensitivity analysis, the area below green-up height is at a maximum between 30 and 60 years, meaning that some harvesting that would otherwise occur in special management zones is forced to occur elsewhere in the TFL. Despite the role of the constraint, there is enough flexibility in the merchantable growing stock that harvest levels are not affected.

5.6.2 Remove VQO constraints

Sensitivity Analysis	Remove VQO constraints
Rationale	The impact of visual quality objectives on harvest levels is a major uncertainty in this timber supply analysis. The purpose of this sensitivity analysis is to determine the level of constraint imposed by Base Case assumptions for VQOs.
Methods	VQO constraints were turned off in the timber supply model.

Table 28: Summary of the sensitivity analysis— Remove VQO constraints.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	784,000	4,000	0.5%
Medium-term harvest level (m^3/yr)	780,000	784,000	4,000	0.5%
Total short/medium-term harvest (000's m^3)	62,415	62,613	198	0.3%

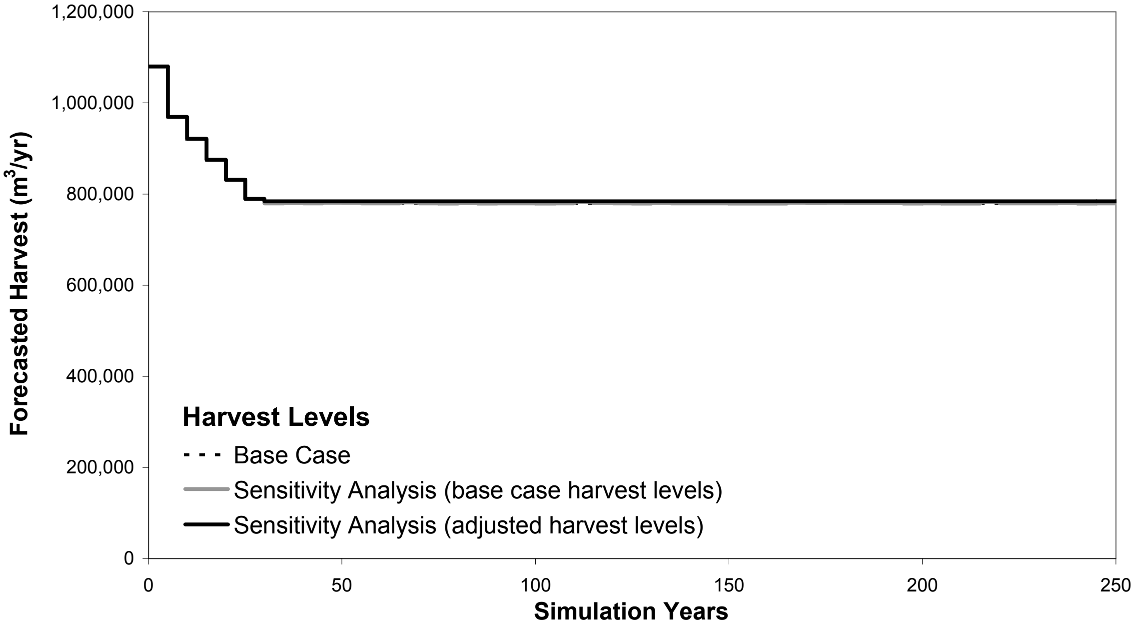

Figure 66: Sensitivity analysis harvest levels— Remove VQO constraints.

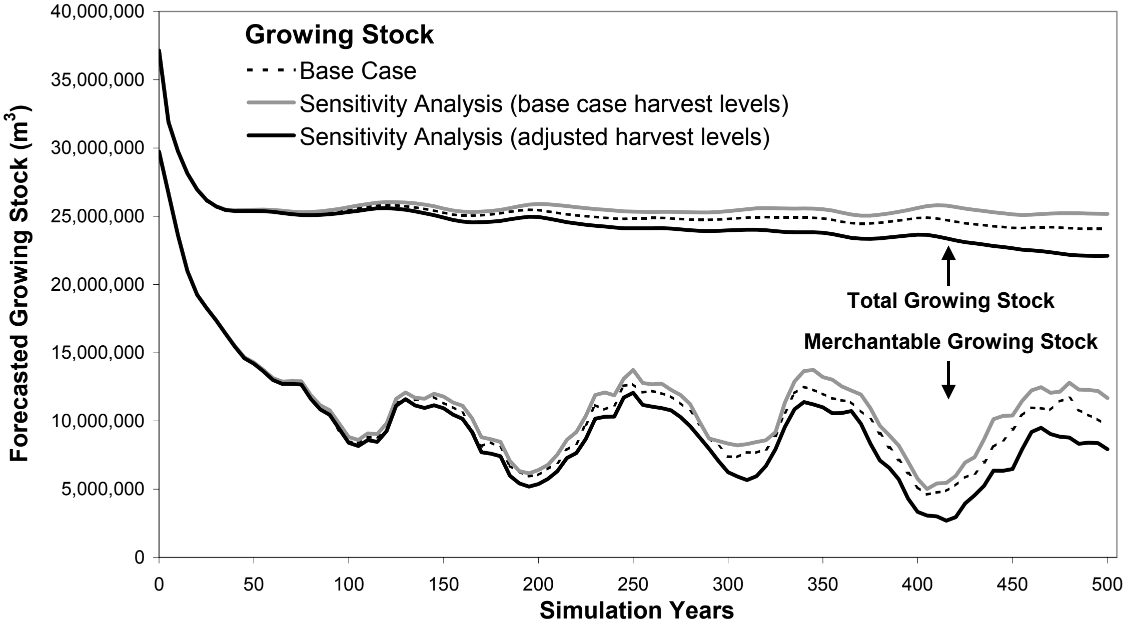

Figure 67: Sensitivity analysis growing stock— Remove VQO constraints.

Discussion

Removal of VQO constraints results in a slight accumulation of growing stock over the planning horizon. Increasing the medium and long-term harvest levels by 4,000 m^3/yr results in a slight decline of growing stock compared to the Base Case. This sensitivity analysis demonstrates that Base Case assumptions for visual quality constraints have a minor (approximately 0.2%) impact on timber supply.

