Tree Farm Licence 3

Timber Supply Analysis

Analysis Report

February 2009

Prepared for:

Springer Creek Forest Products Ltd.
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March 5, 2009

Springer Creek Forest Products Ltd
705 Delany Ave.
Slocan, B.C., V0G 2C0
Attn: Kathy Howard, RPF

Dear Kathy Howard:

Re: Letter of Transmittal, Tree Farm Licence 3 Timber Supply Analysis Report

Pursuant to the requirements for a Tree Farm Licence as outlined in Section 35 of the *Forest Act*, please find enclosed your Tree Farm Licence 3 Timber Supply Analysis Report. This document is intended to provide the Province's Chief Forester with sufficient technical information to consider when making his Allowable Annual Cut determination for Tree Farm Licence 3.

You will find this report is consistent with generally accepted standards for timber supply analysis. If you require further clarification on any aspect of this timber supply analysis, please call me for an explanation.

It has been our pleasure working with you.

Sincerely,
Forest Ecosystem Solutions Ltd.

Mike Bowering, RPF
Senior Resource Analyst

REGISTERED PROFESSIONAL FORESTER
PROVINCE OF BRITISH COLUMBIA
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NO. 4044

Tree Farm Licence 3 Timber Supply Analysis Report
prepared by
Michael Bowering, RPF #4044
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Executive Summary

This timber supply analysis report presents the technical information about the capacity of Tree Farm Licence 3 (TFL3) held by Springer Creek Forest Products Ltd. to sustain appropriate harvest levels for the Chief Forester of the Province to consider when making his allowable annual cut (AAC) determination. The analysis presents the results of the base case harvest forecast, along with an assessment of the risks to timber supply (and where appropriate, non-timber objectives) associated with various uncertainties. This timber supply analysis is accompanied by the *Information Package,* provided as a separate document in Appendix 1.

Minor changes have occurred to the land base, inventories and assumptions since the 1998 timber supply analysis, however the two most critical of these changes are the revised Vegetation Resources Inventory (VRI) that was completed in 2004 and subsequently statistically adjusted in April 2005, and; the draft Old Growth Management Areas (OGMAs) that have been identified and agreed upon by Springer Creek Forest Products Ltd, although they have not yet been formally established,

The gross area of TFL3 is 79,111 ha. The total productive Crown Forested Land Base is 74% or 58,997 ha while 35% of the TFL is comprised of the current Timber Harvesting Land Base (THLB) at 27,587 ha. The low biodiversity emphasis Hoder and Koch Landscape Units are 29% and 64% of the gross area respectively, while the Perry Landscape Unit is 8% of TFL3 and has an intermediate biodiversity emphasis.

The Engelmann Spruce Subalpine-Fir (ESSF) and Interior Cedar Hemlock (ICH) biogeoclimatic zones are 64% and 35% of TFL3 respectively, with the remaining 1% in the high elevation Interior-Mountain-Heather (IMA) zone.

The THLB age class distribution is reasonably balanced. The existing growing stock in the THLB is comprised of approximately 5.4 million m^3, of which 56% is currently at or above the minimum harvest age. Spruce leading stands comprise 31% of the THLB by volume, Douglas-fir (21%), hemlock (16%), larch (14%), lodgepole pine (9%), balsam (6%), cedar <3%, and a minor component (<1%) comes from conifer trees in deciduous leading inventory type groups. Nearly 52% of the timber harvesting land base has a maximum mean annual increment (MAI) between 2.5 and 3.4 m^3/ha per year while the average productivity for the THLB is 2.9 m^3/ha per year.

In 1998, the AAC was determined to be 80,000 m^3 per year, with a 4,000 m^3 per year partition harvest assigned to areas identified as “alternate” in the 1996 operability classification. Under this current timber supply analysis, the base case harvest level is 80,000 m^3 per year over the short and medium-term. The initial harvest declines to the long-term harvest level (LTHL) of 72,500 m^3 per year by the 110th year. The base case represents no change from the current AAC over the short and medium terms of the forecast, but nearly a 10% reduction in the long-term. While a harvest volume of 80,000 m^3 per year can be carried for more than 250 years, the decline to the LTHL must occur in order stabilize the growing stock. No impacts on timber supply were found of partitioning the base case harvest volume by 5% to “alternate” areas, however removing these areas from the THLB will reduce the LTHL by 4% to 69,591 m^3 per year.

A series of 33 sensitivity analysis combinations were conducted to evaluate the impact of uncertainties in land base assumptions on the projected harvest. These uncertainties relate to site productivity, growth and yield, modelling rules, forest cover constraints as well as adjacency and green-up.

Due to the abundant inventory in TFL3 that is currently above minimum harvest age and the reasonably balanced age class distribution, the short and medium-term timber supply is insensitive to uncertainties examined in the sensitivity analyses. Most critically for the Province, the current mountain pine beetle epidemic appears to have no impact on the timber supply on TFL3. There are however, significant downward and upward pressures on timber supply that were determined from the sensitivity analyses.

The most significant downward pressure on timber supply can be attributed to the endemic Armillaria root rot that occurs throughout the Province, particularly on Douglas-fir stands in the ICH zone. Armillaria is known to exist on TFL3; however volume loss has not been quantified explicitly to date. Depending upon the degree of severity, estimated reductions to the base case LTHL ranged from 7,800 m^3 per year to 11,700 m^3 per year to account for uncertainties about Armillaria on Douglas-fir stands in the ICH zone. .Since methods were only available to explicitly examine Armillaria on Douglas-fir stands in the ICH zone, it remains to be seen what the impacts will be if Armillaria is a significant cause of growth loss and mortality on other species and/or BEC zones in TFL3.

Alternatively, the most significant upward pressure on timber supply is related to site productivity. No site index adjustments have been carried out on TFL3 to date. Sensitivity analyses were conducted to examine the harvest level impacts of increased site index values that were derived using four alternative adjustment assumptions. The results of these analyses showed that a non-declining even-flow harvest forecast ranging from 85,050 m^3 per year to 106,650 m^3 per year could be achieved, depending upon the magnitude of the site index change and the adjustment assumption used. It is generally recognized that site indices derived from mature or decadent stands are underestimated (Nigh, 1998; Nussbaum, 1998); therefore an upward pressure on timber supply may be expected if it is determined through appropriate sampling methods that the true estimates of site productivity are underestimated in the VRI.

Based on the findings from this timber supply analysis, the following recommendations were made:

- Consider deriving localized estimates of the Armillaria root rot severity.
- Initiate work on more accurate estimates of site productivity.
- Continue to monitor the results of the seed improvement program, specifically genetic gain, and how improved seed is deployed on TFL3.
- Explore the possibility of conducting a revised operability classification for TFL3, based on both physical operability and economic viability.
- Continue work on managing and updating the resource inventories. There were data inconsistencies in the VRI that are primarily a result of missing or incorrect information about harvest depletions.
- As non-timber objectives such as patch size distribution increasingly become more spatial and dynamically determined, both environmental and operational gains can likely be had with forest planning using true spatial modelling at a tactical level.

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1 Introduction

Springer Creek Forest Products Ltd. (SCFP) is responsible for preparing a timber supply analysis showing the long-term strategic timber supply for the land base of Tree Farm Licence 3 (TFL3). This timber supply analysis report presents the technical information about the capacity of TFL3 to sustain appropriate harvest levels, with due consideration to non-timber resource objectives. Forest Ecosystem Solutions Ltd. (FESL) has conducted this timber supply analysis on behalf of SCFP.

1.1 Timber Supply Analysis

The purpose of the timber supply analysis is to provide the Chief Forester of the Province with sufficient technical information about the rate of timber production that may be sustained in TFL3 when the determination for the allowable annual cut (AAC) is made. The utility of the timber supply analysis is related to how well current information and current practices are captured and depicted in the modelling forecast. Timber supply results should be neither an overestimate nor an underestimate of the capacity of the land base to produce timber volume. As such, the analysis process considers the current forest inventories, the rate of growth, constraints to timber harvesting due to non-timber resource objectives, existing forest management practices and utilization standards, and the composition of the harvestable and non-harvestable land base.

Current harvest levels have the potential to threaten the availability of timber for future harvest levels; therefore the timber supply analysis is conducted under modelling conventions to ensure that harvest levels are sustainable, and that current harvest volume does not create an unavoidable short-fall later in the forecast. Sustainability, solely with regards to timber supply analysis, is typically indicated by a stable inventory growing stock over the long-term.

There are other social, environmental and economic factors that are potentially influenced by the sustainability of the timber supply, but these are typically outside the realm of timber supply analysis. This timber supply analysis does not attempt to assess the sustainability of factors other than the perpetual flow of timber and the accompanying impacts on non-timber objectives that are explicitly considered during the modelling process.

1.2 Timber Supply Forecasts

The timber supply analysis is a modelled forecast of expected timber flows, based on current management practices and the use of the best resource inventory information available at the time of the analysis. A benchmark harvest level referred to as the 'base case' is determined that appropriately reflects current forest management assumptions and the best available resource information. As with any estimate, the base case timber supply forecast typically has a range of uncertainties that may impact the timber supply (or other quantifiable non-timber resources) in some manner, at some point in the forecast.

Sensitivity analyses are conducted to address uncertainties in the base case. These analyses examine the risks to timber supply over different planning periods in the forecast. The sensitivity analyses, when compared with the base case harvest level, provide a risk assessment for the Chief Forester to consider when determining the AAC. Since Section 8 (1) of the *Forest Act* requires the Chief Forest to review the AAC at least once every 5 years, any new information pertaining to the TFL3 land base or the management assumptions used in this analysis can be incorporated into subsequent timber supply reviews.

2 General Description of the Tenure

TFL3 is located in the West Kootenays. It is situated near the village of Slocan City, and is approximately 70 km north of Castlegar. TFL3 is located in the Southern Interior Forest Region and the Arrow-Boundary Forest District. Valhalla Provincial Park borders TFL3 to the north, while TFL 23 shares the northeast, east and southeast boundary, as shown in Figure 1. Lands outside the remaining boundaries are managed under the Arrow Timber Supply Area (Arrow TSA).

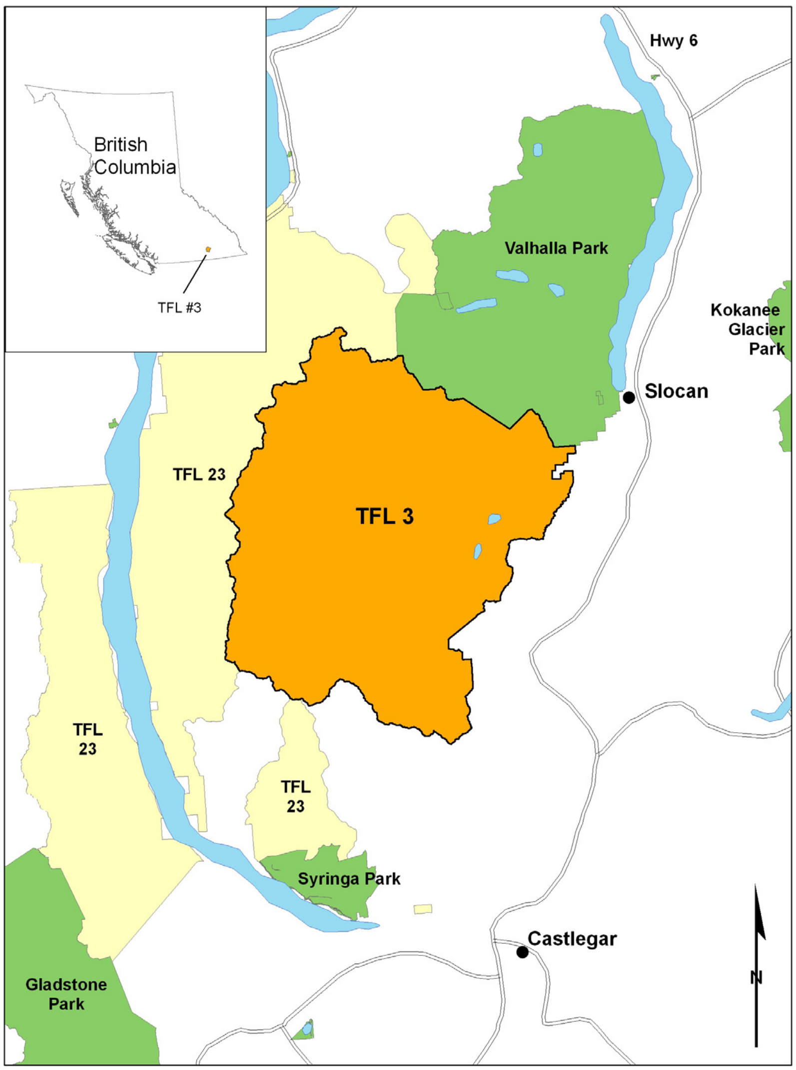

Figure 1: Location of TFL3.

The entire TFL is managed as Crown owned Schedule B land. Therefore, there are no privately held parcels owned or controlled by the licensee (e.g. Schedule A lands) and managed under the tree farm licence. The gross area of TFL3 is 79,111 ha. After accounting for recent harvest depletions, the total standing timber inventory of the Crown owned forest projected to January 01, 2006, is 11.04 million m^3, including 126,653 m^3 of non-commercial deciduous species.

3 Land Base Description

This section briefly describes the general characteristics of the land base and the criteria used for classifying the land base. A complete description of the classification assumptions and the inventory data sources are provided in the *TFL3 Timber Supply Analysis Report Information Package (Information Package)*. The *Information Package* is included as an Appendix to this report.

3.1 Forest Inventory

The forest attribute information for this analysis comes from the current Vegetation Resources Inventory (VRI) that was completed in 2004 and subsequently statistically adjusted in April 2005. Inventory adjustments were based on 2001 Phase II sampling and 2004 Net Volume Adjustment Factor (NVAF) sampling (see Jahraus and Associates Consulting Inc. and Churlish Consulting Ltd., 2005). In March 2006, the VRI coverage was updated for harvesting and re-projected to 2006.

For this analysis, updates to age, volume and height were made to the modelling database to reflect recent harvesting since the inventory was compiled. Further details regarding adjustments to the VRI are discussed in Section 5.1 of the *Information Package.*

3.2 Land Base Classification

The Timber Harvesting Land Base (THLB) was determined through a netdown process in which areas that are ineligible for harvest were sequentially removed from the total land base. Portions of the land base that are reserved from harvest can still contribute to non-timber and biodiversity objectives. Non-forested areas such as roads and water bodies, or areas not managed under the TFL (e.g. privately owned land) were removed first in order to determine the total productive forest land, referred to here as the Crown Forested Land Base. Attribute reductions are made to the productive forest land in order to determine the Timber Harvesting Land Base (THLB).

Table 1 summarizes the netdown procedure. The gross area of TFL3 is 79,111 ha, including 574 ha of privately owned land. The non-productive component, including land not compatible with growing timber, water bodies and the private land holdings amount to 20,224 ha, or 26% of the entire TFL. The total productive forest land is equivalent to the Crown Forested Land Base (CFLB) at 58,997 ha or 74% of the TFL. The non-harvestable land base (NHLB) includes all Crown forested areas that are ineligible for timber harvesting. Approximately 40% or 31,300 ha of the TFL are found in the NHLB areas.

The current THLB is 27,587 ha, and the long-term THLB is 26,214 ha. Details of the attribute deductions shown in Table 1 are provided in Section 6 of the *Information Package*.

Table 1: Timber Harvesting Land Base determination.

Topic and % Removed	Total Area (ha)	Productive Area (ha)	Total Non - Contributing Area (ha)	Net Area Removed (ha)
TOTAL AREA	***79,111***			
Area not managed by Springer Creek Forest Prod.	574		574	574
Non-typed areas in the inventory	37		37	37
Non-Vegetated	4,066		4,066	4,060
Non-Productive	14,661		14,661	14,604
Existing Roads and Trails	905		905	831
Hydro Line Corridors	338		338	7
TOTAL PRODUCTIVE FOREST LAND	*58,997*			
Inoperable 100%	39,109	21,679	39,109	21,679
Steep slope >90 pct 100%	510	168	510	18
Non-Merchantable Age >140yrs 100%	8,481	4,898	8,481	696
Low Site Productivity Age 20 - 140yrs 100%	14,435	8,291	14,435	1,161
Low Site Productivity Age ≤20yrs	0	0	0	0
Low Site Growth Potential Previously Logged 100%	34	33	34	33
Problem Forest Types - Deciduous Stands 100%	941	759	941	50
Problem Forest Types: ITG18 >250yrs 100%	0	0	0	0
Problem Forest Types: ITG19 >250yrs 100%	0	0	0	0
Riparian Buffers 100%	3,639	2,403	3,639	1,803
DRAFT Old Growth Management Areas 100%	4,481	3,293	4,481	1,672
Goshawk Nests 100%	25	24	25	19
AREAS COMPLETELY DEFERRED FROM THLB				*27,131*
ESA - High Avalanche Sensitivity 90%	302	260	299	26
Unstable Terrain TSIL-B,C & ES1s 80%	1,025	837	980	177
Problem Forest Types: ITG12 >140yrs 80%	229	224	211	73
Unstable Terrain TSIL-D 60%	7,197	3,512	7,004	289
Problem Forest Types: ITG11 >140yrs 60%	580	556	432	211
ESA - High Regeneration Sensitivity 50%	11,905	11,161	11,316	561
Problem Forest Types: ITG13-17 >140yrs 40%	2,443	2,386	1,640	511
Problem Forest Types: ITG18 141-250yrs 30%	3,141	1,372	3,122	8
Problem Forest Types: ITG20 >140yrs 20%	5,269	4,138	4,774	119
Potentially Unstable Terrain TSIL-B,C 13%	4,323	3,970	2,055	299
Potentially Unstable Terrain TSIL-D, ES2s 10%	29,199	20,451	21,824	755
ESA - Moderate Regeneration Sensitivity 10%	2,098	2,009	1,459	31
Problem Forest Types: ITG19 141-250yrs 10%	23	21	4	2
Archaeological Sites <5%	17	3	17	0
AREAS PARTIALLY DEFERRED FROM THLB				*3,062*
Existing Landings			110	110
Wildlife Tree Retention Areas			1,106	1,106
TOTAL NETDOWN LAND				*1,217*
TOTAL PRODUCTIVE LAND BASE REDUCTIONS				*31,410*
CURRENT TIMBER HARVESTING LAND BASE	***27,587***			
Future Road Area			1,135	1,135
Future Landings			237	237
FUTURE THLB	***26,214***			

3.3 Current Forest Conditions

This section presents a general description of the climate, Landscape Units, as well as the age structure, types and productivity of forests found in TFL3.

3.3.1 Biogeoclimatic Ecosystem Classification

Figure 2 shows the distribution of biogeoclimatic ecosystem classification (BEC) variants in the TFL, by land base classification. The gross area of TFL3 is comprised predominantly of the Engelmann Spruce Subalpine-Fir (ESSF) and Interior Cedar Hemlock BEC zones at 64% and 35% respectively, while high elevations of the TFL are in the Interior-Mountain-Heather (IMA) zone (1%).

Within the ESSF zone, approximately 39% of the TFL is comprised of the wet cold Selkirk variant (ESSFwc4), while nearly equal proportions of the wet cold Columbia variant (ESSFwc1) and wet cold parkland variant (ESSFwcp) are found in the TFL at 13% and 12% respectively.

In the ICH zone, the moist and warm Shuswap variant (ICHmw2) makes up 26% of TFL3, while the West Kootenay dry warm variant (ICHdw1) is 9% of the TFL gross area.

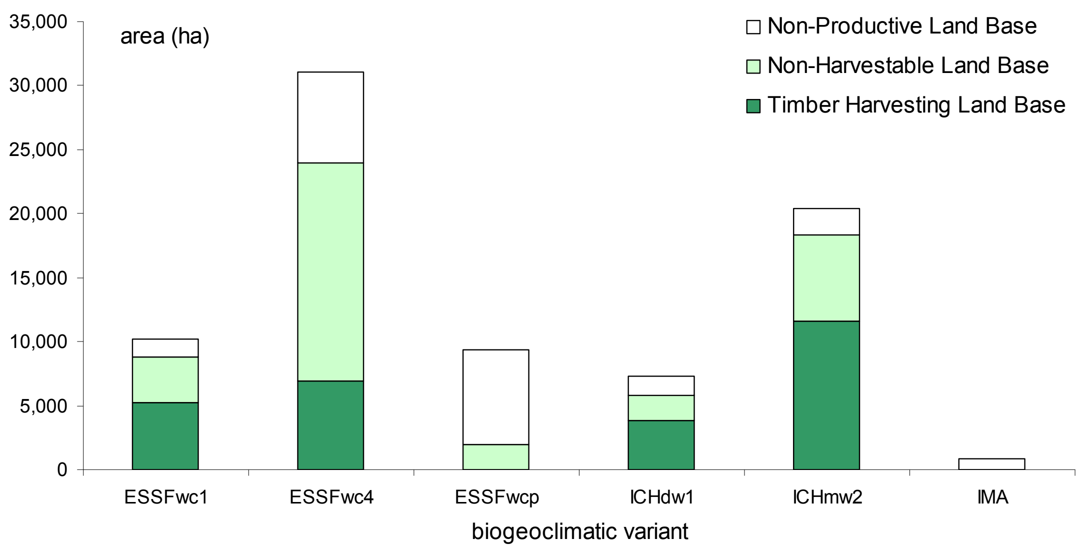

Figure 2: Biogeoclimatic variants in TFL3. Non-productive land base includes non-forested areas incapable of growing trees, water bodies and privately owned land.

3.3.2 Landscape Units

Three Landscape Units are inside TFL3. The Hoder comprises 29% of the gross area of the TFL, while the Koch and the Perry are 63% and 8% respectively. Only the Koch landscape unit is entirely within TFL3. The Hoder and the Koch both have a low biodiversity emphasis option, while the Perry has an intermediate biodiversity emphasis option. Natural disturbance types 1, 2 and 3 are all found within each Landscape Unit. Valhalla Provincial Park is outside the TFL3 boundary, but it makes up the northern portion of the Hoder Landscape Unit.

3.3.3 Age Class Distribution

Figure 3 shows the age class distribution of TFL3. The THLB age class distribution is reasonably balanced, with only slight gaps in the 41 to 60 year class (6% of the THLB) and the two age classes between 101 and 140 years (7% and 5% of the THLB area, respectively). It is not likely that these minor age class gaps will impact timber supply, given that the average minimum harvest age of the standing inventory is 93 years and 43% of the THLB is older than 90 years. Nearly 22% of the THLB is in the 80 to 100 year class. There is almost an equal proportion of the THLB in the two lower age classes (25%) and the two oldest age classes (26%), as shown in Figure 3.

The non-harvestable land base (NHLB) follows the expected trend. Only 5% of the NHLB area is <60 years of age, while 42% of this area is >140 years old.

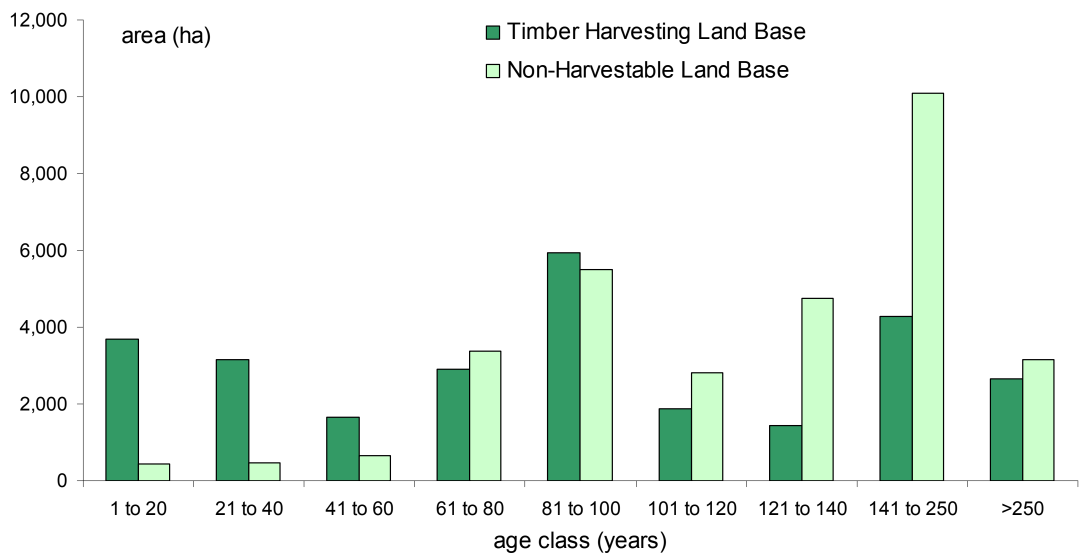

Figure 3: Age class distribution of the productive land base in TFL3.

3.3.4 Tree Species Groups (Inventory Type Groups)

The Crown forest area of TFL3 is comprised predominantly of Balsam leading types (29%), followed by Spruce types at 26%. Interior Douglas-fir, grouped with a small component of ponderosa pine and western white pine (the Fir_Pine group)[1] makes up 14% of the Crown forested area in the TFL, while Hemlock leading stands represent 10%. Larch types and Lodgepole pine leading stands represent 9% and 7% of the TFL forested area respectively. Cedar constitutes a mere 3% of the forested area, while deciduous leading stands are only 2% and mostly in the non-harvestable land base. Figure 4 shows the Crown owned forested area distribution of stands, grouped by leading species types (inventory type groups) in TFL3.

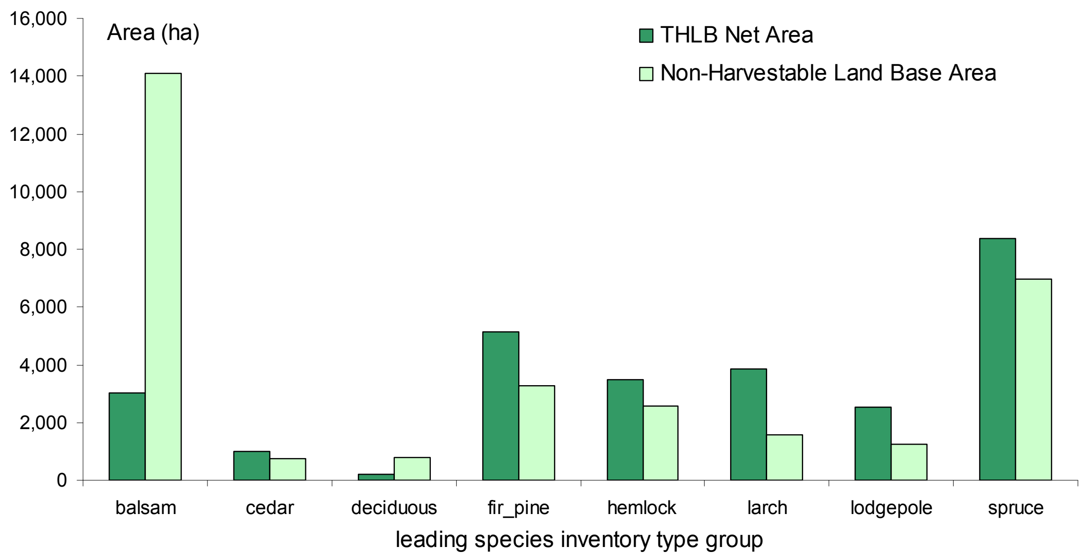

Figure 4: Crown forested area distribution of stands by leading species type group.

Within the THLB, Spruce leading stands comprise 30% of the area and 31% of the net merchantable volume (Figure 5). The Fir_Pine group follows at 21% of the net volume and 19% of the THLB area. At nearly 16%, Hemlock has a higher volume proportion then Larch (14%) but a lower area proportion (Hemlock 13%, Larch 14% of the THLB area). Lodgepole pine leading stands make up 9% of both area and volume of the THLB.

The area and volume proportions of Balsam stands show the widest difference, at 11% and 6% respectively. The Cedar types make up <4% of the area and <3% of the volume. Broadleaf species are not merchantable in TFL3, however Deciduous stands with previous logging history that have a viable component of merchantable species are retained in the THLB (see Section 6.12 of the *Information Package*). Less than 1% of the THLB area is comprised of these Deciduous types, and due to their young age, they have hardly any (0%) net merchantable volumes within the THLB.

[1] The fir_pine group is predominantly interior Douglas-fir with a very small component of pondersosa pine (26 ha) and western white pine (138 ha) leading stands.

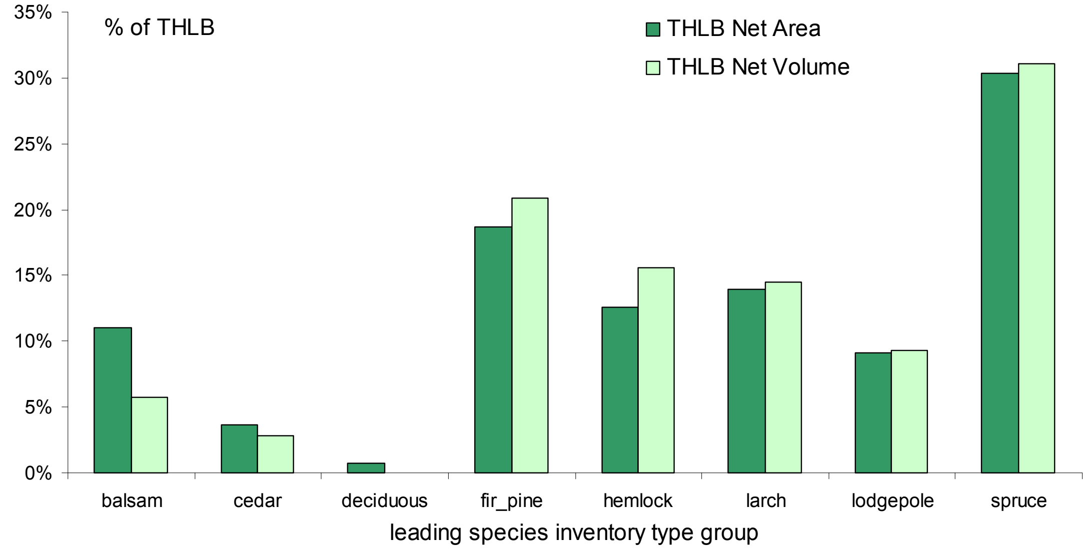

Figure 5: Species composition of the timber harvesting land base. The Fir_Pine group includes Fd and a small component of Py (26 ha) and Pw (138 ha) leading stands.

3.3.5 Site Productivity

Site productivity is typically quantified by site index[2] and is a measure of the stand average tree height growth for a given age, typically breast height age of 50. Site index is a species specific attribute; therefore a particular site index for one species may not represent the same growth rate of an alternate species.

The area weighted average site indices, as calculated from the VRI values are shown for each leading species group in Figure 6. Site indices for Spruce and Lodgepole pine groups are further delineated by BEC zone to be consistent with the species group aggregations used in the timber supply analysis. On average, the THLB is more productive than the non-harvestable component. This is to be expected, since stands with very low site productivity are usually removed from the THLB.

[2] Site index is an estimate of the site productivity for tree growth. Site index is estimated using the average height of site trees (the largest diameter trees free of damaging agents in a site index plot) at a reference age. The reference or base age for site index in the VRI used for this analysis is breast height age 50 years.

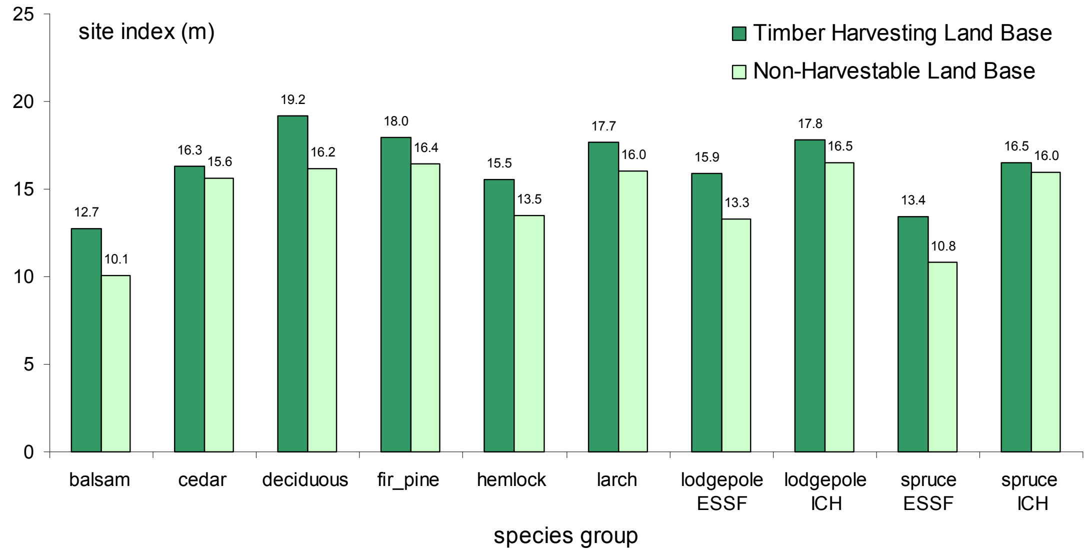

Figure 6: Mean area weighted site index, by leading species group.

Stands in TFL3 were classified into the site index classes shown in Table 2 to reduce variability within species groups. Lodgepole pine and Spruce types were further delineated by BEC zone. The mean site index values shown in Table 2 is the area weighted average THLB site index for the class. A detailed rationale regarding the classification of stands into the site productivity classes found in Table 2 is discussed in Section 7.2.1 of the *Information Package*.

Table 2: Leading species group site productivity class.

		Site Index Class[1]							
		Low		Poor		Medium		High	
Species Group	BEC	Range (m)	Mean (m)	Range (m)	Mean (m)	Range (m)	Mean (m)	Range (m)	Mean (m)
Balsam	All	<11.0	8.6	11.0 - 13.9	12.4	14.0 - 17.9	15.4	≥18.0	20.1
Cedar	All	--	--	≤15.9	14	16.0 - 18.9	17.3	≥19.0	19.5
Deciduous	All	--	--	--	--	<19.0	16.5	≥19.0	20.2
Fir_Pine	All	--	--	≤15.9	14.4	16.0 - 19.9	18	≥20.0	21.2
Hemlock	All	--	--	<14.0	12.1	14.0 - 18.9	16.5	≥19.0	21.2
Larch	All	--	--	<14.0	12.7	14.0 - 19.9	17.5	≥20	21.1
Lodgepole	ESSF	--	--	<14.0	12.5	14.0 - 16.9	15.5	≥17	18.6
Lodgepole	ICH	--	--	--	--	<18.0	15.6	≥18.0	21.1
Spruce	ESSF	<9.0	7.7	9.0 - 12.9	10.8	13.0 - 16.9	14.8	≥17.0	18.9
Spruce	ICH	<13.0	10.7	13.0 - 16.9	14.9	17 - 20.9	18.8	≥21.0	22.2

[1] The site index values used in the classification come from the Vegetation Resources Inventory

Figure 7 shows the site productivity class distribution within the THLB, using the site index classes shown in Table 2. Within the species groups, the site index distributions tend to follow a normal distribution pattern where such distributions occur in the VRI. Where the inventory site indices portray a somewhat skewed distribution, the clustered distributions follow the same trend (i.e. Cedar types in Figure 7).

The medium site classes of Fir_Pine and Larch are each approximately 11% of the THLB, for a total of 22% of the THLB area. Medium site Hemlock stands as well as medium and poor site Spruce stands found in the ESSF zone constitute approximately 8% each of the THLB, making the proportion of THLB area subtotal 46%. High site spruce stands in the ESSF comprise a further 5% of the THLB area, bringing the THLB subtotal to 51%. The poor site classes in Hemlock and Balsam types and the high site Fir_Pine stands make up about 4% each, bringing the proportion of THLB area subtotal to 63%. Poor sites of Fir_Pine and medium sites of Balsam are equally represented and add another 7% combined to the THLB subtotal. The ESSF zone Lodgepole pine stands, low site Balsam and low site Spruce stands found in the ESSF have nearly the same THLB area (3% each); adding these three types subtotal the proportion of THLB area to 79%. The remaining site classes are <3% of the THLB each, but in total comprise about 21% of the THLB area.

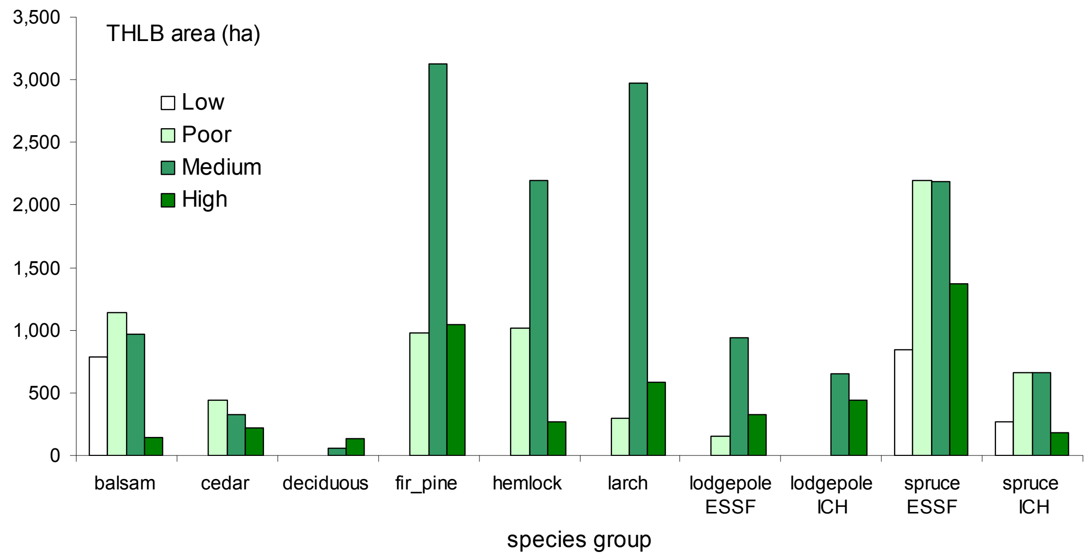

Figure 7: Site productivity classes for the timber harvesting land base by leading species group.

Alternatively, site productivity may be quantified by an indirect estimate, such as the potential maximum annual increment of a stand as projected by a growth and yield model. Unlike site index, this measure can be compared for the entire land base, regardless of species groups, since species is one of a number in input attributes for the growth and yield model. Site index, stand species proportions, net merchantable volume estimates (after loss factors are considered), any favourable silviculture treatments (such as fertilizing or planting preferred stock) and a measure of a stand density are necessary attributes for projecting potential future stand growth and yield.

Figure 8 shows the potential site productivity as projected with Table Interpolated Projected Stand Yield (TIPSY ver. 4.1) and the future managed yield curves (future yield assumptions are discussed in Section 8.8 of the *Information Package*). Nearly 52% of the timber harvesting land base has a maximum mean annual increment (MAI) between 2.5 and 3.4 m^3/ha per year. The area weighted average maximum MAI for the THLB is 2.9 m^3/ha/yr.

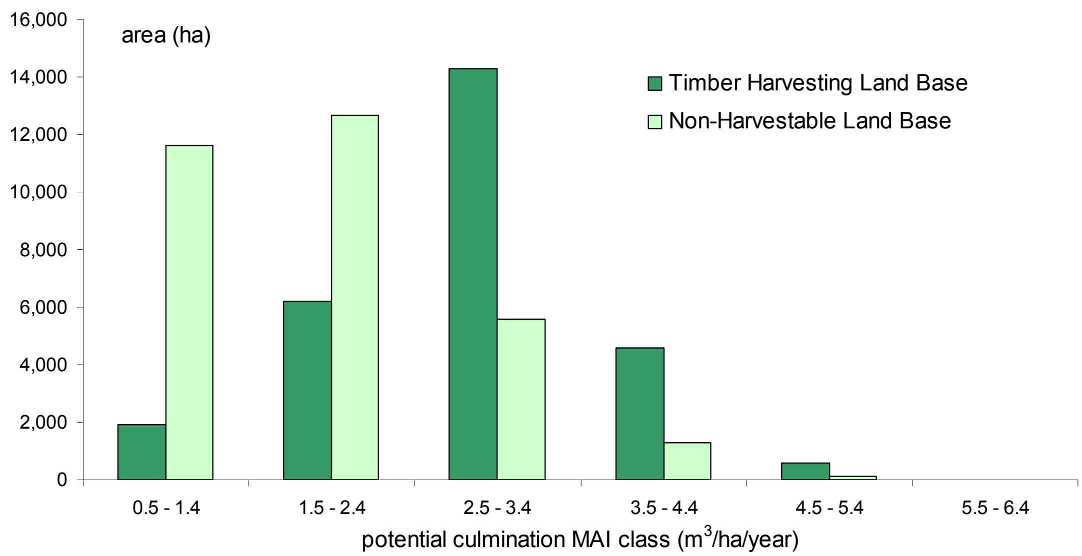

Figure 8: Potential site productivity expressed as the culmination mean annual increment, or maximum MAI based on the future managed yield curves generated with TIPSY.

4 Assumptions and Methods

This section briefly describes the resource aggregations, assumptions and methods used in the timber supply analysis. Further details are presented in the *Information Package.*

4.1 Analysis Units

Stands with similar biological characteristics were aggregated into larger homogenous units called analysis units (AUs) for management prescriptions and objectives. The VRI site index and leading species (inventory type group) were the dominant criteria for determining the AUs.

Stands were separated into site productivity classes, within their respective species group. Spruce and lodgepole pine inventory type groups were further delineated by BEC zone. These site groups were shown previously in Table 2.

4.2 Growth and Yield

Stands within each AU were further categorized by management status to reflect growth and yield assumptions. After adjusting inventory ages for the most recent harvest depletions, four management categories were used for each analysis unit.

1. Existing Natural*:* Stands >20 years of age. Yields projected with the Variable Density Yield Projection Model (VDYP). Referred to as 'natural' stands for this analysis since yields were projected with VDYP. These stands comprise 23,915 ha or 87% of the THLB.
2. Existing managed: Managed stands >10 and ≤20 years of age in the inventory, projected with batch version 4.1 Table Interpolation Program for Stand Yields (TIPSY). Class A seed use not assumed for this category. These stands comprise 1,743 ha, or 6% of the THLB.
3. Existing managed with Class A seed: Managed stands ≤10 years of age were further stratified by age to model the use of Class A seed. These stands comprise 1,929 ha, or 7% of the THLB.
4. Future managed: Future managed stands assume the use of Class A seed. All existing stands in the THLB, regardless of management status, are assumed to regenerate to future managed stand types.

Details of the yield assumptions for each management category are provided in Section 8 of the *Information Package*. Regardless of management status, all yields were projected at the stand level with growth and yield models. Yield model projected attributes made at the stand level were averaged (weighted by polygon area) for each year, by analysis unit and management category.

4.3 Integrated Resource Management

Integrated resource management (IRM) objectives are addressed either at the landscape level or at the stand level. IRM objectives may be applied through volume reductions to yield tables[3], as area based reductions to the THLB or through forest cover constraints. Stand level biodiversity was addressed through area based reductions to the THLB attributable to wildlife tree retention areas, riparian areas and special wildlife habitat. The draft Old Growth Management Areas (OGMAs) were also removed from the THLB. These reductions are discussed in Section 6 of the *Information Package*.

At the landscape level, IRM objectives are typically applied through forest cover requirements. Forest cover constraints allow management objectives for biodiversity, visual quality, water quality and harvest unit adjacency to be incorporated into the timber supply analysis. General landscape level objectives are typically managed and/or monitored by Landscape Unit at the BEC variant level; however objectives may be set for specific resource polygons such as visually sensitive polygons or ungulate winter range areas.

4.3.1 Forest Cover Objectives

Forest cover objectives are applied on TFL3 to manage for visual quality, landscape level biodiversity, water quality and wildlife. Specific details and assumptions for modelling the integrated resources are provided in Section 10 of the *Information Package.* Table 3 summarizes the modelling assumptions for forest cover objectives that are applied in the base case for TFL3.

[3] Other than standard TIPSY Operational Adjustment Factors (OAF1) to address yield reductions attributed to non-productive areas in the stand and/or uneven spacing of crop trees (clumping), volume reductions were not made to the yield tables in this analysis as a surrogate for area reductions to the THLB.

Table 3: Summary of forest cover targets applied in the base case projection.

Resource	Criteria	Cover Requirement	Applied to:	
			Zone	Cover Type
ERDZ-T Zones	Green-up height	Stand re-establishment.	Enhanced Resource Development Zones – Timber unencumbered by other IRM issues.	THLB
Visual Resources Management	% 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.	VQO polygons	Crown forested area
Landscape Level Biodiversity	Old seral cover	A specified percentage of each BEC variant must be greater than the designated old seral age. DRAFT OGMAs expected to meet target requirements in the base case.	BEC variants by Landscape Unit	Crown forested area
	Mature + old seral cover	A specified percentage of each variant must be greater than the designated mature seral age. DRAFT OGMAs are expected to meet old seral component of requirements in base case	NDT 3 BEC variants in Perry Landscape Unit	Crown forested area
Consumptive water	Equivalent clearcut area (ECA)	ECA of each domestic watershed should be less than a specified percentage.	Class 1, 2, and 3 Domestic watersheds	Crown forested area
Ungulate Winter Range	Seral cover	Depending on BEC, 30 or 40% of the UWR management unit in TFL3 must be greater than the minimum age by management unit. No more than 40% of UWR management unit area can be <20 years old	UWR Management Units	Crown forested area excluding broadleaf stands.
Connectivity Corridors	Mature+Old seral cover	Desired spatial location of Mature+Old seral cover requirements appropriate to each BEC variant and LU. OGMAs are assumed to meet old seral requirements in base case.	Connectivity corridors where Mature+Old seral targets apply.	Forested area with slope <80%

4.3.2 Cutblock Adjacency and Greenup

Current practice on the TFL is to emulate natural disturbance patterns to the extent practicable. Patch size areas and distributions are used as management objectives to emulate natural disturbance patterns for each of the natural disturbance types within Landscape Units. In practice however, only early seral patches (stand age ≤20 years) are monitored for patch area distribution. Details of the patch size targeting are provided in Section 10.2.1 of the *Information Package.*

The current management strategy of emulating natural disturbance through patch size targeting presents some difficulty in timber supply modelling. Modelling patch size distributions requires the use of true spatial modelling, using heuristic algorithms and targets, rather than constraints and a simulation modelling approach. Patch targets are not usually defined explicitly. Rather, these targets are often defined as acceptable size ranges.

The nature of the spatial targets described above suggests that the number of suitable spatial solutions is high, i.e., many different combinations of patch size distributions can produce acceptable solutions. As a result, there are no optimum solutions for spatial modeling problems.

Heuristic algorithms provide the means to use a target orientated approach that simulation algorithms lack. Desired future condition can be defined and set as a target. These algorithms can work towards targets and often produce superior spatial solutions. The disadvantage of this approach is that repeated analyses carried out with exactly the same set of inputs and assumptions can produce somewhat different solutions. Also, standard sensitivity analyses are not possible, because no solution is fixed as described above (spatial targets).

Alternatively, harvest unit adjacency may be modelled in a semi-spatial manner, using a minimum green-up height[4] and a limit on the amount of area (usually a proportion of a Landscape Unit) that may be below the minimum height. While this approach is more easily incorporated and replicated during the timber supply modelling, it does not fully reflect current management practice on TFL3.

For this analysis, the harvest unit adjacency was not incorporated into the base case analysis explicitly. Rather, harvest unit adjacency was modelled through two sensitivity analyses. The first sensitivity used true spatial modelling with patch size targeting and heuristics, and the other sensitivity applied the semi-spatial approach of not allowing more than 25% of each landscape not founding the community watersheds, visually sensitive areas and ERDZ-T zones to be more than 2.5 m in height. Where more restrictive green-up heights than adjacency heights were required (as in visual polygons), the more restrictive height limits were applied in the modelling.

[4] The *Kootenay Boundary Higher Level Plan Order* (*Government of B.C., 2002)* specifies the green-up height for all areas other than community watersheds, visually sensitive areas and Enhanced Resource Development Zones – Timber (ERDZ-T) to be 2.5 metres.

4.4 Natural Disturbance

Natural disturbance has the potential to impact the timber supply analysis either by reducing the amount of timber available for harvest in the THLB, or by disturbing stands that were otherwise contributing to the IRM objectives, such as old seral targets, in the non-harvestable land base. Not accounting for natural disturbance may over estimate the available timber volume, or over estimate the forest cover contribution of areas outside the THLB.

4.4.1 Non-Harvestable Land Base Disturbance

Disturbance in the non-harvestable land base (NHLB) was modelled by randomly assigning a disturbance period to forested stands within the NHLB, regardless their stand age or integrated resource management objectives. Details on the amount of disturbance and how it was applied are provided in Section 10.3 of the *Information Package*.

4.4.2 Unsalvageable Losses

Unsalvageable losses represent natural disturbance events that are non-recoverable (either due to access or complete loss) and result in a decrease in the productive harvest volume of the TFL. Generally, endemic losses such as the spruce weevil or Armillaria root rot are accounted for through operational adjustment factors (OAFs) in managed stands or by the existing inventory sampling.

For this analysis, unsalvageable losses focused on epidemic losses, such as fire, windthrow or other disturbance events like the mountain pine beetle epidemic. Section 9 of the *Information Package* describes the unsalvageable loss categories, the volume estimates and how the estimates were determined.

To date, mountain pine beetle has not had a significant impact on the lodgepole pine trees in TFL3. Sensitivity analyses were conducted (see Section 6.4.5 and Section 6.5.1) to examine the impacts of the mountain pine beetle epidemic on timber supply within TFL3, including the loss of the pine component within mixed species stands. Beetle impacts are based on the current Provincial mountain pine beetle projections (see Walton et al. 2008). It is expected that the non-recoverable losses attributed to mountain pine beetle will decline over the length of the planning horizon once the beetle infested pine is dead (B.C. Ministry of Forests and Range. 2008a).

4.5 Minimum Harvest Ages

Minimum harvest age is the criterion that defines whether a stand is merchantable or not in the timber supply model. For TFL3, the minimum age requirement is determined from the amalgamated yield curves as the age where the minimum volume requirement is met.

Current practice on the TFL is to only harvest where the merchantable volume is ≥150 m^3/ha when the slope is ≤40%. Where the slope is >40%, minimum merchantable volume limits are ≥225 m^3/ha. A weighted average minimum merchantable volume harvest age was derived for each analysis unit across the two slope categories. A sensitivity analysis was also conducted to examine the impacts on timber supply of setting the minimum harvest age to the age where 95% of maximum MAI occurs.

If there are gaps in the age class distribution, and otherwise merchantable stands are constrained for non-timber objectives, then arbitrarily high minimum harvest ages can adversely impact timber supply. Alternatively, if a relatively high proportion of the TFL is beyond the arbitrary minimum harvest age, then the minimum harvest age will likely have little impact on timber supply. Harvest queuing rules, such as the relative oldest first, and modelling to meet various management objectives through forest cover requirements will likely influence the actual age at harvest, shifting it beyond the minimum values.

4.6 Timber Supply Modelling

The timber supply analysis was conducted using Forest Simulation and Optimization System (FSOS), a proprietary model developed by Forest Ecosystem Solutions Ltd. FSOS functions in both simulation and heuristic modes. The time step simulation mode was used primarily in this analysis, with the exception of the patch size targeting sensitivity analysis. The FSOS model uses the multiple resultant polygons created by GIS overlay as the basic model unit.

4.6.1 Timber Supply Projection Parameters

The standard timber supply analysis projection is 250 years. This analysis used a 400-year timber supply projection to provide a better response to growing stock changes throughout the planning horizon; however the harvest level is only reported in this report for the first 250 years. Target harvest levels were not adjusted between 250 and 400 years.

FSOS is capable of using annual harvest levels or alternatively, grouping the harvest activities and associated reporting into planning periods. The length of the planning period influences growth and yield estimates, management objectives and constraints. Overly narrow planning periods tend to overstate the operational reality of targets and constraints while overly broad planning periods provide unrealistic flexibility in meeting these targets and constraints. A planning period of 5 years tends to depict operational circumstances reasonably. Consequently, for this analysis the planning periods were set to 5-year increments.

In the discussion, references are often made to changes occurring at given years in the timber supply projection. Since a 5-year period is used for the analysis, the years where changes occur refer to the final year within the 5-year period. For example, where changes are reported to occur at year 10, they are actually occurring in the timber supply model during the second 5-year period, between years 6 and 10. Therefore, in order to simplify the discussion, these changes will be reported as occurring at year 10.

4.6.2 Precision of Harvest Forecasts

The minimum resolution of harvest forecasts is 1% throughout the planning period.

In the timber supply model, periodic harvest volumes may fluctuate around the target harvest level, since polygons are not split for harvest between adjacent periods. This means in some periods, that the actual harvest volume may be slightly above the target, while in other periods it may be slightly below. At minimum, successful modelled harvest volumes must be within 1% of the target harvest level.

4.6.3 Harvest Scheduling Rule

A 'relative oldest first' rule will be applied in the base case to rank stands for harvest. In this rule, the age of a stand is relative to its minimum harvestable age. Stands that have the greatest positive difference between their actual age and their minimum harvest age are selected for harvest, subject to forest cover requirements.

A sensitivity analysis of altering the 'relative oldest first' rule to an 'oldest-first' rule was conducted to examine the impact on timber supply.

4.6.4 Harvest Profile

The proposed harvest units in the GIS resultant will be fixed for harvest in their intended year when the model runs the timber supply projection. Currently, there are 10 cutting permits under review, comprising 857 ha of cutblocks that SCFP estimates will be harvested by the end of 2008.

Species were not prioritized for harvest in the analysis, with one exception. The timber supply impact of prioritizing Pine leading stands was investigated explicitly in the mountain pine beetle sensitivity analyses.

5 Base Case Harvest Forecast

This section presents the base case harvest level. The base case represents the projected timber flows based on current practice in TFL3 and the best information available at the time of the analysis. The *Information Package* details the assumptions of the base case analysis, including the THLB, forest cover requirements, growth and yield, and the harvesting rules used in the modelling.

The intent of the base case analysis is to provide a benchmark analysis with which to test uncertainties in the existing resource information and assumptions, and to evaluate the impacts of current management strategies on future timber supply.

5.1 Sustainable Harvest Levels

There are a number of ways to determine sustainable harvest levels in timber supply modelling. In past, harvest levels were deemed to be sustainable if the timber supply analysis failed to produce "crashes" or demonstrate significant deviations from the target harvest level. This approach may be appropriate if the land base shows considerable age class gaps and/or is highly constrained for non-timber objectives. Crashes in the timber supply will occur at pinch points where the timber supply model is unable to harvest any merchantable timber. Where there is a large component of available merchantable timber, evaluation of the long-term growing stock is a more appropriate indicator of sustainability.

As discussed in Section 3.3.3, TFL3 shows only minor age class gaps. In fact, a large component of the THLB is currently merchantable, without consideration of forest cover constraints for non-timber objectives (i.e. availability). Figure 9 shows that nearly 15,500 ha, or 56% of the THLB is currently at or beyond minimum harvest age. Slightly more than 2,500 ha (9% of the THLB) will become available in the next 10 years.

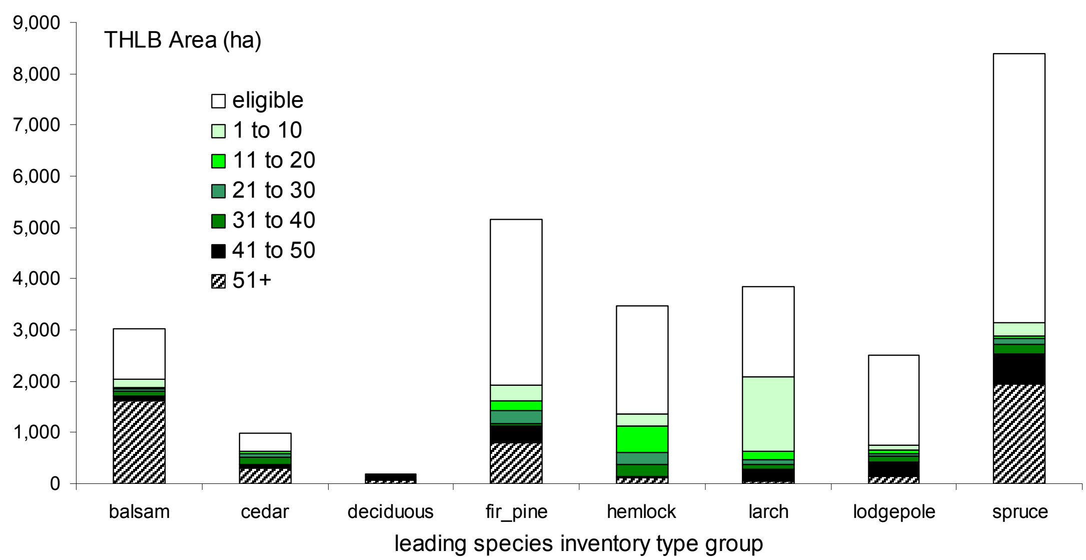

Figure 9: Number of years until minimum harvest age, by species group in the THLB. Eligible stands are at or beyond minimum harvest age.

A further consideration to consider in determining appropriate measures of sustainability is to review the amount of area that is under some form of a forest cover constraint for non-timber objectives. Forest cover constraints for IRM objectives may directly impinge the harvest level. Figure 10 shows the area within the THLB that is constrained in some manner for visual, watershed and ungulate winter range resources. There is some degree of overlap in these features too. In total, nearly 8% of the THLB is encumbered with visual quality objectives, 10% with domestic watershed restrictions on harvesting and 7% of the THLB must be managed for ungulate winter range. In total, about 22% of the THLB is managed for one or more of these non-timber attributes.

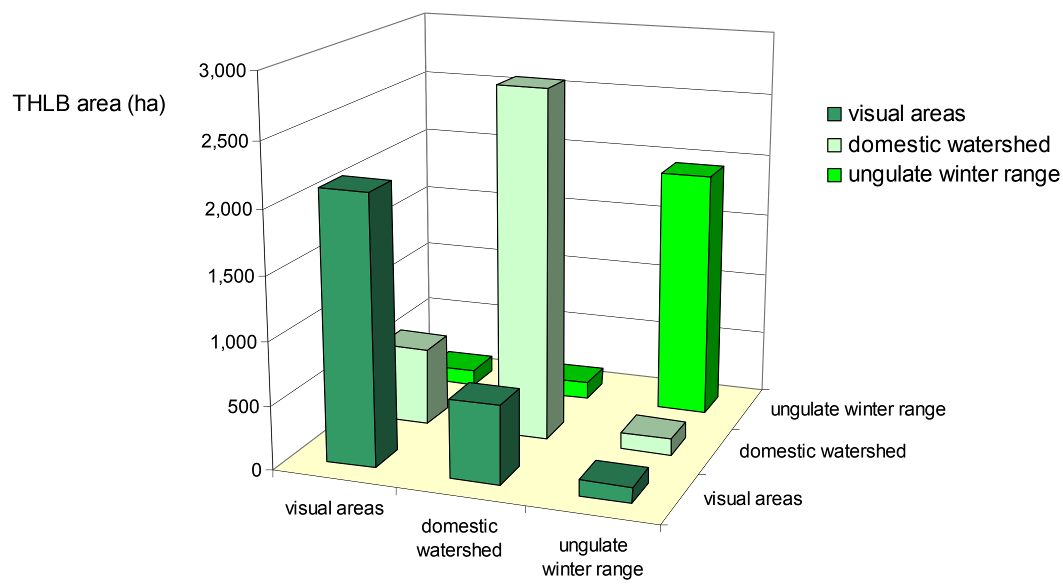

Figure 10: Visual areas, domestic watersheds and ungulate winter range areas and the overlap between these resource management features.

Given that a relatively large proportion of the THLB is currently merchantable and that a smaller proportion of the THLB is constrained in some manner for non-timber objectives, the use of the timber supply forecast alone will not likely be a very sensitive indicator of the sustainability of the harvest level. Pinch points are not as likely on an available and merchantable land base.

Evaluation of the timber supply model output from this analysis considers both the long-term growing stock and any indicators of any pinch points in the timber supply analysis. Harvest levels in the short and mid-term portion of the forecast were considered sustainable if the long-term growing stock remained relatively constant.

5.2 Determining the Base Case Harvest Level

The 1998 timber supply analysis (TSR2) projected an even-flow harvest level of 75,779 m^3 per year, based on a THLB of 26,156 ha. The base case in the 1998 analysis did not include 1,860 ha of otherwise harvestable area classified as "alternate" in the operability classification. When these "alternate" areas were included in a sensitivity analysis in TSR2, the even-flow timber supply projection was 80,000 m^3 per year. The AAC from the 1998 analysis was set at 80,000 m^3 per year, and this volume was used as the initial harvest level for the current analysis.

Determining the base case harvest level is an iterative process where the analyst must consider not only the current AAC, but the capacity of the land base to support a sustainable harvest level throughout the planning horizon. For this analysis, the harvest flow objective was to determine an even-flow harvest level along with a stable growing stock throughout the planning horizon, and ensure that the long-term harvest level is appropriately established.

For comparison, the land base was evaluated by removing all forest cover constraints and setting the harvest level to the Long Run Sustained Yield (LRSY). The LRSY is a theoretical maximum harvest level of the biological capacity of the land base, and defined by maximum productivity at the maximum MAI (culmination age) of the future THLB. Forest cover constraints for non-timber objectives are not modelled when evaluating the LRSY harvest level. For TFL3, the LRSY harvest level is 76,612 m^3 per year, after removing all future roads and landings from the existing THLB. Under the theoretical assumptions of the LRSY analysis, this harvest level could be maintained throughout the 400 year timber supply projection, and the associated long-term growing stock remained relatively stable.

Initially, a non-declining even flow, or flatline harvest level of 80,000 m^3 per year, equivalent to the current AAC, was evaluated. The timber supply forecast showed that the current AAC could be maintained well past the 250 year standard timber supply projection, although it did so at the cost of the long-term growing stock. Eventually the decline in the long-term growing stock impacted the volume available for harvest, as the harvest level crashed in the 37th decade of the projection. Given that the LRSY harvest level is less than 80,000 m^3 per year, this overall decline in the long-term growing stock and the associated crash in the timber supply were expected at some point in the projection. A declining harvest level from the current AAC to the Long-Term Harvest Level (LTHL) was in order.

5.2.1 Establishing the Long Term Harvest Level

For the same land base and management assumptions, the LTHL is a fixed entity, while the short and mid-term harvest levels may vary. Ideally, the short and mid-term harvest levels create an equilibrium condition in the land base so that long-term growing stock is relatively stable once the fixed LTHL is attained. Many options exist for both the timing and the magnitude of change for the transition from the initial timber flow to the LTHL. Conventional practice in timber supply is not to lessen the harvest volume in the mid-term for an immediate gain in the short-term, and to show a gradual change in harvest volumes, generally no more than 10% per decade (B.C. Ministry of Forests, 2000b).

In order to establish the LTHL, the harvest volume transition from the natural stands to managed stands was examined for the 80,000 m^3 per year even flow projection. An appropriate timing window for the harvest decline was evaluated, based on the harvest transition from natural to managed stands. As shown in Figure 11, the transition began in the 80th year, with managed stand volumes making up the majority of the harvest by the start of the 110th year.

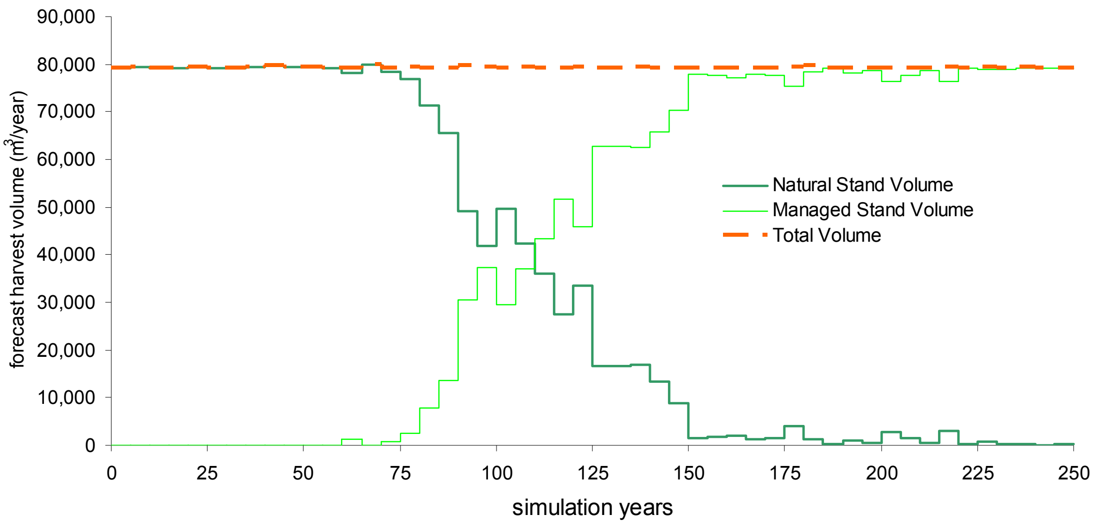

Figure 11: Harvest volume transition from natural to managed stands, based on a non-declining even flow harvest of 80,000 m^3 per year.

To determine the actual timing and the magnitude of the harvest decline, a matrix of thirty five harvest level reduction scenarios were examined whereby the initial harvest level was reduced between 6,500 and 10,000 m^3 per year, between the years 80 to 120 (Table 4) that coincided with the managed stand transition as shown in Figure 11. Harvest reductions were applied to the forecast within the first 5 year period before the years shown in Table 4. Generally, it was desired to retain the initial harvest level as long as possible, and only reduce the harvest level by the amount necessary to create an equilibrium condition in the long-term growing stock.

Table 4: Base case harvest level reduction scenarios from the initial harvest volume of 80,000 m^3 per year. Values in bold indicate the base case LTHL and the 5-year period final year when the reduction occurred.

Harvest Reduction (%)	Reduced Harvest (m^3/year)	Harvest Reduction Timing				
		Year	Year	Year	Year	Year
12.5%	70,000	80	90	100	110	120
11.3%	71,000	80	90	100	110	120
10.6%	71,500	80	90	100	110	120
10.0%	72,000	80	90	100	110	120
9.4%	**72,500**	80	90	100	**110**	120
8.8%	73,000	80	90	100	110	120
8.1%	73,500	80	90	100	110	120

Figure 12 shows the effects on the long-term growing stock of applying the range of harvest reductions presented in Table 4, by 110 years into the projection. For comparison, the growing stock of both the LRSY and the 80,000 m^3 per year non-declining even flow harvest levels are shown.

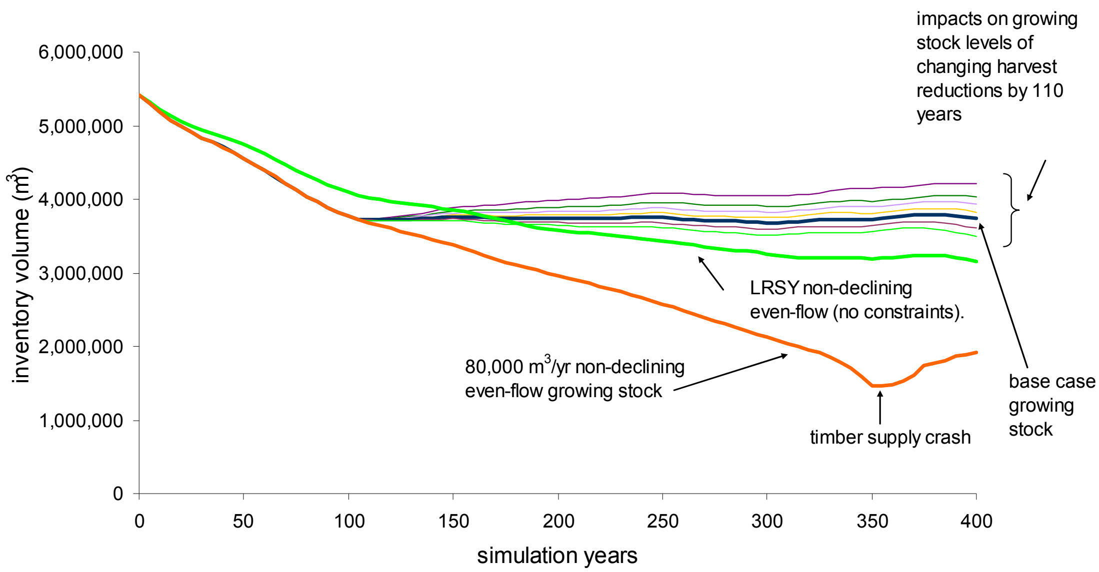

Figure 12: Impacts on growing stock of reducing the 80,000 m^3 per year initial harvest level to the reduced harvest levels shown in Table 4 by 110 years. Growing stock for the LRSY and the 80,000 m^3 per year even flow harvest volumes are shown for comparison.

Figure 13 shows the impacts on the growing stock of applying the same harvest reduction (7,500 m^3 per year or 9.4% of the initial harvest) but at different periods in the timber supply projection. Applying the reduction by year 80 shows a gradual but slight decline in the growing stock. If the same harvest reduction is applied by year 120, a very slight increase in the growing stock is found, overall.

The actual timing of the harvest reduction makes little difference in the long-term growing stock, since an equilibrium condition is eventually met sometime after 300 years. For analysis purposes, if the growing stock is generally increasing in the base case, impacts from the sensitivity analyses are less likely to be apparent. Alternatively, slight declines may over emphasise the effects of the sensitivity analyses.

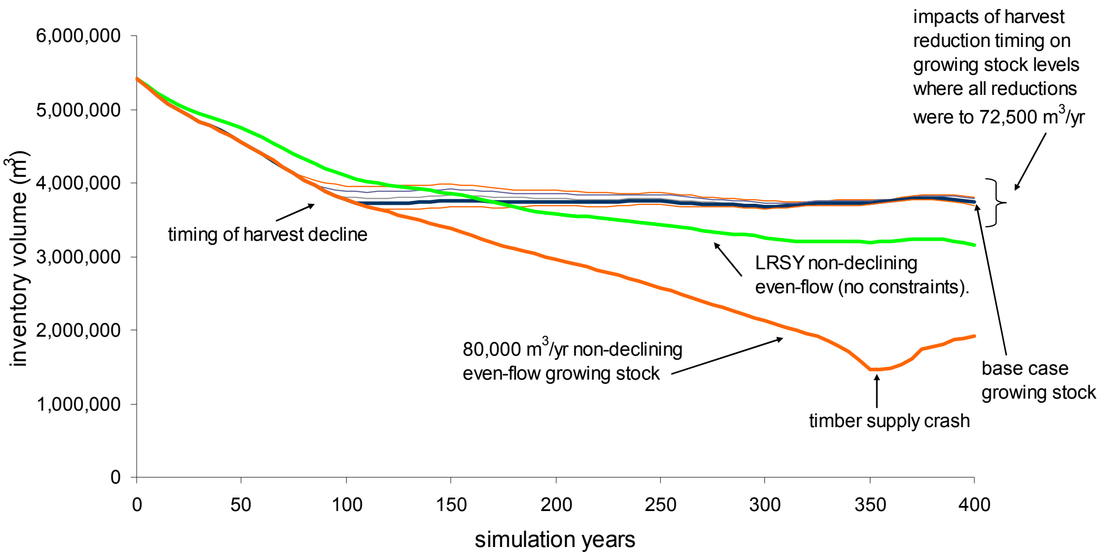

Figure 13: Impacts on growing stock of applying a harvest reduction to 72,500 m^3 per year in the 8th, 9th, 10th, 11th or 12th decade. Growing stock for the LRSY and the 80,000 m^3 per year even flow harvest levels are shown for comparison.

Based on an evaluation of the growing stock of the various harvest transitions shown in Table 4 and the harvest volume transition from natural to managed stands presented in Figure 11, the most appropriate time for the reduction to occur was determined to be around year 110 when managed stands comprised the majority of the harvest volume. This allowed the initial harvest level of 80,000 m^3 per year to be retained for the longest time. A relatively stable growing stock was established by reducing the initial harvest by 9.4% to 72,500 m^3 per year by the 110th year. Holding the 80,000 m^3 per year initial harvest volume and then declining the cut level to a LTHL of 72,500 m^3 per year by the 110th year was determined to be an appropriate base case harvest forecast that resulted in a sustainable growing stock for TFL3.

5.3 Description of the Base Case

5.3.1 Base Case Harvest Forecast

The base case harvest forecast indicates the current AAC of 80,000 m^3 per year can be maintained until the 105th year of the projection, after which the forecast harvest volume must decline to the LTHL of 72,500 m^3 per year by year 110. Figure 14 shows the base case harvest forecast and the LTHL. The base case harvest volume above the LTHL in the short and mid-term portions of the projection is referred to as the “falldown surplus” volume.

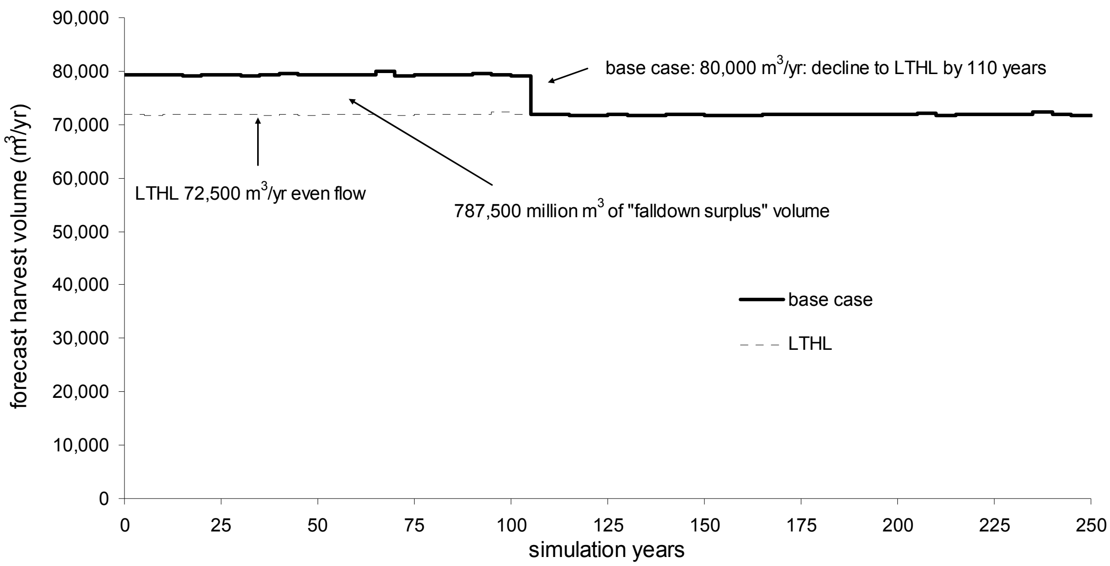

Figure 14: Harvest forecast for the base case.

Figure 15 shows the base case growing stock, along with the merchantability component of the total growing stock. Both the merchantable and non-merchantable growing stocks remain relatively stable once the total growing stock has stabilized after harvest reduction occurs by the 110th year.

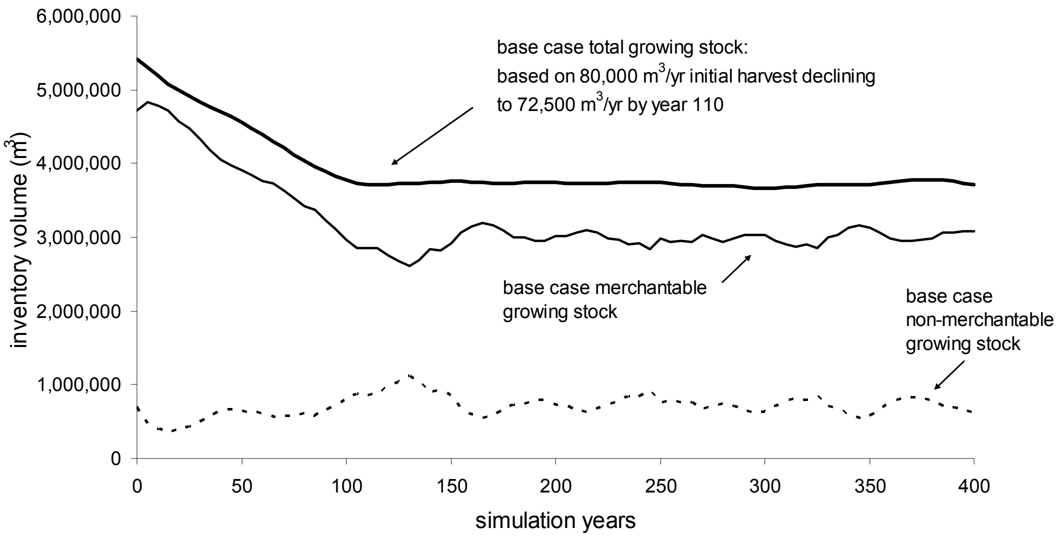

Figure 15: Base case harvest level growing stock.

5.3.2 Definitions of the Short-term, Medium-term and Long-term

In a typical timber supply analysis, the harvest projection is usually described in terms of broad periods, reflecting the short, medium and long-term portions of the timber supply projection. For this analysis, the long-term always begins by the 110th year (specifically this is at period 22, from years 106 to 110), when the harvest level in the base case is reduced to the LTHL. The short-term refers to the first 25 years (first five, 5-year periods), since management strategies during this time-frame will have the most impact on both the mid and long-term timber supply. The medium or mid-term refers to the period from the 26th year to the five-year period ending at year 105 (5-year periods 6 through 21).

5.3.3 Alternatives to the Base Case Harvest Flow

The maximum sustainable LTHL for TFL3 is 72,500 m^3 per year. This harvest level is required after sustaining an 80,000 m^3 per year annual harvest volume for the first 105 years of the timber supply projection. Since there is a large component of merchantable high volume older forests in the TFL3 inventory, there exists an opportunity to harvest a higher volume than the LTHL in the short and mid-terms, before the harvest level must decline, or "falldown" to the LTHL. Currently there are nearly 787,500 m^3 of excess or "falldown surplus" volume in the TFL3 inventory (see Figure 14, above). How the "falldown surplus" volume is allocated over the timber supply projection is somewhat flexible. Generally, a short-term harvest that is much higher than the LTHL will require a transition to the LTHL sooner in the projection. Conversely, a short and midterm harvest level that is only slightly higher than the LTHL will mean the transition to the LTHL can occur later in the forecast.

Depending on the magnitude of an increased harvest level, the transition to the LTHL level may occur sooner than by 110 years. Figure 16 shows two alternative harvest flows in comparison with the base case harvest level. Under Alternative #1, the short and early mid-term harvest level is 15% higher than the base case, with an initial harvest level of 92,000 m^3 per year for the first 35 years. After 35 years, the harvest level steps down over a 30-year period at < 10% per decade, until the LTHL is met by year 65. Alternative #2 shows a small increase of an additional 4,000 m^3 per year (5%) over the base case harvest level. The harvest of 84,000 m^3 per year is maintained for 70 years, at which point the harvest volume is projected to decline to 80,000 m^3. By year 90, Alternative #2 harvest level must decline to the LTHL of 72,500 m^3 per year.

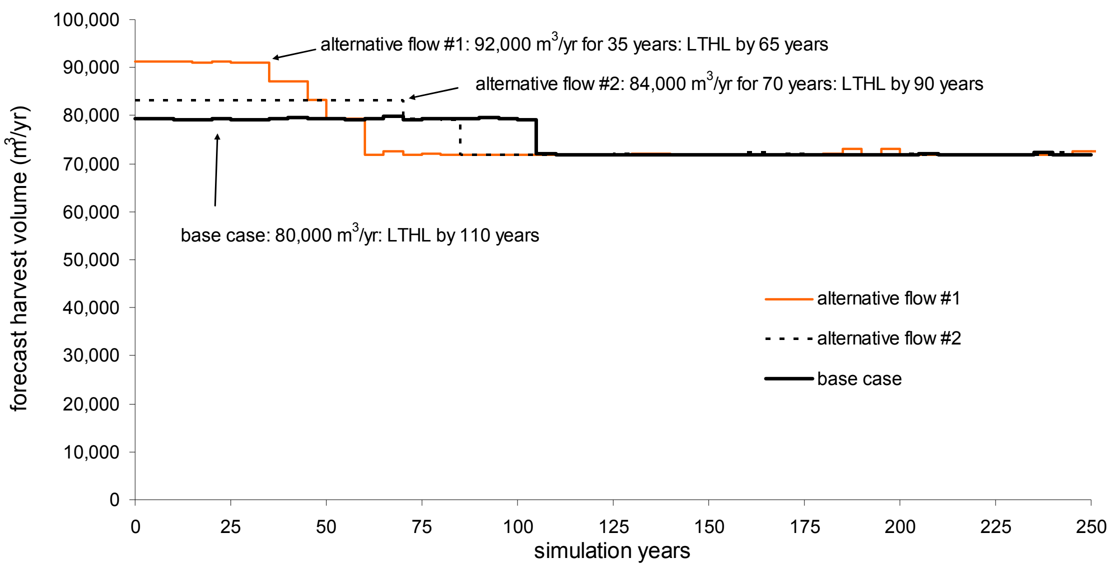

Figure 16: Total harvest levels for the base case harvest flow alternatives using different harvest targets in the short and medium term.

The growing stocks for the two alternative harvest flows are shown in Figure 17. The total volume harvested in the first 105 years of the projection is roughly the same, although as shown in Figure 16, there are periodic differences in the harvest volumes in the short and medium term. These differences are reflected in the rate of decline in the growing stock, however once the LTHL is met, the growing stocks of each alternative flow follows the same trend as the base case.

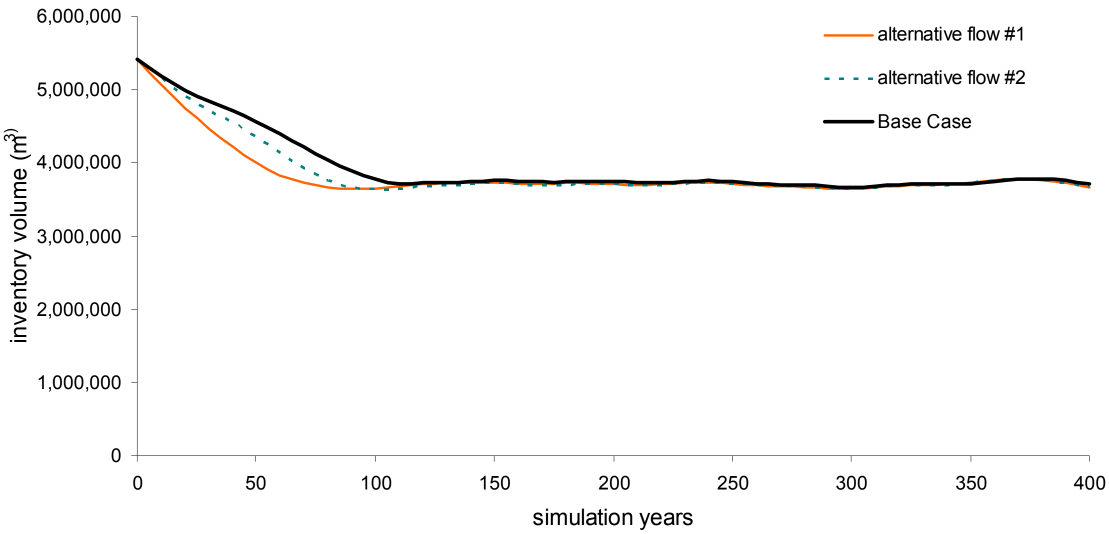

Figure 17: Growing stock levels for the base case harvest flow alternatives using different harvest targets in the short and medium term.

5.3.4 Comparison with TSR2

Under TSR2, the 1998 timber supply analysis projected an even-flow harvest level of 75,779 m^3 per year, based on a THLB of 26,156 ha that did not include a 1,860 ha of otherwise harvestable areas classified as “alternate” in the operability classification. When 1,860 ha of “alternate” areas were included, an even-flow projection of 80,000 m^3 per year was obtained. Figure 18 compares the current base case harvest flow target with these two targets from the TSR2 analysis. The base case for this analysis includes all operable areas (25,164 ha classified as “conventional” and 2,101 ha of “alternate” areas in the THLB) along with areas classified as “inoperable” in the inventory that have been previously logged (275 ha in the THLB).

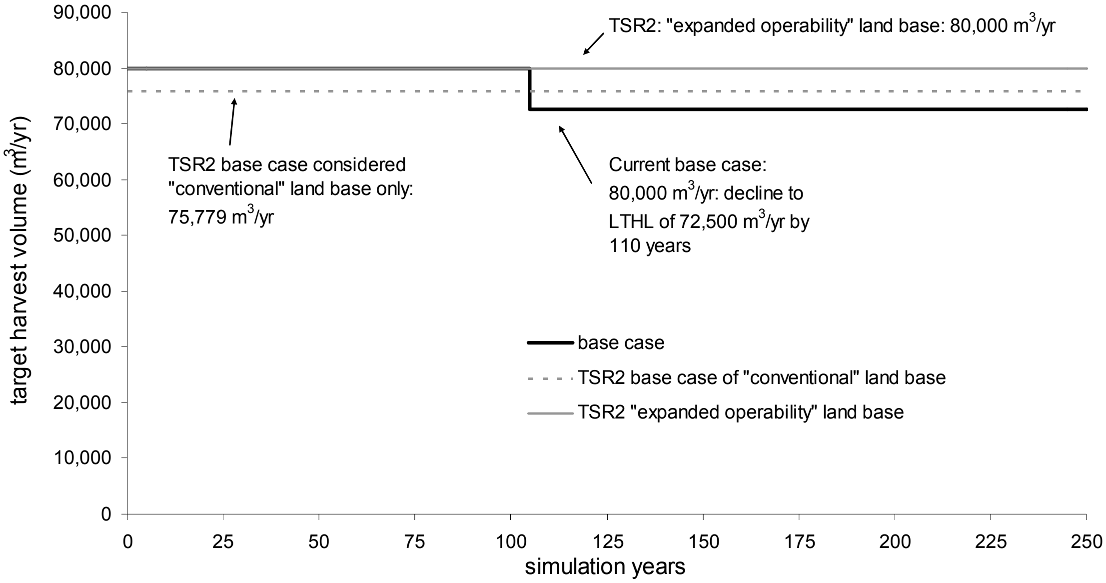

Figure 18: Target harvest volume comparisons between the base case and TSR2.

Differences between the achieved harvest volumes between the two timber supply reviews can be attributed to a number of factors. Most critical is the use of the Vegetation Resources Inventory (VRI) under the current analysis, compared with the old Forest Cover Inventory used under TSR2.