5.6.3 Absolute VEG for VQOs

Sensitivity	Regulate Base Case visual quality constraints using the standard TSR method for green-up.
Rationale	Visual quality constraints specify a maximum proportion of each visually sensitive polygon that can be below visually effective green-up (VEG). Traditionally, timber supply analyses have assumed that a cutblock has 100% visual impact until it reaches VEG height (BC MoF 1998). The Base Case was modeled using an alternate approach, where stands progressively recover towards a visually effective green-up condition after harvest. In theory, the Base Case approach to VEG is less constraining than the standard TSR approach. This sensitivity determines how much less constraining the new VEG assumptions are to timber supply.
Methods	Base Case visual quality targets were maintained, but cutblocks were considered to have 100% visual impact until they reach VEG height.

Table 29: Summary of the sensitivity analysis— Absolute VEG for VQOs.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Total short/medium-term harvest (000's m^3)	62,415	62,415	0	0.0%

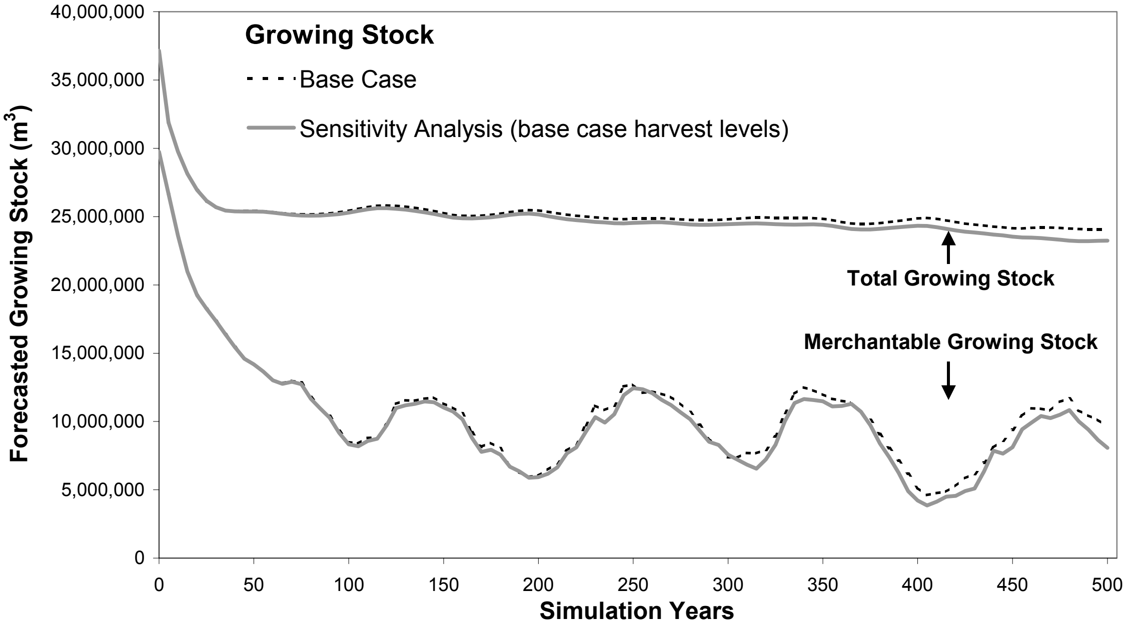

Figure 68: Sensitivity analysis growing stock— Absolute VEG for VQOs.

Discussion

Absolute VEG assumptions produce a subtle reduction in growing stock over the planning horizon, though this effect is not sufficient to necessitate a reduction in harvest levels. The Base Case assumptions for VEG have no significant effect on timber supply.

5.6.4 Standard TSR visual constraints

Sensitivity	Model visual quality objectives with standard TSR values for percent denudation.
Rationale	Due to their use of internal retention and visual design in the scenic corridor, Canfor considers standard TSR assumption of percent denudation to be overly constraining for TFL 37. The Ministry of Forests (Lloyd Davies, Visual Landscape Forester, Coast Forest Region, MoF) reviewed and accepted modified percent denudation values that Canfor believes better reflects local conditions and practices. These modified constraints were used in the Base Case. The purpose of this sensitivity analysis is to determine the difference between applying standard TSR assumptions for planimetric percent denudation.
Methods	Percent denudation was calculated using the methodology specified in the *Procedures for Factoring Visual Resources into Timber Supply Analyses* (BC Ministry of Forests *et al.* 1998), assuming clearcutting is the silvicultural system applied. In addition, the traditional interpretation of VEG was applied (100% visual impact below VEG height).

Table 30: Summary of the sensitivity analysis— Standard TSR visual constraints.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	752,000	-28,000	-3.6%
Medium-term harvest level (m^3/yr)	780,000	740,000	-40,000	-5.1%
Total short/medium-term harvest (000's m^3)	62,415	60,684	-1,731	-2.8%