Given the different attributes found in these inventories, the criteria used to establish the THLB differ to some degree, particularly when determining the non-forested component[5]. Overall there is a small difference in the THLB area, as the current THLB is only 429 ha smaller (1.5%) than the “expanded operability” land base described in TSR2 (Sterling Wood Group, 1998).

Although there is little difference in THLB areas between the current and previous timber supply reviews, there are a number of critical factors that may influence the differences in the forecasted harvest levels. For example, the current THLB is net of the draft old growth management areas (OGMAs) that otherwise would have been included in TSR2. Areas previously excluded due to backlog NSR status in TSR2 have been rehabilitated and are now a productive component of the TFL. A comprehensive spatial approach to estimating the roads, trails and landings has been made under the current analysis, while the access reductions in the TSR2 analysis were considered to be underestimated (B.C. Ministry of Forests, 1998a).

Visually effective green-up heights are locally calculated based on plan-to-perspective ratios rather than the single 5 m estimate used in TSR2 (Sterling Wood Group, 1998). More intense terrain stability mapping has been conducted on TFL3 since the last TSR and revisions have been made by SCFP to the netdown criteria for deducting problem forest types.

The current analysis now incorporates empirical forecasts for genetic worth in the managed stand yields and the VRI inventory attributes used in the current analysis have

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[5] See discussion in Section 6.5 of the *Information Package* in Appendix 1.

had a Phase 2 sampling adjustment applied (Jahraus and Associates Consulting Inc. and Churlish Consulting Ltd, 2005). It is also likely that the VRI site index estimates used in this analysis differ by some degree from the site productivity classes used in the TSR2 analysis (Sterling Wood Group, 1998).

The initial forecast of 80,000 m^3 per year in the base case for the current analysis requires a reduction to the LTHL of 72,500 m^3 per year at 110 years into the forecast in order to create an equilibrium condition in the growing stock. While an even flow harvest level can be maintained for 250 years (see Figure 11 above) as in the TSR2 'expanded operability' option shown in Figure 18, the growing stock continues to decline well past 250 years and eventually results in a crash in the timber supply after 370 years (see Figure 12 above).

5.3.5 Harvest Profile by Management Category

Stands in TFL3 were aggregated into analysis units, and were further stratified into one of four management categories based on stand age (see Section 4.2). Stands were categorized into natural stands, existing managed, existing managed with Class A seed assumptions applied and all harvested stands were regenerated to the future managed category.

Figure 19 shows the harvest profile by management category. The 'natural' stands (all inventory stands >20 years of age) make up the majority of the harvest profile for the first 70 years, after which categories of existing managed stands begin coming on line for harvest. The harvest transition where the managed stands dominate the harvest volume occurs by 110 years into the projection, the same time the initial harvest level is reduced to the LTHL of 72,500 m^3 per year. Existing inventory stands make up a progressively smaller component of the harvest profile until after year 180 when they contribute about 1800 m^3 per year, on average.

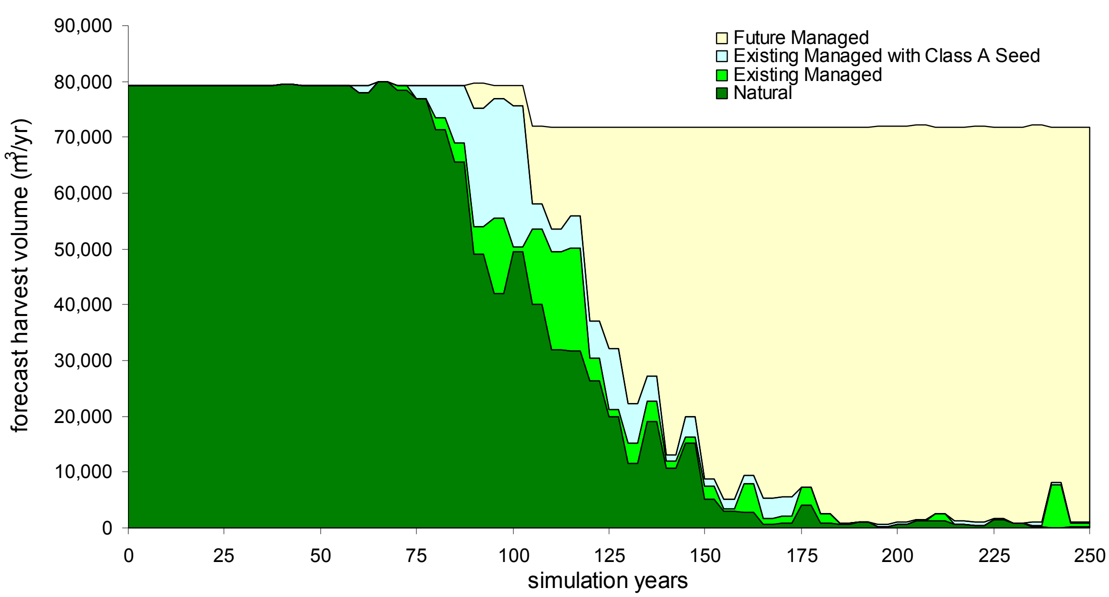

Figure 19: Harvest profile by management category.

5.3.6 Species Composition

There are seven major commercial tree species in TFL3: spruce (S, Se, Sw, Sx and Sxw), cedar (Cw), Douglas-fir (Fd), hemlock (Hw), larch (Lw and Lt), pine (Pl, Pw, Py and Pa) and balsam (Bl).

When reviewing the species composition over the term of the timber supply projection, it is important to note that the species profile in the short and medium term is an artefact of the existing inventory, while in the long term the species profile is dependent on the regeneration assumptions of managed stands. Typically species distributions within stands will change over time, given stand dynamics, individual species tolerances and growth rates and the inter-species relationships within stands. Therefore the current snapshot of existing species profiles (as in the current inventory or as assumed under the managed stand regeneration assumptions) may not necessarily reflect reality at periods in the future. Despite this shortcoming, reviewing the species composition over time does provide information about modelling the current inventory and the eventual transition from the current inventory to a forest comprised under the regeneration assumptions of the managed stands.

Harvest Profile by Species Composition

Figure 20 shows the tree species component of the harvest profile. In the short-term of the planning horizon, spruce dominates the harvest profile at 30%, followed by Douglas-fir and hemlock at 16% each, balsam at 13%, with cedar and larch at 9% and the pine species at 8%.

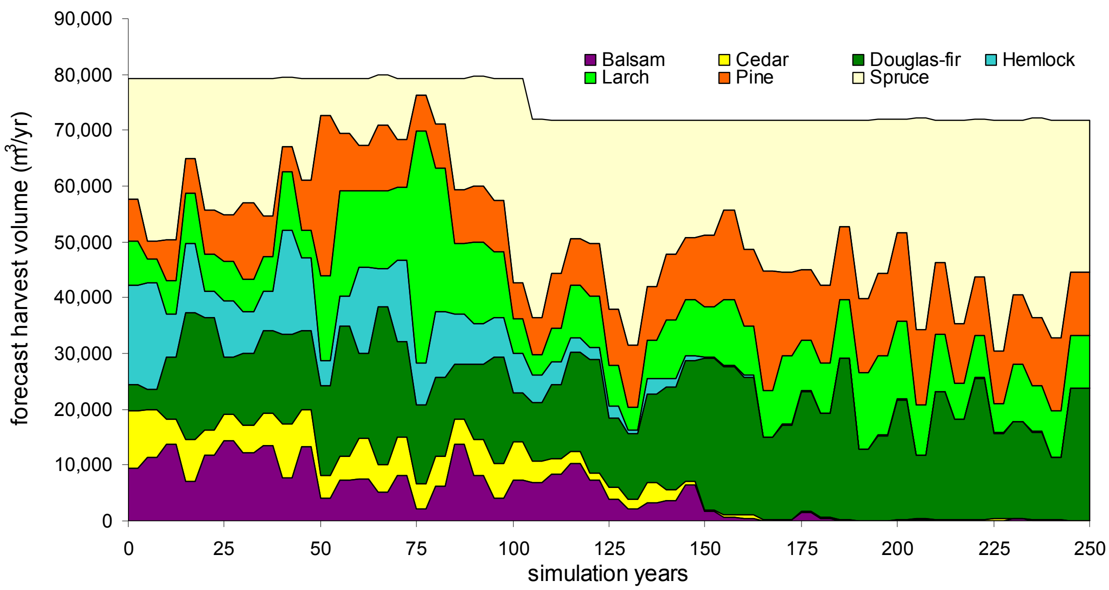

Figure 20: Harvest profile by tree species

The spruce component is gradually reduced over the midterm up to the 80th year, when the managed spruce stands become available for harvest. Over the midterm spruce makes up only 20% of the harvest, slightly more than Douglas fir at 19%. Larch follows at 17%, although there is a noted increase in larch volume over the 50 years prior to the harvest transition. Pine (13%), hemlock (12%) and balsam (11%) make nearly similar contributions while cedar makes up the remaining 7% of the midterm harvest volume, on average.

After the harvest transition to managed stands, the long-term harvest profile is significantly dominated by spruce and Douglas-fir, at 40% and 26% respectively. Pine follows at 17%, while the larch component is 13% on average. Balsam (3%), hemlock and cedar (1% each) harvest volume declines in the long-term as spruce and Douglas-fir volume increases.

Figure 20 shows the estimated growing stock by species. The trend in species harvest volumes is reflected in the species composition profile of the THLB. The Spruce, Douglas-fir and pine component of the THLB increases by the long-term, while larch declines prior to the transition, then increases slightly and stabilizes over the long-term. The decline in balsam, hemlock and cedar in the growing stock reflects the species conversions in the managed stand yield assumptions.

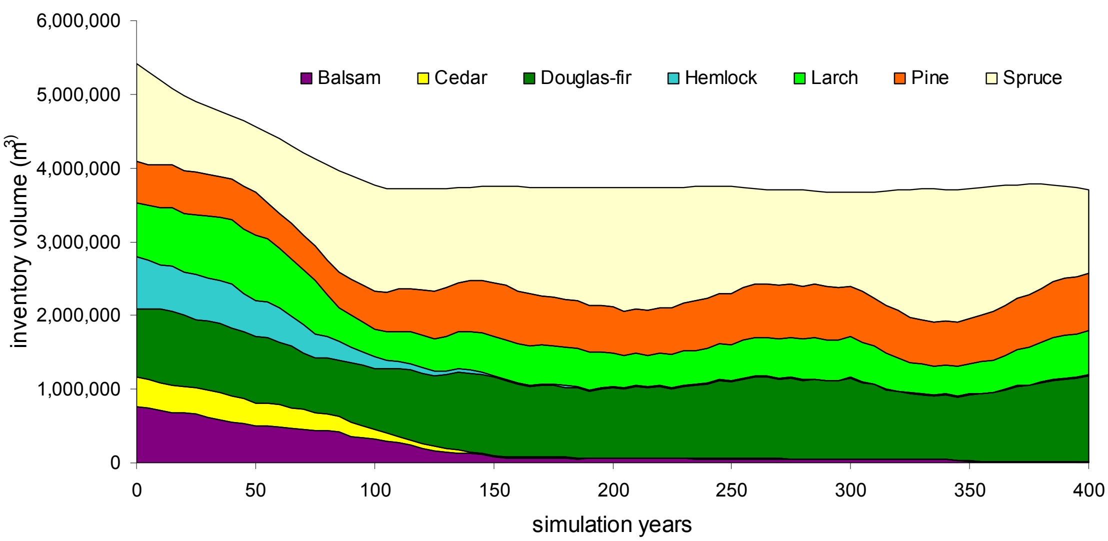

Figure 21: Growing stock profile by tree species.

5.3.7 Stand Age

Typically it is of interest to know the average stand age at harvest, calculated using both area and volume weighting. Figure 22 shows both the area and volume weighted average stand ages at harvest for the base case. Given that 56% of the THLB is at or above minimum harvest age (see Figure 9) and that 25% of the THLB is older than 140 years (see Figure 3 above), it is not surprising that the average harvest age is higher in the short-term and declines as managed stands become available for harvest. In the short-term the area-weighted average harvest age (the volume-weighted values are shown in brackets) is 231 (230), declining to 163 (160) years on average for the mid-term and settling at 130 (128) years on average over the long-term portion of the projection.

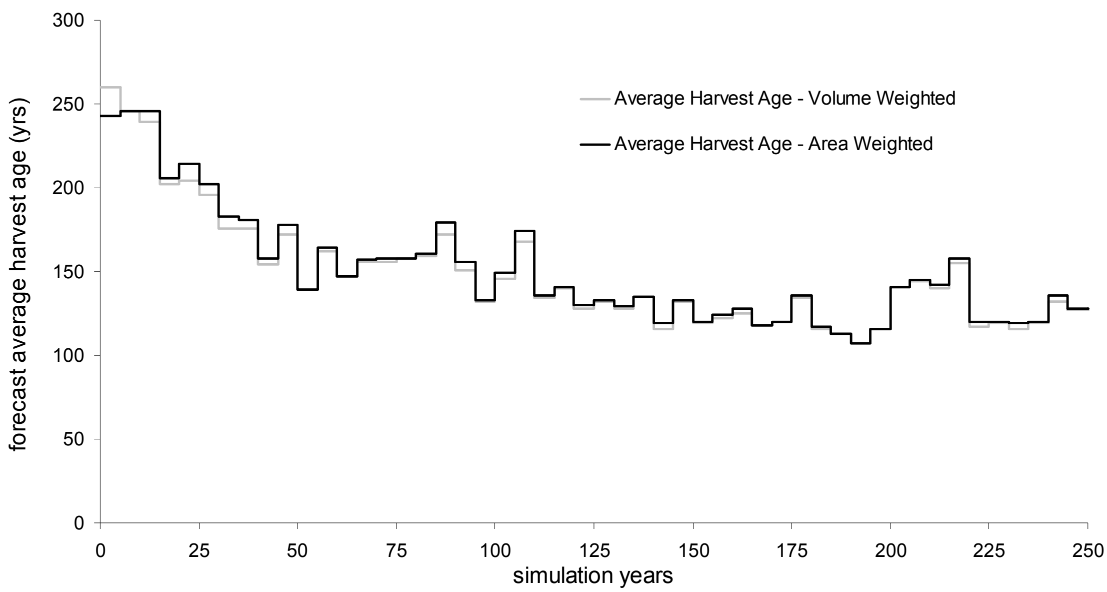

Figure 22: Area and volume weighted average harvest age.

Figure 23 shows the estimated harvest composition by age class for the base case harvest forecast. Most of the short-term harvest volume comes from the two oldest age classes, with the class >250 making up 41% and the 141-250 year group contributing 47%. The 121-140 year age category made up 9% of the harvest volume, while the 81-100 year and 101-120 year age groups made up 1% each. Stands ≤60 years of age were not projected for harvest at any point in the projection by the timber supply model.

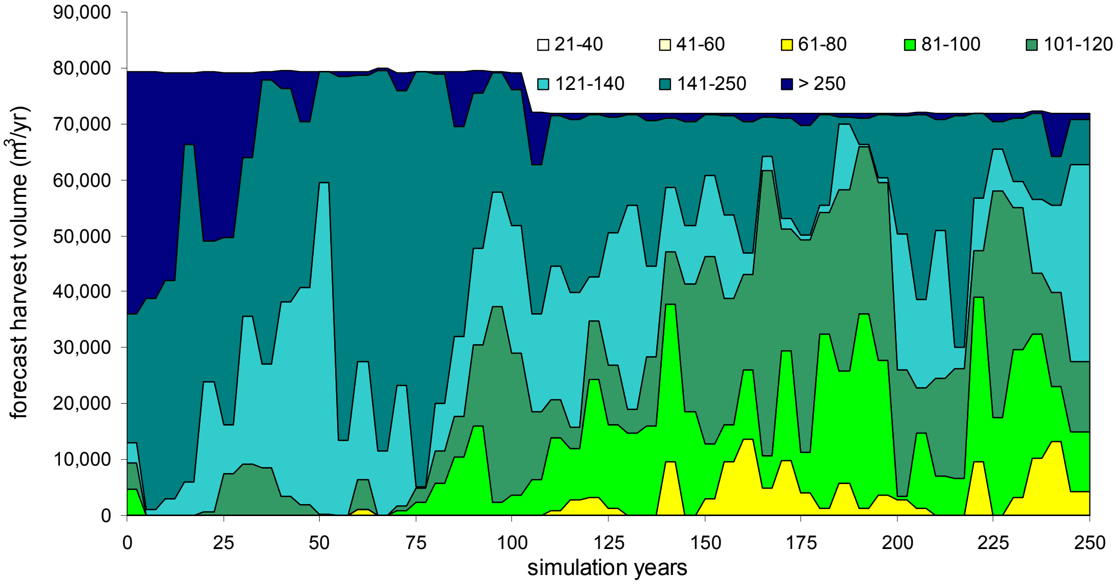

Figure 23: Stand age class at harvest. No stands were harvested <20 years of age.

A relatively large component of the mid-term harvest volume came from the 141-250 year group, making up 54% of the volume, followed by the 121-140 year group at 27%. The 101-120 year category comprised 10%, the oldest class was 6% on average and the 81-100 year class made up 3% of the harvest volume in the mid-term.

Over the long-term portion of the projection, the harvest contribution of the oldest age class is 2%, on average, while the 61-80 year class makes up 6%. The 101-120 year age class and the 141-250 year age class comprise 28 and 25% of the long-term harvest volume, respectively, followed by the 81-100 year class at 22% and the 121-140 year class at 18%.

As shown in Figure 24, the age class structure of the THLB appears to become reasonably well balanced for all but the very oldest age class category and the 121-140 year class by the long-term portion of the projection. Evidence of a transition in the distribution of age classes is apparent at the beginning of the mid-term portion of the projection. The age classes appear to be balanced throughout the long-term, after the harvest transition occurs.

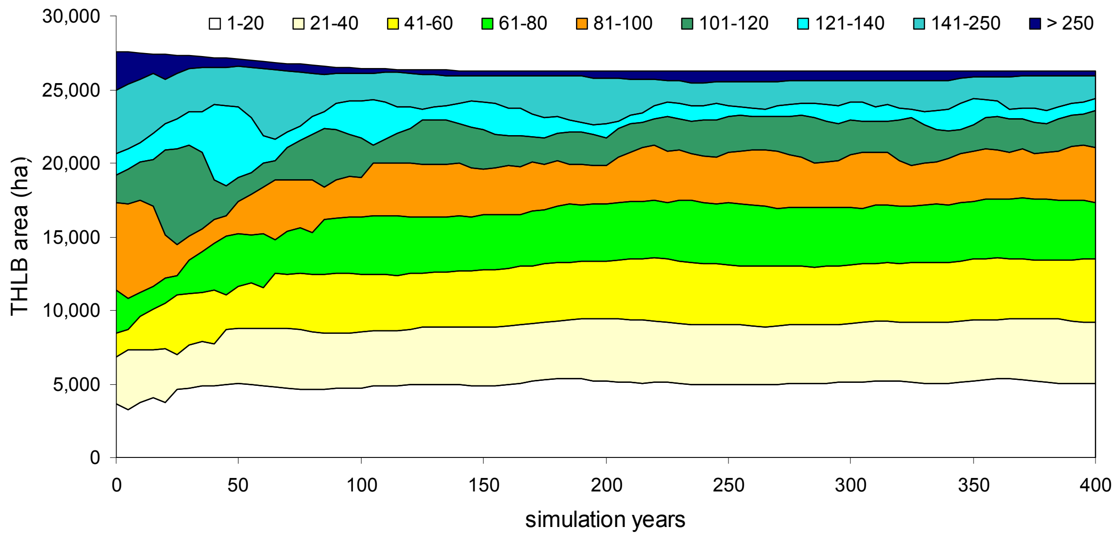

Figure 24: Age class distribution of the THLB.

Figure 25 shows the growing stock profile by age class. Volume in the two oldest age class categories is declining in the short-term, since stands in these age classes categories are predominantly filling the harvest component at this time (Figure 23).

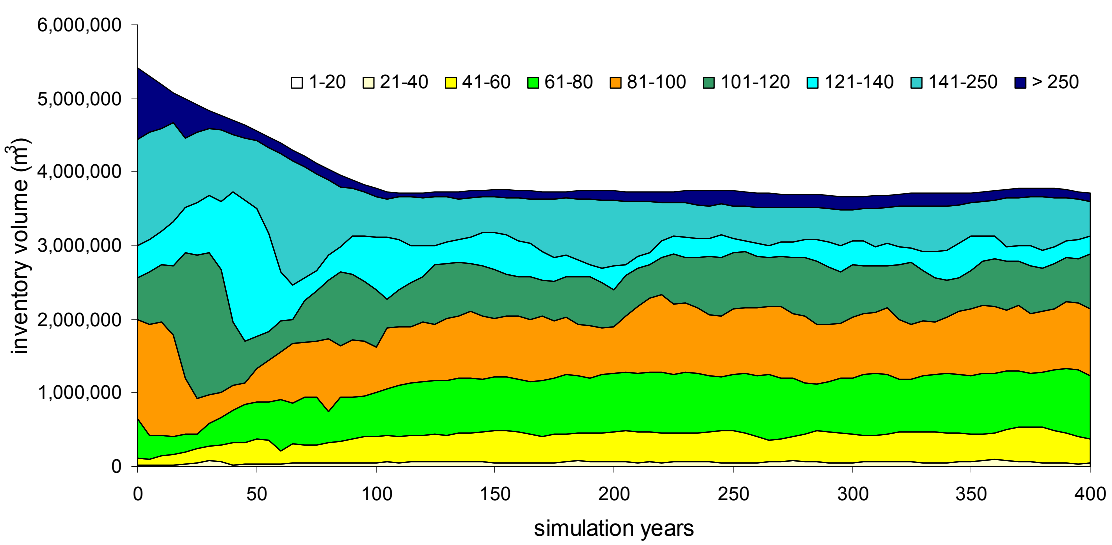

Figure 25: Growing stock profile by age class.

In the short and early mid-term, the decline in growing stock of the middle age classes is indicative of stands moving up in age class category, since there is a relatively large proportion (22%) of the THLB currently in the 81-100 year class. The decline in the harvest volume at the harvest transition at 110 years, corresponding with the levelling of the growing stock creates an equilibrium condition in the age class categories, similar to the age class distribution shown in Figure 24.

5.3.8 Harvest Profile by Average Stand Volume

Corresponding with the average harvest age, Figure 26 shows the average volume per hectare declining over the planning horizon, although not at the same rate as the average harvest age. In the short-term the average yield at harvest is 410 m^3/ha. Over the mid-term, the average harvest yield declines to 389 m^3/ha. After the harvest transition to predominantly managed stands, the average yield at harvest is 355 m^3/ha. On average stands are harvested about 100 years earlier in the long-term than in the short-term of the projection.

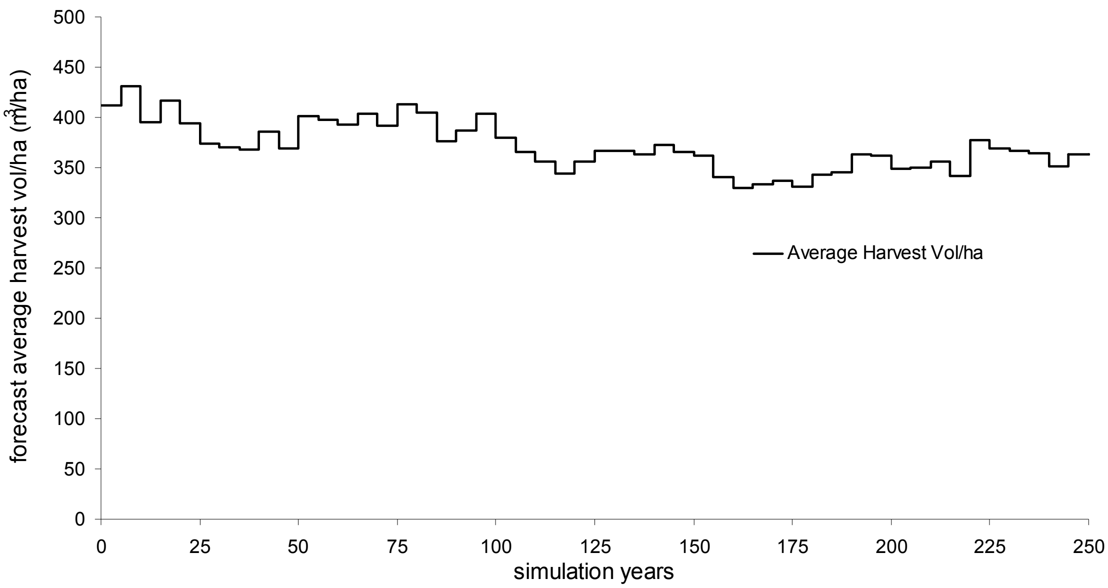

Figure 26: Average harvest volume per hectare.

The average annual net area harvested remains relatively constant throughout the planning horizon, even after the harvest level is reduced by year 110. There is little variability in this estimate, since an average of 203 ha per year (Figure 28) is harvested over the entire planning horizon with a coefficient of variation of 4%. In the short-term 196 ha are harvested on average while in the mid-term the average annual area harvested increases to 205 ha. The long-term average net area harvested per year is 202 ha.

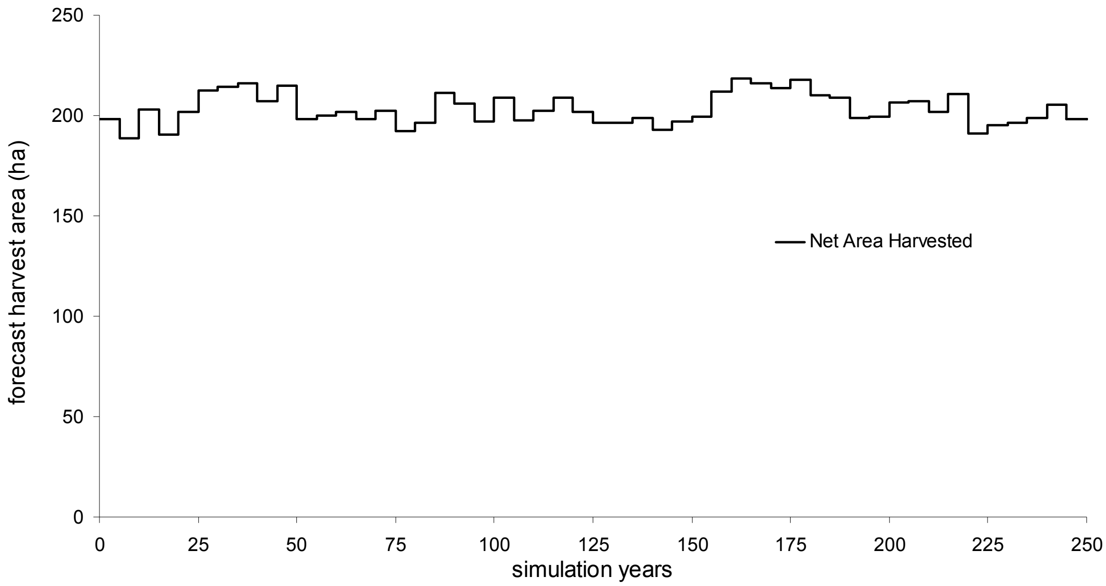

Figure 27: Forecast average net area harvested.

Figure 28 shows the forecasted harvest volume by average yield class. Approximately 58% of the short-term harvest comes from stands containing 400-500 m^3/ha. The 300-400 m^3/ha class contributes 33% and the 500-600 m^3/ha class contributes 7%. The remaining portion of the harvest volume in the short-term comes from stands yielding 200-300 m^3/ha.

Throughout the early portion of the mid-term, the trend in the contribution of the 400-500 m^3/ha class shows a decline to the 50^{th} year, only to increase over the next 25 years and then decline again until the early long-term when it levels off. The 300-400 m^3/ha class mirrors this pattern, showing an increase until the 50^{th} year, a decline towards the 75^{th} year and an overall increase to the early portion of the long-term when it too, levels off. In the mid-term, the 400-500 m^3/ha class and 300-400 m^3/ha class make up an average of 49% and 51% of the harvest volume, respectively.

Over the long-term, after the harvest transition and the associated reduction in total harvest volume, the 300-400 m^3/ha class comprises 85% of the annual cut. The 400-500 m^3/ha class contributes 12% on average, followed by the 200-300 m^3/ha class at 3%. Only 1% of the harvest volume in the long-term comes from the 500-600 m^3/ha class, with virtually no contribution from any of the other yield categories.

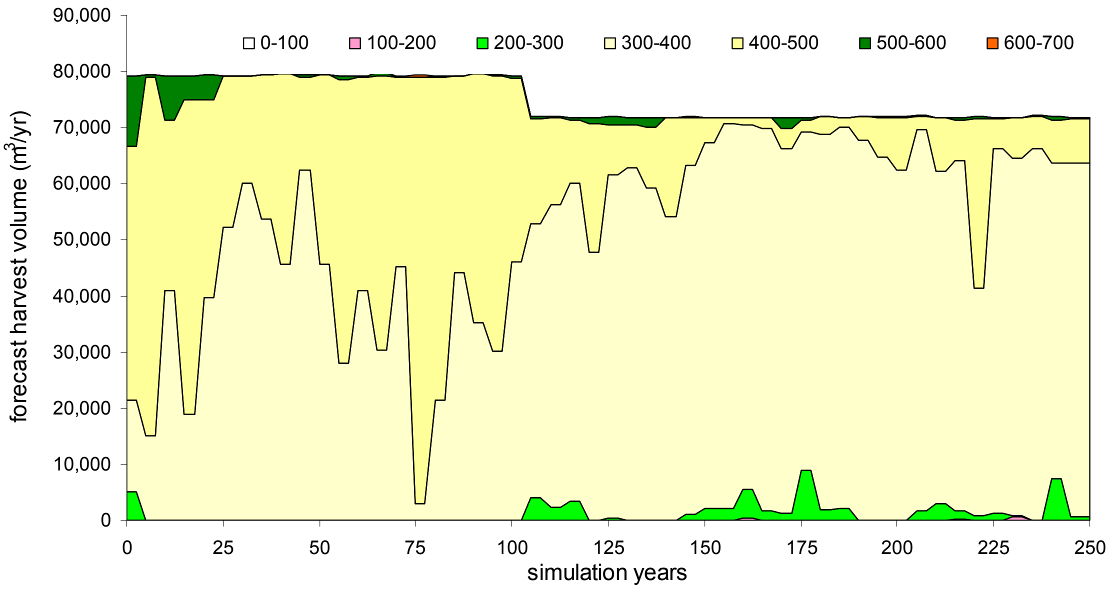

Figure 28: Harvest profile by average yield class, expressed as volume per hectare.

5.3.9 Harvest Profile by Operability Class

In the TSR2 AAC determination (B.C. Ministry of Forests,1998a), the AAC was set at 80,000 m^3 per year, including a 4,000 m^3 per year (5%) partition cut from the areas classified as "alternate" under the 1996 operability classification. The "alternate" areas in TFL3 are areas that were previously thought to be difficult for road development, such as hanging valleys. It is expected that a variety of appropriate harvest methods will be used in the "alternate" areas and as road construction proves to be environmentally acceptable in these areas, they will be reclassified as conventionally operable (Slocan Forest Products Ltd., 2003).

The base case for this current analysis includes all conventionally operable (25,164 ha of classified as "conventional" and 2,101 ha of "alternate" areas in the THLB) along with areas classified as "inoperable" in the inventory that have been previously logged (275 ha in the THLB), without partitioning a component of the harvest. The impacts of partitioning the harvest from the "alternate" operability areas will be examined through sensitivity analysis in Section 6.2.1.

Figure 29 shows the forecasted harvest volume by operability class. In the short-term the "alternate" areas comprise 10% of the harvest volume or about 7,800 m^3 on average, but only 7% in both the mid and long-term portions of the projection. In the midterm, the average volume contribution of "alternate" areas is approximately 5,800 m^3, while in the long-term only 4,900 m^3. In all portions of the projection, the average volume coming from the alternate areas is highly variable, with a coefficient of variability ranging from 62% in the short-term, to 86% in the mid-term and 65% in the long-term.

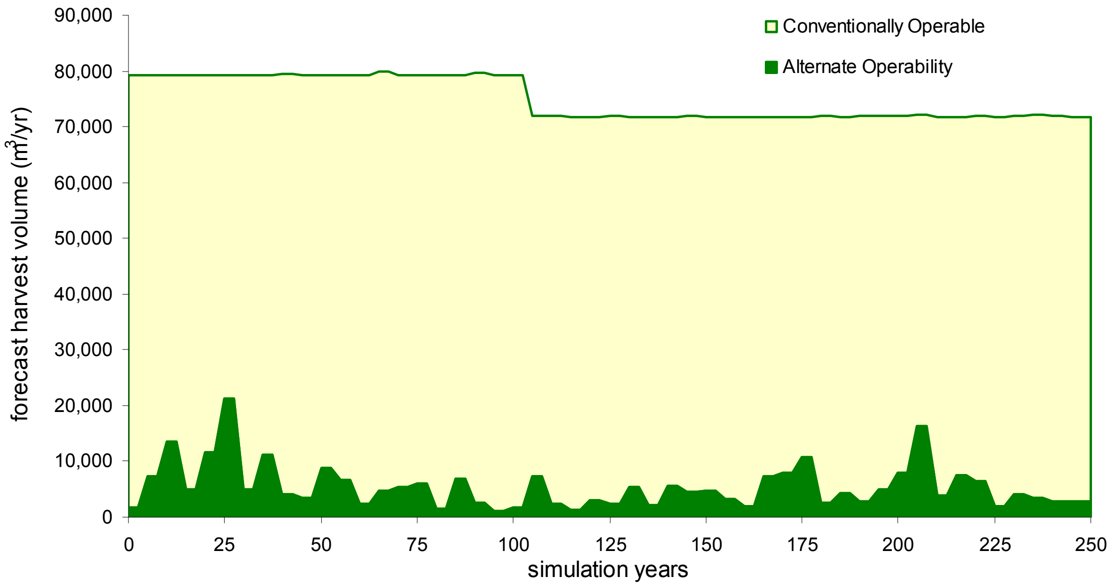

Figure 29: Harvest profile by operability class. "Conventionally operable" includes areas classified as "inoperable" with previous logging history.

5.3.10 Visual Quality Objectives

There are 14 visual polygons in TFL3, of which 9 have forested area inside the THLB. The 9 visual polygons with THLB area are modelled for their effective green-up height individually in the timber supply analysis, however for reporting the harvest volume in Figure 30 they were grouped by visual quality objective (VQO) and visual absorption class (VAC). The VQO Modification Medium VAC group constitutes the largest component of the THLB at 1,714 ha. Most of the harvest from VQO polygons comes from this category and on average 4% of the harvest volume comes from this group in the short-term, 5% in the mid-term and 6% in the long-term. Contributions from the other groups are negligible; although between 250 and 300 m^3 per year comes from the 352 ha THLB in the VQO Partial Retention Medium VAC group over the entire projection.

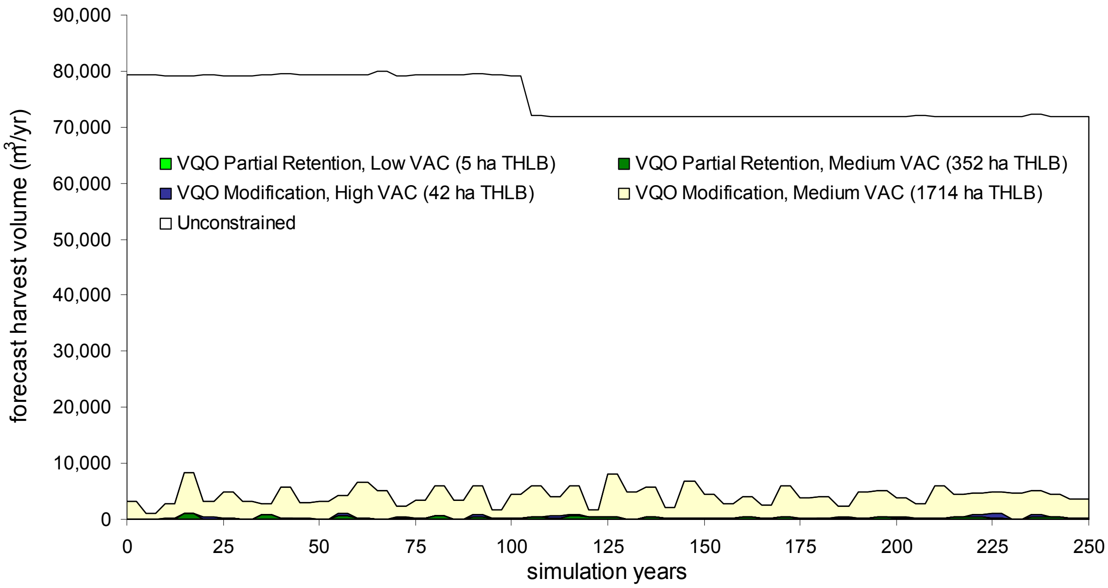

Figure 30: Harvest profile from visual quality polygon areas, further delineated by visual absorption class. Unconstrained areas are not managed for visual quality objectives, but like VQO polygons, may be managed for other non-timber objectives.

The maximum forest area allowed under the effective green-up height

[6] is evaluated in the timber supply model for each individual visual polygon. Figure 31 shows a sample of four of the 14 VQO polygons in TFL3, along with the maximum allowable target and the contribution from the THLB and the non-harvestable land base (NHLB). An increase in the NHLB contribution shows that natural disturbance is occurring in this visual polygon. Approximately 19% of the forested area in VQO_383 is above the effective green-up height for this polygon[7], for the first 10 years of the projection. This is most likely due to current harvest units being fixed for harvest in the timber supply model. A similar condition occurs in the largest visual polygon, VQO_420.

Alternatively, legacy disturbance, either in the form of previous harvesting activities or natural disturbance may result in a constraint violation for the visual polygon. The high proportion of area below the effective green-up height in VQO_803 appears to be caused by a combination of disturbance in both the NHLB and the THLB. Once VQO_803 stands meet the effective green-up height, the model limits any harvesting activity to ensure the maximum allowable area constraint is not violated.

VQO_453 is relatively small at 208 ha, of which only 42 ha are in the THLB. Unlike the other visual polygons shown in Figure 31, the maximum allowable area constraint of 18% for meeting visual quality objectives does not appear to be limiting timber supply in this polygon. If the harvest in the model was constrained by the visual constraints, the VQO polygon would have the maximum allowable area consistently at the target level. Overall, all visual polygons

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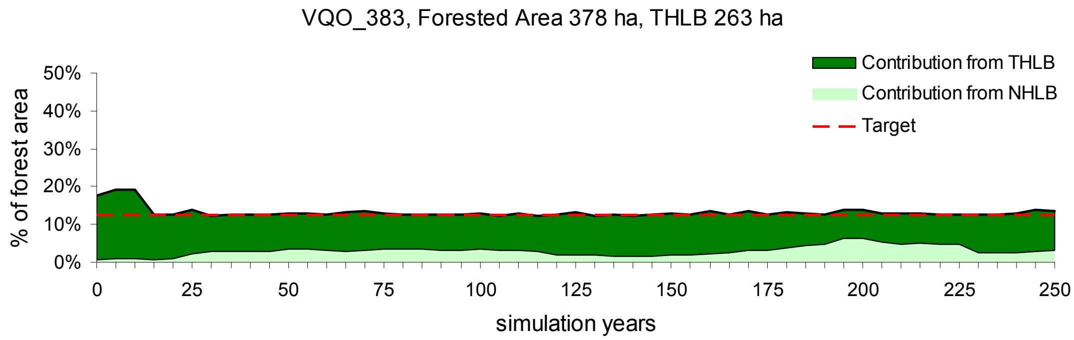
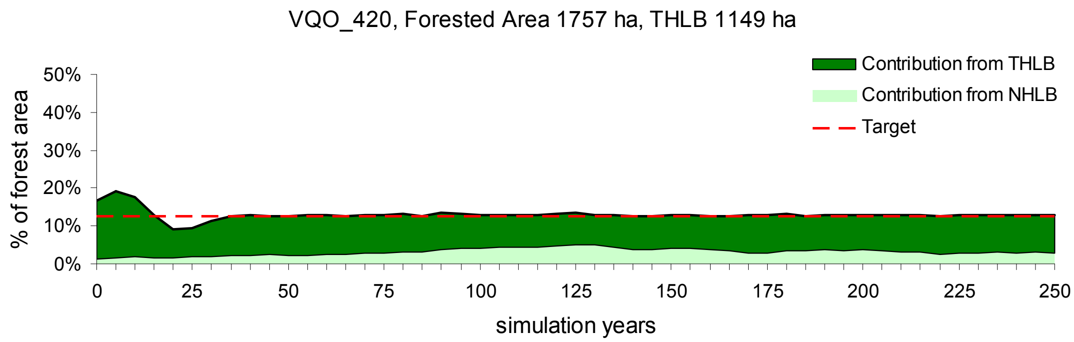
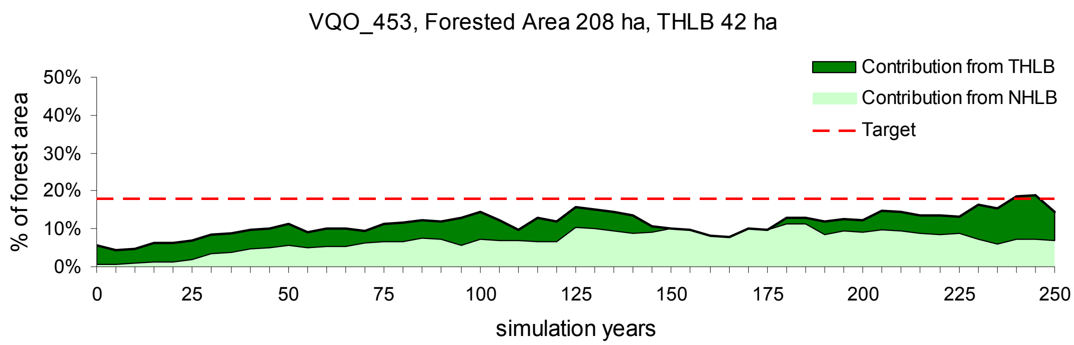
[6] Effective green-up heights are calculated for each visual polygon using the P2P ratios, as described in Section 10.2.2 of the Information Package in Appendix 1

[7] Effective green-up heights for VQO polygons are provided in Table 50 of the Information Package in Appendix 1.

with the exception of VQO_453 are consistently constraining harvest in the timber supply projection.







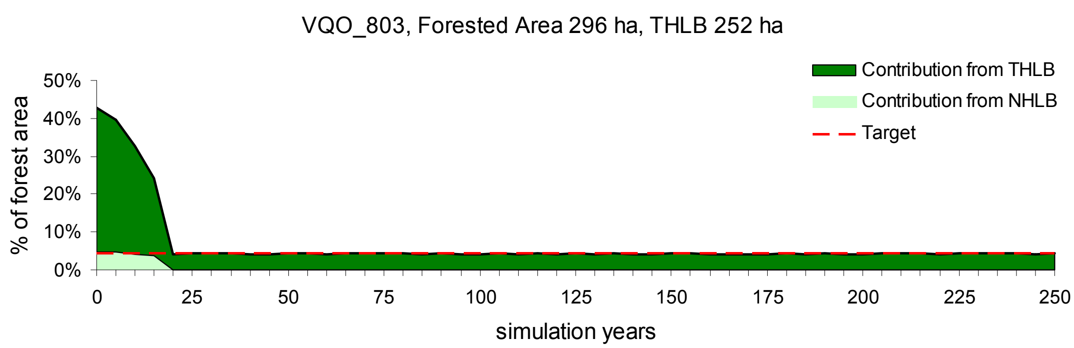


Figure 31: Sample of the VQO polygons in TFL3, demonstrating the impacts of harvesting on the constraints.