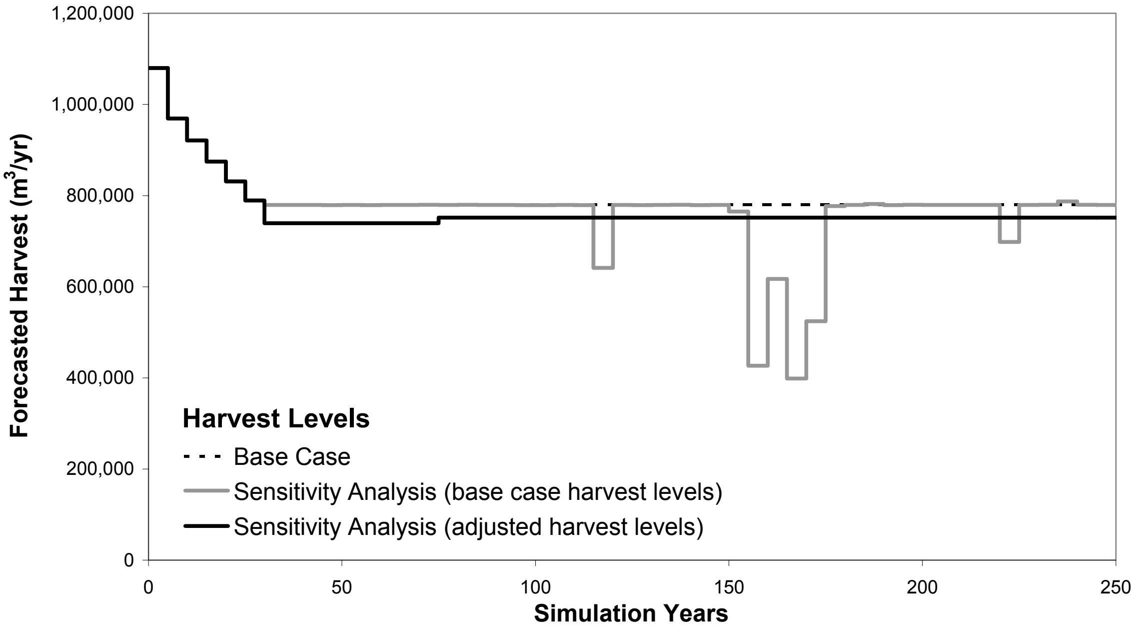

Figure 69: Sensitivity analysis harvest levels— Standard TSR visual constraints.

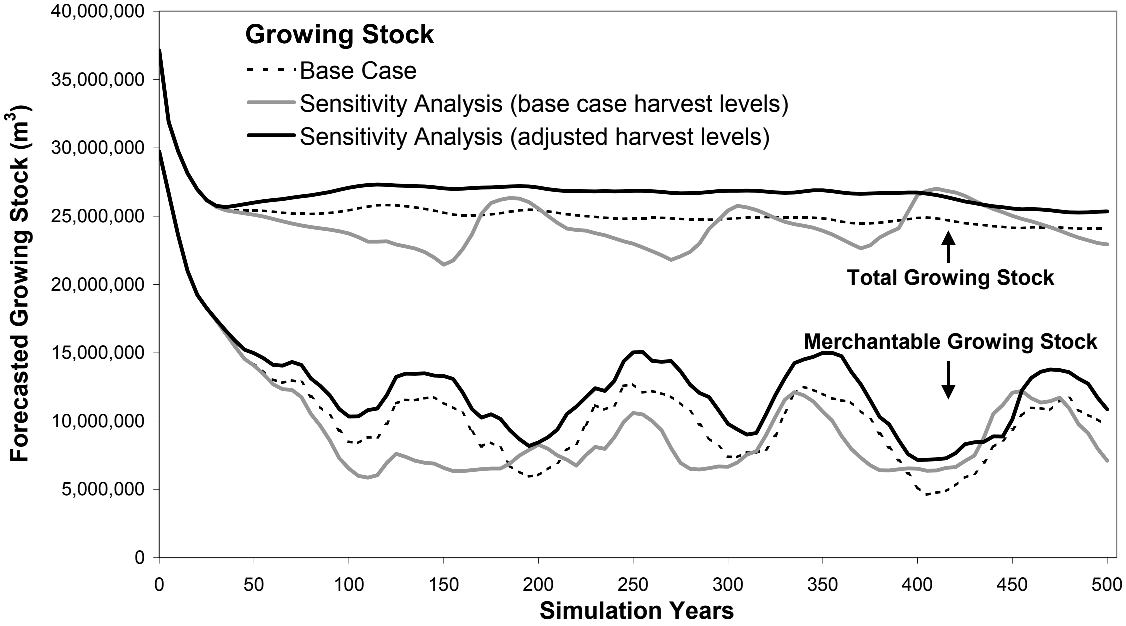

Figure 70: Sensitivity analysis growing stock— Standard TSR visual constraints.

Discussion

Visual quality constraints do not directly affect stand productivity. However, by delaying conversion of natural stands to managed stands and forcing redistribution of harvest into stands that are below culmination age, growing stock can be depleted. At Base Case harvest levels, this effect is detectable as a decline in growing stock starting at 50 years. This decline accelerates and results in a major timber supply crash at 160 years. Note that the crash occurs even though there is more than 6,000,000 m^3 of merchantable growing stock available. These are merchantable stands that are retained in order to satisfy visual quality objectives. Such crashes continually occur throughout the planning horizon at Base Case harvest levels, indicating that standard TSR constraints introduce considerable inflexibility to harvest in TFL 37.

A 5.1% reduction in the medium-term harvest level is necessary to compensate for standard TSR visual constraints. Subsequently, a 3.6% reduction stabilizes growing stock in the long-term. The greater reduction in the medium-term harvest level is necessary to accumulate sufficient merchantable growing stock for long-term sustainability. Higher growing stock combined with lower harvest levels is an indicator that visual quality constraints are extending the length of rotations within scenic polygons beyond culmination age.

5.6.5 Remove mature-plus-old constraints

Sensitivity	Remove mature-plus-old constraints
Rationale	The Vancouver Island Land Use Plan Higher Level Plan Order specifies that 25% of each special management zone should be mature or old (>80 years old in the CWH and >120 years in the MH zone) at any given time. The purpose of this sensitivity analysis is to determine the extent to which this objective is constraining to timber supply.
Methods	The mature-plus-old constraints were turned off in the timber supply model.

Table 31: Summary of the sensitivity analysis— Remove mature-plus-old constraints.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Medium-term harvest level (m^3/yr)	780,000	780,000	0	0.0%
Total short/medium-term harvest (000's m^3)	62,415	62,415	0	0.0%

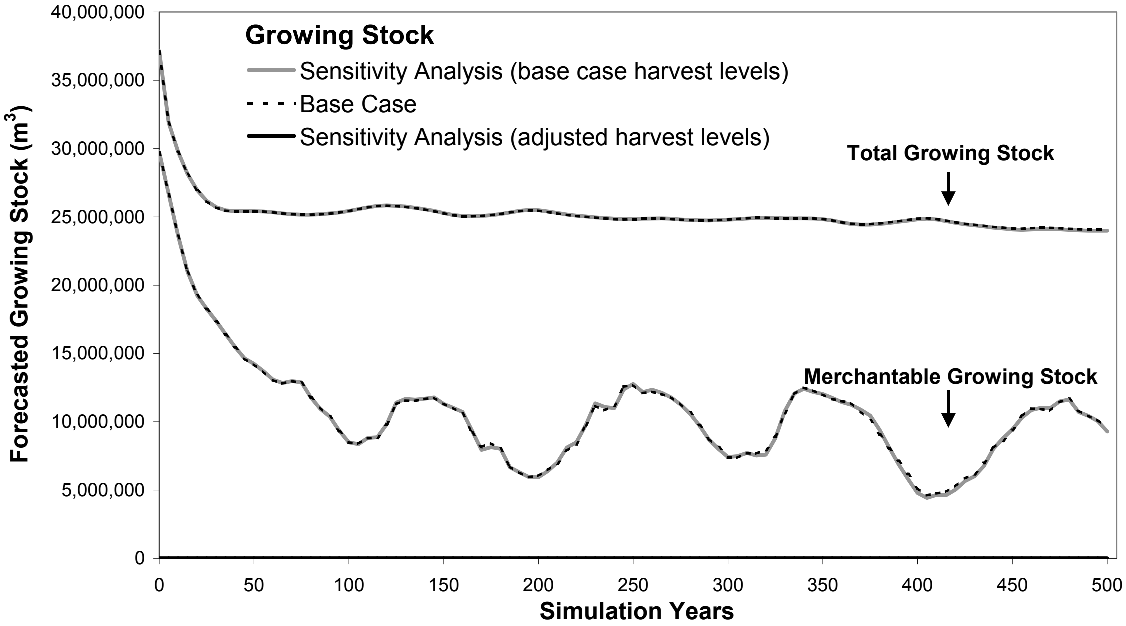

Figure 71: Sensitivity analysis growing stock— Remove mature-plus-old constraints.

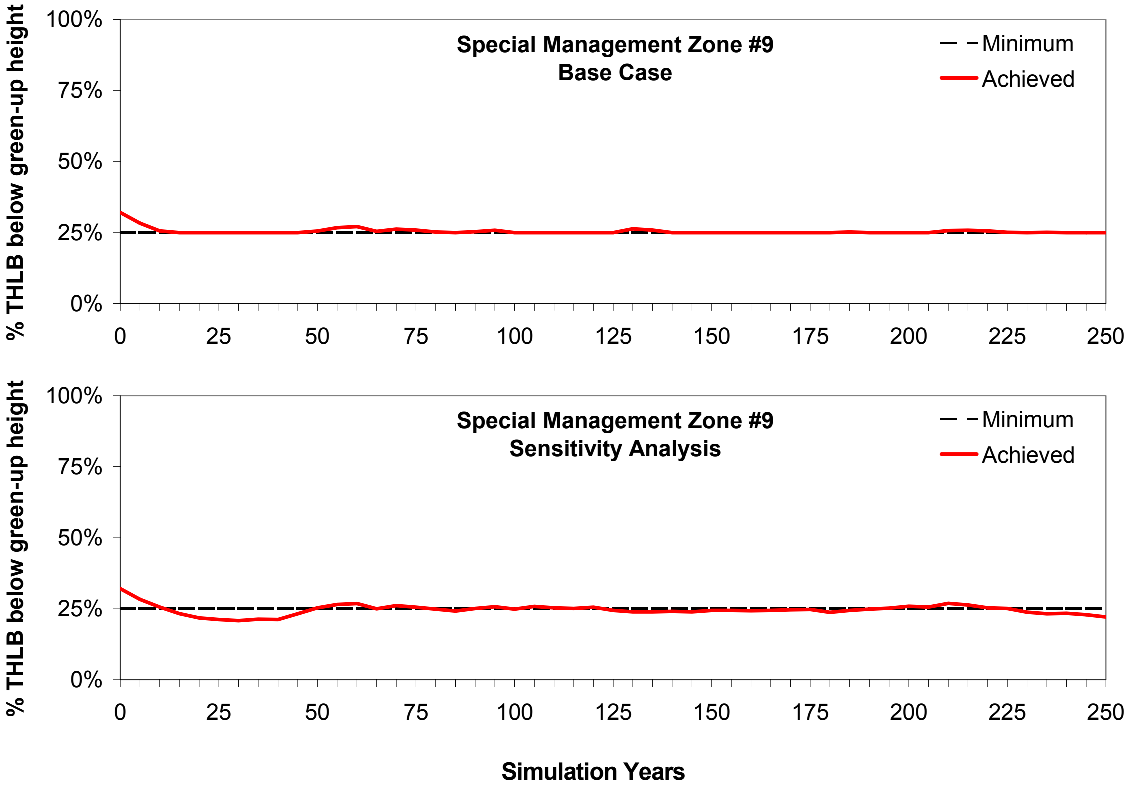

Figure 72: Status of mature-plus-old relative to targets in SMZ 9—comparison of the Base Case and the sensitivity analysis

Discussion

Turning the mature-plus-old constraints off has no effect on growing stock and harvest levels. The description of the Base Case in Section 4.2.11 demonstrated that SMZ 9 is the only zone being constrained by mature-plus-old objectives. Figure 72 shows that this sensitivity analysis allows small violations of the mature-plus-old objective in SMZ 9. This indicates that some modification of the harvest schedule is necessary to accommodate the objective. Nevertheless, this effect is not sufficient to affect harvest levels or the development of growing stock.

5.7 SUMMARY OF SENSITIVITY ANALYSES

The general results of the sensitivity analyses are summarized in Table 32.

Table 32: Summary of harvest level impacts of sensitivity analyses.