5.3.11 Ungulate Winter Range

The contribution to harvest volume from any of the 11 ungulate winter range polygons varies over the timber supply projection. As shown in Figure 32, there appear to be two 15-year spikes in the harvest from UWR areas. The first 15 year spike begins at the 15th year and the second begins 100 years later at year 115. Spikes of 5 to 10 year durations happen again at years 220 and 240 of the projection. Outside of these periods of more intensive harvesting in the UWR, the average harvest volume coming from ungulate polygons is approximately 4,800 m^3 per year. The average volume across the intensive harvest spikes is nearly 15,400 m^3 per year.

In the short-term, the average harvest from UWR areas is approximately 8,300 m^3 (10%), while in the midterm it is about 5,700 m^3 per year (7%) and in the long-term it is approximately 6,700 m^3 per year (9%), on average. Overall the coefficient of variation is very high in the short-term at 115%, while the mid-term and long-term variability are both lower at 48% and 73% respectively

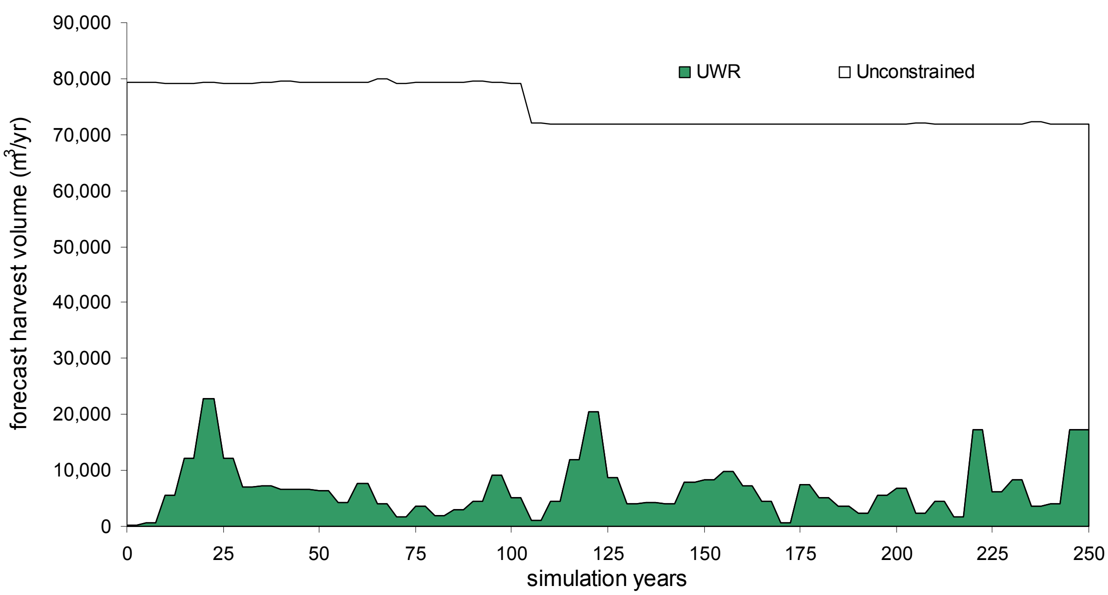
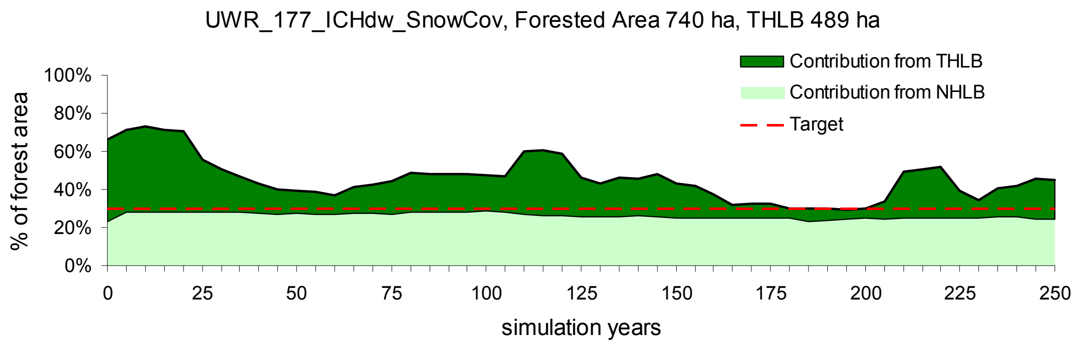


Figure 32: Harvest contribution from UWR areas. Unconstrained areas are not managed for ungulate winter range, but like UWR polygons, may be managed for other non-timber objectives.

Figure 33, Figure 34 and Figure 35 show the UWR targets for snow interception cover, forage areas and early seral requirements respectively for two sample UWR polygons that have all three types of forest cover constraints applied. Under the snow interception cover (Figure 33) and forage areas (Figure 34), the objectives are to reach meet or exceed the target amount of forest cover area. Alternatively, the early seral targets (Figure 35) are a constraint, whereby the target is a limit to the amount of area that may be at or below the early seral age limit, in this case 20 years.

Snow interception cover

The forest cover targets for snow interception cover, as demonstrated in Figure 33, require that some portion of the forested area of the UWR polygons be older than a given age[8]. UWR 177 is constrained by the snow interception cover target for 20 years following year 180, while UWR 186 is constrained from years 70 to 125 and again for 15 years after year 210.



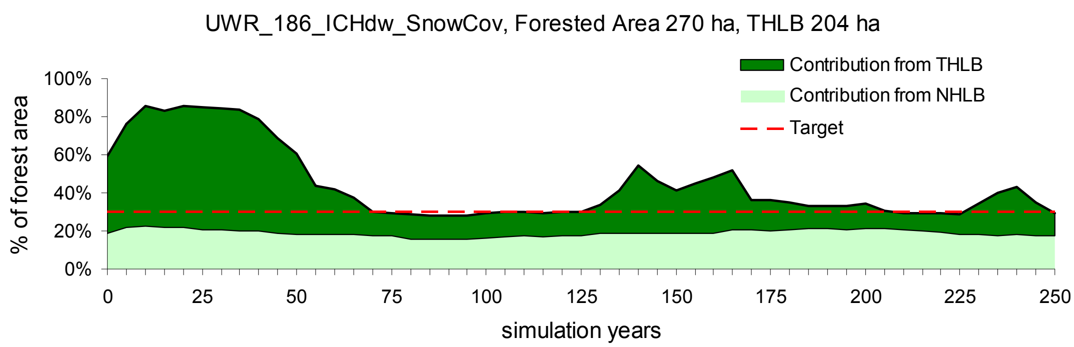


Figure 33: Sample of the UWR snow interception cover polygons and forest cover targets.

All UWR polygons in TFL3 that are managed for snow interception cover are constrained at some point in the mid and long-term portions of the projection. Timber supply is also constrained in UWR_159 and UWR_165 in the short-term, although the THLB in these polygons is relatively small, at 35 ha and 55 ha respectively.

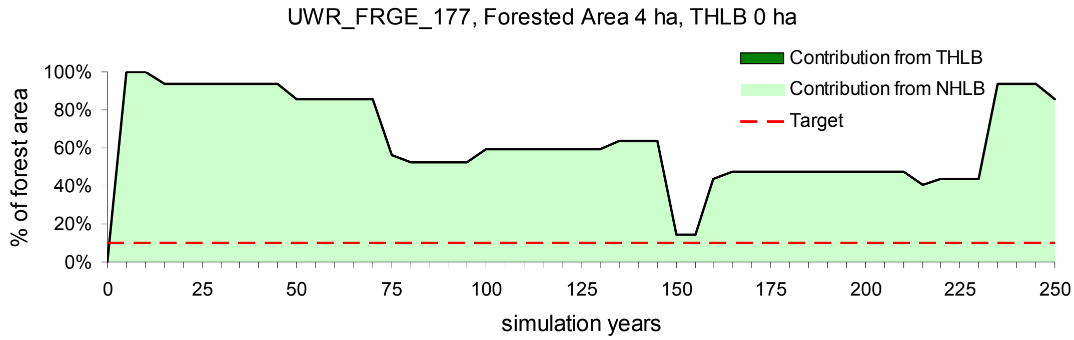
Forage Areas

Only UWR 159, 165, 177 and 186 are managed for ungulate forage targets in TFL3. The forage targets require that at least 10% of the forested area in the forage polygons is ≥ 81 years of age. UWR_177 does not have forage areas inside the THLB; therefore all contributions come from the non-harvestable land base. At the beginning of the timber supply projection, the area in UWR 177 is just under the minimum age. Declines in the

[8] See Table 50 in the *Information Package* for the forest cover requirements for each UWR area.

eligible forested area over the projection reflect the natural disturbance assumption in the NHLB.

The forest cover targets for forage areas in UWR_186 do not appear to be constraining timber supply, since the target is being met in the NHLB throughout the projection. Timber supply is not constrained due to forest cover targets in forage areas for any UWR polygon in TFL3.



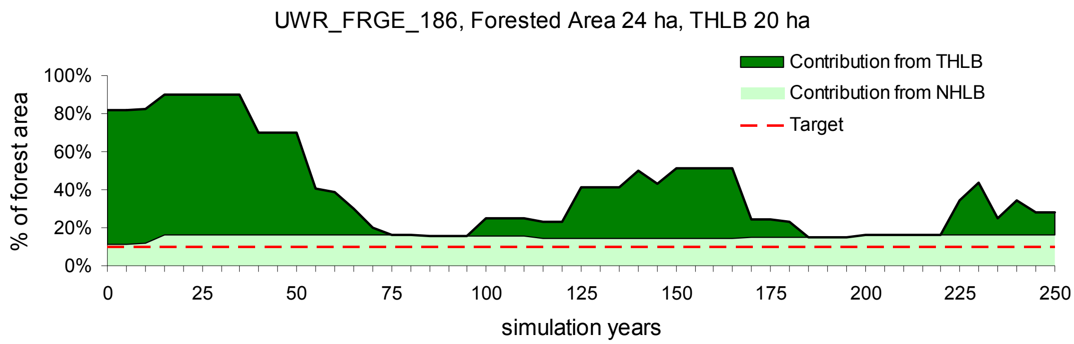
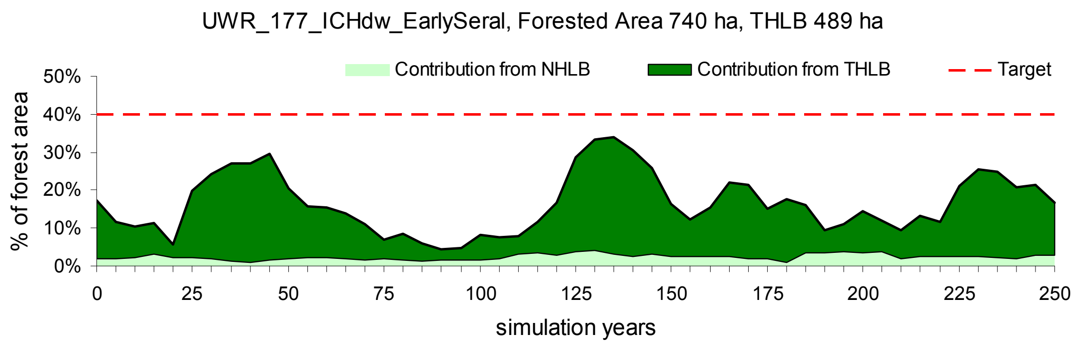


Figure 34: Sample UWR forage area polygons and forest cover targets.

Early Seral

The early seral targets shown in Figure 35 require that no more than 40% of the forested area in each UWR polygon can be ≤20 years of age. The early seral target is not constraining on UWR_177, but is periodically constraining UWR 186 between years 60 and 70. As for other UWR polygons in TFL3, the early seral constraint is also constraining timber supply for rather short durations, and only over a few periods in UWR 159 (38 ha THLB), 198 (148 ha THLB) and 195 (348 ha THLB). Given the short duration and low frequency of the constraints in these three UWR areas, any impacts on timber supply are not likely to be significant.



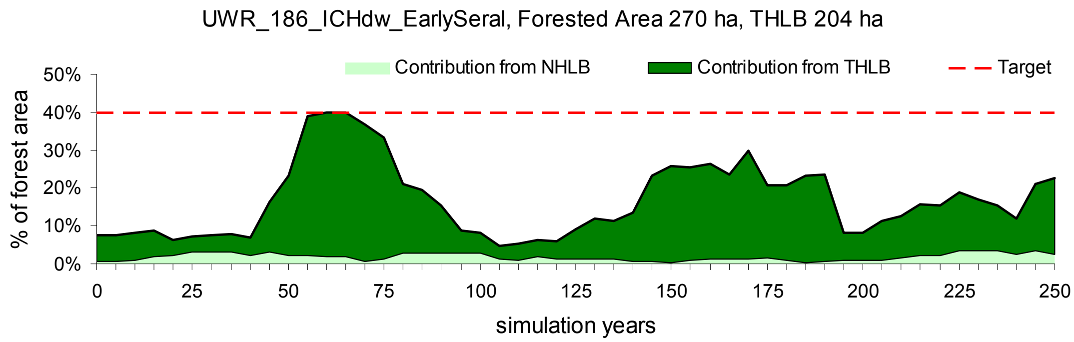


Figure 35: Sample UWR early seral targets as applied to UWR polygons.

5.3.12 Domestic Watersheds

The contribution to harvest volume from any one of the 14 domestic watersheds (DWS) varies over the timber supply projection. There is an apparent increase in DWS harvest at the 95^{th}, 145^{th} and 225^{th} year of the projection, as shown in Figure 36. Outside of the small increases at these years, the harvest level from DWS appears to be relatively stable throughout the projection.

In the short-term, approximately 2,000 m^3 per year comes from the from the Class 2 and Class 3 watersheds. The Class 3 watershed contributes an average of 2,550 m^3 per year in the short-term, but the contribution decreases over the medium term and settles to an average of 2,000 m^3 per year in the long term. Class 1 watersheds contribute between 400 and 500 m^3 per year on average, over the entire projection. Class 3 watersheds provide nearly 3,000 m^3 per year over the mid and long-term portion of the timber supply projection.

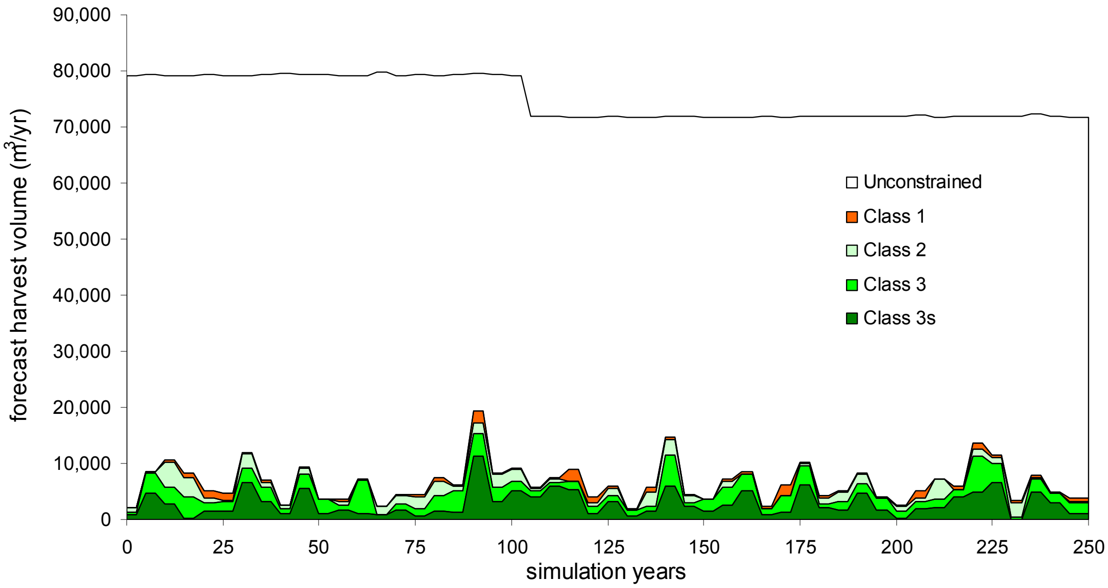


Figure 36: Harvest contribution from domestic watershed areas.

Domestic watersheds are modelled using a graduated equivalent clear-cut area (ECA) "Red Flag" threshold, based on a reduced hydrologic green-up recovery height of 6 metres. This approach was implemented under Management Plan #10 on the understanding that any expert advice from a qualified professional would override these thresholds (Slocan Forest Products Ltd., 2003). For modelling purposes, the "Red Flag" ECA thresholds for each of the domestic watersheds were applied in the timber supply model and are shown as the targets for each water shed class on the panels in Figure 37.

A sample of the DWS classes with the "Red Flag" ECA targets applied are shown in Figure 37. These watersheds have the largest THLB component. Nearly 39% of forested area in the Class 1 Airy-Cowie Face is above the target of 15% in the short-term of the projection, thereby constraining timber supply at this point. Timber supply is likely constrained in this watershed for 10 years after the125th year due to the ECA targets.

Timber supply is periodically constrained in the Class 2 Varney Creek watershed over the term of the projection. The "Red Flag" ECA targets do not appear to be constraining timber supply in the Class 3 Airy Creek or the Class 3 Airy Creek 1 watersheds.

Of the DWS polygons not shown in Figure 37, only the Class 1 ZZ Creek (2 ha THLB), Class 3s Goose Creek 2 (8 ha THLB), Class 3s Wolverton Creek (1 ha THLB) and Class 3s Airy Creek 4 (210 ha THLB) are not constrained at any period in the projection. The Class1 Talbot Face (10 ha THLB) is constrained periodically over the short and long-term portions, while the Class 3s Airy Creek 2 (149 ha THLB) and Class 3s Airy Creek 6 (105 ha THLB) are constrained periodically, but only near the end of the medium and the end of the long term portion of the projection. The Class 3s Airy Creek 3 is constrained for one period ≤35 years beginning at 145 years into the projection, while the remaining watersheds are constrained for a relatively short durations towards the end of the mid-term, or at some point in the long term portion of the projection.

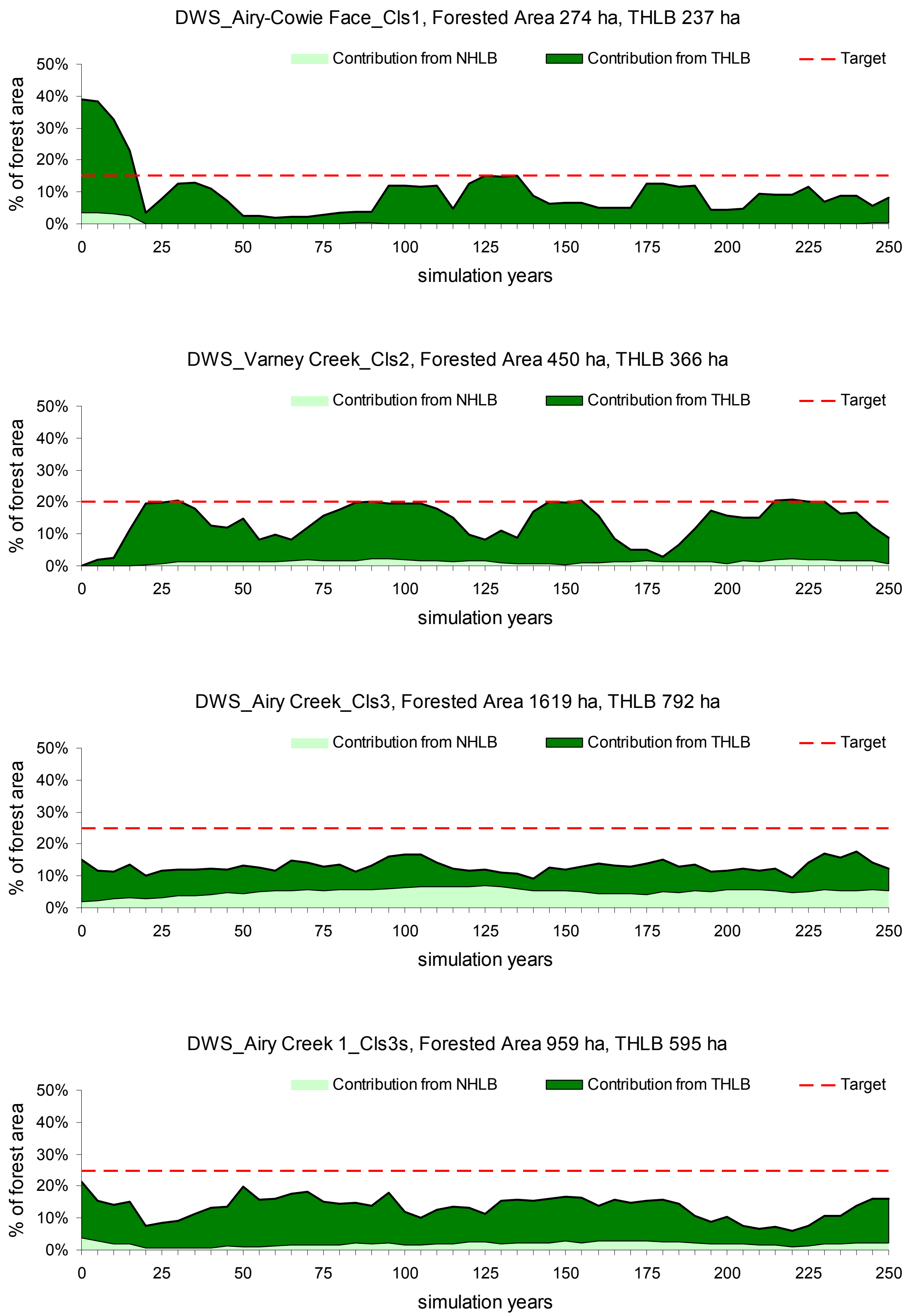


Figure 37: Sample of the domestic watershed polygons with the largest THLB area in each class.

5.3.13 Mature+Old Forest Cover

In accordance with Objective 2(2) and 2(3) of the *Kootenay Boundary Higher Level Plan Order*, (*KBHLP Order*) mature+old seral targets are limited to BEC subzone and variants with an Intermediate biodiversity emphasis option. In TFL3, only the ICHdw subzone in the Perry Landscape Unit (LU) is managed for mature+old seral targets.

Figure 38 shows the mature+old forest cover contribution in the ICHdw1 variant, within the Perry LU. Throughout the short and midterm portion of the projection, the mature+old forest cover targets do not seem to be constraining timber supply. In the long-term however, the timber supply appears to be constrained.

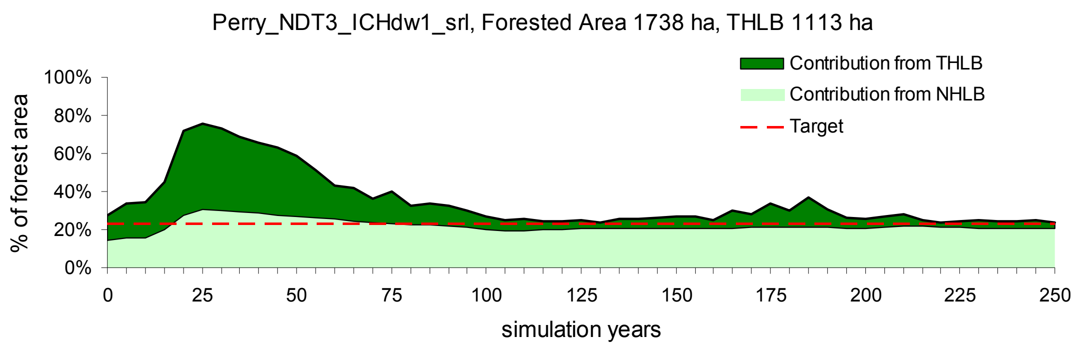


Figure 38: Mature + Old targets for the ICH dw1 subzone in the Perry Landscape Unit.

Under Objective 5(5) of the *KBHLP Order*, the mature+old forest cover targets for landscape level biodiversity must be met for each Landscape Unit and BEC variant within the connectivity corridor. Figure 39 shows the impact of the connectivity corridor constraint on the ICHdw1 variant in the Perry LU.

Nearly 94% of Crown Forested Land Base within the ICHdw1 subzone in the Perry LU is eligible[9] connectivity corridor. The connectivity corridor appears to be constraining timber supply, but only to a minor degree throughout most of the long term. Much of the old seral area is coming from the NHLB. As the THLB component of the constrained area is relatively small at 49 ha, on average, the impacts on timber supply attributed to mature+old targets, are minor.

[9] Under Objective 5(4) of the *KBHLP Order*, forested areas on slopes > 80% do not contribute to the connectivity component.

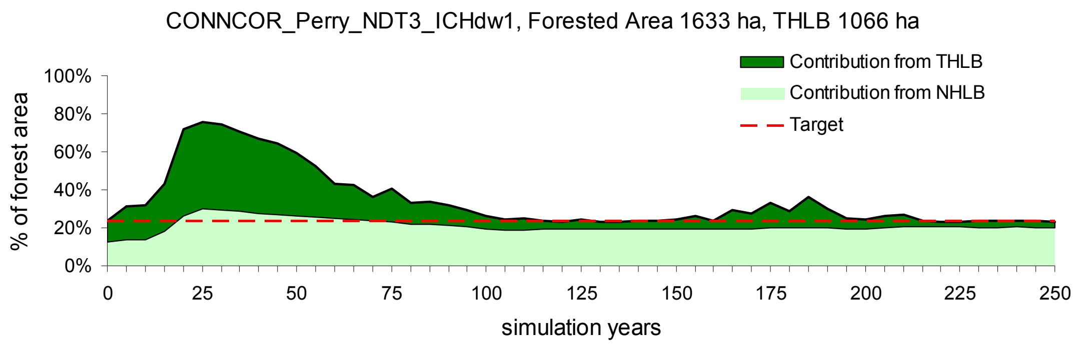


Figure 39: Connectivity corridor targets for mature + old seral stands the ICH dw1 subzone in the Perry LU.

5.3.14 Old Forest Cover

The old growth cover targets in the two Low biodiversity emphasis Landscape Units (Hoder and Koch) reflect a two-third drawdown during the first rotation[10] and are expected to be restored to the full target after the third rotation. In accordance with Objective 2(1) of the *KBHLP Order*, a recruitment strategy will be applied over the timber supply projection to meet the full old seral targets by the end of the third rotation in the Koch and Hoder LUs. The Perry LU has an Intermediate biodiversity emphasis, therefore the full old growth forest cover targets apply.

In order to meet the old seral targets, draft OGMAs have been identified within TFL3. SCFP has agreed to work around the draft OGMAs, even though they have not been formally established. The draft OGMAs are intended to reflect the current biodiversity targets of a two-thirds drawdown in the Hoder and Koch Landscape Units. The full biodiversity targets for the Perry LU are met through the draft OGMAs identified both within and outside of TFL3.

It is important to note that only the Koch Landscape Unit is located entirely within TFL3. The south-eastern half of Perry LU (N514) is outside the TFL, and the north-eastern half of Hoder LU (N516) is in Valhalla Provincial Park.

Since the draft OGMAs in the Hoder and Koch Landscape Units only represent one-third of the old seral targets, an incremental, but non-spatial approach is used to recruit suitable areas in order to meet the full biodiversity objectives by the end of the third rotation. The draft OGMAs contribute towards these incremental targets at each period.

In theory, applying an incremental target with the initial target set to the two-third draw-down level works well, provided there is enough area under the draft OGMAs within each BEC variant that adequately meet the desired old seral objectives at start of the projection .

This however, may not always be the case. The draft OGMAs may be deficient in meeting seral targets for legitimate reasons. For example, portions of the OGMAs may be old and have old stand attributes for biodiversity purposes, but are not quite old

[10] Rotation age is defined as 80 years in *Landscape Unit Planning Guide* (Government of B.C. 2000a).

enough to have met the arbitrary target age. OGMAs may also be located in a Landscape Unit that is comprised of more than one management unit (i.e. both a TFL and a TSA). Where multiple management units are in a Landscape unit, the OGMAs may be adequately meeting the seral objectives for each BEC variant in the entire Landscape Unit as designed, but may not be spatially distributed in such a manner that they meet the old seral target within any particular management unit.

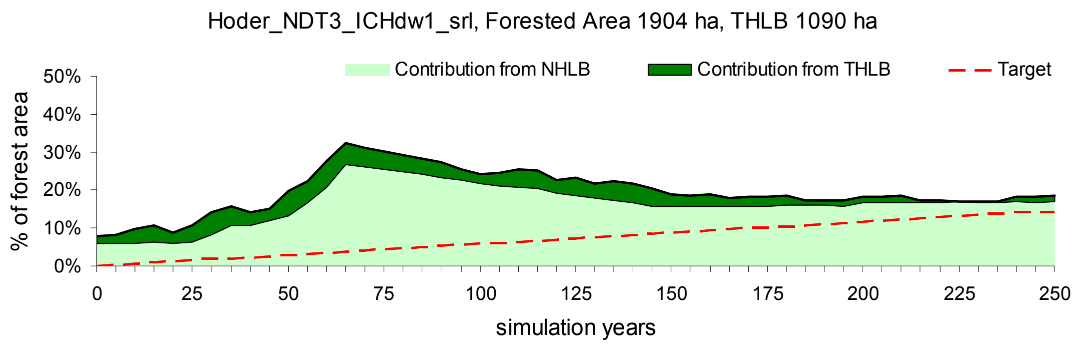
If the draft OGMAs are deficient in meeting the desired seral targets for each variant within the respective LU, the timber supply model may unnecessarily constrain forested stands from harvest outside of the OGMAs. In order to minimize the recruitment of additional areas in the modelling, the incremental targets are set to 0% at the start of the projection, instead of the two-thirds drawdown old target.

The target increases in a linear manner, reaching the full target after 240 years. This allows the draft OGMAs to representatively meet the old seral targets as designed (i.e. reflecting the two-third drawdown at the start of the projection), without overly constraining the THLB particularly in the short and mid-term portions of the projection where OGMA deficiencies, either due to age or spatial distribution, may be most apparent.

As an example, Figure 40 shows the old seral targets for ICHdw1 variant in the Hoder and Koch Landscape Units. The target is set at 0% initially, as the two-third drawdown old seral objectives are expected to be met with the draft OGMAs. After 80 years, the target is 4.7% which also is assumed to have been met with the draft OGMAs. After 240 years the full target of 14% is met through the recruitment of additional areas in addition to the draft OGMAs.

In the ICHdw1 within the Hoder and Koch Landscape Units, timber supply is not constrained due to old seral targets at any point in the projection. In the ICHdw1 variant found in the Hoder LU, the entire target is met through the NHLB.

The target is met with contributions from both the THLB and the non-harvestable portion in the ICHdw1 variant of the Koch LU; however timber supply does not appear to be constrained due to old seral targets. The decline in the proportion of old seral area in the NHLB in the Hoder example is attributed to modelling natural disturbance outside the THLB.



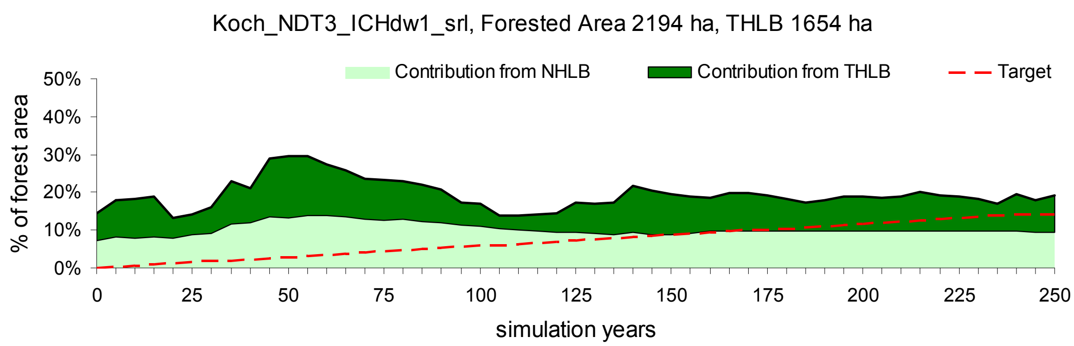


Figure 40: Old seral targets for the ICHdw1 variant in Koch and Hoder LUs, reflecting the two-third drawdown.

Of the other Hoder LU BEC variants, timber supply is constrained only in the ESSFwc1 for the final 20 years of the projection. Timber supply is not constrained due to old seral targets in any of the Koch LU BEC variants.

Old seral targets are not shown for the Perry LU since full biodiversity targets are assumed to be met through the draft OGMAs, both within and outside the TFL3 boundary.

6 Sensitivity Analyses

Sensitivity analyses are necessary in timber supply analysis to help quantify uncertainties about the assumptions used in the base case. Sensitivity analyses also provide a relative assessment of the risks to the short, medium and long-term associated with these uncertainties and an evaluation of the impacts of alternate short-term harvest strategies on the timber supply. Table 5 presents the sensitivity analyses evaluated for this timber supply report.

Table 5: Sensitivity analyses.

Section	Sensitivity Analysis
6.2	**Land Base Assumptions**
6.2.1	Partition the harvest in “Alternate” operability areas
6.2.2	Remove “Alternate” operability areas from the THLB.
6.2.3	Increase the THLB by 10%
6.2.4	Reduce the THLB by 10%
6.2.5	Remove permanently deactivated roads from the THLB
6.3	**Site Productivity**
6.3.1	Adjust Site Index for managed stands by ±10%
6.3.2	Adjust Site Index for managed stands by ±2.5 m
6.3.3	Old Growth Site Index (OGSI) adjustment for managed stands
6.3.4	PEM derived SIBEC Site Index Estimates
6.4	**Growth and Yield**
6.4.1	Reduce existing stand yield volumes by 10%
6.4.2	Reduce future managed stand yield volumes by 10%
6.4.3	Adjust genetic gain to 2008-2018 Forest Genetic Council Forecast
6.4.4	Apply Armillaria OAFs to Douglas-fir in the ICH zone
6.4.5	Apply the Provincial mountain pine beetle forecasts
6.5	**Modelling Rules**
6.5.1	Prioritize mountain pine beetle susceptible stands for harvest
6.5.2	Minimum harvest age
6.5.3	Change the harvest priority rule to oldest first
6.6	**Forest Cover Constraints**
6.6.1	Adjust green-up in visually sensitive areas ±1.5 m
6.6.2	Adjust the allowable disturbance percent in visually sensitive areas.
6.6.3	Return DRAFT OGMAs to THLB.
6.6.4	Return DRAFT OGMAS to THLB, and apply connectivity corridors.
6.7	**Adjacency & Green-up**
6.7.1	Apply traditional adjacency and green-up rules.
6.7.2	Apply an early seral patch strategy using true spatial modelling and heuristics.

Sensitivity analyses may show larger impacts on harvest levels at different periods in the timber supply forecast. Uncertainties that pose a high risk to timber supply in the short-term will have more immediate repercussions than a long term timber supply reduction that can be mitigated through proper planning and forecasting.

6.1 Guide to Interpreting the Sensitivity Analyses

The sensitivity analyses are organized into six general categories; land base assumptions; site productivity; growth and yield; modelling rules; forest cover constraints, and; adjacency. Within these categories, each of the sensitivity analyses follow the same reporting format; the sensitivity analysis is defined, a rationale for conducting the analysis is presented, the methods used to model the analysis are described and finally the results are presented and discussed. The results of each sensitivity analysis show a summary table of the target harvest levels for the short, medium and long-term portions of the projection. Also shown is the total achieved harvest volume (expressed as total cubic metres) for the short and medium-term portions of the projection. Additional summaries are provided where appropriate, such as changes to the size of THLB or revised assumptions about the productive capacity of the land base. Changes to these attributes relative to the base case are described and discussed.

The achieved harvest levels and the total growing stock of the THLB are shown for each sensitivity analysis. Under each sensitivity analysis, any changes to the timber availability were first assessed using the base case harvest levels. If the base case target harvest levels were achieved, the growing stock was evaluated for sustainability as described in Section 5.1. In situations where the base case harvest level targets were not achieved, or where the growing stock was not relatively stable in the long-term, adjusted harvest levels were determined for the sensitivity analysis. Both the harvest level and growing stock graphs depict the achieved harvest levels and growing stocks (total and mature) under the base case harvest levels (solid grey line) and where appropriate, when the adjusted harvest levels (solid black line) are required. Since the sensitivity analyses are always compared against the base case, the harvest levels and growing stocks for the base case (dotted black line) are also shown. Comparison graphs are usually shown for sensitivity analyses with a variance (i.e. Low/Moderate/High). Comparison graphs may omit the less relevant information in the interest of clarity.

Where appropriate, additional charts are shown depicting forest cover targets and constraints where that information is pertinent to describing the impacts on timber supply of the sensitivity analysis.

The sensitivity analyses, beginning with the land base assumptions are presented in the following sections.

6.2 Land Base Assumptions

This section presents the sensitivity analyses to address uncertainties around the timber harvesting land base. The sensitivity analyses shown here will explore the contributions of the “alternate” operability areas either through a partitioned harvest or by removing these areas altogether from the THLB. An overall 10% variance in the size of the THLB will be examined as will the assumptions regarding permanently deactivated roads.

6.2.1 Partition the Harvest in “Alternate” Operability Areas

Sensitivity Analysis

Partition the harvest of the 2,101 ha of THLB area classified as “alternate” in the 1996 operability classification.

Rationale

In the AAC determination for TSR2, the Chief Forester assigned a partition harvest of 4,000 m^3 per year (5% of the AAC) from areas identified as “alternate” in the 1996 operability classification. The “alternate” areas in TFL3 are areas that were previously thought to be difficult for road development, such as hanging valleys. It is expected that a variety of appropriate harvest methods will be used in the “alternate” areas and that as road construction proves to be environmentally acceptable in these areas, they will be reclassified under “conventional” operability (Slocan Forest Products Ltd., 2003).

Methods

The timber supply model allows a partition harvest to be applied to compartments or management zones within the TFL. “Alternate” and “conventionally operable” areas were categorized into two compartments. To control the harvest from either operability compartment, harvest volume limits were set. The maximum allowable harvest proportions were set to 5% from the “alternate” areas and 95% from the “conventionally operable” areas.

Results and Discussion

Table 6 shows that there are no changes required in the target harvest levels at any point in the projection. The total volume harvested by the model over the short and medium-term periods is 0.1% less than the base case when 5% of the harvest volume must come from the “alternate” areas.

Table 6: Sensitivity analysis summary – partition the harvest in “alternate” areas.

	Base Case	Convent-ional	Alter-nate	Total	Change	% Change
Long-term harvest level (m^3/yr)	72,500	68,875	3,625	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	76,000	4,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	76,000	4,000	80,000	0	0.0%
Total short/medium-term harvest (000’s m^3)	8,329	7,901	422	8,323	-6	-0.1%

Figure 41 depicts the projected harvest volume for the sensitivity analysis, along with the harvest volume coming from the “alternate” operability areas. By partitioning the harvest, a consistent volume is coming from the “alternate” areas, as opposed to the wide amplitude in the base case forecast where the partitioned harvest is not applied.

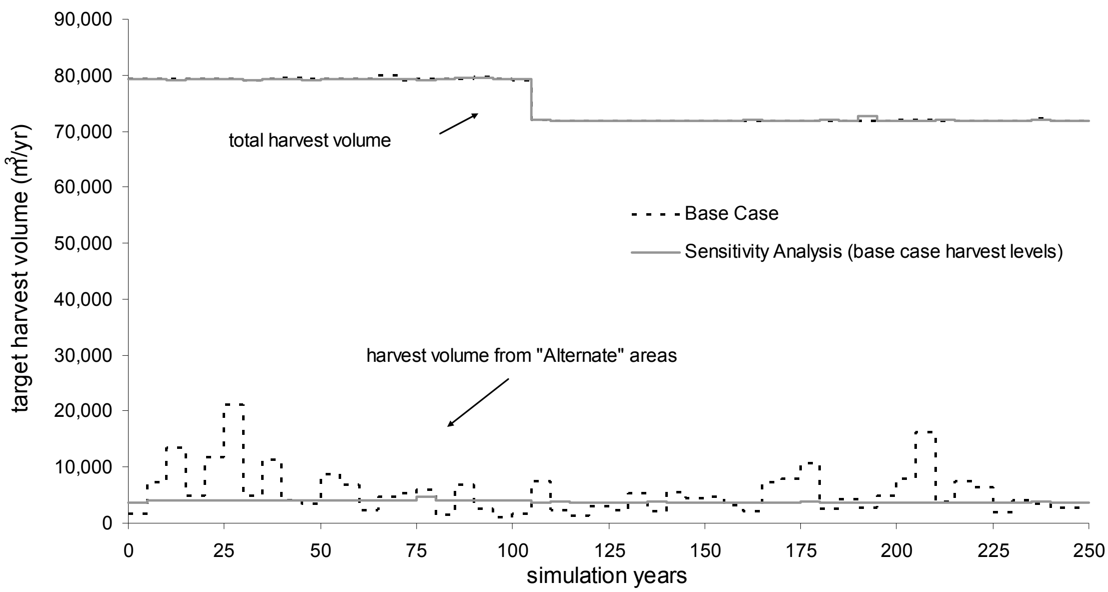


Figure 41: Total harvest forecast – partition 5% of the harvest volume to the “alternate” operability areas. “Alternate” area harvest volume is also shown.

Table 7 shows that on average, partitioning the harvest reduces the contribution from the “alternate” areas by 50% over the short-term, by nearly 30% over the mid-term and by approximately 25% in the long-term.

Table 7: Average annual harvest volume in “alternate” operability areas.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term "alternate" average annual harvest volume (m^3/yr)	4,890	3,660	-1,230	-25.2%
Medium-term "alternate" average annual harvest volume (m^3/yr)	5,778	4,049	-1,729	-29.9%
Short-term "alternate" average annual harvest volume (m^3/yr)	7,817	3,911	-3,906	-50.0%

Applying a 5% partitioned harvested to the 2,101 ha (THLB) of “alternate” operability areas results in a long-term growing stock that is approximately 2.5% lower than the base case, on average. The merchantable growing stock is also slightly lower than the base case in the long-term. The growing stock does however, remain relatively stable throughout the projection (Figure 42), indicating that there is little impact on the total inventory of applying this partitioned harvest.

As the “alternate” areas are expected to be developed over the short and medium-terms they will become more easily accessible. The necessity of a partitioned harvest component will likely become less significant by the long-term because the majority of these stands will have been converted to managed stand types.

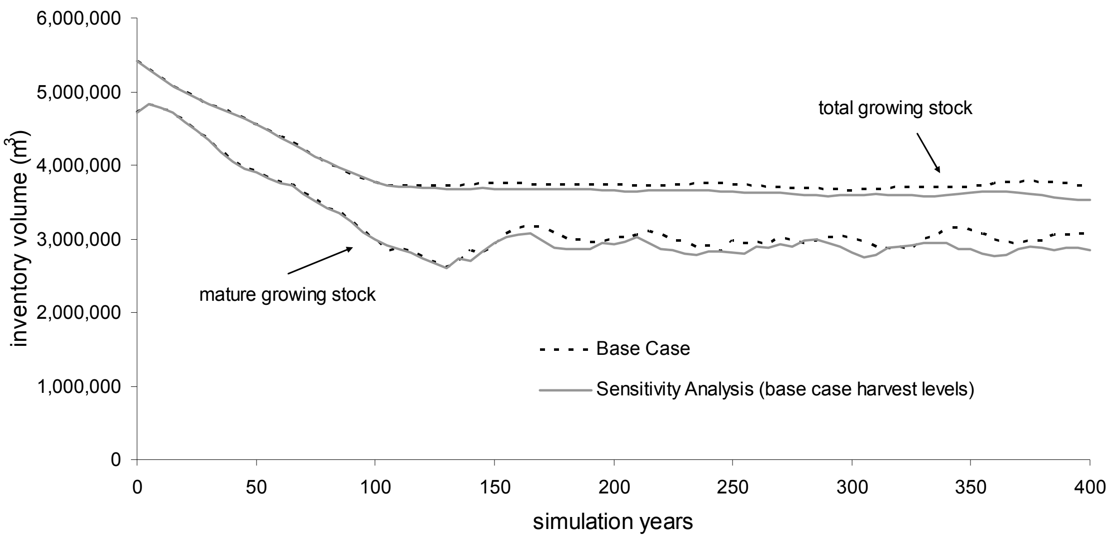


Figure 42: Sensitivity analysis growing stock – partition 5% of the harvest volume to the “Alternate” operability areas.

6.2.2 Remove the "Alternate" Operability Areas from the THLB

Sensitivity Analysis

Remove the areas classified as "alternate" operability that have not been previously logged from the timber harvesting land base.

Rationale

Under TSR2, the base case analysis did not include areas classified as "alternate" operability; however the contribution of these areas was examined through an "expanded operability" sensitivity analysis. As a result of the TSR2 analysis, the Chief Forester partitioned 4,000 m^3 per year to come from the "alternate" operability areas. The Chief Forester noted that the relatively small proportion of area involved would not present a significant risk to the timber supply and that the partitioned harvest would be reviewed at the next timber supply determination, pending licensee performance in the "alternate" areas (B.C. Ministry of Forests. 1998a). This sensitivity analysis examines the impacts on timber supply if these "alternate" areas are indeed excluded from the THLB.

Methods

The THLB was recalculated by removing "alternate" operability areas without previous logging history from the harvestable land base in the same manner in the netdown procedure as areas identified as "inoperable". The THLB for this sensitivity analysis retained 95 ha of "alternate" areas with previous logging history that are identified in the inventory. Note that a partitioned harvest was not applied to these 95 ha of previously logged "alternate" areas. After removing all "alternate" areas without previous logging history, the recalculated existing THLB was 25,637 ha, an overall net reduction of 1,950 ha.

Results and Discussion

Removing the "alternate" operability areas reduces the existing THLB by 7.1%, and the existing THLB inventory volume by approximately 524,000 m^3 or 9.7%. A corresponding reduction in overall productivity was not found however, as the LRSY volume only decreased by 6.1%, relative to the 7.3% reduction in the future THLB (Table 8).

Table 8: Land base summary statistics – remove "alternate" areas from the THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Current THLB (ha)	27,587	25,637	-1,950	-7.1%
Future THLB (ha)	26,214	24,290	-1,924	-7.3%
Current THLB Inventory Volume (000's m^3)	5,410	4,886	-524	-9.7%
LRSY (m^3/yr)	76,612	71,955	-4,657	-6.1%

In accordance with the reduction in the THLB, the long-term harvest level (LTHL) is 4% lower than the base case projection (Table 9). The short and medium-term harvest levels of the base case can be maintained, but by the 110th year the harvest level must decline by an average of 4.5% per 5-year period before reaching the revised LTHL of 69,591 m^3 per year (Figure 43). There is little change in the achieved short and medium-term total harvest volume relative to the base case.

Table 9: Sensitivity analysis summary – remove "alternate" areas from the THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	69,591	-2,909	-4.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,324	-5	-0.1%

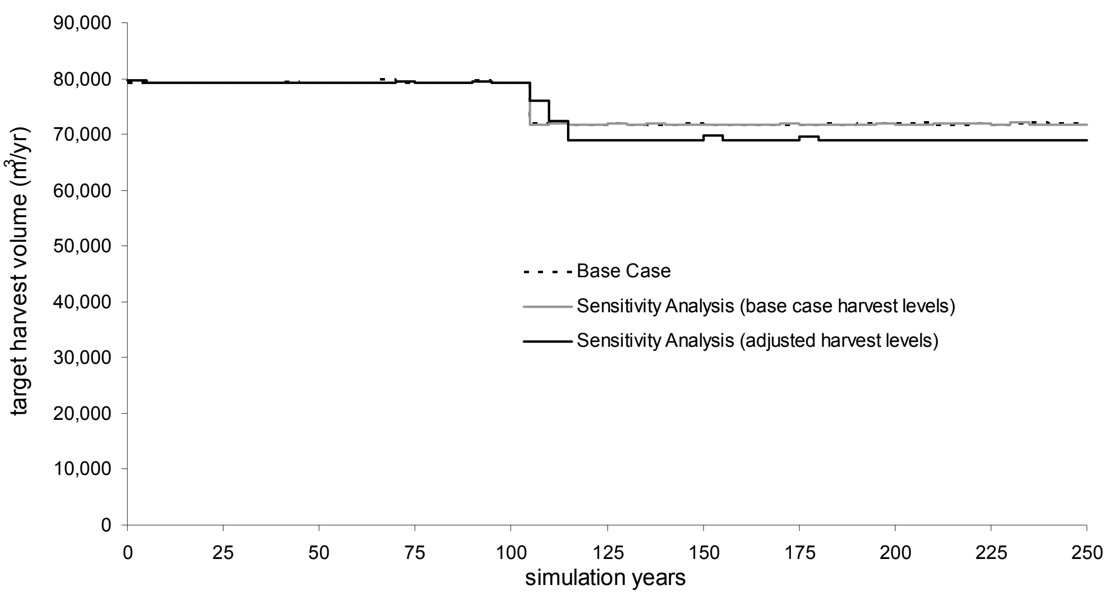


Figure 43: Total harvest forecast – remove the "alternate" operability areas from the THLB.

Figure 44 shows the nearly 10% difference in initial growing stocks of the base case and the sensitivity analysis land base. Applying the base case harvest level to a land-base that is about 7% smaller significantly impacts the growing stock in an adverse manner in the long-term. Adjusting the long-term harvest level rectified this and the result is a relatively stable growing stock. The merchantable component of the base case and the sensitivity analysis harvest levels correspond with their respective total growing stocks. It is important to note that a timber supply crash occurs by the 375th year under the base case harvest level when the "alternate" areas are removed from the THLB.

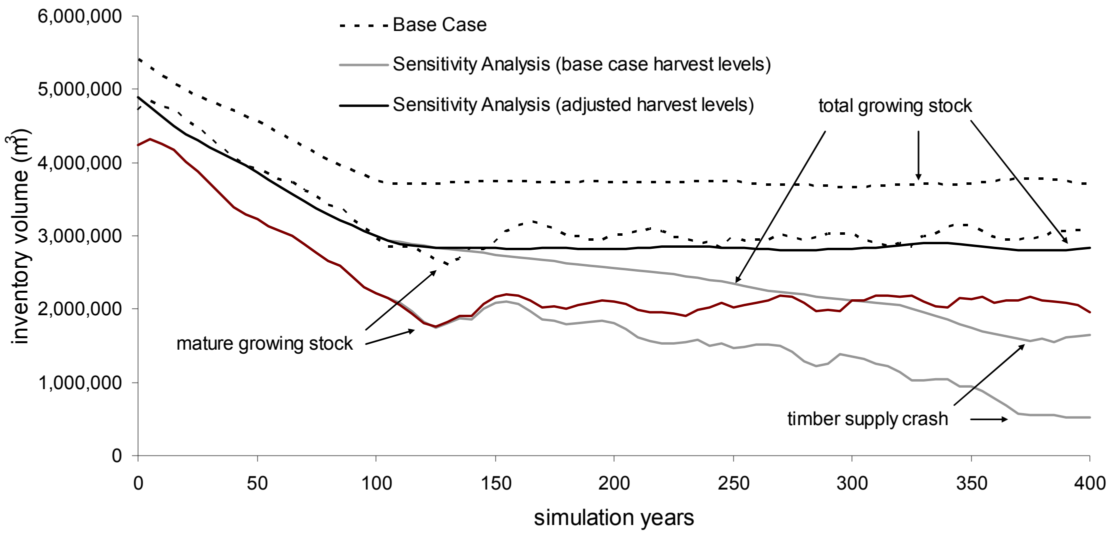


Figure 44: Sensitivity analysis growing stock – remove the "alternate" operability areas from the THLB.

6.2.3 Increase the THLB by 10%

Increase the size of the timber harvesting land base by 10% without increasing the area of the TFL by adding additional area from the partially removed polygons.

Rationale

Uncertainties typically surround the partial netdown assumptions when determining the timber harvesting land base. This sensitivity analysis examines the impacts on timber supply if the THLB was actually underestimated by 10% from the true value. The 2,759 ha of incremental area comes from polygons that were partially removed from the THLB during the netdown procedure, as depicted in Table 1 (i.e. ESA's, unstable terrain, wildlife tree patches, and partially removed problem forest types).

Methods

The THLB was increased 10% by redistributing the non-harvestable land base and the THLB, without increasing the forested area of TFL3. The increased THLB came from areas partially removed during the net-down procedure. Polygons with a larger non-harvestable component in the base case THLB contributed proportionately more to the THLB increment for this sensitivity analysis than polygons with a smaller non-harvestable component. For example, non-harvestable land base polygons that were 80% removed from the THLB in the base case contribute proportionally larger area to the increased THLB than polygons where only 10% of the area was removed. None of the polygons that were removed entirely from the THLB in the base case (i.e. inoperable, non-forested) contribute to the THLB increment.

Results and Discussion

Increasing the THLB by 10% in this manner increased the standing inventory volume by 13.3% to approximately 6.1 million m^3. The LRSY is higher, but proportionally less to the area increase, indicating that the area from the partially removed polygons is of lower productivity than the base case THLB, on average.

Table 10: Land base summary statistics – increase the THLB by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Current THLB (ha)	27,587	30,345	2,759	10.0%
Future THLB (ha)	26,214	28,835	2,621	10.0%
Current THLB Inventory Volume (000's m^3)	5,410	6,131	721	13.3%
LRSY (m^3/yr)	76,612	83,569	6,957	9.1%

The short and medium term harvest levels increased by about 10% to 88,000 m^3 per year, while the long-term harvest level was 8.3% higher at 78,500 m^3 per year (Table 11). A harvest decline at a rate of 5% per five-year period began by the 110th year, the same time as the transition in the base case projection (Figure 45).

Table 11: Sensitivity analysis summary – increase the THLB by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	78,500	6,000	8.3%
Medium-term harvest level (m^3/yr)	80,000	88,000	8,000	10.0%
Short-term harvest level (m^3/yr)	80,000	88,000	8,000	10.0%
Total short/medium-term harvest (000's m^3)	8,329	9,164	835	10.0%

If the THLB was in fact underestimated by 10%, then the harvest levels shown for the base case would be underestimated by 8,000 m^3 per year over the short and medium-terms, and underestimated by 6,000 m^3 per year over the long term.

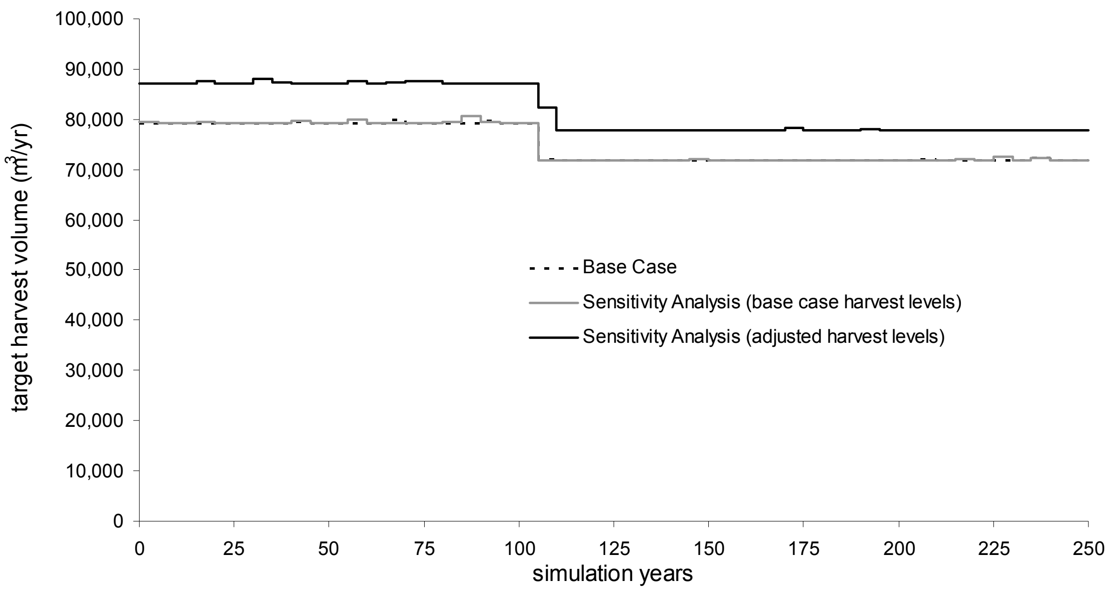


Figure 45: Total harvest forecast – increase the THLB by 10%.

When the base case harvest level is applied to the increased THLB under this sensitivity analysis, the total growing stock shows a slight increase over the long-term (Figure 46). By adjusting the harvest levels to the values shown in Table 11, the growing stock declines and then stabilizes after the harvest transition from the existing inventory to managed stands at the start of the long term. The merchantable growing stock of the adjusted harvest level for the sensitivity analysis follows the same pattern as the base case merchantable growing stock, although it is higher, as expected.

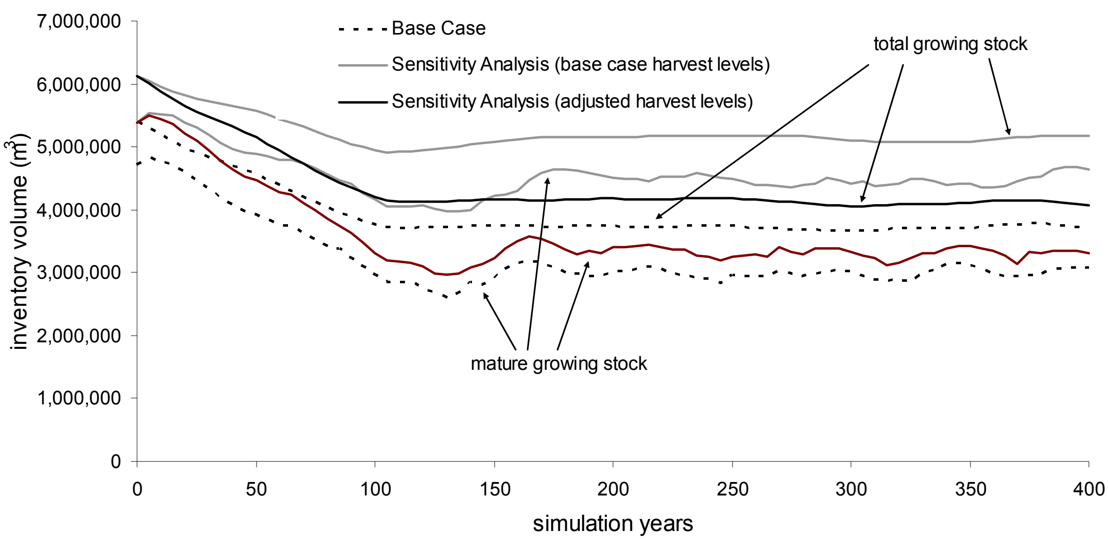


Figure 46: Sensitivity analysis growing stock – increase the THLB by 10%.

6.2.4 Reduce the THLB by 10%

Sensitivity Analysis

Reduce the size of the timber harvesting land base by 10% and increase the non-harvestable land base accordingly. No changes were made to the overall forested area of TFL3.

Rationale

To address any uncertainties in the timber supply attributed to the THLB being overestimated, this sensitivity analysis reduces the size of the THLB by 10%.

Methods

The THLB area of each polygon in the harvestable land base was reduced by 10%. The removed area was retained in the timber supply model as a component of the non-harvestable land base. No changes were made to the total forested area of the TFL.

Results and Discussion

Reducing the THLB by 10% in this manner reduced the current inventory volume by 10% to approximately 4.8 million m^3. As expected, the LRSY is also proportionately lower since every base case THLB polygon was reduced by 10% for this sensitivity analysis. Table 12 shows the land base summary statistics when the THLB is reduced by 10%.

Table 12: Land base summary statistics – reduce the THLB by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Current THLB (ha)	27,587	24,828	-2,759	-10.0%
Future THLB (ha)	26,214	23,593	-2,621	-10.0%
Current THLB Inventory Volume (000's m^3)	5,410	4,869	-541	-10.0%
LRSY (m^3/yr)	76,612	68,950	-7,662	-10.0%

Although the THLB is 10% smaller, the long-term harvest is only 7.5% lower than the base case (Table 13). There is no change to the target harvest in the short-term and throughout most of the medium-term. The achieved harvest volumes in the short and medium term are 0.6% less than those in the base case, primarily due to the long-term harvest level transition beginning 10 years earlier than in the base case.

Table 13: Sensitivity analysis summary – reduce the THLB by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	67,046	-5,454	-7.5%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,282	-47	-0.6%

Figure 47 shows that if the true area THLB is actually underestimated by 10%, then the base case harvest level will result in a timber supply crash during the long-term. Under the adjusted harvest level the harvest transition occurs 10 years earlier than in the base case. Three harvest level declines occur at a rate of <5% per 5-year period until the long-term harvest level of 67,046 is met by year 115.

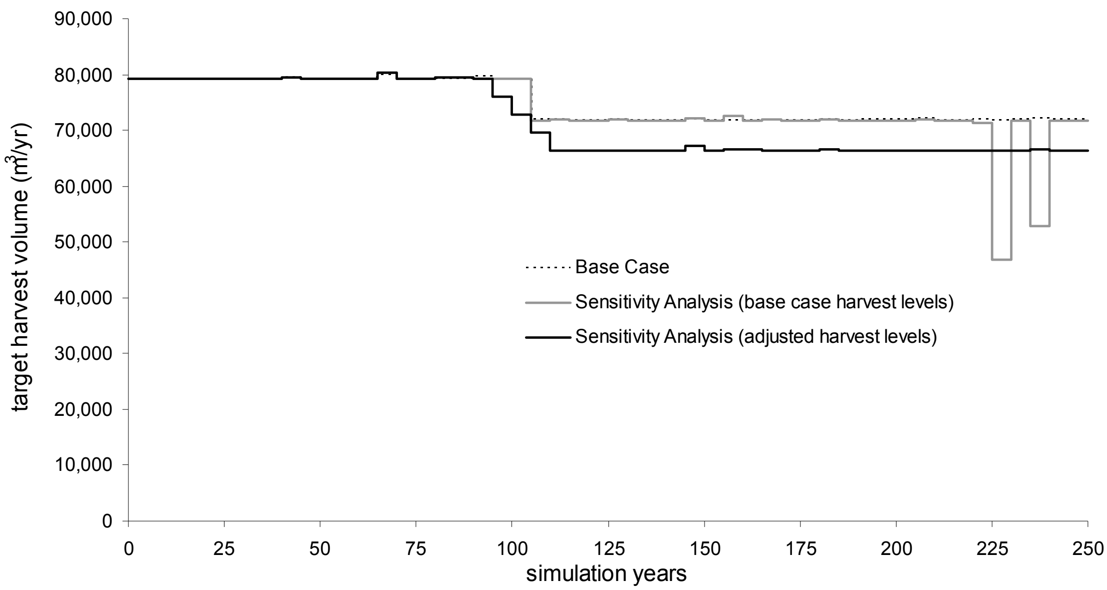


Figure 47: Total harvest forecast – reduce the THLB by 10%.

The timber supply crash under the base case harvest levels shown in Figure 47 are also apparent on the corresponding merchantable growing stock in Figure 48. If the THLB is underestimated by 10% then the base case harvest levels will result in an unstable growing stock. By reducing the long-term harvest level and initiating the harvest decline 10 years earlier, a relatively stable growing stock results. As expected, the total growing stock is less than the base case level, due to the smaller THLB.

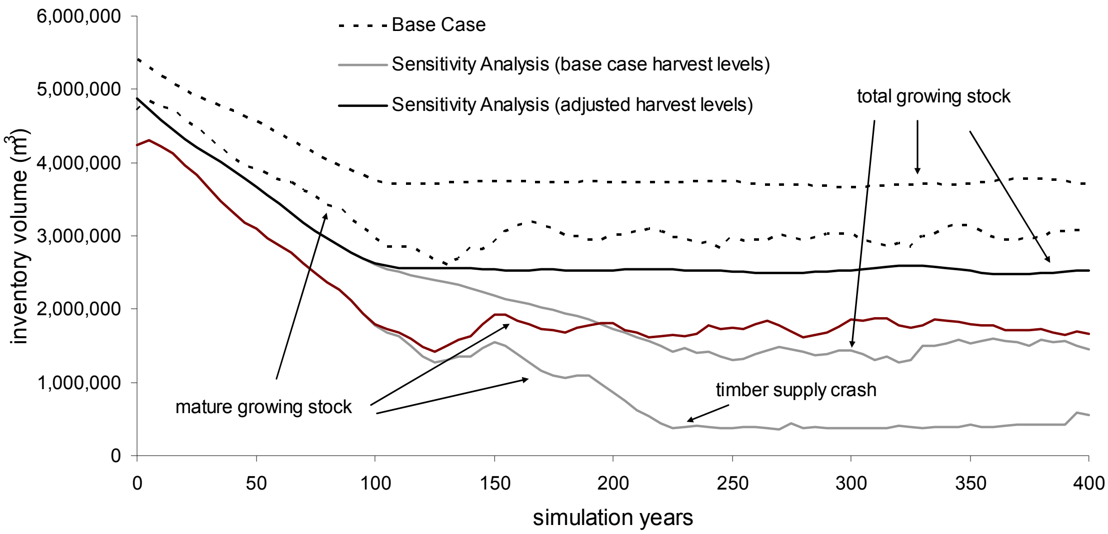


Figure 48: Sensitivity analysis growing stock – reduce the THLB by 10%.

Under the base case, the long-term harvest level is approximately 95% of the LRSY level, compared with 97% for this sensitivity analysis. This difference can be attributed to fact that areas removed from the THLB were assigned to the non-harvestable land base and meet non-timber objectives accordingly. In effect, less of the THLB is constrained for non-timber objectives in this sensitivity analysis than in the base case.

6.2.5 Remove Permanently Deactivated Roads from the THLB

Sensitivity Analysis

Remove roads classified as "permanently deactivated" from the contributing land base.

Rationale

Roads are both seasonally and permanently deactivated in TFL3. While seasonally deactivated roads contribute to the road network and remain unproductive for growing trees, permanently deactivated roads and machine trails were assumed to contribute to the productive growing space after rehabilitation, and were not removed from the THLB in the base case. Nearly 247 km were identified in the roads inventory as being permanently deactivated. To address uncertainties around the road deactivation estimate, this sensitivity analysis removes the permanently deactivated roads from the THLB in perpetuity.

Methods

The THLB was recalculated for this sensitivity analysis with the assumption that permanently deactivated roads and machine trails were removed from the harvestable land base, in the same manner as seasonally deactivated and permanent roads. Assuming the existing deactivated roads were removed from the THLB modified the future road estimate accordingly.

Results and Discussion

Assuming the permanently deactivated roads will never contribute to the harvestable land base results in a net reduction of 215 ha to the THLB, or a -0.8% change.

No adjustments were required in the harvest level, at any point in the projection (Table 14), and the total short and medium-term harvest volume was nearly the same as the base-case analysis.

Table 14: Sensitivity analysis summary – remove permanently deactivated roads from the THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,330	1	0.0%

Figure 49 and Figure 50 show the harvest levels and the growing stock for this sensitivity analysis, respectively. The base case harvest levels resulted in a stable growing stock, nearly identical to the base case analysis (Figure 50), therefore only an adjusted harvest level was not required for this sensitivity analysis.

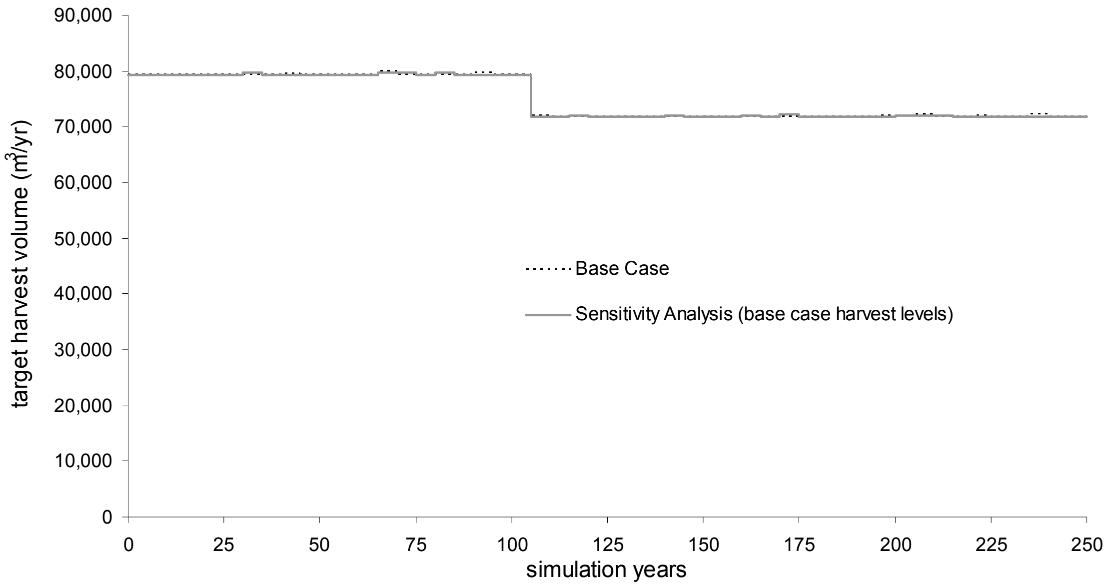


Figure 49: Total harvest forecast – remove permanently deactivated roads from the THLB.

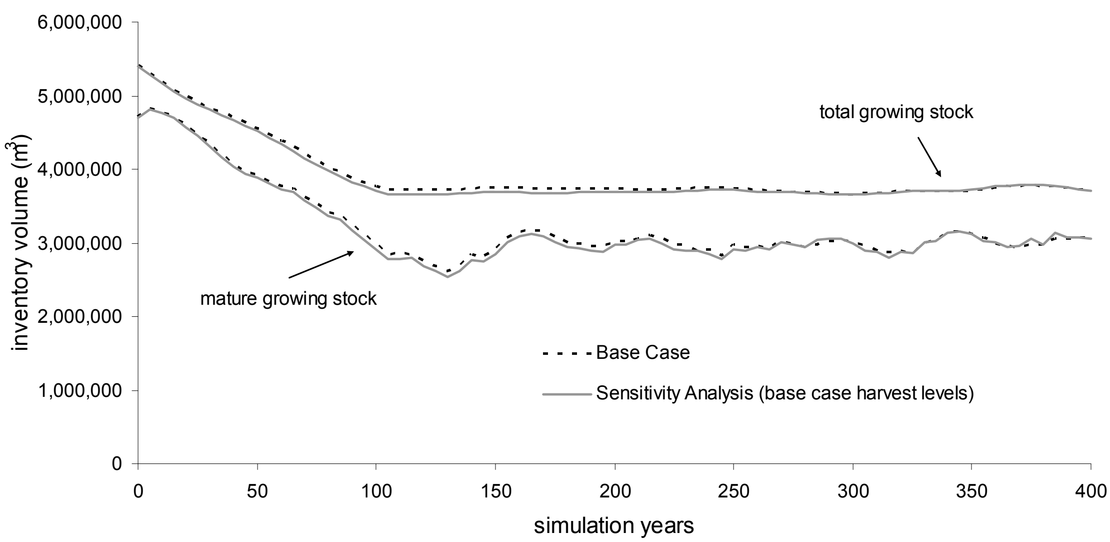


Figure 50: Sensitivity analysis growing stock – remove permanently deactivated roads from the THLB.

6.3 Site Productivity

Of particular interest to this timber supply analysis are the site productivity estimates for managed stands. The base case timber supply projection requires a decline in the harvest level to stabilize the growing stock as the managed stands become available for harvest. The existing inventory has in been adjusted through a Phase II sampling procedure; however it is generally recognized that the VRI inventory site indices used to estimate regenerated stand yields are underestimated, since they are typically derived from mature or decadent stands (Nigh, 1998; Nussbaum, 1998).

Alternate site index estimates for managed stands were examined to investigate the impact of uncertainty in estimating site productivity on the base case harvest forecast. Applying the Predictive Ecosystem Mapping (PEM) derived Site Index Biogeoclimatic Ecosystem Classification (SIBEC) values, old growth site index (OGSI) estimates (Nigh, 1998; Nussbaum, 1998) and arbitrary metre and percentage adjustments to the VRI site indices were examined through sensitivity analyses.

All site productivity sensitivity analyses shown here did not include an adjustment to the net down criteria; that is to say, the THLB as determined with the VRI site index was retained for these sensitivity analyses. No changes were made to the analysis unit clusters, low productivity stand thresholds or the THLB area calculations based on adjusted managed stand yields from the site index sensitivity analyses. However, minimum harvest ages were adjusted for the revised yield curves to reflect the age where the minimum volume limits were met.

When reviewing the results of adjusted site indices shown in these sensitivity analyses, it is important to consider the relative magnitude of change between site productivity classes in the analysis unit groups. Each of the site index sensitivity analyses has a different impact on site productivity in diverse components of the THLB. For example, by changing the site index by a given percentage, stands with a high site index will show a larger change than poor site stands. Conversely, by changing all inventory site indices by a fixed amount, poor site areas will show a proportionately larger impact relative to the existing site index. Table 15 shows the relative magnitude of change with each of the sensitivity analyses by presenting the area-weighted average adjusted site index values by analysis unit.

Table 15: Site index comparisons by analysis unit for the site index sensitivity analyses. Values for adjusting the site index by -10% and -2.5m are not shown.

Analysis Unit	THLB Area (ha)	VRI (m)	PEM derived SIBEC (m)	VRI + 10% (m)	VRI + 2.5 m (m)	OGSI (m)
Balsam_High	143.0	20.1	17.5	22.1	22.6	20.1
Balsam_Low	783.2	8.6	16.7	9.5	11.1	9.2
Balsam_Med	966.0	15.4	16.7	16.9	17.9	15.5
Balsam_Poor	1138.7	12.4	16.7	13.6	14.9	13.8
Cedar_High	222.9	19.5	23.7	21.5	22.0	19.5
Cedar_Med	326.9	17.3	21.9	19.1	19.8	18.1
Cedar_Poor	445.7	14.0	22.0	15.4	16.5	15.9
DecidLarch_High	137.9	20.2	22.4	22.2	22.7	20.2
DecidLarch_Med	53.2	16.5	22.4	18.1	19.0	16.5
Fir_Pine_High	1045.2	21.2	23.6	23.4	23.7	21.2
Fir_Pine_Med	3126.2	18.0	23.2	19.8	20.5	18.1
Fir_Pine_Poor	976.5	14.4	22.4	15.8	16.9	15.5
Hemlock_High	266.7	21.2	18.7	23.3	23.7	21.2
Hemlock_Med	2191.7	16.5	18.3	18.1	19.0	16.7
Hemlock_Poor	1020.3	12.1	18.2	13.3	14.6	15.9
Larch_High	583.9	21.1	22.6	23.2	23.6	21.1
Larch_Med	2969.7	17.5	22.8	19.3	20.0	18.0
Larch_Poor	293.4	12.7	21.9	14.0	15.2	18.0
Lodgepole_ESSF_High	327.6	18.6	19.4	20.5	21.1	18.6
Lodgepole_ESSF_Med	936.5	15.5	19.4	17.0	18.0	16.0
Lodgepole_ESSF_Poor	152.0	12.5	19.5	13.8	15.0	15.8
Lodgepole_ICH_High	442.6	21.1	22.9	23.2	23.6	21.1
Lodgepole_ICH_Med	654.2	15.6	23.0	17.2	18.1	15.8
Spruce_ESSF_High	1372.0	18.9	17.5	20.8	21.4	19.0
Spruce_ESSF_Low	848.2	7.7	16.8	8.5	10.2	18.9
Spruce_ESSF_Med	2189.3	14.8	17.3	16.3	17.3	16.8
Spruce_ESSF_Poor	2196.6	10.8	17.0	11.9	13.3	19.3
Spruce_ICH_High	184.0	22.2	17.9	24.4	24.7	22.2
Spruce_ICH_Low	264.1	10.7	17.7	11.8	13.2	16.5
Spruce_ICH_Med	662.0	18.8	17.6	20.7	21.3	18.8
Spruce_ICH_Poor	666.3	14.9	17.8	16.4	17.4	16.1
Average Site Index		**15.7**	**19.8**	**17.3**	**18.2**	**17.4**

6.3.1 Adjust Site Index for Managed Stands by ±10%

Sensitivity Analysis

Adjust the VRI site index by an arbitrary ±10% and re-calculate the managed stand yield tables.

Rationale

This sensitivity analyses explores the impacts of applying an arbitrary 10% adjustment to the VRI site index estimates. As the impact is directly proportional to the inventory site index, more productive stands in the inventory will see a larger overall adjustment then poorer stand types.

Methods

An adjusted site index was calculated for each VRI inventory polygon by increasing (decreasing) the inventory value by 10%. Managed stand yields were recompiled in TIPSY using the adjusted site indices. Adjusted analysis unit yield curves were derived in the same manner as the base case (see Section 4.2 above and Section 8 in the *Information Package*).

Results and Discussion

Table 16 shows the results of the sensitivity analyses when the managed stand site indices are varied by ±10%.

Table 16: Sensitivity analyses summary – adjust site index for managed stands by ±10%

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Increase by 10%	Long-term harvest level (m^3/yr)	72,500	85,050	12,550	17.3%
	Medium-term harvest level (m^3/yr)	80,000	85,050	5,050	6.3%
	Short-term harvest level (m^3/yr)	80,000	85,050	5,050	6.3%
	Total short/medium-term harvest (000's m^3)	8,329	8,853	524	6.3%
	Mean Site Index (m)	15.7	17.3	1.6	10%
	Mean Culmination MAI (m^3/ha/year)	2.9	3.4	0.5	18.0%
Reduce by 10%	Long-term harvest level (m^3/yr)	72,500	61,233	-11,267	-15.5%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,309	-20	-0.2%
	Mean Site Index (m)	15.7	17.3	1.6	-10%
	Mean Culmination MAI (m^3/ha/year)	2.9	2.4	-0.5	-16.9%

When the site indices are 10% higher, a larger component of managed stands become available for harvest 20 years sooner than in the base case. In this scenario, a non-declining even flow harvest level of 85,050 m^3 per year is attainable. Under this adjusted harvest level, the growing stock declines until the end of the medium-term, where it stabilizes until the end of the projection at an average level approximately 7% higher than the base case growing stock (Figure 51). The average productivity, expressed as the mean culmination MAI, increased by 18% to 3.9 m^3/ha per year.

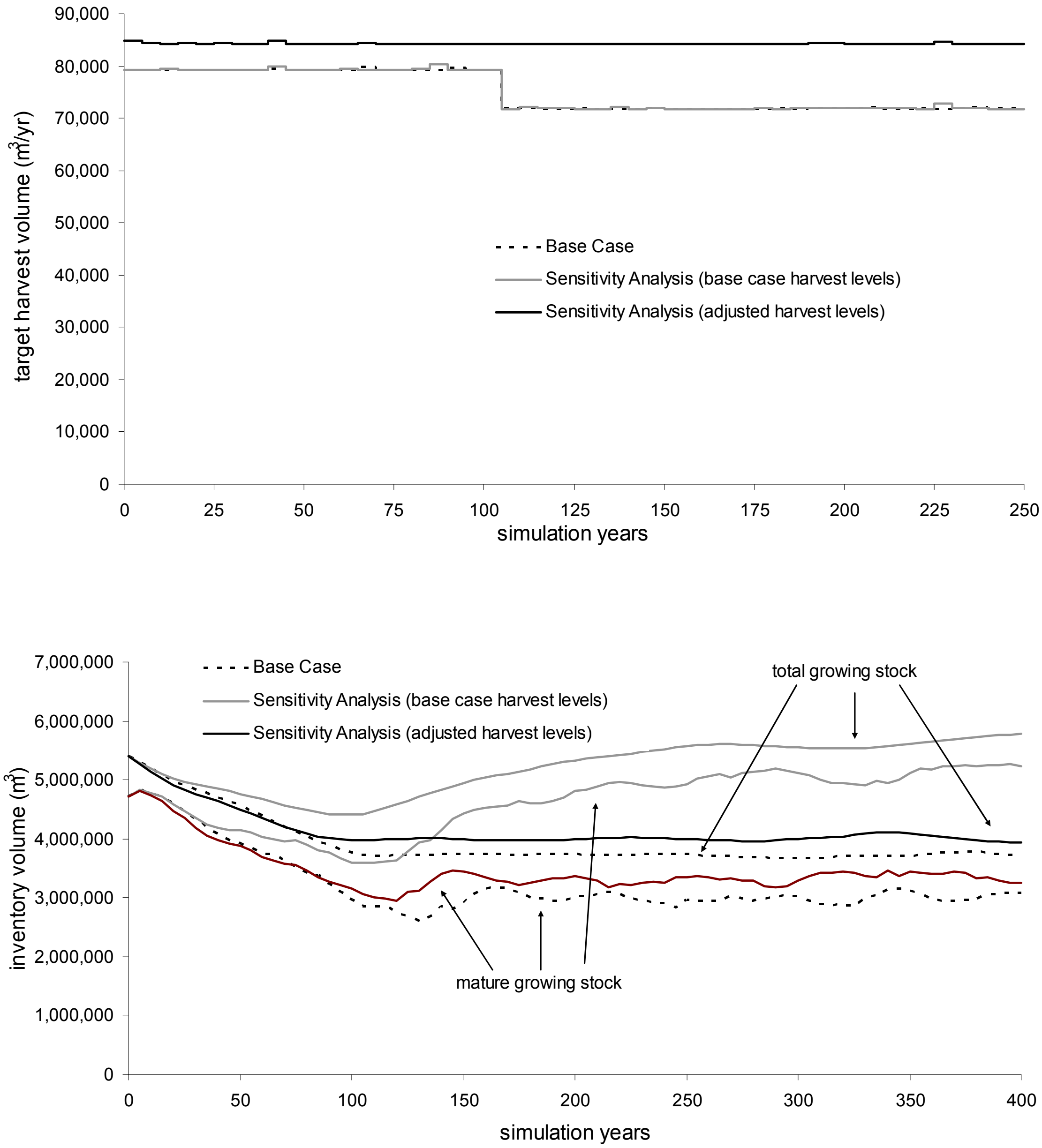
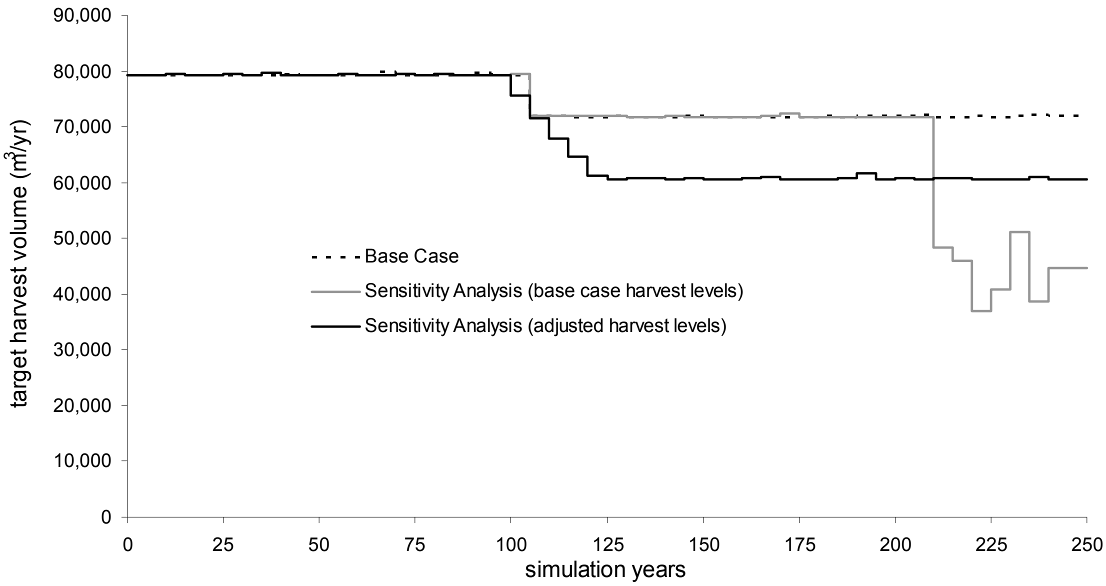


Figure 51: Total harvest forecast (top panel) and growing stock (bottom panel) – increase the managed stand site indices by 10%.

A 10% reduction in the managed stand site indices results in crash in the timber supply by year 215 when the base case harvest level is applied (Figure 52). The average productivity, expressed as the mean culmination of the MAI, is 16.9% lower than the base case. The adjusted LTHL of 61,233 m^3 per year is met by year 130, after short and medium-term harvest levels decline at a rate of 5% per 5-year period. Since the harvest decline begins 5 years earlier than in the base case, there is a small reduction in the total harvest volume in the short and medium-term. The total growing stock is stable, but it is nearly 21% lower than that of the base case, on average.



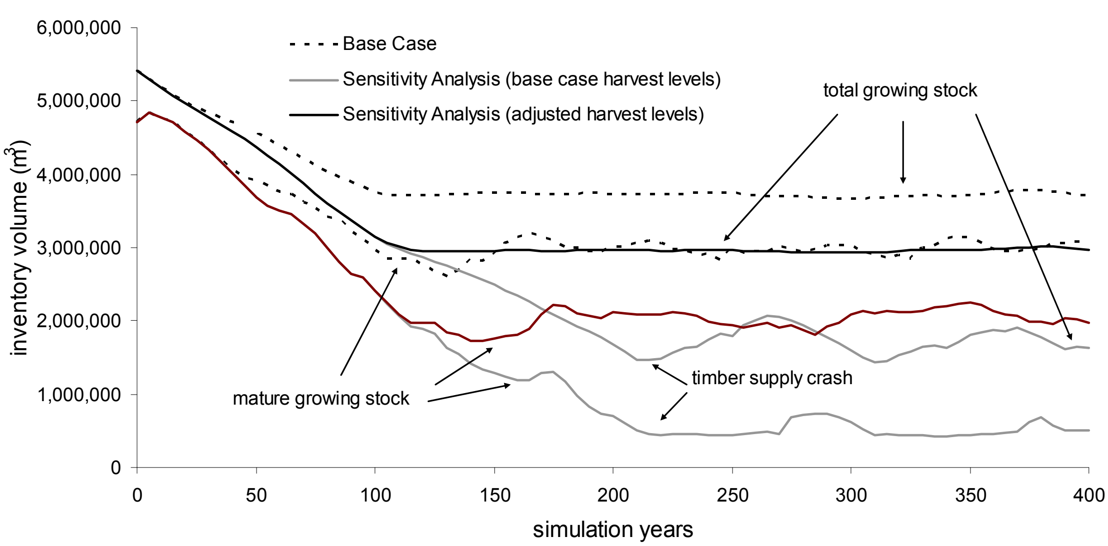


Figure 52: Total harvest forecast (top panel) and growing stock (bottom panel) – reduce the managed stand site indices by 10%.