		Change in harvest			
Section	**Sensitivity Analysis**	**Long-Term Harvest Level**	**Medium-Term Harvest Level**	**Total Harvest in the Short and Medium-Terms**	**General Scale of the Sensitivity**
	Harvest Rules				
5.3.1	Remove DBH criteria for minimum merchantability	-	-	-	.
5.3.2	Set minimum harvest ages at 90% culmination age	-	-	-	.
5.3.3	Relative oldest first scheduling	-	-3.8%	-2.1%	-
5.3.4	Random harvest scheduling	-	-1.9%	-1.1%	-
	Timber harvesting land base				
5.4.1	Remove hembal-heli stands	-4.6%	-4.6%	-4.9%	--
5.4.2	Partition the helicopter-operable land base	-0.6%	-2.1%	-1.6%	-
5.4.3	Remove marginally economic stands	-4.0%	-4.0%	-2.4%	-
5.4.4	Remove conditionally operable	-1.3%	-1.3%	-0.8%	-
5.4.5	Return MAMU reserves to THLB	0.9%	2.3%	1.4%	+
5.4.6	Return MAMU reserves and OGMAs to THLB	2.7%	7.2%	4.5%	+
5.4.7	Return MAMU/OGMAs/NOGO territories to THLB	4.1%	10.3%	6.6%	++
	Growth and Yield				
5.5.1	Reduce natural stand volumes by 10%	-	-9.0%	-4.8%	--
5.5.2	Reduce existing managed stand volumes by 10%	-	-7.1%	-3.8%	--
5.5.3	Inventory site index for CWHvm2 stands	-1.5%	-	4.1%	++
5.5.4	TIPSY for transitional stands	-	5.5%	3.5%	+
5.5.5	Increase OAF1 to 15%	-5.1%	-6.4%	-3.4%	--
5.5.6	Increase OAF2 to 7%	-1.4%	-1.4%	-0.8%	-
5.5.7	Remove yield reductions for partial harvesting	3.8%	1.3%	0.7%	+
5.5.8	Increase regeneration delay by 1 year	-2.3%	-1.3%	-0.7%	-
	Forest Cover Constraints				
5.6.1	Reduce IRM green-up to 25%	-	-	-	.
5.6.2	Remove VQO constraints	0.5%	0.5%	0.3%	(+)
5.6.3	Absolute VEG for VQOs	-	-	-	.
5.6.4	Standard TSR visual constraints	-3.6%	-5.1%	-2.8%	--
5.6.5	Remove mature-plus-old constraints	-	-	-	.

General conclusions

- The Base Case short-term is robust. Adjustment of the medium-term harvest level can compensate for major reductions in the THLB or yields. Timber supply crashes associated with changes to short-term assumptions tend to occur in the long-term.
- Some changes in assumptions did not create timber supply crashes until beyond 250 years. A 500-year planning horizon was necessary to effectively test sensitivities.

Specific conclusions

Harvest scheduling rules and minimum harvest ages

- Minimum harvest ages alone do not play a crucial role in setting Base Case harvest levels. Standard culmination-based minimum harvest ages produce a similar pattern of growing stock.
- The medium-term is sensitive to the order in which stands are harvested. Relative poorest first scheduling allows higher medium-term harvest than random scheduling, while relative oldest first scheduling produces lower harvest compared to random scheduling.

Timber harvesting land base

- The Base Case is highly dependent on areas identified for helicopter logging. In the absence of "hembal-heli" sites, not economically viable in the foreseeable future, the short-term harvest level must be reduced by 6.8% (904,000 m^3/yr in 2006).
- Partitioning harvest from all helicopter-operable areas further reduces the overall short-term harvest level by 1.7% (888,000 m^3/yr in 2006).
- Marginally economic stands contribute 4% of the harvest in the medium and long-terms. However, the Base Case harvest levels can be sustained for the first 30 years in the absence of these sites.
- The long-term harvest level is moderately dependent on harvesting conditionally operable sites, which contribute 1.3% of harvest volume.
- MAMU, OGMA, and NOGO reserves collectively reduce the harvest in the short and medium-terms by 4 million m^3 (6.6%). The short-term impact of these reserves is considerably greater than their impact in the long-term (4.4%) because they contain higher-than-average amounts of standing volume.

Growth and yield

- A 10% reduction in natural stand yields (>40 years old) has a 4.8% impact in the short and medium-term, which can be deferred as a 9% reduction to the medium-term harvest level.
- A 10% reduction in existing managed stand yields (6-40 years old) has a 7.1% impact on the medium-term, and a subtle impact in the long-term.
- Modeling 40-80 year old stands with TIPSY instead of VDYP produces a 2.2 million m^3 (3.5%) increase in the volume harvestable in the short and medium-terms. This surplus volume could support an 8.7% increase in the short-term harvest level or a 5.5% increase in the medium-term harvest level.
- Increases in OAF1 produce proportional decreases in the long-term harvest level.
- Increases in OAF2 produce slightly less than proportional decreases in the long-term harvest level.
- Yield effects of partial harvesting, as modeled in the Base Case, reduce the long-term harvest level by 3.8%, with minor impacts in the medium-term and no impact in the short-term.
- Regeneration delay is important to timber supply in TFL 37. A one-year increase in regeneration causes a 1.3% reduction in the medium-term harvest level and a 2.3% reduction in the long-term. Delayed green-up for VQOs and reduced stand productivity appear to be equally responsible for these impacts.

Forest Cover Constraints

- Changing the IRM green-up constraint to 25% has no effect on Base Case harvest levels.
- Base Case objectives for visual quality are a minor (0.2%) constraint to harvesting. Applying standard TSR constraints would put approximately 3% downward pressure on timber supply throughout the planning horizon. These differences are entirely due to dissimilar percent denudation values.
- Mature-plus-old objectives in special management zones are not constraining to timber supply.

6 COMPARISON WITH MANAGEMENT PLAN 8

The Base Case harvest levels forecasted in this analysis report are substantially lower than those of the Base Case for Management Plan 8. The purpose of this section is to describe and explain the differences between these harvest forecasts.

Volume flows for MP8 and SFM Plan 9 Base Cases are compared in Figure 73. Note that year 0 in this figure is 2002, and the first five years of the MP8 forecast have been removed to account for the differences between the planning horizons of the analyses. Both harvest forecasts start at the current AAC of 1,068,000 m^3/yr (the first-period harvest in SFM Plan 9 is slightly higher than the AAC due to a 1-year lag between the forecast periods and the cut-control periods – see Section 4.2.2:). The second-period harvest SFM Plan 9 is 7.5% lower than the MP8 harvest level. In contrast to the SFM Plan 9 Base Case, the MP8 Base Case required a relatively small decline to the medium term harvest level (1,034,000 m^3/yr) followed by a large increase to the long-term harvest level of (1,172,000 m^3/yr). The MP8 Base Case harvest forecast in the medium term is 25% greater than the SFM Plan 9 Base Case and 33% greater in the long term.