6.3.2 Adjust Site Index for Managed Stands by ±2.5 m

Sensitivity Analysis

Adjust the VRI site index by an arbitrary ±2.5 m, and re-calculate the managed stand yield tables.

Rationale

This sensitivity analyses explores the impacts on timber supply of applying the same arbitrary 2.5 m site index adjustment to each inventory VRI inventory polygon. The same adjustment is applied to each inventory polygon, regardless of the VRI values. Hence, inventory stands with a lower site index will be adjusted proportionally more than high site index stands.

Methods

The adjusted site index was calculated for each VRI inventory polygon by increasing (decreasing) the inventory value by 2.5 m. Managed stand yields were recompiled in TIPSY using the adjusted site indices. Adjusted analysis unit yield curves were derived in the same manner as the base case (see Section 4.2 above and Section 8 in the *Information Package*).

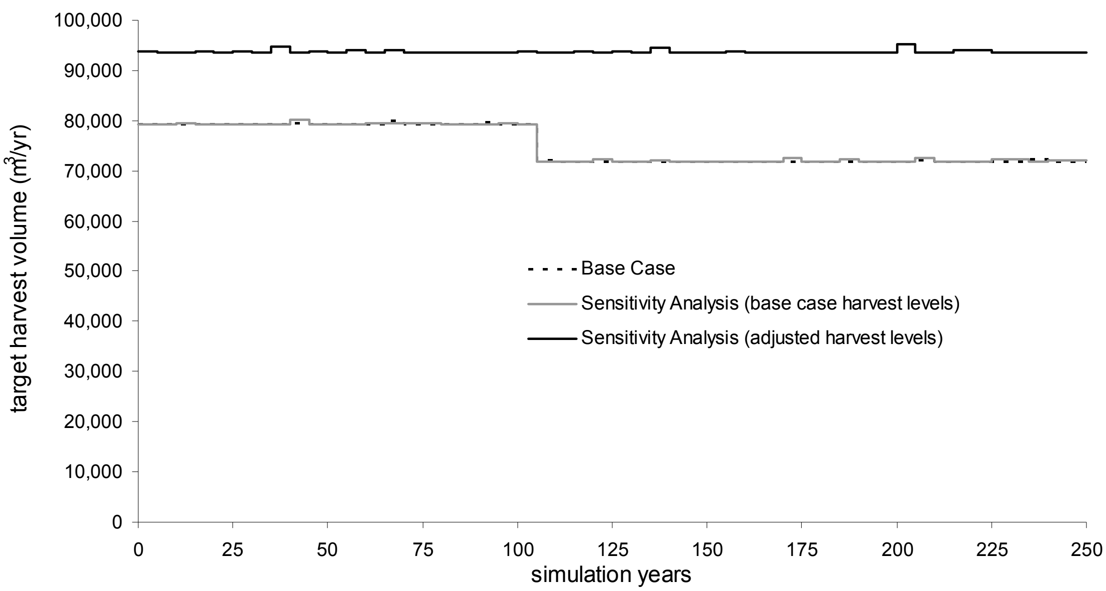
Results and Discussion

Table 17 shows the results of the two sensitivity analyses when the managed stand site indices are varied by ±2.5 m. A ±2.5 m change in site index corresponds to a ±15.9% change in the average site index.

Table 17: Sensitivity analyses summary – adjust site index for managed stands by ±2.5 m.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Increase by 2.5 m	Long-term harvest level (m^3/yr)	72,500	94,500	22,000	30.3%
	Medium-term harvest level (m^3/yr)	80,000	94,500	14,500	18.1%
	Short-term harvest level (m^3/yr)	80,000	94,500	14,500	18.1%
	Total short/medium-term harvest (000's m^3)	8,329	9,841	1,512	18.2%
	Mean Site Index (m)	15.7	18.2	2.5	15.9%
	Mean Culmination MAI (m^3/ha/year)	2.9	3.8	0.8	28.4%
Reduce by 2.5 m	Long-term harvest level (m^3/yr)	72,500	54,402	-18,098	-25.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,306	-23	-0.3%
	Total harvest for periods ending at years 110 to 140 (000's m^3)	2,514	2,165	-349	-13.9%
	Mean Site Index (m)	15.7	13.2	2.5	-15.9%
	Mean Culmination MAI (m^3/ha/year)	2.9	2.2	-0.7	-25.4%

Increasing the inventory site index by 2.5 m and re-calculating the managed stand yield tables increases the mean culmination MAI by 28.4% to 3.8 m^3/ha per year. The increased productivity allows the harvest level to be increased to a non-declining even-flow level of 94,500 m^3 per year. This corresponds to an increase in the short and medium-term achieved harvest volume of 18.2%, and a long-term harvest level increase of 30.3%. Figure 53 shows the achieved harvest levels and the corresponding growing stock values. The long-term growing stock is stable; however it is approximately 6% lower than that of the base case, on average.



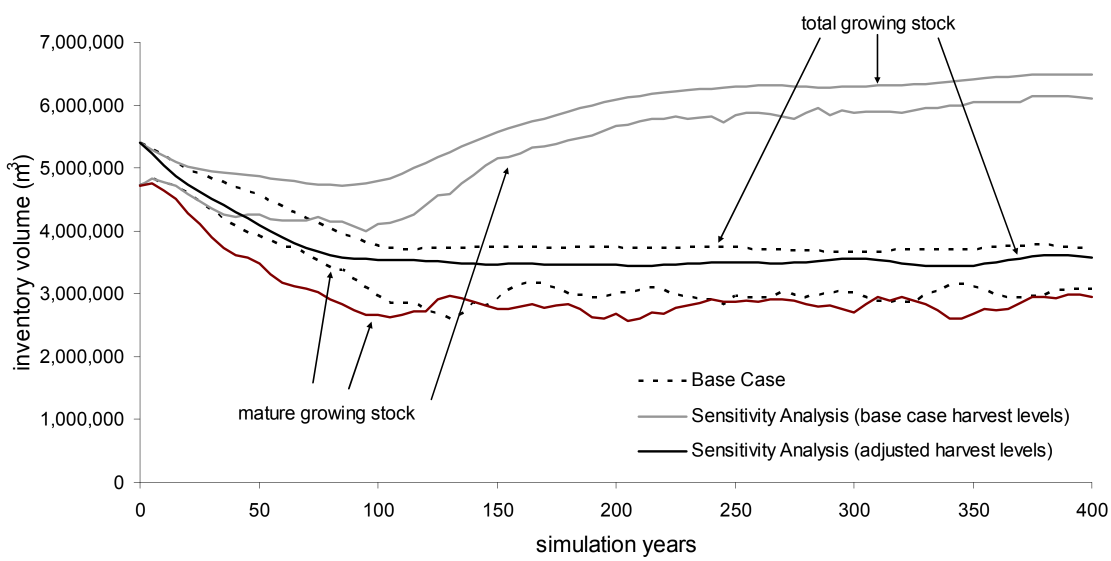


Figure 53: Total harvest forecast (top panel) and growing stock (bottom panel) – increase the managed stand site indices by 2.5 m.

For comparison purposes, the inventory site indices were reduced by 2.5 m. No changes were made to the harvest levels in the short-term and throughout most of the medium term, as much of the harvest comes from the existing inventory. The harvest decline to the LTHL began 5-years earlier than in the base case, resulting in a decrease in the total short and medium-term harvest level of 0.3% (Figure 54). For the first 35 years of the long-term, the harvest level declines at a rate of 5% per period, eventually reaching the LTHL of 54,402 m^3 per year; a value 25% less than the base case. Throughout the 35 year transition period, the achieved harvest volume is nearly 14% less than that in the base case. Once the LTHL is met, the growing stock stabilises, although it is approximately 33% lower than the growing stock in the base case.

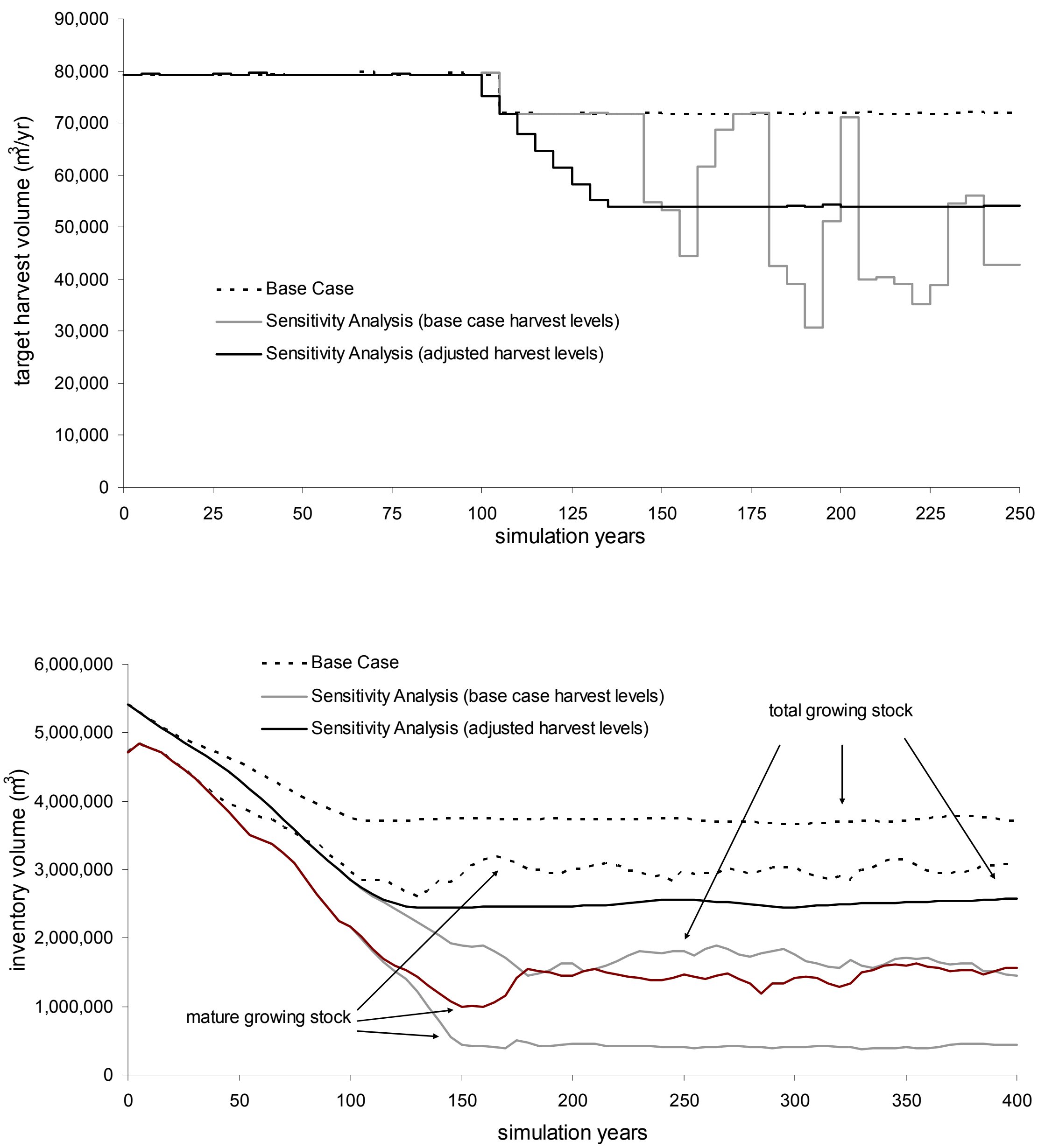


Figure 54: Total harvest forecast (top panel) and growing stock (bottom panel) – reduce the managed stand site indices by 2.5 m.

6.3.3 Old Growth Site Index (OGSI) Adjustment for Managed Stands

Sensitivity Analysis

Adjust the VRI site index by applying the Old Growth Site Index (OGSI) adjustments to stands older than 140 years, and re-calculate the managed stand yield tables.

Rationale

This sensitivity analyses explores the impacts of applying OGSI site index adjustments to inventory stands >140 years of age. The OGSI program was comprised of two studies; old growth site index adjustments based on paired plots (Nussbaum, 1998), and; site index adjustments for old stands based on veteran trees (Nigh, 1998). The veteran tree study (Nigh, 1998) was conducted to provide site index adjustment equations for stand and productivity types >140 years that were not sampled in the paired plot study. Since the equations developed from the OGSI study were derived from Provincial samples, the adjustment equations were intended to provide an interim estimate until more localized sampling of site productivity could be completed. Both OGSI studies sampled a range of trees >140 years of age within specific site index ranges.

Methods

For this sensitivity analysis, the OGSI adjustment equations were applied to stands within the species, inventory site index and age range of the OGSI study sampled stands. The equations derived in the paired plot study (Nussbaum, 1998) were only applied to eligible lodgepole pine and spruce leading stands within the site index ranges sampled in the study. No OGSI adjustment equations were available for western white pine (Pw) leading stands in either study. All other eligible leading stand types and the eligible spruce and lodgepole pine stands outside the site index ranges found in Nussbaum (1998) had the veteran tree (Nigh, 1998) adjustment equations applied. The VRI inventory site index was retained for ineligible stands (i.e. younger than 140 years, or outside the sampled species or site index ranges found in either study).

The managed stand yield tables used in this sensitivity analysis were recompiled using the adjusted site indices from the OGSI studies. Adjusted analysis unit yield curves were derived in the same manner as the base case (see Section 4.2 above and Section 8 in the *Information Package*).

Results and Discussion

Applying the OGSI adjustments appears to have a greater impact on the site indices of the poor site analysis units (see Table 15 above). To be consistent with the sampling in the two OGSI studies, the site index adjustments were only made only to stands >140 years. In general, higher site index stands as identified in the inventory tend to be younger than 140 years and were not eligible for the OGSI adjustments.

Table 18 and Figure 55 show that applying the OGSI site index adjustments to the managed stand yield tables results in a non-declining even-flow harvest level of 85,500 m^3 per year. This is an increase of 5,500 m^3 per year (6.9%) over the short and medium-terms, and 13,000 m^3 per year (17.9%) over the long-term. The mean site index for the THLB increased by 10.8% to 17.4 m at breast height age 50 while the average productivity expressed as the mean culmination MAI, increased by 17.0% to 3.4 m^3/ha per year.

Table 18: Sensitivity analysis summary – apply OGSI adjusted site indices to the managed stand yield tables.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	85,500	13,000	17.9%
Medium-term harvest level (m^3/yr)	80,000	85,500	5,500	6.9%
Short-term harvest level (m^3/yr)	80,000	85,500	5,500	6.9%
Total short/medium-term harvest (000's m^3)	8,329	8,899	570	6.8%
Mean Site Index (m)	15.7	17.4	1.7	10.8%
Mean Culmination MAI (m^3/ha/year)	2.9	3.4	0.5	17.0%

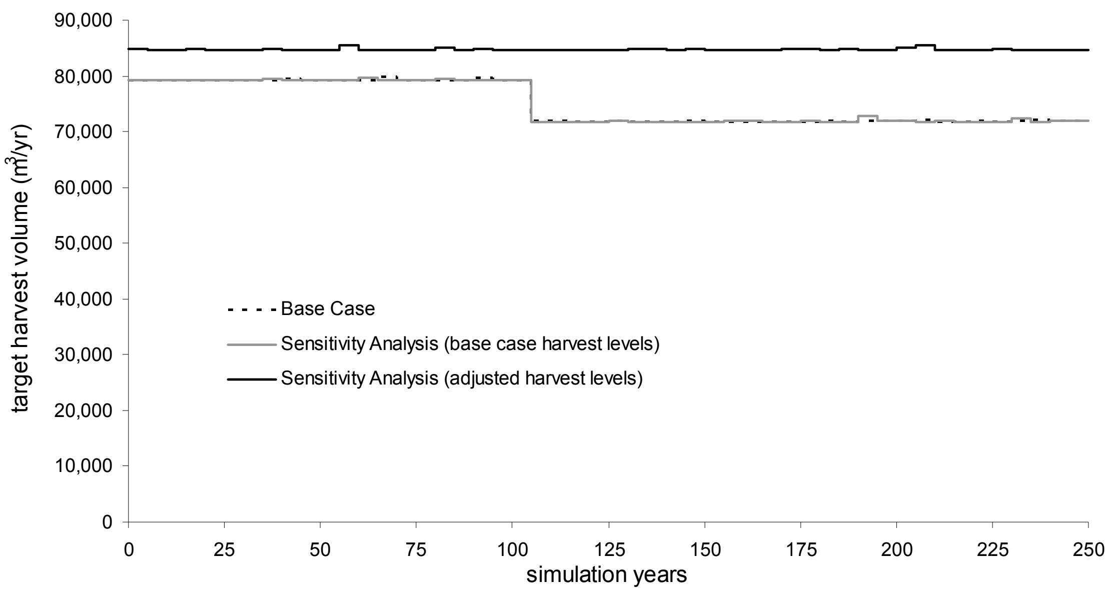


Figure 55: Total harvest forecast – apply OGSI adjusted site indices to the managed stand yield tables.

In the short term and throughout the first half of the medium term, the growing stock under the adjusted harvest level declines below the base case, as the 'natural' stands are depleted (Figure 56). Both the mature and total growing stocks of the adjusted harvest level increase beyond the respective base case growing stocks around 75 years into the forecast. Well into the long term, there is little difference in the growing stock from the base case, as the growing stock for the adjusted harvest level is only about 2% higher than that of the base case, on average.

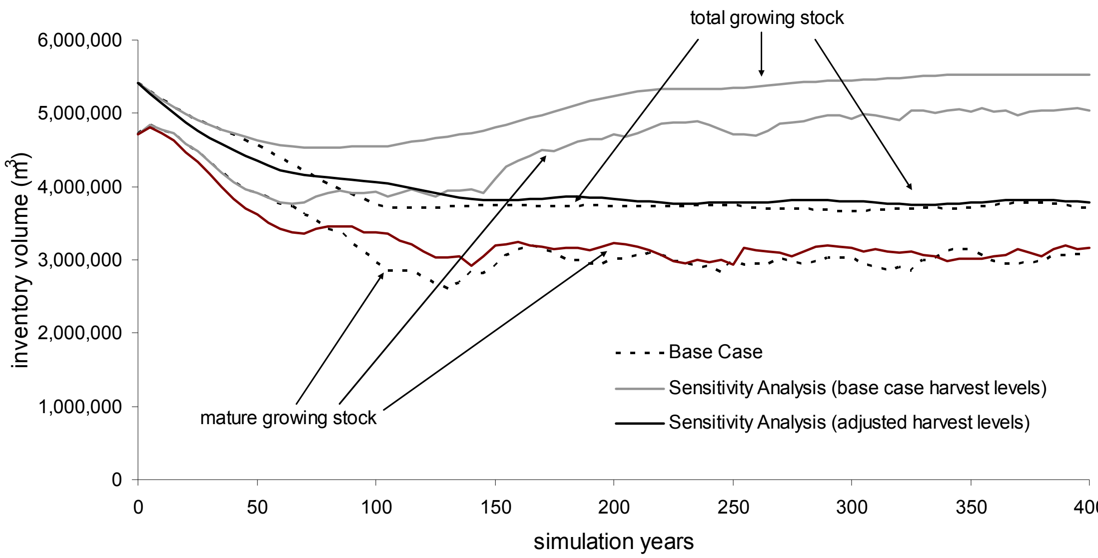


Figure 56: Sensitivity analysis growing stock – apply OGSI adjusted site indices to the managed stand yield tables.

6.3.4 PEM Derived SIBEC Site Index Estimates

Sensitivity Analysis

Adjust the VRI site index by applying the Site Index Biogeoclimatic Ecosystem Classification (SIBEC) site index estimates, based on the site series data found in the Predictive Ecosystem Mapping (PEM) project conducted on TFL3 (JMJ Holdings and Ecologic Research, 2001).

Rationale

This sensitivity analyses explores the impacts of applying SIBEC site index estimates to TFL3. The BEC site series classification data, a necessary attribute for assigning SIBEC estimates, came from the PEM project conducted on TFL3 in 2001 (JMJ Holdings and Ecologic Research, 2001). A subsequent accuracy assessment report for the PEM project[11] showed the PEM data did not meet the minimum acceptable standards for use in a timber supply analysis base case, as described in the *Protocol for Accuracy Assessment of Ecosystem Maps*, *Tech.Rpt. 011* (Meidinger, 2003b)[12].

It is generally recognized that the SIBEC productivity estimates provide a more accurate estimate of the true site productivity than inventory values derived from mature or decadent stands. However, the uncertainties around the PEM data accuracy in TFL3 meant the SIBEC estimates were only appropriate for use in sensitivity analyses in a timber supply review.

Methods

The PEM data was overlaid on the TFL3 resultant and the appropriate site series was determined for each resultant polygon. The 2008 SIBEC site index estimates (B.C. Ministry of Forests and Range. 2008b) were applied to each species by BEC classification to the estimated site series level. Where site series data was missing, weighted average site values by leading species and BEC variant were calculated.

The managed stand yield tables used in this sensitivity analysis were recompiled using the SIBEC adjusted site indices derived using the site series data from the PEM project. Adjusted analysis unit yield curves were derived in the same manner as for the base case (see Section 4.2 above and Section 8 in the *Information Package*).

Results and Discussion

Applying the PEM derived SIBEC site index values to the managed stand yield tables allows for a non-declining even-flow harvest level of 106,650 m^3 per year (see Table 19 and Figure 57). This is an increase of 33% in the short and medium term, and 47% in the long-term.

[11] See JMJ Holdings Inc. (2003): *Tree Farm Licence 3 predictive ecosystem mapping accuracy assessment report*.

[12] The minimum accuracy standards for PEM data to be used in a base case timber supply analysis are shown in Appendix D of *Protocol for accuracy assessment of ecosystem maps, Tech.Rpt. 011* (Meidinger, 2003b). The values presented in Table 7 of *Tree Farm Licence 3 Predictive ecosystem mapping accuracy assessment report* (JMJ Holdings Inc., 2003) do not meet the minimum accuracy standards for use in the timber supply analysis base case.

Table 19: Sensitivity analysis summary – apply PEM derived SIBEC site index estimates to the managed stand yield tables.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	106,650	34,150	47.1%
Medium-term harvest level (m^3/yr)	80,000	106,650	26,650	33.3%
Short-term harvest level (m^3/yr)	80,000	106,650	26,650	33.3%
Total short/medium-term harvest (000's m^3)	8,329	11,098	2,769	33.2%
Mean Site Index (m)	15.7	19.8	4.1	26.1
Mean Culmination MAI (m^3/ha/yr)	2.9	4.3	1.4	46.3

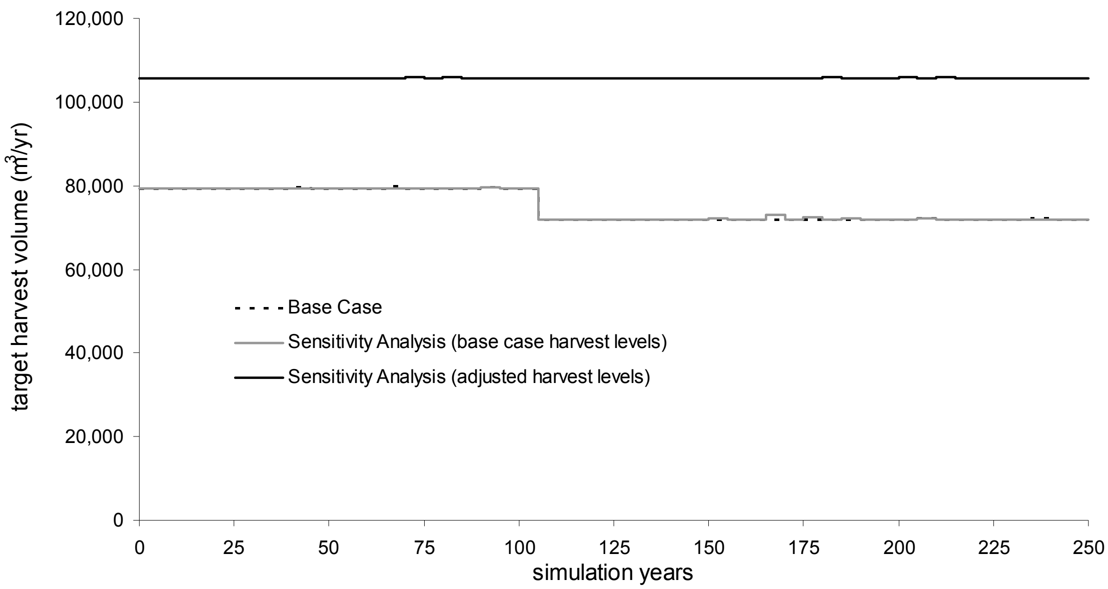


Figure 57: Total harvest forecast – apply PEM derived SIBEC site index estimates to the managed stand yield tables.

Given the accelerated harvest level of the existing inventory during the short and medium terms, the growing stock of the adjusted harvest level declines slightly below the base case as the 'natural' stands are depleted (Figure 56). The growing stock levels off after 65 years under the even-flow forecast; however the long-term growing stock remains approximately 19% lower than that of the base case.

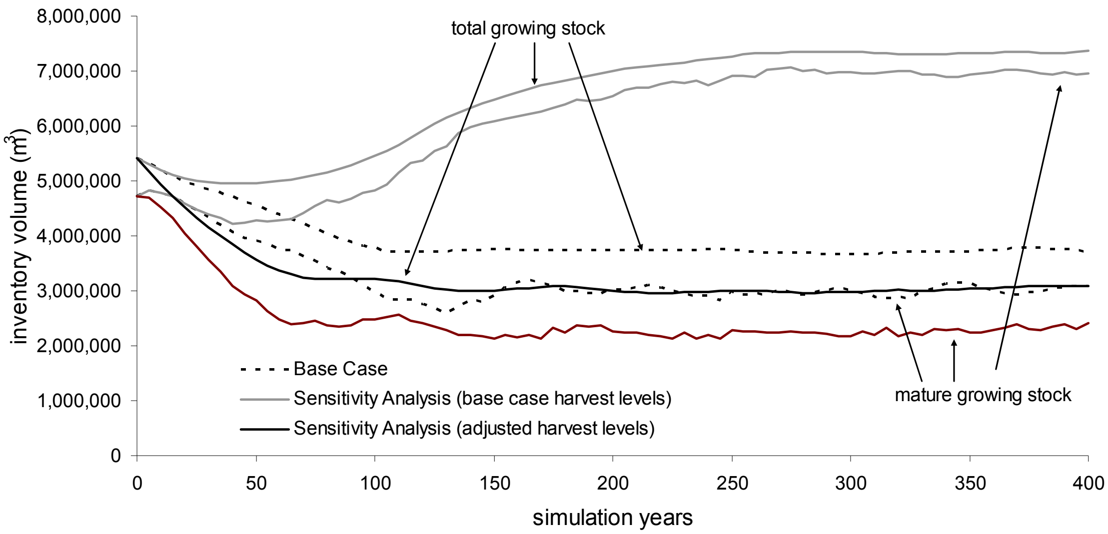


Figure 58: Sensitivity analysis growing stock – apply PEM derived SIBEC site index estimates to the managed stand yield tables.

Applying the PEM derived SIBEC site index estimates results in the largest impact to harvest levels of the site productivity sensitivity analyses. The average productivity, expressed as the culmination maximum MAI, increased by about 46% to 4.3 m^3/ha per year. The PEM and SIBEC derived adjusted mean site index for the THLB increased by 26% to 19.8 m at breast height age 50, however there is little distinction between the average site indices across site class categories within analysis units (see Table 15, above). This is likely an artefact of the PEM accuracy in estimating the true site series of the land base[13]. Obtaining localized SIBEC site index adjustments under a more accurate ecosystem classification than the existing PEM data would likely show a broader range of average site index values across the inventory.

[13] See the PEM project accuracy report in JMJ Holdings (2003): *Tree Farm Licence 3 predictive ecosystem mapping accuracy assessment report*.

6.4 Growth and Yield

The growth and yield sensitivity analyses are intended to address uncertainties around the growth and yield assumptions used in the base case, outside of the site productivity sensitivities discussed in the previous section. There are four uncertainties that are examined in this section: existing and regenerated stand volume estimates; genetic gain forecasts for regenerated stands; the potential impacts of Armillaria root rot on Douglas-fir stands in the ICH zone, and; the potential impacts of the mountain pine beetle epidemic.

The growth and yield sensitivity analyses shown here did not include an adjustment to the net down criteria; that is to say, the THLB as determined with the attributes in the VRI inventory was retained for these sensitivity analyses. No changes were made either to the analysis unit clusters, low productivity stand thresholds or the THLB area calculations based on adjusted managed stand yields from these growth and yield sensitivity analyses.

6.4.1 Reduce Existing Stand Yield Volumes by 10%

Sensitivity Analysis

Reduce all existing standing timber volumes in the VRI by 10%.

Rationale

Stands older than 20 years of age were adjusted for bias under the Phase II inventory adjustment sampling project as discussed in Jahraus and Associates Consulting Inc. and Churlish Consulting Ltd., (2005). The purpose of this sensitivity analysis is to evaluate the risk on timber supply if the exiting inventory volumes were overestimated.

Methods

Yield tables for the existing inventory stands (both natural and existing managed) were adjusted downwards by 10% in the timber supply model. The existing stand yield volumes were 90% of those used in the base case. No changes were made to the future managed stand yield volumes. Minimum harvest ages for existing inventory stands were adjusted accordingly for this sensitivity analysis.

Results and Discussion

Reducing the existing stand yield volume by 10% has no appreciable impact on the harvest forecast (Table 20). The base case harvest level can be maintained throughout the forecast (Figure 59).

Table 20: Sensitivity analysis summary – reduce existing stand yield volumes by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,331	2	0.0%

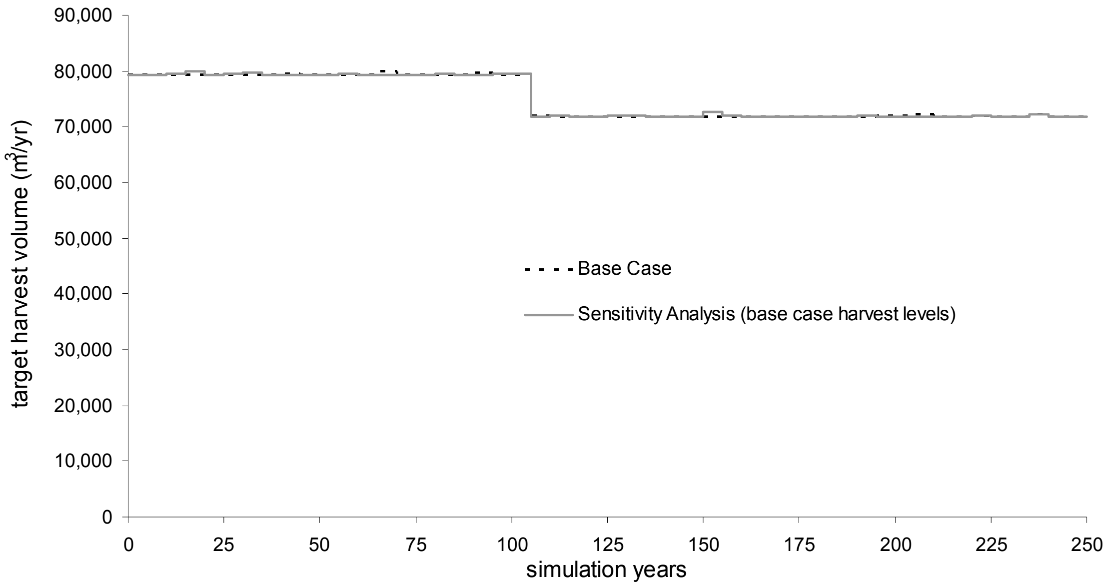


Figure 59: Total harvest forecast – reduce existing stand yield volumes by 10%.

The initial growing stock is less than that of the base case and declines at a more rapid rate over the medium-term (Figure 60). For much of the long-term, the growing stock increases to a minor degree, but eventually stabilizes by 320 years into the projection.

Overestimating the growing stock by 10% poses no significant risk to timber supply.

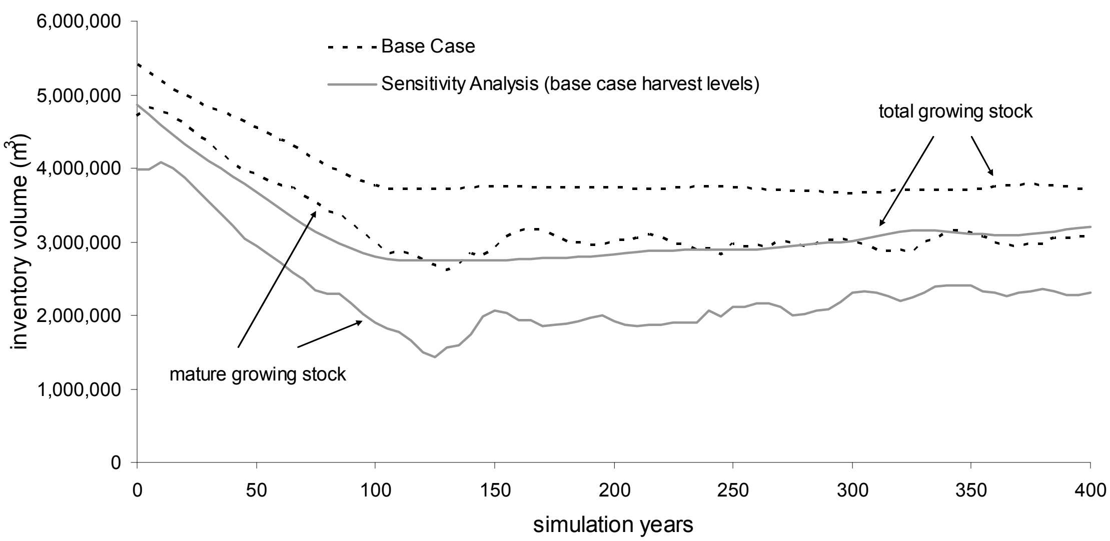


Figure 60: Sensitivity analysis growing stock – reduce existing stand yield volumes by 10%.

6.4.2 Reduce Future Managed Stand Yield Volumes by 10%

Sensitivity Analysis

Reduce all future managed stand yield volumes as generated with TIPSY by 10%.

Rationale

The purpose of this sensitivity analysis is to evaluate the risk to timber supply associated with an overestimation of the yield volumes for stands yet to be established on the TFL. In this analysis, future managed stand yields are function of site productivity and the regeneration assumptions applied in TIPSY.

Methods

Yield tables for the future stands were adjusted downwards by 10% in the timber supply model resulting in future managed stand yield volumes that were 90% of those used in the base case. No changes were made to the existing inventory yield volumes. Minimum harvest ages for future stands were adjusted accordingly for this sensitivity analysis.

Results and Discussion

By reducing the future stand yields by 10%, the long-term harvest level must also decline by 10%, accordingly. No changes are made to the target harvest levels in the short and medium term, since future managed stands generally are not harvested unit the long-term (Table 21).

Table 21: Sensitivity analysis summary – reduce future managed stand yield volumes by 10%.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	65,228	-7,272	-10.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,337	8	0.1%
Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,042	-36	-3.3%

Figure 61 shows the harvest decline between the first three 5-year periods of the long-term, when the LTHL of 65,228 m^3 per year level is reached by year 120. The achieved harvest over the decline period is 3.3% less than the base case analysis.

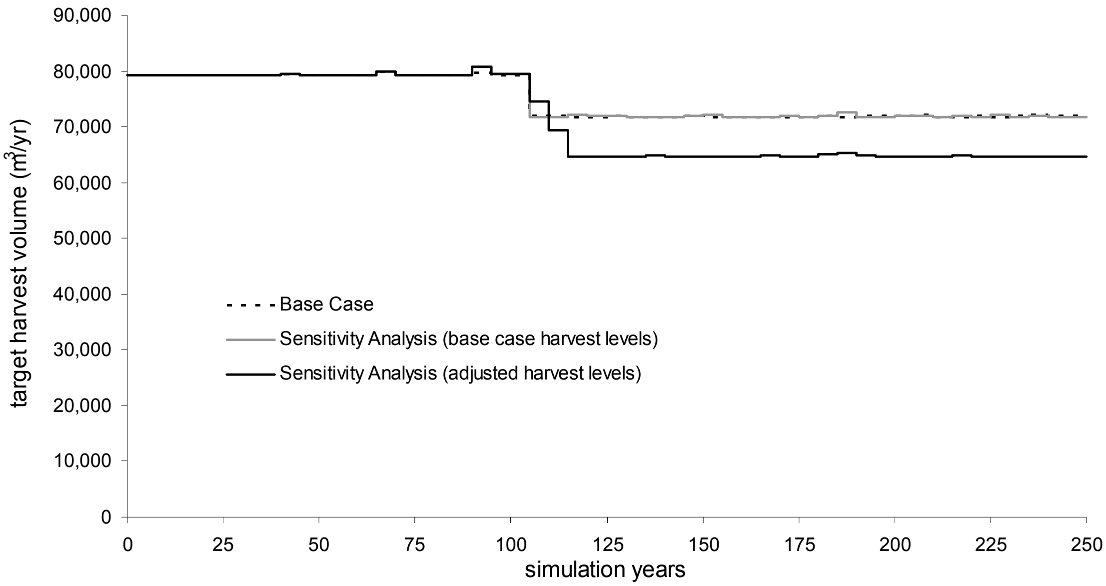


Figure 61: Total harvest forecast – reduce future managed stand yield volumes by 10%.

Figure 62 shows the growing stock graph of the sensitivity analysis. If the base case harvest level is applied, a timber supply crash occurs by the 340th year. By reducing the long-term harvest level by 10% to 65,228 m^3 per year, the growing stock stabilizes after the harvest decline to a level that is approximately 7% below the base case level, on average.

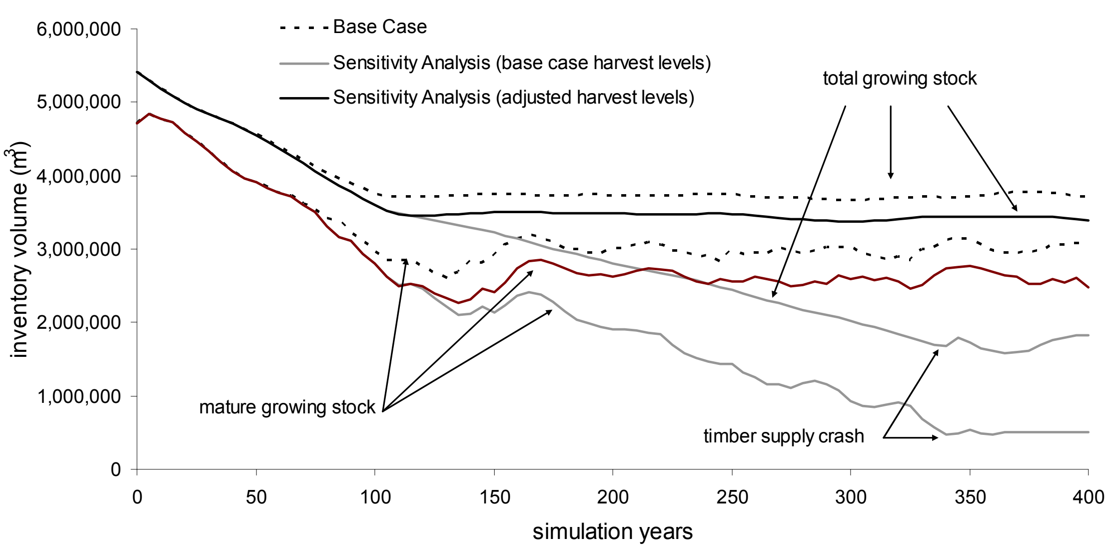


Figure 62: Sensitivity analysis growing stock – reduce future managed stand yield volumes by 10%.

6.4.3 Adjust Genetic Gain to the 2008-2018 Forest Genetics Council Forecast

Sensitivity Analysis

Apply the 2008-2018 genetic worth forecasts provided in the annual report of the Forest Genetics Council (Forest Genetics Council of B.C., 2007) to the future managed stand yield curves.

Rationale

As a result of an on-going tree improvement program, a rational volume increase is expected for stands regenerating from genetically-improved stock. The base case forecast was based on empirical data obtained from the MoFR's Seed Planning and Registry (SPAR) on the genetic worth (GW) and the proportion of Class A seed planted by seed planning unit on TFL3.

The Forest Genetic Council (FGC) expects genetic gains to improve over the next 10 years (Forest Genetics Council of B.C., 2007). Given the uncertainty of future gains, this sensitivity analysis explores the impacts on timber supply of applying the 2018 GW forecasts shown in Section 8.8.1 of the *Information Package.*

Methods

Future managed stand yields were recompiled in TIPSY using the 2018 GW forecasts shown in Table 40 of the *Information Package*. Adjusted analysis unit yield curves were derived in the same manner as the base case. No adjustments were made to the netdown criteria as a result of improved genetic worth. However, minimum harvest ages were adjusted for the revised yield curves to reflect the age where the minimum volume limits were met.

Results and Discussion

If the 2008-2018 GW forecasts from the 2007 Forest Genetics Council annual report are applied, a long-term increase of nearly 6,300 m^3 per year in timber supply is expected. Associated with the increase in the long term harvest level is an 11.5% increase in the overall productivity, expressed here as the LRSY value.

Table 22: Sensitivity analysis summary – adjust the genetic gain in future managed stand yield curves to the 2008-2018 forecasts from the FGC annual report.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	78,797	6,297	8.7%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,324	-5	-0.1%
LRSY (m^3/yr)	76,612	85,459	8,847	11.5%

Figure 63 shows the predicted harvest pattern. The long-term harvest level is only 1.4% lower than the short and medium-term levels when the estimated GW forecasts are applied. There are no changes to the short and medium-term harvest levels.

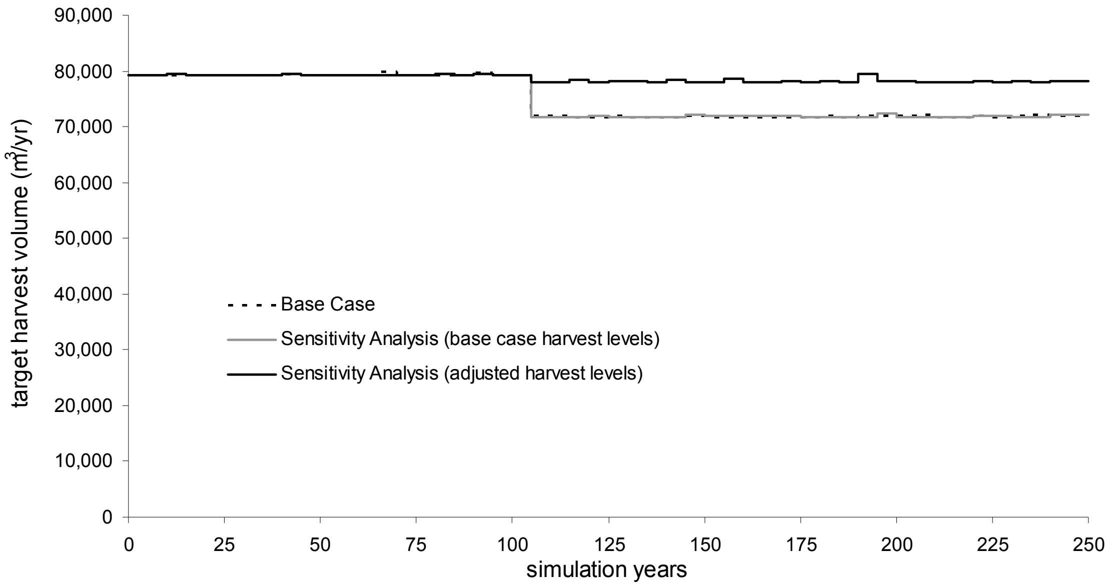


Figure 63: Total harvest forecast – adjust the genetic gain in future managed stand yield curves to the 2008-2018 forecasts from the FGC annual report.

The base case harvest level increases over the long-term (Figure 64). When the adjusted LTHL of 78,797 m^3 per year is applied, a long-term stable growing stock is achieved that is approximately 12% higher than the base case, on average.

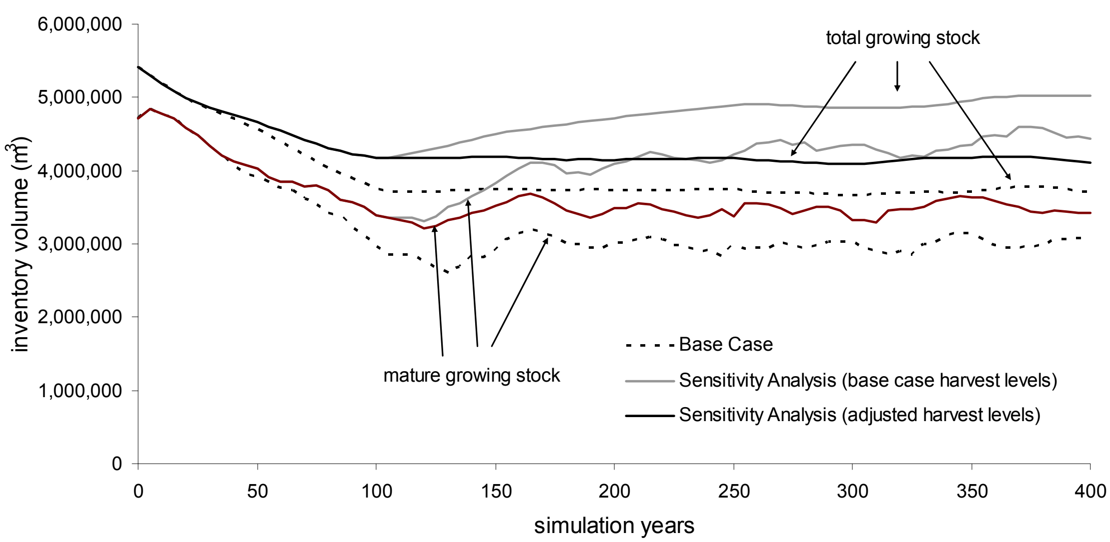


Figure 64: Sensitivity analysis growing stock – adjust the genetic gain in future managed stand yield curves to the 2008-2018 forecasts from the FGC annual report.

6.4.4 Armillaria Root Rot Impacts on Douglas-fir in the ICH Zone.

Sensitivity Analysis

Examine the impacts on timber supply of Armillaria root rot on Douglas-fir in the ICH zone.

Rationale

Armillaria is known to exist on the TFL and has been recorded as an incidence on recent silviculture surveys. However, due to the below ground and often hidden symptoms of the disease, the volume loss has not been quantified explicitly to date. A 2004 study (Stearns-Smith *et al.*, 2004) in the Arrow TSA analysed the impacts of different levels of Armillaria root rot infections on timber supply in the Douglas-fir stands in the ICH. Growth losses were estimated to be 30 ±10% and corresponding volume losses were projected with TASS and incorporated into TIPSY as custom OAFs. As a result of that study, the current version of TIPSY (ver. 4.1) incorporates Armillaria root rot OAFs, although these OAFs are only applied to the Douglas-fir component of stands found within the ICH zone[14]. Given the un-quantified volume losses attributed to Armillaria in TFL3, this sensitivity analysis examines the timber supply impacts of applying three Armillaria severity assumptions (Low, Moderate and High) to regenerated Douglas-fir stands in the ICH zone.

Methods

Managed stand yield tables were recompiled in TIPSY using the three built-in Armillaria OAFs to represent the three severity levels; Low, Moderate and High. Adjusted managed stand analysis unit yield curves were derived in the same manner as in the base case. No adjustments were made to the netdown assumptions when Armillaria OAFs were applied; however, minimum harvest ages were adjusted for each severity level yield curve set to reflect the ages where the minimum volume limits were met.

Three sensitivity analyses were conducted independently, one for each Armillaria severity assumption.

Results and Discussion

Applying the three Armillaria severity assumptions to Douglas-fir stands in the ICH zone impact the long term timber supply to varying degrees (Table 23), If a High severity level of Armillaria root-rot is assumed, the long-term timber supply is reduced by 11,700 m^3 per year, or roughly 16%. There is a corresponding reduction in the overall productivity of the THLB, since the LRSY is 11% lower at 68,218 m^3 per year. The High severity assumption requires a harvest decline that begins in the long-term and occurs over five, 5-year periods at a rate of 5% per period. The total harvest volume achieved over this transition period is 5.1% less than in the base case.

A Low Armillaria severity assumption will have a more modest impact on the long-term timber supply, as the harvest level is only reduced by 5,550 m^3 per year. There is a 6% decline in the productivity of the land base, as the LRSY estimate is 4,577 m^3 per year less than in the base case.

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[14] To date, Armillaria OAFs have only been calibrated in TIPSY for Douglas-fir in the ICH zone. Other than Douglas-fir, other tree species that are susceptible to Armillaria as main host trees include Engelmann spruce, subalpine-fir, western hemlock, western larch, western white pine, lodgepole pine, white spruce, western redcedar and ponderosa pine (Allen *et al.*, 1996). Douglas-fir and balsam are highly susceptible to Armillaria (Government of B.C., 1995c). Other than the IDF zone, at the landscape level, Armillaria is also known to be a high hazard in the ESSF wc1 variant (Government of B.C., 1995c).

The Moderate Armillaria severity assumption falls between the Low and the High levels, but the impacts are closer to the Low incidence level. Under the Moderate assumptions, the long-term harvest level is nearly 11% lower than in the base case at 64,700 m^3 per year. The average productivity, expressed as the LRSY value, is 8.6% lower than that of the base case.

For both the Low and Moderate severity levels, the harvest decline begins at the long-term and occurs over three 5-year periods. The achieved harvest volume is 0.4% less than the base case when assuming a Moderate incidence and 0.7% lower when assuming a Low severity level. Given that Armillaria was modelled to impact the regenerated stands, there are no discernable impacts on the short and medium-term harvest levels or the total achieved harvest volumes for the short and medium-terms under any of the three Armillaria assumptions.

Table 23: Sensitivity analyses summary – assume High, Moderate or Low Armillaria severity.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
High Armillaria	Long-term harvest level (m^3/yr)	72,500	60,800	-11,700	-16.1%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,333	4	0.0%
	Total harvest for periods ending at years 110 to 130 (000's m^3)	1,796	1,704	-92	-5.1%
	LRSY (m^3/yr)	76,612	68,218	-8,393	-11.0%
Moderate Armillaria	Long-term harvest level (m^3/yr)	72,500	64,700	-7,800	-10.8%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,329	0	0.0%
	Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,074	-4	-0.4%
	LRSY (m^3/yr)	76,612	69,989	-6,623	-8.6%
Low Armillaria	Long-term harvest level (m^3/yr)	72,500	66,950	-5,550	-7.7%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,330	1	0.0%
	Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,070	-8	-0.7%
	LRSY (m^3/yr)	76,612	72,035	-4,577	-6.0%

For comparison, the harvest level and growing stock graphs show each Armillaria severity assumption together. In the interest of clarity, only the adjusted harvest levels required to stabilize the growing stock are presented in Figure 65. Only the total growing stock, at the base case and the adjusted harvest levels are shown in Figure 66 for each sensitivity analysis.

The growing stock graphs show a timber supply crash occurring by year 240 under the High severity and by year 320 under the Moderate severity when the base case harvest levels are applied. The base case harvest level can be maintained for the full 400 years under a Low severity assumption; however the growing stock fails to stabilize. If harvest levels are adjusted, the average long-term growing stocks are lower than in the base case by 6% for Low severity, 11% for Moderate severity, and 12% below the base case under the High Armillaria severity assumption. If Armillaria is impacting the growth rates and mortality levels of species other than Douglas-fir stands in the ICH zone, then larger downward pressures on timber supply than those shown here, will likely be had as a result.

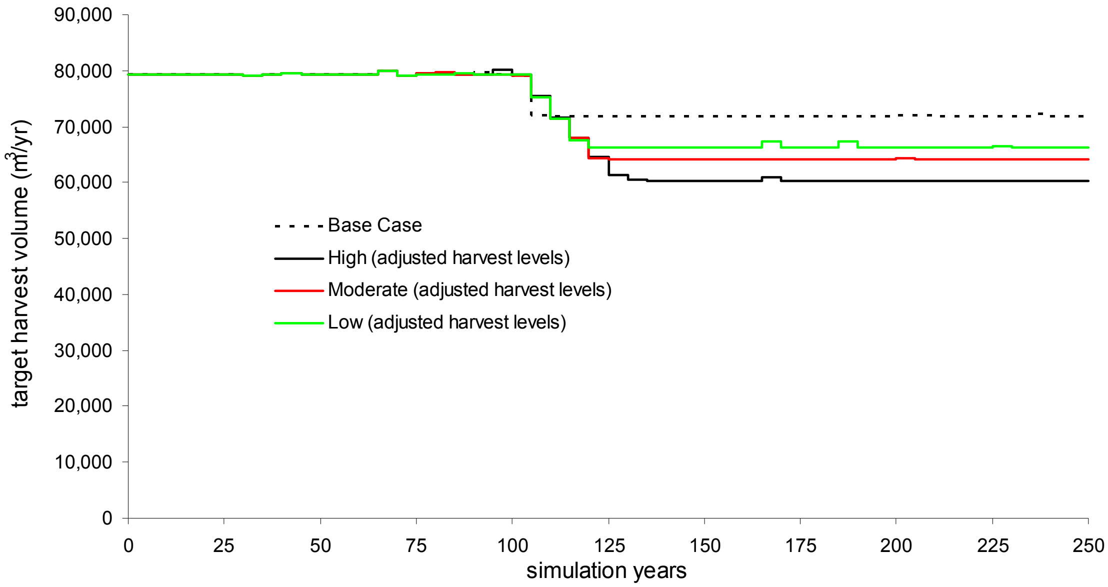

Figure 65: Total harvest forecast – assume High, Moderate or Low Armillaria severity.

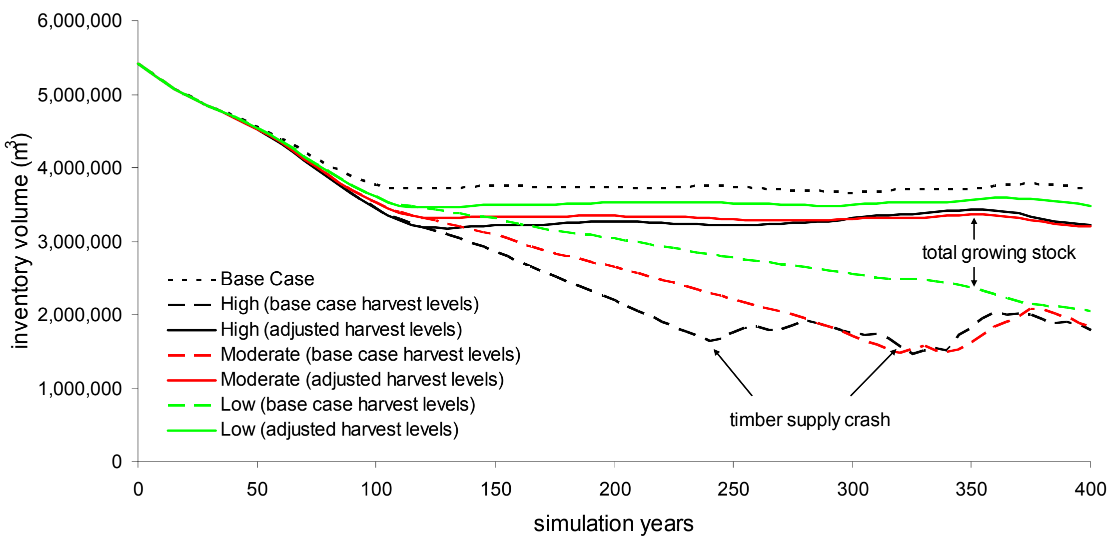

Figure 66: Sensitivity analyses total growing stock – assume High, Moderate or Low Armillaria severity.

6.4.5 Apply the Provincial Mountain Pine Beetle Forecasts

Sensitivity Analysis

Apply the results of the Year 5 BC Mountain Pine Beetle (Walton *et al.,* 2008) attack assumptions to TFL3 and examine the risk to timber supply.

Rationale

Since 2004, the Ministry of Forests and Range, Research Branch has been forecasting the current mountain pine beetle outbreak. Mountain pine beetle attack assumptions for the TFL3 analysis are based on the spatial Year 5 BCMPB results (BCMPB) for the provincial level projection of the attack (Walton *et al.,* 2008). This sensitivity analyses examines the risk to timber supply in TFL3 associated with the current mountain pine beetle outbreak.

Methods

The two main challenges in applying the Provincial BCMPB forecast are incorporating the grid data into the TFL3 resultant and converting the percent killed into percent volume lost using shelf life curves. Section 9.2 of the *Information Package* provides extensive detail as to how the BCMPB results were incorporated into the TFL3 analysis.

Results and Discussion

The mountain pine beetle epidemic does not appear to have any real discernable impact on timber supply (Table 24). There are no adjustments required in the harvest levels and the achieved harvest volume over the short and medium-term portions of the projection are about the same as the base case analysis. The lack of impact is not surprising considering that pine trees susceptible to mountain pine beetle only make up about 10% of the inventory volume (see Table 43 in the *Information Package*).

Table 24: Sensitivity analysis summary – apply the Provincial mountain pine beetle forecasts to TFL3.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,330	1	0.0%

Figure 67 shows the base case harvest level can be maintained throughout the entire projection. The data shown here uses the average loss curve assumptions (i.e., the average shelf-life attributed to logs sorted for lumber and logs sorted for chips). When the analysis was conducted using either lumber or chip loss curves, there was no significant difference in the harvest levels (Figure 67) or the growing stock curves shown in Figure 68.

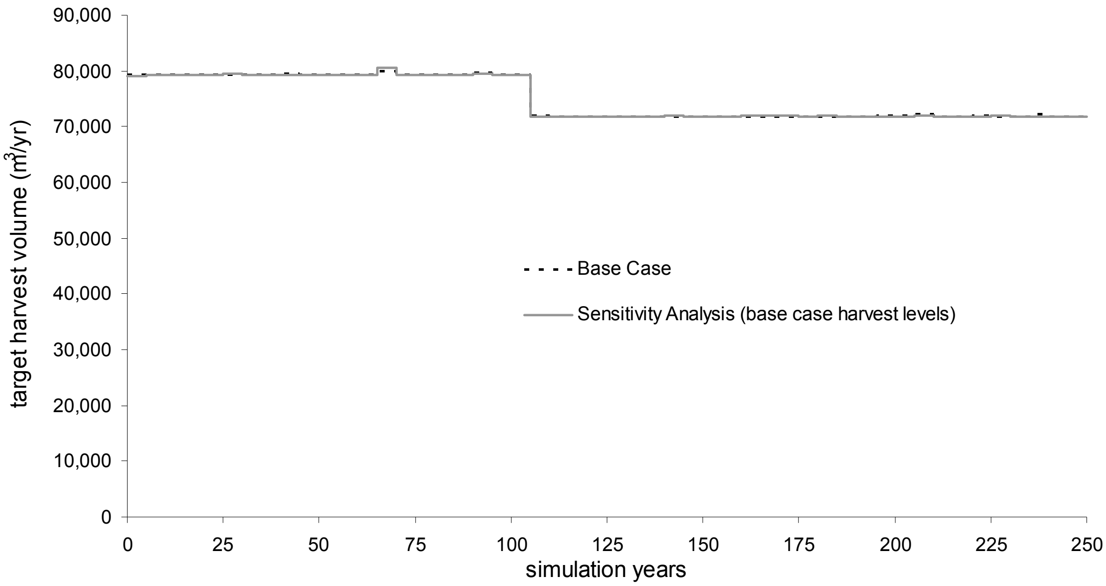

Figure 67: Total harvest forecast – apply the Provincial mountain pine beetle forecasts to TFL3.

The more rapid decline of the growing stock during the short and medium terms and the increasing trend in the growing stock over the long-term is indicative of the decline in the merchantable volume of infected stands as well as stand break-up and subsequent re-establishment of these stands (Figure 68). Eventually the growing stock stabilizes by the last 75 years of the projection, although at a level about 6% lower than that of the base case.

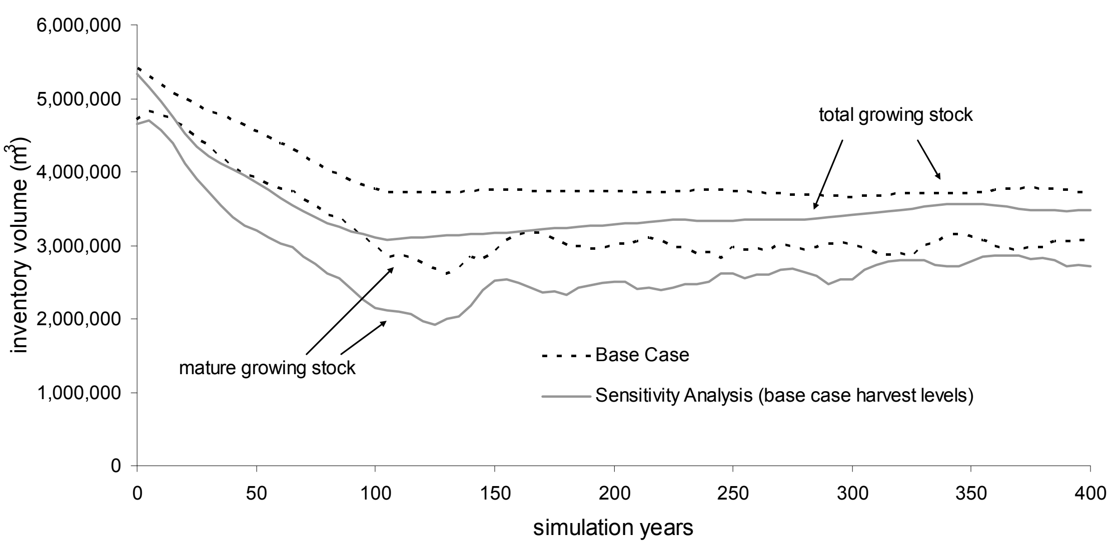

Figure 68: Sensitivity analysis growing stock – apply the Provincial mountain pine beetle forecasts to TFL3.

6.5 Modelling Rules

This section addresses uncertainties and evaluates risk to timber supply of the modelling rules applied in the base case. Typically the discussion around modelling rules involve factors such as when stands are eligible to be harvested, and how the timber supply model prioritizes which stands will be harvested, whether by age, species type, or even proximity to the mill.

In the base case analysis, a 'relative oldest first' rule was used where a stand is prioritized based on a ratio of current age relative to minimum harvest age. In this section, an 'oldest first' rule is examined through a sensitivity analysis.

Minimum harvest ages in the base case were defined as the age where the minimum volume requirement is met. Two sensitivity analyses examine the risks of modifying the minimum harvest age by using the age which 95% of the culmination MAI occurs, and by varying the base case minimum volume ages by $\pm$10 years.

Species types are not prioritized for harvest in the base case, since species priorities tend to change over time due to markets and end uses or due to forest management priorities. The first sensitivity analysis presented here follows on the mountain pine beetle sensitivity analysis discussed in Section 6.4.5 and prioritizes pine leading stands susceptible to mountain pine beetle for harvest.

6.5.1 Prioritize MPB Susceptible Stands for Harvest

Sensitivity Analysis

Following on the sensitivity presented in Section 6.4.5, this sensitivity prioritizes pine leading stands that are more susceptible to beetle kill for harvest in the timber supply model. The results of the Year 5 BC Mountain Pine Beetle (Walton *et al.,* 2008) attack assumptions are applied, as discussed in Section 6.4.5.

Rationale

The BCMPB work models the projected beetle infestation spatially. Infected pine leading stands have a shelf life that is dependent upon the moisture conditions (i.e. dry, moist or wet subzones) and the final product use (i.e. lumber or chips). Prioritizing the susceptible stands where the beetle forecast is more severe and the shelf life is shorter will recover wood volume that may otherwise be lost to mortality.

Methods

The pine leading stands most susceptible to volume loss and eventual break-up were prioritized for harvest. More susceptible stands were identified as those within clusters that showed the most rapid proportionate volume reduction in Figure 3 in Section 9.2.2 of the Information Package. Pine leading stands less susceptible to volume loss were ranked lower in the harvest queue, while unsusceptible stands were not prioritized for harvest at all.

Results and Discussion

Given the results of Section 6.4.5, prioritizing susceptible pine leading stands for harvest while applying the BCMPB assumptions do not have any impacts on timber supply (Table 25 and Figure 69). Adjustments are not required to the harvest levels compared with the base case and the achieved harvest volume over the short and medium-term portions of the projection are about the same as the base case analysis.

Table 25: Sensitivity analysis summary – prioritize pine leading stands most susceptible to MPB for harvest.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,331	2	0.0%

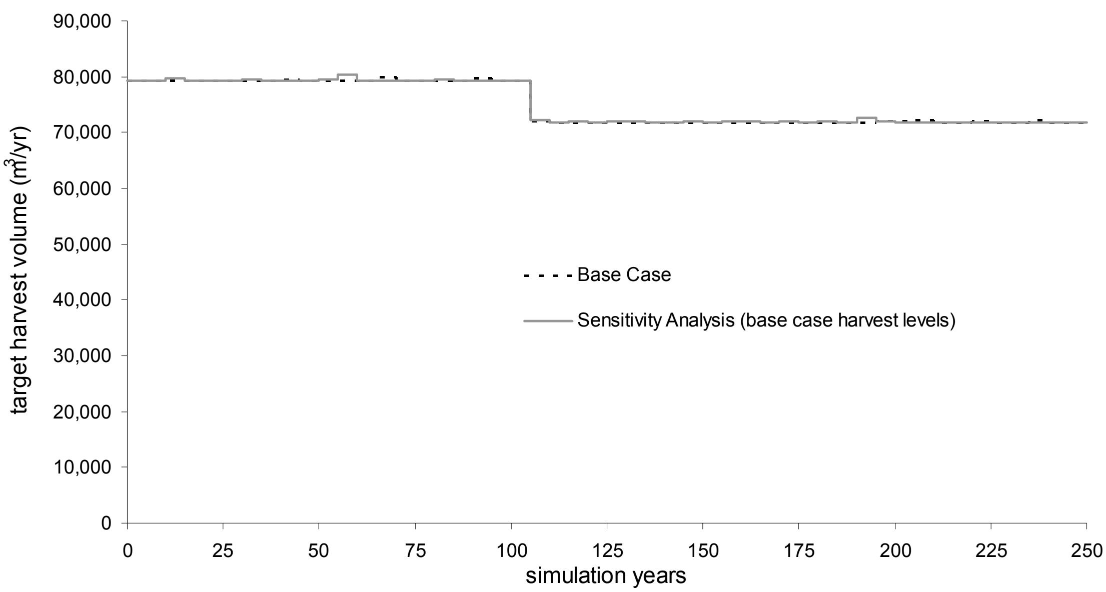

Figure 69: Total harvest forecast – prioritize pine leading stands most susceptible to MPB for harvest.

Figure 70 shows the growing stock for both mountain pine beetle sensitivity analyses; when susceptible pine leading stands are prioritized, and when no species priorities are applied as presented in Section 6.4.5. Under the BCMPB attack assumptions, prioritizing susceptible pine leading stands for harvest increases the growing stock relative to a non-prioritized harvest. The pine priority growing stock shows the same general trend as the non-prioritized growing stock, but the total reduction in growing stock is less when susceptible stands are selected for harvest first. This is due to the fact that more volume from the most susceptible stands is harvested, rather than being lost to mortality. Susceptible stands that are lost to mortality and eventual break-up are assumed to eventually re-establish under their existing natural stand yield assumptions, rather than as more productive managed stands. When susceptible stands are harvested, they are regenerated as future managed stands.

Prioritizing the most susceptible pine stands for harvest eventually results in a stable growing stock over the final 75 years of the projection. The growing stock under a prioritized harvest is about 3.5% lower than the base case, while a non-prioritized harvest is about 6% lower than the base case, on average, over the last 75 years of the projection.

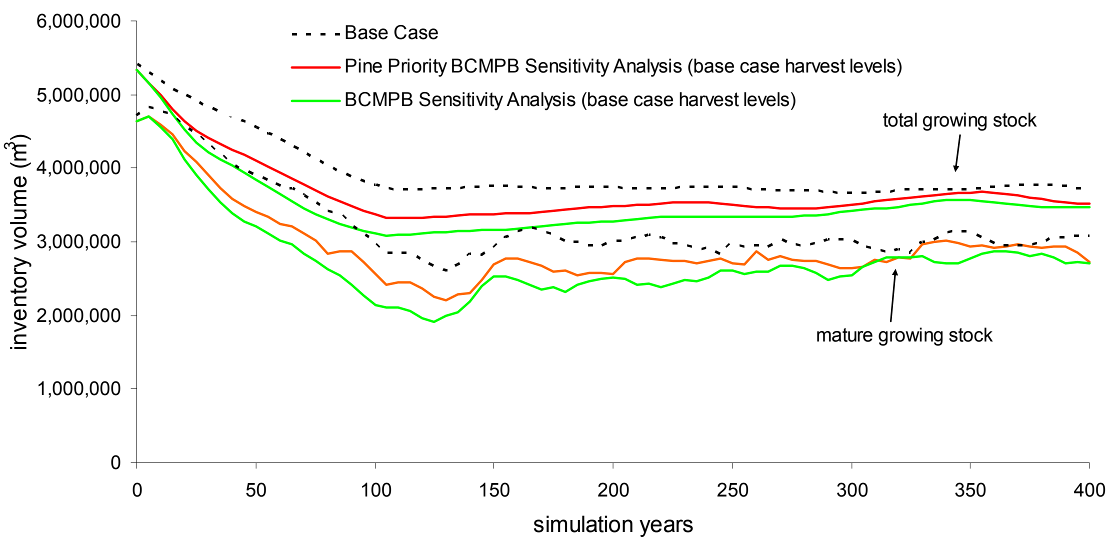

Figure 70: Sensitivity analysis growing stock – prioritize pine leading stands most susceptible to MPB for harvest. The growing stock from the BCMPB sensitivity analysis discussed in Section 6.4.5 is also shown.

6.5.2 Minimum Harvest Age

Sensitivity Analysis

This sensitivity analysis examines the risk to timber supply of varying the minimum harvest age used in the base case. Three minimum harvest age sensitivity analyses are shown for comparison; varying the base case minimum harvest age by ±10 years, and setting the minimum harvest age to the age where 95% of the culmination MAI occurs.

Rationale

Uncertainties typically surround the minimum harvest age assumptions in a timber supply analysis for a number of reasons. Where a land base is tightly constrained and age class gaps exist, minimum harvest ages that are high will result in a short fall in available timber, because there may not be enough eligible and unconstrained volume available. Under the same age class gap and constraint conditions, if the minimum harvest ages are too low then the timber supply model will end up selecting stands for harvest that are further down the priority queue, and may harvest areas stands much before their most productive growth period at the age of culmination MAI. If the actual ages at harvest are lower than the ages of culmination MAI, stands will be harvested with lower yields since the land base is harvested prior to the age where maximum productivity occurs.

If there is a fairly large growing stock of merchantable and available timber much older than the arbitrary minimum harvest age, then the minimum harvest age will likely have little impact on timber supply. Harvest queuing rules, such as the relative oldest first, and modelling to meet various management objectives through forest cover requirements will likely influence the actual age at harvest, shifting it beyond the minimum values.

For the base case analysis, the minimum harvest ages reflect current operational practice in TFL3. Specifically, stands are typically not harvested in the TFL until they meet the minimum volume requirement of 150 m^3/ha on lower slopes and 225 m^3/ha on steeper terrain. The sensitivity analyses presented here provide a relative assessment of the risk to timber supply of the minimum harvest ages used in the base case.

Methods

Three separate sensitivity analyses were conducted. The minimum harvest ages used in the base case were increased by 10 years, decreased by 10 years and, finally set to the age at which 95% of the culmination MAI occurs.

Results and Discussion

Table 26 shows there are no changes required to the harvest levels at any point in the timber supply forecast when the minimum harvest ages are varied by ± 10 years, or when they are set to the age where 95% of the culmination MAI occurs. Figure 71 shows the achieved harvest volumes for all three minimum harvest age sensitivity analyses.

There are no discernable differences to the total growing stock under any of the minimum harvest age sensitivity analyses either (Figure 72). There are significant differences in the mature component of the growing stock; however the mature component is a function of whether or not stands have met or exceeded the minimum harvest age. The mature growing stock does not appear to be limiting timber supply.

It is important to note that setting the minimum harvest ages below the base case values will mean that the minimum volume requirements will be violated if stands are actually harvested at minimum harvest ages in the timber supply model.

Table 26: Sensitivity analyses summary – adjust the minimum harvest age to ±10 years from the base case values or to the age at 95% of culmination MAI.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Plus 10 years	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,327	-2	0.0%
Minus 10 years	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,327	-2	0.0%
Age at 95% of culmination MAI	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,324	-5	-0.1%

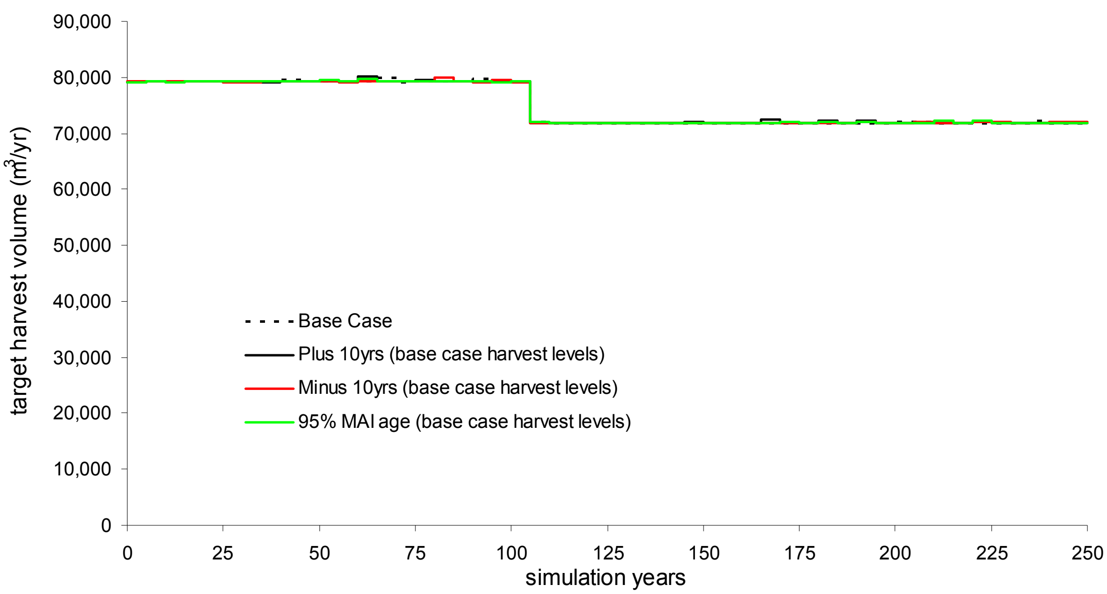

Figure 71: Total harvest forecast – adjust the minimum harvest age to ±10 years from the base case values or to the age at 95% of culmination MAI.

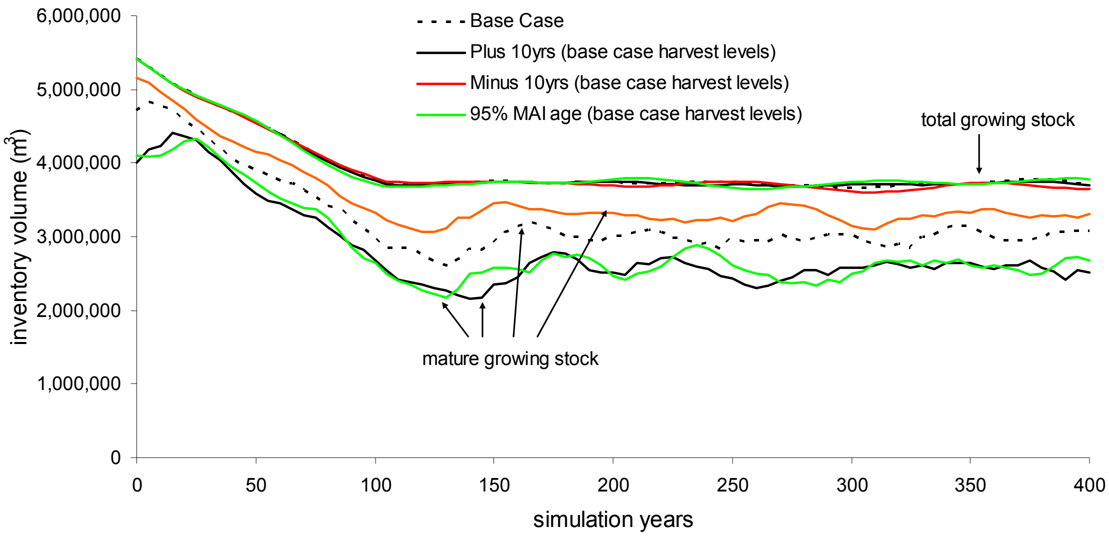

Figure 72: Sensitivity analyses growing stock – adjust the minimum harvest age to ±10 years from the base case values or to the age at 95% of culmination MAI.

The stable total growing stock and the abundant mature component under these scenarios indicate that the base case and minimum harvest ages presented here pose no discernable risk to the sustainability of timber supply in TFL3. Furthermore, the average age at harvest is reasonably similar regardless of the minimum harvest ages shown here, indicating that minimum harvest age is not likely a constraining factor to timber supply (Figure 73).

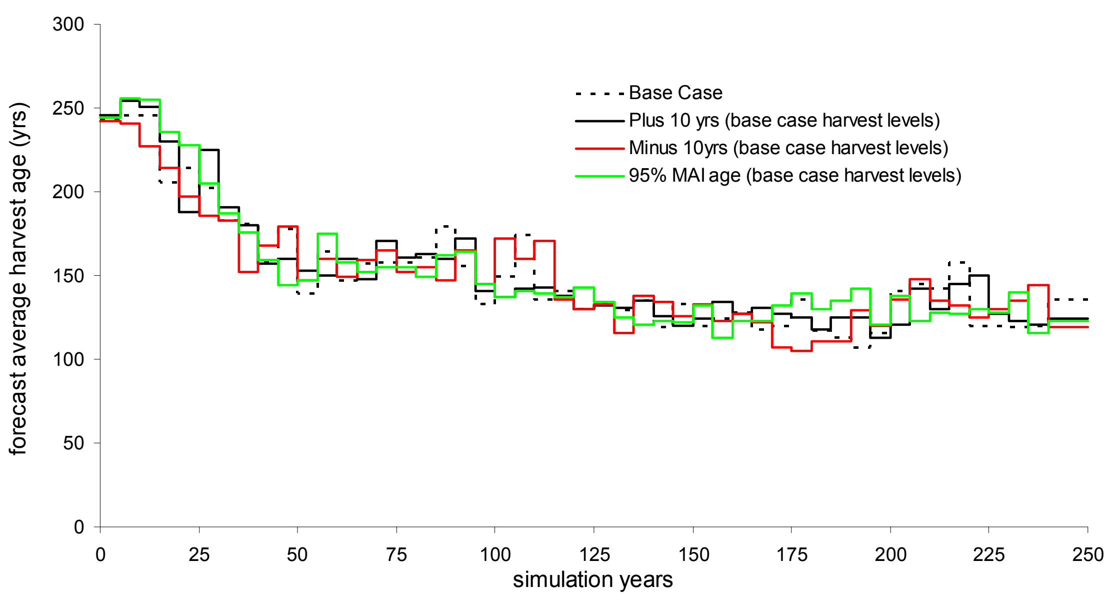

Figure 73: Area weighted average harvest age when the minimum harvest age is ±10 years of the base case values or to the age at 95% of culmination MAI.

6.5.3 Change the Harvest Priority Rule to Oldest First

Sensitivity Analysis

This sensitivity analysis examines the timber supply impacts of the 'relative oldest first' rule as used in the base case, by applying an 'oldest first' rule in this sensitivity analysis.

Rationale

In the base case analysis, the 'relative oldest first' scheduling rule was applied, whereby stands with the largest gap between their current age and their minimum harvest age are prioritized for harvest. This sensitivity analyses applies the timber supply scheduling rule of prioritizing the oldest stands for harvest.

TFL3 that has had a long history of management activities, a somewhat balanced age class distribution, and uses a minimum merchantability criterion to define the eligible harvest age. Under these conditions, a 'relative oldest first' rule will generally tend to prioritize stands for harvest that are older but also more productive. This is due to the inverse relationship with stand productivity and minimum harvest age. Under the assumption of full stand stocking, more productive stands tend to have a lower minimum harvest age when the criterion for setting minimum harvest age is a merchantability attribute like minimum volume or minimum diameter. The least productive areas will have the highest minimum harvest ages, and therefore unless they grow to a very old age, they will tend to be of lower priority on the harvest queue.

Alternatively, an 'oldest first' rule will simply harvest the oldest eligible stands first, regardless of their minimum harvest age and therefore, relative productivity. In a land base with a long history of forest management, an 'oldest first' rule will likely prioritize the less productive areas, since in general, areas with higher productivity will most likely have been harvested once already.

Methods

The timber supply model was set to prioritize oldest stands for harvest first.

Results and Discussion

Applying an 'oldest first' harvest priority rule results in a small 1.7% decrease in the long-term harvest level, indicating that the land base is slightly sensitive to harvest scheduling rules (Table 27). This small difference can only be attributed to scheduling, as the overall productive capacity of the land base is the same for this sensitivity analysis as it is for the base case.

Figure 74 shows the harvest decline begins at the start of the long-term and by year 120, the long term harvest level of 71,250 m^3 per year is met.

Table 27: Sensitivity analysis summary – change the harvest priority rule to 'oldest first'.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	71,250	-1,250	-1.7%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,330	1	0.0%
Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,087	9	0.8%

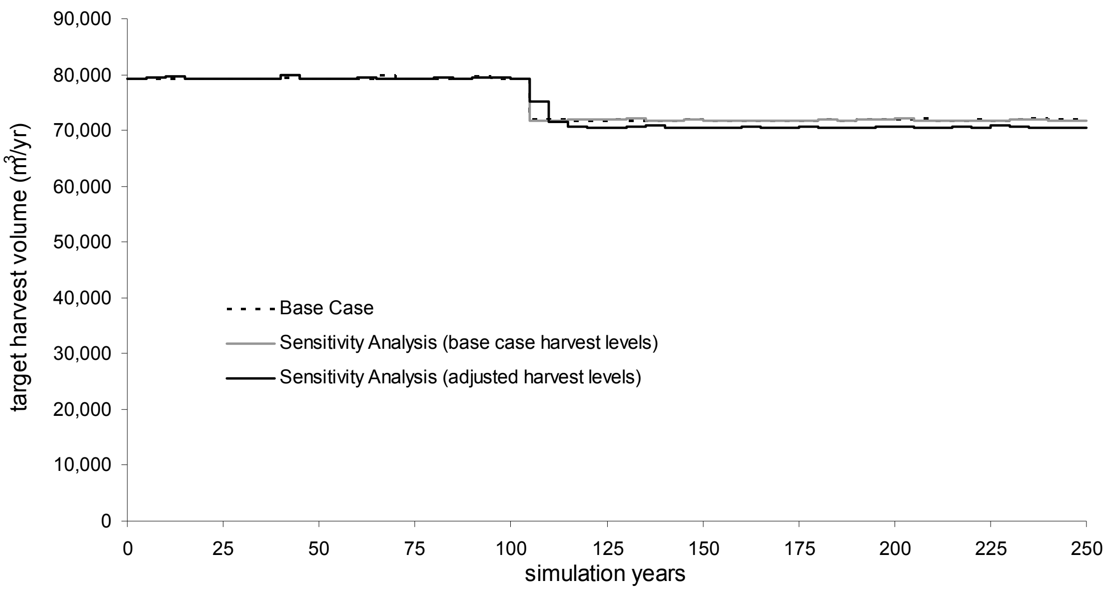

Figure 74: Total harvest forecast – change the harvest priority rule to 'oldest first'.

The total growing stock for the adjusted harvest level is relatively stable, although over the long-term it is about 5% less than in the base case, on average (Figure 75). The mature growing stock is more erratic, relative to the base case.

Figure 76 shows that by prioritizing the oldest stands for harvest first, lower volume stands are selected over the entire short term, during a 15-year interval towards the end of the medium-term, and for a 25-year period in the early long-term. Furthermore, the average yield is also more variable over the late medium-term and early long-term portion of the planning horizon. In the short-term, the average volume per hectare is 49 m^3/ha or 12% less than the base case. After 150 years, the average yield for the sensitivity analysis follows the trend of the base case since natural stands have been converted to managed stands at that time.

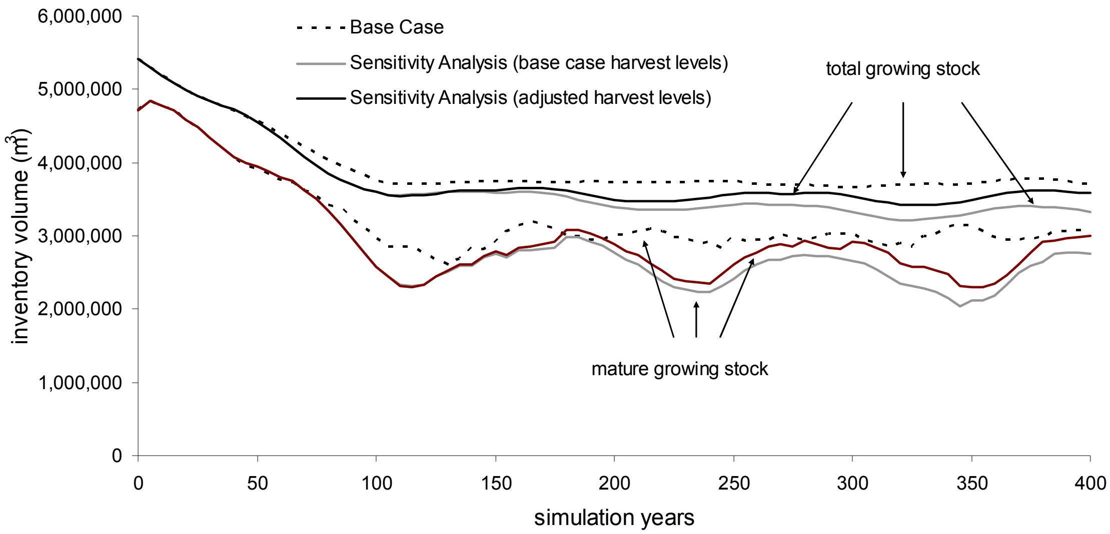

Figure 75: Sensitivity analysis growing stock – change the harvest priority rule to 'oldest first'.