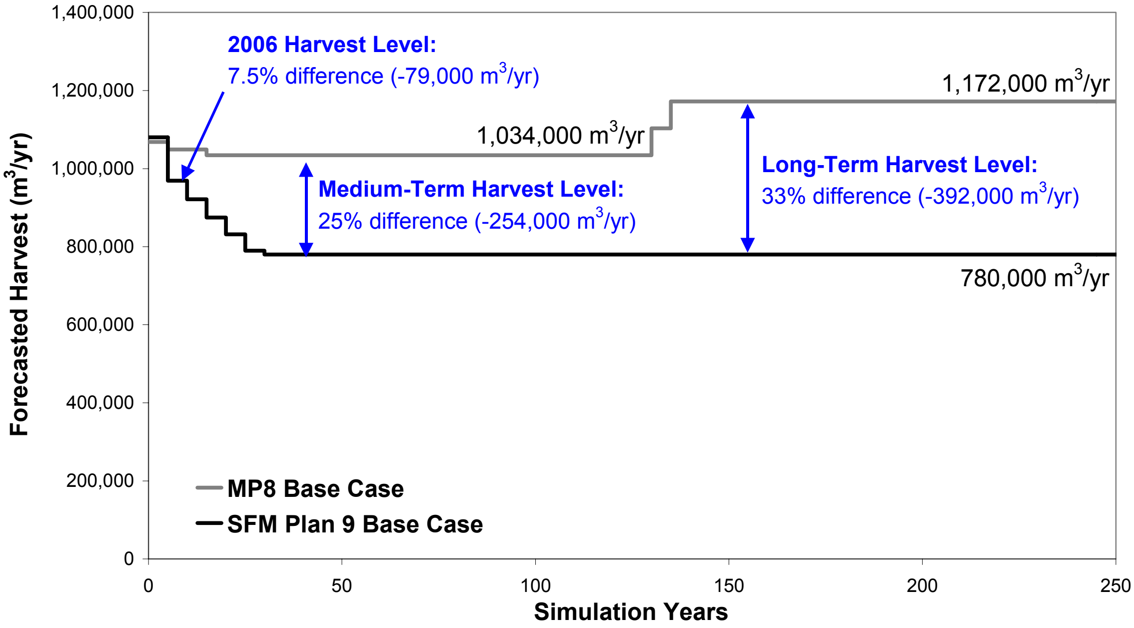

Figure 73: Comparison of the Base Case harvest forecasts for MP8 and SFM Plan 9.

When comparing timber supply analyses, it is useful to divide the comparison into the four major categories of timber supply assumptions used above: (1) harvest rules and minimum harvest ages; (2) forest cover requirements; (3) THLB; and (4) growth and yield. During the assessment of the differences between MP8 and SFM Plan 9, the first two categories were found to have little effect on timber supply. Changes to the THLB and the assumptions for growth and yield, however, were found to be the major factors contributing to the difference between the two analyses. These factors are discussed below.

6.1 HARVEST RULES AND FOREST COVER REQUIREMENTS

MP8 and SFM Plan 9 use different harvest rules and forest cover requirements, but these differences do not contribute to the downward pressures creating lower timber supply in SFM Plan 9. The rationale for this conclusion is given below.

6.1.1 Harvest rules and minimum harvest ages

MP8 used the "oldest first" harvest scheduling rule and minimum harvest ages that were approximately 90% of minimum harvest ages. The sensitivity analysis in Section 5.3.3 tested the impact of applying this combination of harvest rules to the SFM Plan 9 Base Case ("oldest first" and "relative oldest first" are similar harvest rules). That sensitivity analysis indicated that the harvest rules used in SFM Plan 9 have an upward pressure on the medium term and no effect on the long term. Therefore, the harvest rules and minimum harvest ages used in SFM Plan 9 are not likely contributing to the downward pressures creating the differences with MP8, and may be mitigating them.

6.1.2 Forest cover requirements

The sensitivity analyses in this report indicate that forest cover requirements (VQOs, IRM greenup, and mature-plus-old targets) affect the order in which stands are harvested but do not put downward pressure on the Base Case. The equivalent forest cover requirements in MP8—namely visual quality objectives and old forest targets—were not constraining on the MP8 Base Case either (Canadian Forest Products Ltd. et al. 1998, p. 12). Therefore, forest cover requirements are not a factor in the differences between MP8 and SFM Plan 9.

6.2 TIMBER HARVESTING LAND BASE & GROWTH AND YIELD

Given that the effects of forest cover objectives and harvest rules are not constraining to either MP8 or SFM Plan 9, the size of the THLB, the current availability of mature volume, and stand productivity are the key variables that control timber supply in both analyses. These attributes are summarized in Table 33 below. The current THLB is 11.5% less than MP8, but the initial growing stock is 21% smaller. The productivity (culmination MAI) of future managed stands also decreased by 23%. This comparison implies that the difference between MP8 and SFM Plan 9 are due to the combined effect of changes to the netdown, the forest cover inventory, and the yield tables.

Table 33: Overview comparison of the attributes of the THLB in MP8 and SFM Plan 9

Assumption	MP8	SFM Plan 9	Difference	% Difference
Current THLB (ha)	103,248	91,325	-11,923	-11.5%
Long-term THLB (ha)	101,080	90,221	-10,859	-10.7%
Growing Stock at Year 0 (m^3)	46,221	36,511	-9,710	-21.0%
Culmination MAI of future managed stands (m^3/ha/yr)	11.6	8.9	-2.7	-23.2%

6.2.1 Changes to the netdown

The current THLB is 11,923 ha (11.5%) smaller in this analysis than it was in MP8. This change is a result of (1) improvements in the spatial data used to define the THLB, and (2) new management conditions applied in TFL 37. There are many differences in the netdowns for MP8 and SFM Plan 9, but the major factors contributing to the reduction in the THLB are listed below. Net effects are only approximate because differences in the order of the netdowns do not allow direct comparisons between the two analyses.

New Data:

- Partial netdown for decile-level non-productive sites in Terrestrial Ecosystem Mapping (approx. 925 ha);
- New road mapping and an updated road classification (approx. 900 ha);
- New riparian linework and classification (approx. 1,500 ha);

New Management Conditions:

- Partial reductions for harvesting avoidance of areas with sensitive karst geology (approx. 1,000 ha);
- Spatial reserves for northern goshawk territories, marbled murrelet nesting habitat, and OGMAs (approx. 5,000 ha);
- Internal retention (partial harvesting) for ecosystem management (approx. 5,600 ha).

These reductions to the THLB have two effects on harvest levels: (1) they reduce the inventory of mature volume available for harvesting, and (2) they reduce the area of growing sites for future managed stands. The sensitivity analysis of returning NOGO, MAMU, and OGMA reserves to the THLB (Section 5.4.7) demonstrated that the effects of removing mature stands from the land base are often greater in the short term than in the long term because the current inventory of mature stands is characterized by high volumes but relatively poor site potential.

6.2.2 Changes to the forest cover inventory

The photography and stand delineation (linework), which are the base of the forest cover inventory, remained unchanged during the course of MP8. However, the forest cover attributes underwent the following major changes since the last timber supply analysis.

- Uniform use of VDYP for inventory volume and growth of natural stands (JS Thrower & Associates, 2003)—the analysis for Management Plan 8 used average volume lines (AVLs) to model growth and current inventory volume of most natural stands. AVLs were not used in SFM Plan 9 due to their incompatibility with the VRI phase II adjustment process.
- Phase 2 adjustments (JS Thrower & Associates, 2004a)—The phase II inventory adjustment process calibrated the inventory ages, heights, site index, and volume to a random field sample. This project found that the unadjusted forest cover inventory underestimated age and volume and overestimated site index.
- NVAF adjustment (JS Thrower & Associates, 2004b)— The NVAF is derived from destructive sampling and adjusts VRI volumes for bias associated with taper equations and decay estimates. The NVAF adjustment ratio is 1.06.
- Updates and depletions—The forest cover inventory was updated for depletions to January 1, 2001. Total depletions in this period were approximately 5 million m^3. This volume removal was not completely offset by forest growth in other areas of the TFL. Even if the area of the THLB was the same as MP8, the starting volume would be lower in SFM Plan 9.
- Terrestrial Ecosystem Mapping (Green 2000)—whereas preliminary mapping was used for the MP8 analysis, final site mapping and variant boundaries were later verified through field sampling. This change affects the assignment of site index to managed stands.

These changes to the source data for the analysis likely introduced a combination of upward and downward pressures on timber supply. The net effect of these changes is not known.

6.2.3 Changes to the growth and yield assumptions

The most dramatic difference between the Base Cases is the 33% reduction in the long-term harvest level. This reduction is a result of the combined effects of a 10.7% reduction in the long-term THLB and the 23% reduction in the growth rate of the future yield. Changes to the yield tables are more than twice as important as changes to the netdown in creating the reduction in the long-term harvest level. Although a comprehensive comparison of the growth and yield methodology is not practical, some important differences can be identified.

Changes to site index conversion equations for secondary components of Cw

The method for assigning site index to secondary species in mixed-species stands is different in this analysis than it was in MP8. While this is a seemingly esoteric detail of the analysis assumptions, it has profound implications for timber supply and deserves some explanation.

Different tree species on the same site grow in height at different rates, so each species has its own site index (height at 50 years) for a given site. The MoF developed site index conversion equations for mixed species stands, which are used by TIPSY to assign site index to minor species based on the site index of the leading species. However, no site index conversion equations are currently available in TIPSY for Cw and its proxy species (Yc). In fact, current versions of TIPSY (TIPSY version 3.2 Beta, May 6, 2004) apply no site index conversion between Cw and other species. For example, the Cw component in a Fd-leading stand would be assigned the same site index as Fd. Potential site index estimates for Cw are 20-45% less than Fd on equivalent site series in TFL 37. As Cw is considerably shorter on equivalent sites, assigning it the same site index as Fd in mixed stands results in an overestimation of volume yield in these mixed stands.

The managed stand yield tables for MP8 used the standard TIPSY site index conversions, which assigns the leading species site index to Cw and Yc. As discussed above, this method overestimates the yields from Cw and Yc. To correct this, managed stand yields for SFM Plan 9 were developed using site index conversions for Cw developed during the site index adjustment project for TFL 37 (JS Thrower & Associates 2000).

The difference in assumptions only produces a timber supply effect where Cw and Yc are primarily represented as a secondary species. It does not have a large effect on short term timber supply SFM Plan 9 because existing managed stands represent Cw/Yc as both a leading and secondary species in approximately equal proportions. However, Cw and Yc are primarily represented as a secondary stand component in future managed stands in both MP8 and SFM Plan 9. Modeling secondary Cw/Yc with its own site index rather than the site index of the leading species created a reduction in the long-term harvest level of approximately 140,000 m^3/yr, or 12%, relative to MP8 (JS Thrower & Associates, 2004c).

Changes to potential site index

The methods for assigning site index to managed stands are different in MP8 and SFM Plan 9. The methods depend on BGC variant:

- **CWHxm/mm/vm1**—In MP8, preliminary potential site index estimates were developed using expert opinion about the relationship between site series and site productivity of managed stands. These estimates were then adjusted to SIBEC values as a way of eliminating bias in the average site index estimate. In SFM Plan 9, the preliminary potential site index estimates were calibrated to a field sample of TFL 37 as part of the site index adjustment project completed in 2000. The timber supply impact of these changes appears to be small (JS Thrower & Associates, 2004c).
- **CWHvm2**—Both analyses used an elevation model to assign site index in the CWHvm2 variant. Both models use site index of equivalent site series in the CWHvm1 and MHmm1 variants as the upper and lower limits of site index in CWHvm2 site series, with linear interpolation between these limits. The SFM Plan 9 methodology gives more conservative estimates of yields, and reduces the long-term harvest level by about 65,000 m^3/yr, or 5.5% relative to MP8 (JS Thrower & Associates, 2004c).
- **MHmm1**—MP8 applied unadjusted preliminary potential site index (expert opinion) throughout the MHmm1 whereas SFM Plan 9 used inventory site index for all managed stands in this variant. Inventory site index is slightly greater than unadjusted PSI on average (13.7 m vs. 12.0 m).

6.3 SUMMARY

The differences between the analyses are most pronounced in the long term, where harvest levels of SFM Plan 9 are about 33% lower than those of MP8. Identified changes in timber supply assumptions and their effect on the long-term harvest level are summarized in Table 34. Approximately 80% of the differences in the long-term harvest level can be explained by the factors identified above. Changes to the site index conversion methods for secondary Cw/Yc explain about a third of the difference between the analyses.

Other identified changes in the netdown, area/yield reductions for partial harvesting, and site index assumptions for the CWHvm2 collectively explain about half of the difference. Slightly less than 20% of the difference between MP8 and SFM Plan 9 remains unexplained and is likely due to a combination of changes to the terrestrial ecosystem mapping, the netdown, and yield table compilation methods.

Table 34: Summary of identified changes in timber supply assumptions and their effect on the long-term harvest level.

Change in Assumptions	**Approximate reduction to LTHL (m^3/yr)**	**% reduction relative to MP8**
Changes to the timber harvesting land base	113,000	9%
NP reductions for non-productive deciles in TEM	5,000	0.5%
Updated road mapping and classification	7,000	1%
Updated riparian mapping and classification	17,000	1%
Karst management	7,000	1%
Goshawk, marbled murrelet, and OGMA reserves	32,000	3%
Area reductions for partial harvesting (Area VRAF)	45,000	4%
Changes to the inventories	Unknown	
New TEM Mapping	Unknown	
Changes to the yield tables	234,500	20%
Potential site index for secondary Cw/Yc	140,000	12%
Inventory site index for MHmm1 MSYTs	Unknown	
New elevation model in CWHvm2	65,000	6%
Yield reductions for partial harvesting (Yield VRAF)	29,500	3%
Potential site index from 2000 site index adjustment	Unknown	
Total Difference between MP8 and SFM Plan 9	**392,000**	**33%**
Total Difference quantitatively explained by above factors	**320,000**	**27%**
Total difference not quantitatively explained	**72,000**	**6%**

7 CONCLUSIONS AND RECOMMENDATIONS

The Base Case forecast includes an immediate drop in the current harvest level from 1,068,000 m^3/yr to 970,000 m^3/yr. This decrease allows subsequent declines in the harvest level to proceed at 5% every five years until the long-term harvest level is reached. This type of harvest flow, where harvest levels are initially higher than the long-term harvest level, is typical of coastal forest management units that are still harvesting a legacy of high-volume old growth stands.

The Base Case for this analysis is robust for the purposes of setting the allowable annual cut, because downward pressures on the short term can be deferred to the medium term. The sensitivity analyses demonstrate that timber supply crashes associated with changes to analysis assumptions do not occur until at least 100 years from the present. This delayed response reduces the risk associated with the short-term harvest level, because it allows future AAC determinations to respond to new information and management regimes.

7.1 RECOMMENDATIONS FOR IMPROVING THE NEXT TIMBER SUPPLY ANALYSIS

The inventories and assumptions used to create the Base Case are the best available information about forest management and stand growth on TFL 37. Still, there are uncertainties associated with this information that can be reduced through further study. The following areas of uncertainty have direct implications for short term timber supply, and should be given priority.

Second Growth
The sensitivity analyses demonstrated that the short-term harvest level is sensitive to the assumptions for growth and yield of existing second-growth stands (currently 6-80 years old). The next timber supply analysis would benefit from better knowledge about the growth and yield of these stands.

High Elevation Site Index
Site index assumptions for managed stands in the higher elevation areas of the TFL (CWHvm2 and MHmm1) variants are an important determinant of the short-term harvest level. Although the assumptions used in the Base Case for managed stand site index in the CWHvm2 and MHmm1are the best available information, they lack statistical support. A sampling program to take advantage of new opportunities for site index measurements in these variants should be considered. New research in equivalent sites elsewhere on the coast should also be investigated and incorporated into future high elevation site index assumptions.

Helicopter-operable areas
A disproportionate amount of the remaining old growth stands available for harvest on TFL 37 are located in areas currently accessible only by helicopter. As a result, helicopter-operable stands are important to timber supply in the next 75 years. However, current mapping of the helicopter-operable land base is approximate, and the general economic operability of stands within this land base is not defined well. The next timber supply analysis should incorporate more detailed assumptions about the location and economic viability of helicopter-accessible stands.

7.2 RECOMMENDATIONS FOR MANAGING TIMBER SUPPLY

Timber harvesting land base
The size of the THLB is a key determinant of timber supply. Accordingly, balancing the use of land area for timber harvesting/production with other uses (e.g. roads, reserves) is a means of managing timber supply. The following examples are ways for managing the THLB:

- Reduce the area of the road system through planning efficiencies and rehabilitation;
- Develop and adopt new techniques that expand the economically viable land base;
- Find overlaps between non-timber uses that require removals from the THLB (e.g. reserves for old growth management and karst geology).
- Work with other land uses to minimize conversion of productive THLB to non-forest states (e.g. transmission line right-of-ways for new power utilities).

Stands that currently have high volume are important to short-term timber supply, while highly productive sites are more important to medium- and long-term timber supply. The Base Case harvest forecast is dependent on the assumption that the current forest management regime does not progressively reduce the productivity of future rotations of managed stands. In addition to measures that mitigate site degradation, the productivity of the THLB is sensitive to the following management actions:

Regeneration Delay
Regeneration delay affects the long-term harvest level by increasing the length of harvesting rotations. A one-year regeneration delay on a site that normally produces a 100-year rotation will reduce the volume production on that site by 1%. A 1-year delay on a 50-year rotation will reduce production by 2%. The current policy of prompt regeneration of harvested sites is beneficial to long-term timber supply.

Harvest sequence of old forest
The harvest rules sensitivity analyses demonstrated that harvest scheduling is important to the medium term. The “relative productivity” principle states that the medium term can be increased by prioritizing stands that are growing slowest relative to the growth of the stand that will replace them after harvest. Incorporating knowledge about potential site productivity and current growth rates of merchantable stands into harvest scheduling may increase the availability of harvestable volume during the next 50 years.

Harvest age of managed stands
The Base Case long-term harvest level is dependent on the assumption that future managed stands are harvested on a physical rotation (i.e., they are targeted to be harvested at culmination of mean annual increment (CMAI)). Harvesting stands on other rotations, such as a financial rotation, would require a reduction in the long-term harvest level. Although alternative rotations may have management advantages, they require a reduction in the long-term harvest level.

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