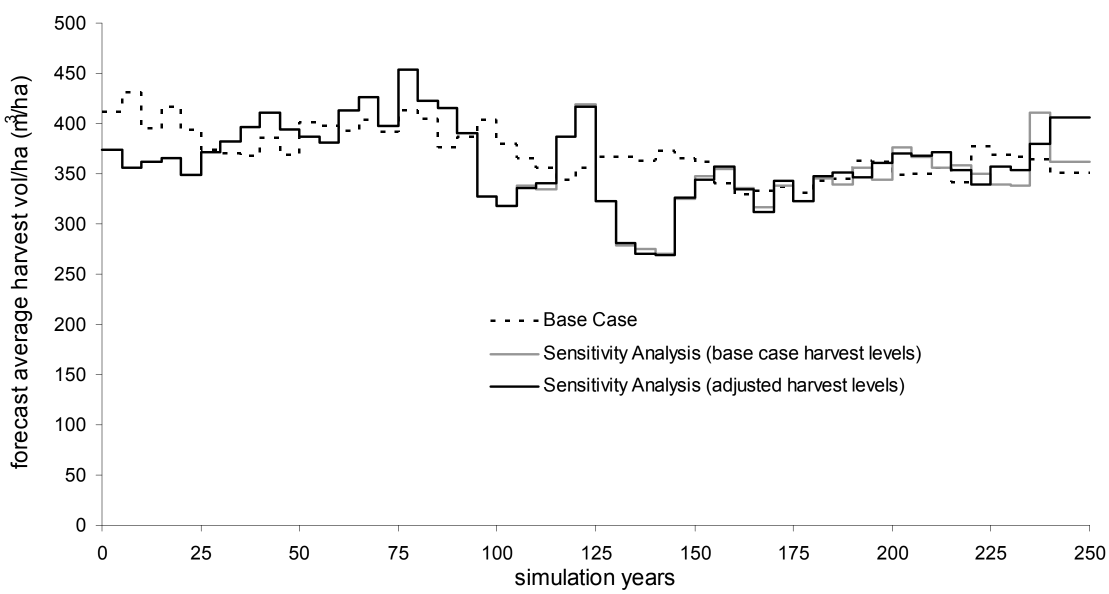

Figure 76: Average harvest volume per hectare for the base case and when the harvest priority rule is changed to 'oldest first'.

6.6 Forest Cover Constraints

Forest cover constraints for visual quality, biodiversity, water quality and wildlife are applied in the base case analysis. The sensitivity analyses presented here examine the uncertainties around the modelling assumptions used for meeting visual quality objectives, and the impact of returning the draft OGMAs to the THLB on timber supply.

6.6.1 Adjust Green-up Height in Visually Sensitive Areas by ±1.5 m.

Sensitivity Analysis

Vary the effective green-up height in visually sensitive areas by ±1.5 m.

Rationale

For the base case analysis, the visually effective green-up (VEG) height was calculated for each visual polygon, using the approach outlined in the B.C. Ministry of Forests (1998b) document *Procedures for Factoring Visual Resources into Timber Supply Analyses* and discussed in more detail in the *Information Package* appended to this report. The calculated VEG height for each visual polygon is highly dependent on the slope.

Given the uncertainties in determining a TRIM derived average slope for each visual polygon, the VEG heights used in the base case are adjusted by ± 1.5 m, to evaluate the impacts on timber supply.

Methods

Two sensitivity analyses were conducted where the base case visually effective green-up heights were increased or decreased by 1.5 m in the timber supply model.

Results and Discussion

Varying the VEG heights by ±1.5 m has no discernable impact on timber supply. As shown in Table 28, there is only a very minor difference in the achieved total short and medium-term harvest volume when VEG heights are increased by 1.5 m.

Table 28: Sensitivity analyses summary – adjust the green-up height in visually sensitive areas by ±1.5 m.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Plus 1.5 m	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,326	-3	0.0%
Minus 1.5 m	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,329	0	0.0%

Figure 77 shows the total achieved harvest when the VEG heights used in the base case are increased or decreased by 1.5m.

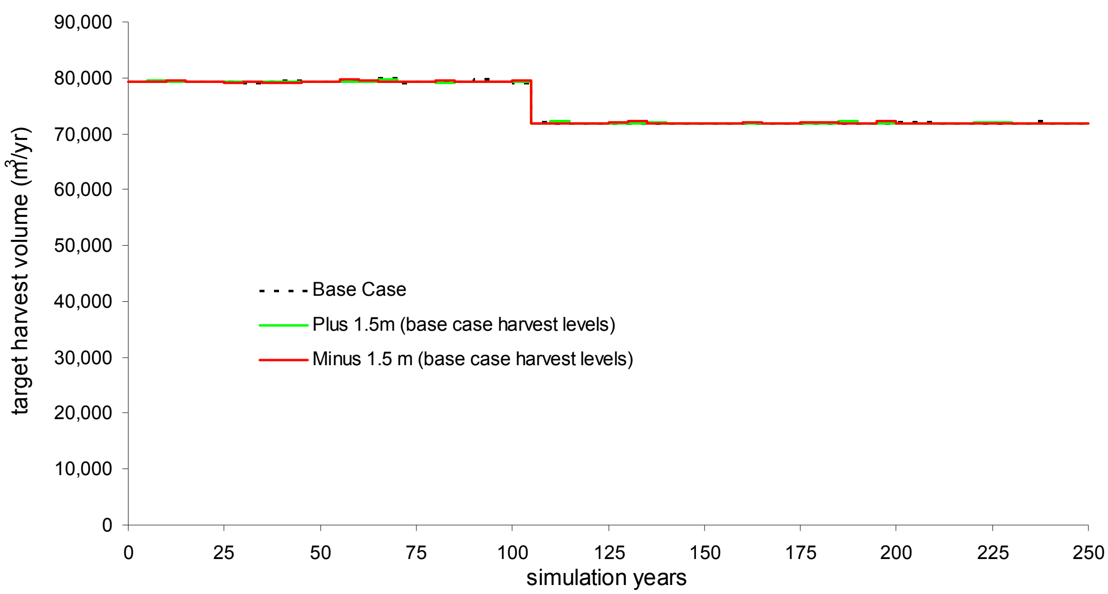

Figure 77: Total harvest forecast – adjust the green-up height in visually sensitive areas by ±1.5 m.

As with the harvest levels, there are no significant differences in the growing stock when the VEG heights are increased or reduced by 1.5 m in visually sensitive areas Figure 78.

Figure 78: Sensitivity analyses growing stock – adjust the green-up height in visually sensitive areas by ±1.5 m.

6.6.2 Adjust the Allowable Disturbance Percent in Visually Sensitive Areas

Sensitivity Analysis

Adjust the allowable disturbance percent in visually sensitive areas to the upper and lower limits of the allowable alteration percent, based on the visual quality objective (VQO) of the visual polygon.

Rationale

In the base case analysis, the allowable alteration limits reflect the visual absorption class (Low, Moderate or High) and the allowable percent alteration limits by VQO class found in Table 3 of the B.C. Ministry of Forests (2003) *Bulletin – Modelling visuals in TSRIII.* Visual polygons with a visual absorption class of Moderate used the midpoint of the allowable alteration percents shown in Table 29, while the Low and High absorption class used the lower and upper limits, respectively.

In February of 1996, the Minister of Forests sent a memo to the Chief Forester suggesting that a new policy be developed in light of the Forest Practices Code in effect at the time, and that "…the new policy should ensure that establishment and administration of visual quality objectives is less restrictive on timber harvesting." (Government of B.C., 1996). Subsequent timber supply analyses (i.e. Arrow TSA) conducted while the Forest Practices Code was still in effect used the maximum allowable disturbance percent[15].

Table 29: Permissible percent alteration ranges for visually sensitive areas (B.C. Ministry of Forests, 2003).

VQO	Permissible % Alteration
Preservation	0
Retention	0 – 1.5
Partial Retention	1.6 – 7.0
Modification	7.1 – 18.0
Maximum Modification	18.1 – 30.0

Methods

Two separate sensitivity analyses were conducted, with the allowable disturbance percents set to the lower and upper permissible % alteration limits shown in Table 29.

Results and Discussion

No impacts were found on timber supply by setting the alteration limits to the highest allowable percent limits for each VQO class. A -2.5% change to the long-term harvest level occurred when the alteration limits were set to the lowest percents by VQO class (Table 30).

[15] See the 2003 Timber Supply Analysis for the Arrow TSA (Timberline Forest Inventory Consultants Ltd. 2004a, and; Timberline Forest Inventory Consultants Ltd. 2004b)

Table 30: Sensitivity analyses summary – adjust the allowable alteration percents to the upper and lower limits by VQO class shown in Table 29.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
High Alteration % Limit	Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,331	2	0.0%
Low Alteration % Limit	Long-term harvest level (m^3/yr)	72,500	70,682	-1,818	-2.5%
	Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,326	-3	0.0%
	Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,085	7	0.6%

The adjusted long-term harvest level under the low alteration limits shows a decline at 5% per 5 year period beginning in the long-term (Figure 79). In order to meet the forest cover targets for the lower alteration levels, the long term harvest level is set to 70,682 m^3 per year.

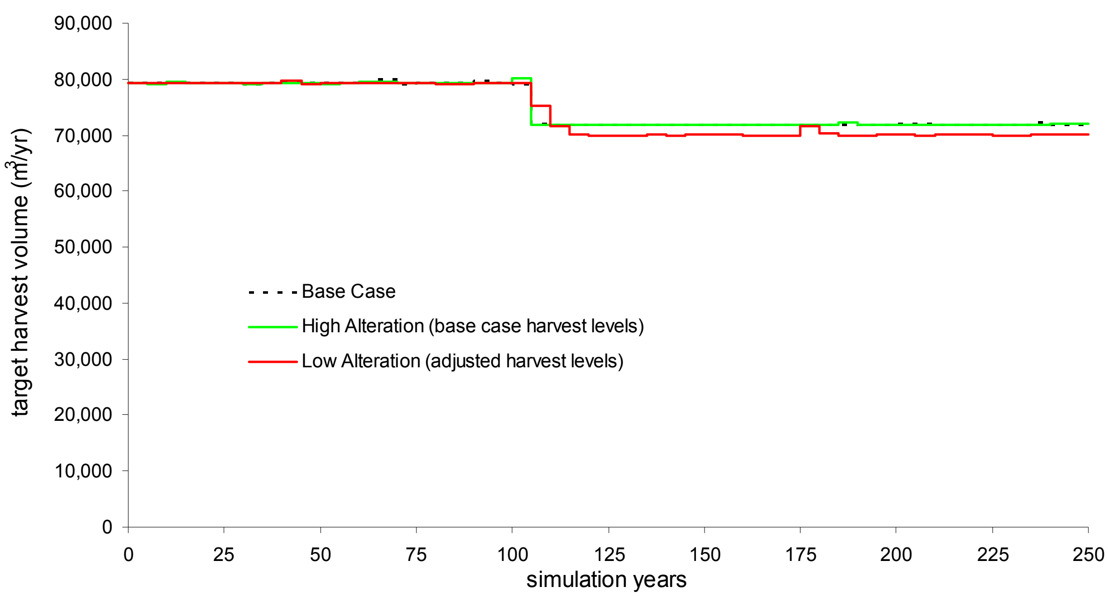

Figure 79: Total harvest forecast – adjust the allowable alteration percents to the upper and lower limits in visually sensitive areas. The base case harvest level for the low alteration is not shown.

An adjusted harvest level is required to stabilize the growing stock when the alteration percents are set to their lower limits (Figure 80). Harvest level changes are not required when the allowable disturbance percents are at the highest level.

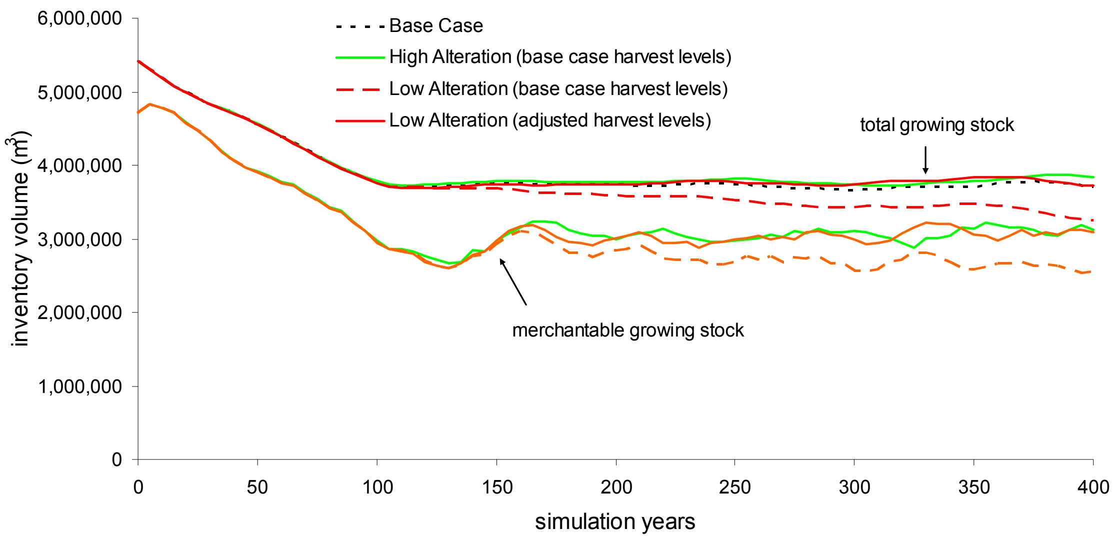

Figure 80: Sensitivity analyses growing stock – adjust the allowable alteration percents to the upper and lower limits in visually sensitive areas.

6.6.3 Return the Draft OGMAs to the THLB

Sensitivity Analysis

This sensitivity analysis examines the impacts on timber supply if the draft OGMAs are returned to the THLB and the non-spatial old seral targets are applied instead.

An additional sensitivity analysis was conducted where the Valhalla Park inventory data was included in the non-contributing portion of the Hoder Landscape Unit. Connectivity corridors are not modelled in this sensitivity analysis, but are examined in Section 6.6.4.

Rationale

Although Springer Creek Forest Products has agreed to the identified draft OGMAs, they have not been formally established to date.

Methods

The THLB was recalculated using the netdown procedure under the assumption that draft OGMAs were not removed from the THLB. Otherwise ineligible portions of the OGMAs were removed due to other netdown criteria.

Under a separate sensitivity analysis, the VRI data for Valhalla Park was included in the modelling database to examine the impacts of allowing the park to contribute to old seral targets in the Hoder Landscape Unit.

Results and Discussion

Managing for old seral targets non-spatially and the returning the draft OGMAs to the harvestable land base increased the existing THLB by 4.2% to 28,738 ha (Table 31). A corresponding increase of 3.5% in the LRSY was also found in comparison to the base case.

Table 31: Land base summary statistics – return the draft OGMAs to the THLB.

	Base Case	Sensitivity Analysis	Change	% Change
Current THLB (ha)	27,587	28,738	1,151	4.2%
Future THLB (ha)	26,214	27,344	1,130	4.3%
Current THLB Inventory Volume (000's m^3)	5,410	5,812	403	7.4%
LRSY (m^3/yr)	76,612	79,296	2,684	3.5%

Returning the draft OGMAs to the THLB increases the short and medium-term harvest levels by 7% to 85,600 m^3 per year, while the long-term harvest level increased 4.6% to 75,800 m^3 per year. The total achieved volume over the short and medium-term periods is 6.9% higher than the base case analysis (Table 32).

Valhalla Park is found in the northern portion of the Hoder Landscape Unit, while the southern portion of the Hoder Landscape Unit is managed under TFL3. If the forested portion of Valhalla Park is considered when modelling the old seral objectives in the Hoder Landscape Unit, the NHLB increases to 46,101 ha. Including the Valhalla Park contribution to the non-spatial old seral targets makes no discernable difference to the achieved harvest levels (Figure 81) or to the total growing stock projections Figure 82.

Table 32: Sensitivity analyses summary – return the draft OGMAs to the THLB.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Return OGMAs	Long-term harvest level (m^3/yr)	72,500	75,800	3,300	4.6%
	Medium-term harvest level (m^3/yr)	80,000	85,600	5,600	7.0%
	Short-term harvest level (m^3/yr)	80,000	85,600	5,600	7.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,906	577	6.9%
	Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,161	83	7.7%
Return OGMAs & include Valhalla Park	Long-term harvest level (m^3/yr)	72,500	75,800	3,300	4.6%
	Medium-term harvest level (m^3/yr)	80,000	85,600	5,600	7.0%
	Short-term harvest level (m^3/yr)	80,000	85,600	5,600	7.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,905	576	6.9%
	Total harvest for periods ending at years 110 to 120 (000's m^3)	1,078	1,162	84	7.8%

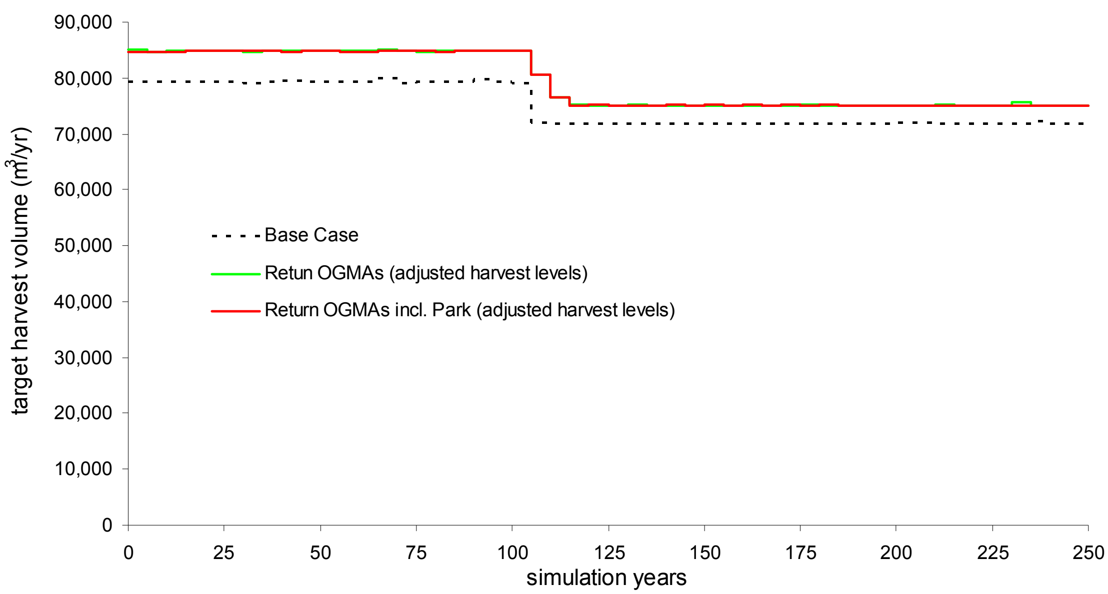

Figure 81: Total harvest forecast – return the draft OGMAs to the THLB.

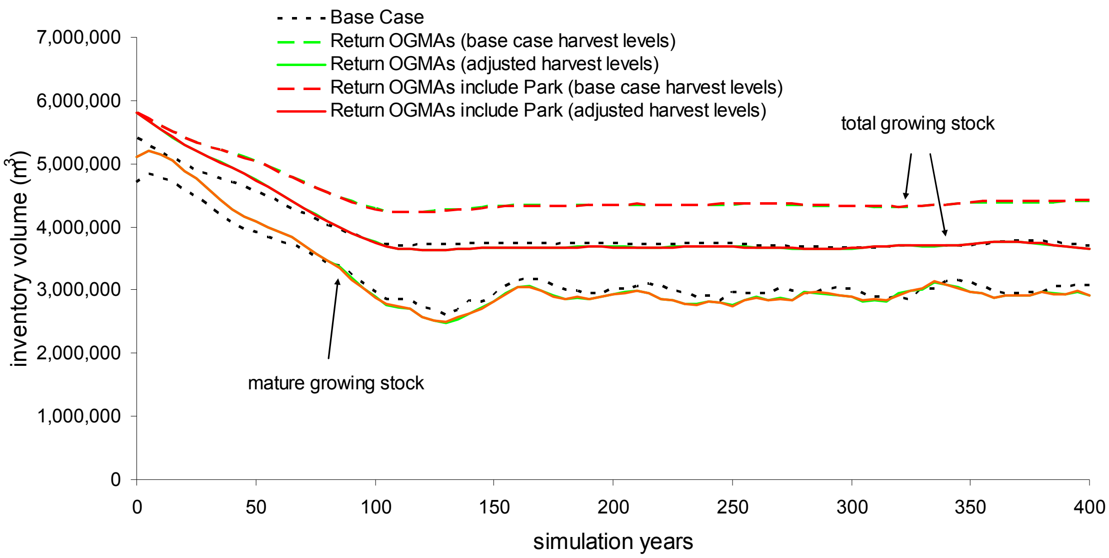

Figure 82: Sensitivity analyses growing stock – return the draft OGMAs to the THLB. Mature growing stocks for the sensitivity analyses at the base case harvest levels are not shown.

In practice, old seral targets are set and monitored at the BEC variant level within each Landscape Unit. For modelling purposes, the seral targets are set for the forested area within the Landscape Unit, making an implicit assumption that the seral objectives are equally distributed across management units (i.e. a TFL and a TSA) in the same Landscape Unit. This assumption may not adequately reflect reality, however. Where multiple management units are in a Landscape Unit, the non-spatial targets may be deficient in one particular management unit, more than adequate in other management units, and on average, meet the target objectives for the BEC variant within the Landscape Unit. Unless Landscape Units are modelled entirely without regard to the management unit type, the non-spatial seral targets may be either poorly or alternatively, overrepresented in one or more management units.

When the old seral non-spatial targets are applied in these two sensitivity analyses, timber supply is constrained in all BEC variants of the Perry Landscape Unit. The only exception in the Perry LU is the ICHdw1 variant, or Natural Disturbance Type 3 (NDT3). Figure 83 shows the old seral targets for the BEC variants in the Perry LU. Timber supply is constrained in the Perry LU for the first 165 years in the variants within the NDT1 and NDT2 areas. A shortfall in the old seral targets is also found for the first 25 years in the ESSFwc1 variant, for the first 100 years of the ESSFwc4 variant, and for the first 90 years in the ICHmw2. Much of the old seral area in the NDT1 and NDT2 is coming from the THLB in this sensitivity analysis; area that otherwise would have been removed from the THLB as draft OGMAs or not accounted for proportionately as a non-spatial target within the TFL3 management unit.

There are no target shortfalls and timber supply is not binding in any of the natural disturbance types within the Hoder or Koch Landscape Units when non-spatial targets are applied. Furthermore, there does not appear to be a significant difference in the proportion of old growth areas compared with the base case when the OGMAs are returned to the THLB. The increased harvest volume appears to be a function of greater flexibility awarded by the non-spatial targets.

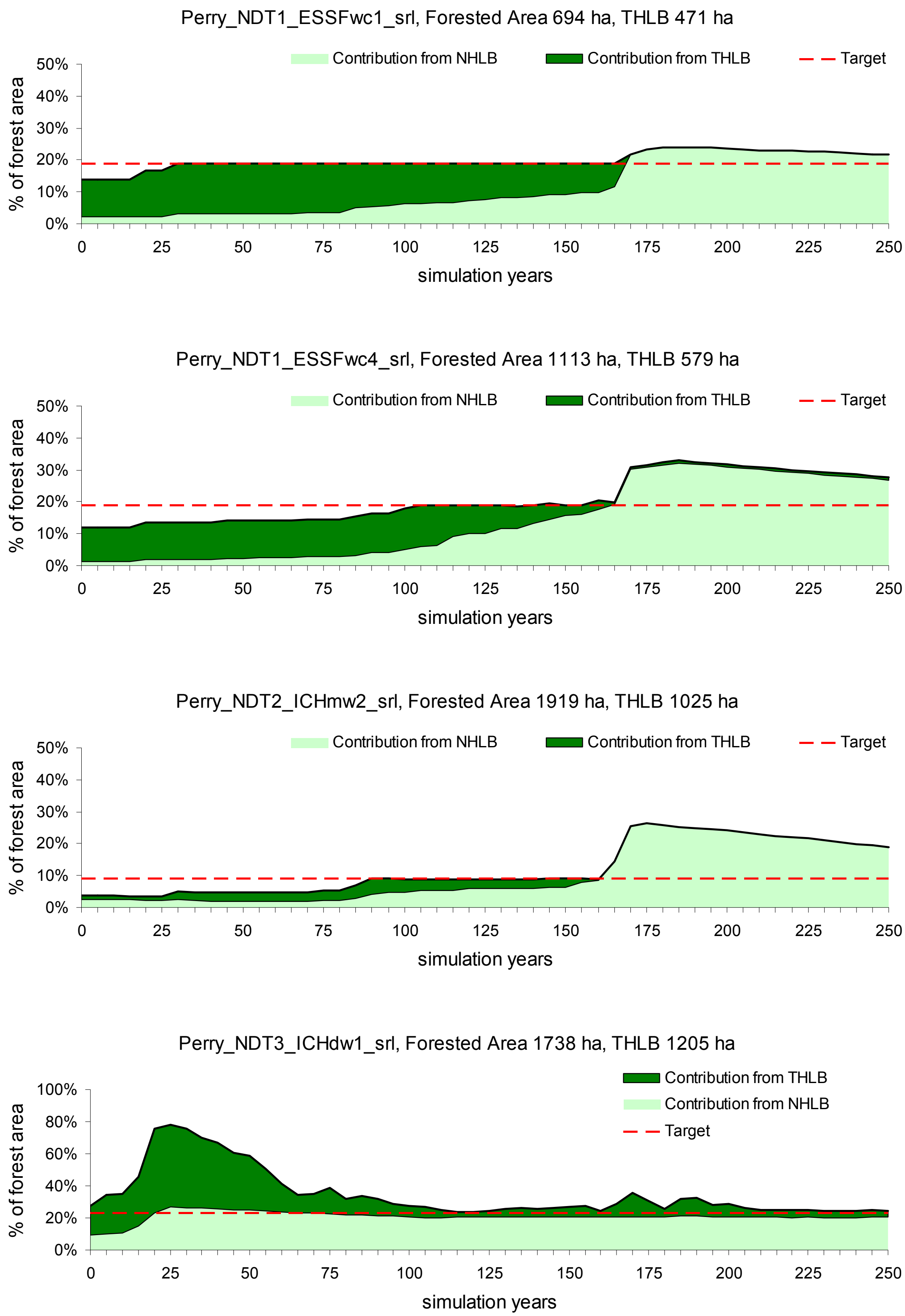

Figure 83: Old seral targets for the BEC variants in the Perry Landscape Unit.

Valhalla Park Contribution

When the Valhalla Park contribution to old seral targets is considered, there is a shortfall in meeting the 2/3rd drawdown target in the ESSFwc4 variant in the Hoder LU for the first 20 years. This is counterintuitive, but an explanation lies with the fact that about 944 ha or 17% of the park forested area in the ESSFwc4 variant will have met the 250 year old seral target age after 20 years.

The short-term old seral target deficiency in the Hoder ESSFwc4 variant does not impact timber supply as there was no discernable difference in the harvest levels or growing stock when Valhalla Park was included in the NHLB.

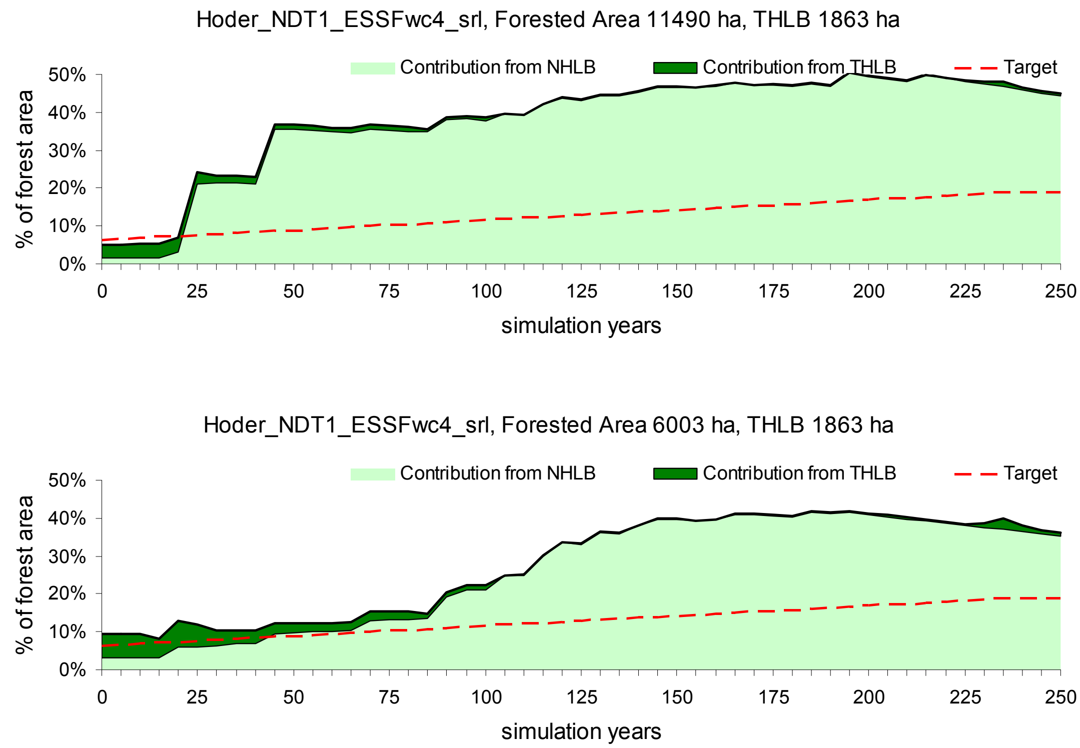

Figure 84: Old seral targets for the Hoder ESSFwc4 variant when draft OGMAs are returned to the THLB. Old seral targets when Valhalla Park is included in the NHLB are shown in the top panel.

6.6.4 Return the Draft OGMAs to the THLB and Apply Connectivity Corridors

Sensitivity Analysis

Following the sensitivity analyses presented in the Section 6.6.3, sensitivity analyses shown here examine the impacts on timber supply of targeting the old seral objectives to occur in the connectivity corridors, as per Objective 5(6) of the *KBHLP Order*.

Rationale

Objective 5(6) of the *KBHLP Order* states that old seral targets *should* be used to meet the connectivity corridor objectives, with protected areas first contributing to the old seral area targets.

Connectivity corridors add a further degree of complexity to the non-spatial old seral target objectives, simply because they specify where the old seral targets should occur within the BEC variants of the Landscape Unit.

Methods

Draft OGMAs were returned to the THLB and a separate sensitivity analysis was conducted to evaluate the Valhalla Park contribution to old seral objectives in the Hoder Landscape Unit, using the methods described in Section 6.6.3.

Proportional targets were set for connectivity corridors based on the old seral targets for each Landscape Unit and BEC variant combination and the eligible[16] connectivity corridor area. For example, if the forest area of a given Landscape Unit and BEC variant is 1,000 ha and the old seral target is 19%, then the target old seral area is 190 ha. If 400 ha of the same LU and BEC variant consist of an eligible connectivity corridor, then the target old seral area for the connectivity corridor portion is 190/400 or 47.5%. When connectivity corridors are modelled, at least two forest cover objective are carried in the timber supply model; one for old seral targets for the entire forested area within the Landscape Unit and BEC variant (e.g. 19%) and one for the connectivity corridor specifically (e.g. 47.5%). By setting the old seral target for the connectivity corridor in this manner, a greater emphasis is placed on the connectivity corridors for meeting the old seral objectives.

Results and Discussion

The land base statistics for these sensitivity analyses are the same as the values shown in Table 31, above.

Returning the draft OGMAs to the THLB and applying the connectivity corridors results in a 4% increase to both the short and medium-term harvest levels, whether or not the Valhalla Park old seral contribution is considered (Table 33). Under either scenario, the decline to the long-term harvest level occurs 5 years earlier than in the base case.

When the old seral contribution of Valhalla Park is accounted for in the Hoder Landscape Unit, the long-term harvest level is only 2.5% lower than the base case. When the park contribution is not considered, there is a 5% decrease in the long-term harvest level. Figure 85 shows the achieved harvest levels for these two sensitivity analyses.

[16] Only forested slopes ≤80% contributes to the connectivity component in the corridor.

Table 33: Sensitivity analyses summary – return the draft OGMAs to the THLB and apply connectivity corridors.

Sensitivity Analysis	Attribute	Base Case	Sensitivity Analysis	Change	% Change
Return OGMAs & apply connectivity corridors	Long-term harvest level (m^3/yr)	72,500	68,875	-3,625	-5.0%
	Medium-term harvest level (m^3/yr)	80,000	83,200	3,200	4.0%
	Short-term harvest level (m^3/yr)	80,000	83,200	3,200	4.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,651	322	3.9%
	Total harvest for periods ending at years 105 to 115 (000's m^3)	1,115	1,118	3	0.3%
Return OGMAs, include Valhalla Park & apply connectivity corridors	Long-term harvest level (m^3/yr)	72,500	70,683	-1,817	-2.5%
	Medium-term harvest level (m^3/yr)	80,000	83,200	3,200	4.0%
	Short-term harvest level (m^3/yr)	80,000	83,200	3,200	4.0%
	Total short/medium-term harvest (000's m^3)	8,329	8,640	311	3.7%
	Total harvest for periods ending at years 105 to 115 (000's m^3)	1,115	1,118	3	0.3%

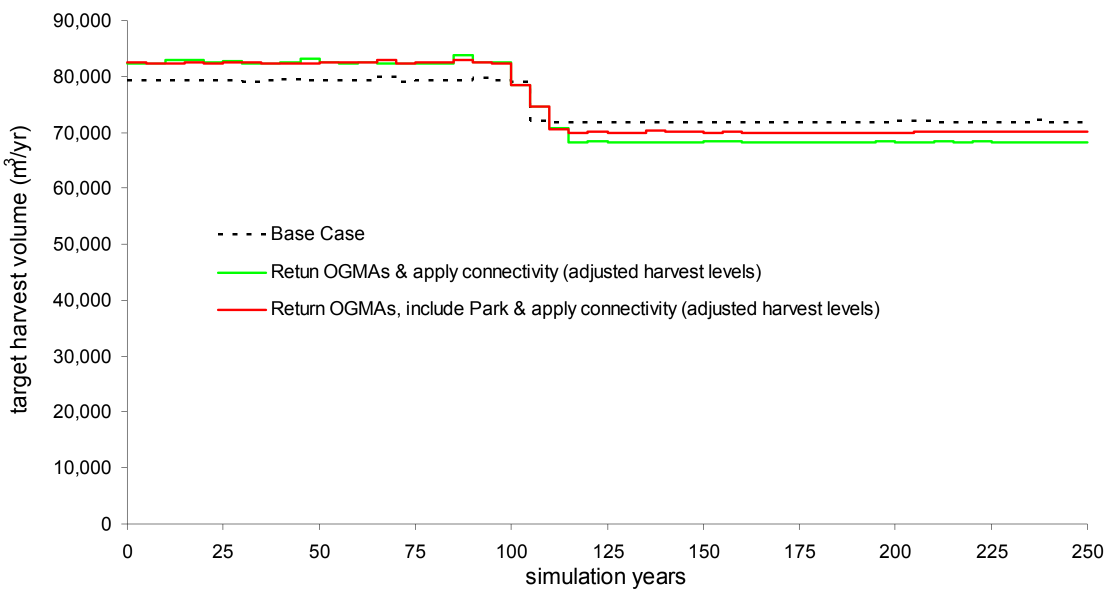

Figure 85: Total harvest forecast when the draft OGMAs are returned to the THLB and connectivity corridors are applied. Base case harvest levels for the sensitivity analyses are not shown

The initial growing stock is higher than that of the base case, since areas encompassed by the draft OGMAs are now included the THLB in these sensitivity analyses. Note that they are managed under forest cover constraints (Figure 86).

While the base case harvest levels could be met for the entire projection under either scenario (not shown in Figure 85), the growing stock declines over the long-term (Figure 86). The decline is less rapid when the old seral areas in Valhalla Park are considered under the base case harvest levels. By adjusting the harvest levels, a stable growing stock occurs.

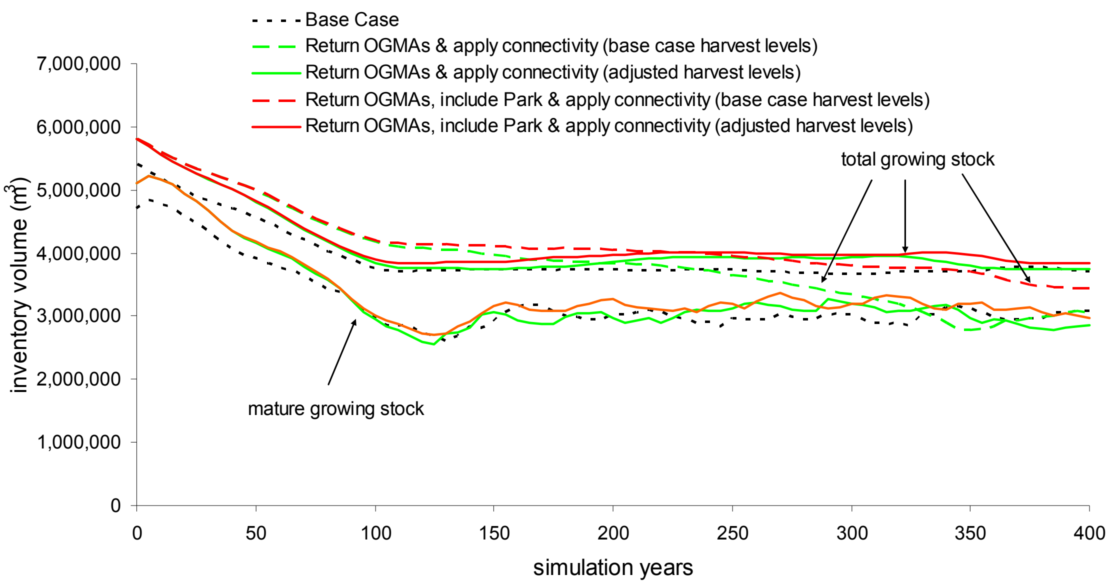

Figure 86: Sensitivity analyses growing stock – return the draft OGMAs to the THLB and apply the connectivity corridors. Mature growing stocks for the sensitivity analyses at the base case harvest levels are not shown.

The connectivity corridors appear to constrain timber supply by varying degrees in all BEC variants found in the Hoder, Koch and Perry Landscape Units. In some cases, the connectivity corridor targets are never achievable.

There is a shortfall in old seral areas within connectivity corridors in the Perry Landscape Unit during the short-term in the ESSFwc1 and the ICHdw1 variants, and throughout most of the short and medium-term in the ESSFwc4 and ICHmw2. In the Perry LU, timber supply is constrained in the variants found in NDT1 and NDT2 for approximately the first 165 years. In the ICHdw1 variant found in NDT3, timber supply is constrained for the first 55 years and for the 5-year periods ending between 210 and 230.

Timber supply is constrained in all variants in the Koch Landscape unit over all periods of the projection due to the connectivity corridors, and for the two ESSF variants found in NDT1 there is a shortfall in old seral area in connectivity corridors throughout the entire projection. Figure 87 presents a sample of the relationship between old seral targets as applied to the Koch Landscape Unit in the ESSFwc4 variant and as applied to connectivity corridors.

The top panel in Figure 87 shows that throughout the timber supply projection the old seral targets are met for the Koch ESSFwc4 variant. Although an initial 2/3rd drawdown to 6.3% is applied at the start of the projection, after 240 years, the full biodiversity targets of 19% are achieved. Conversely, the connectivity corridor targets are never achieved in the Koch ESSFwc4 variant (bottom panel of Figure 87). Further examination determined that the failure to achieve the old seral targets was a result of two factors: an existing deficiency in the proportion of old seral stands in this variant in the short-term, and; to the randomly assigned natural disturbance that is modelled in the non-harvestable land base. When the natural disturbance and harvesting is turned off, the old seral targets are eventually met by 145 years into the forecast (Figure 88).

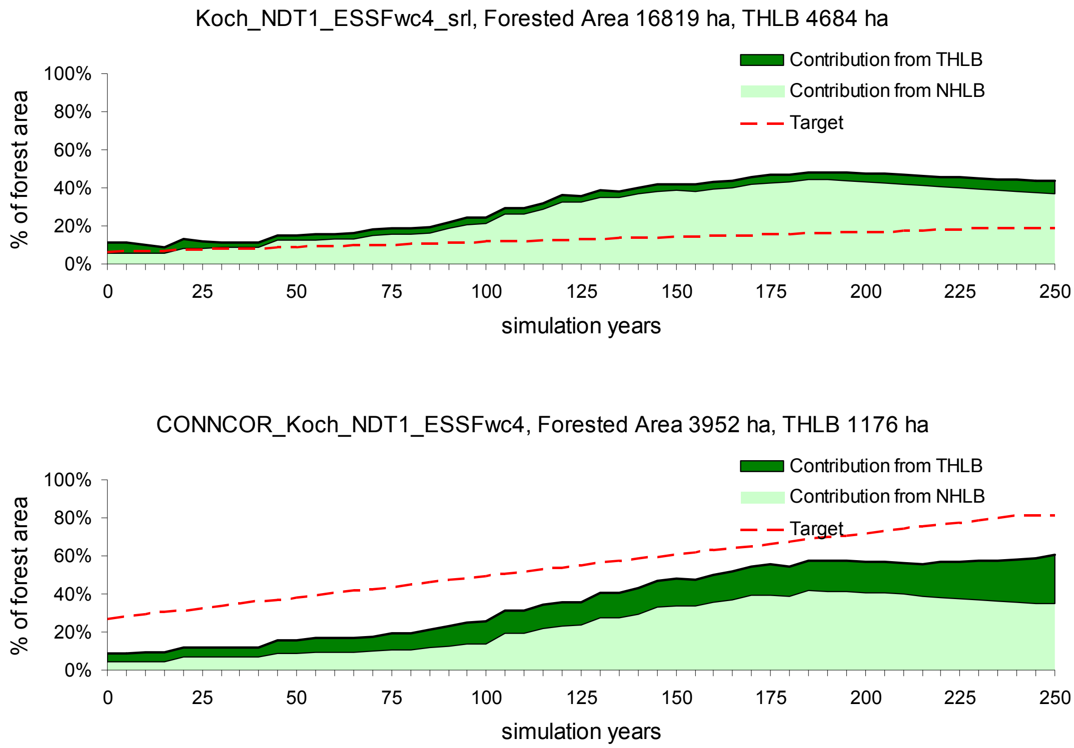

Figure 87: Old seral targets for the Koch ESSFwc4 variant (top panel) and the connectivity corridor areas within the same variant (bottom panel).

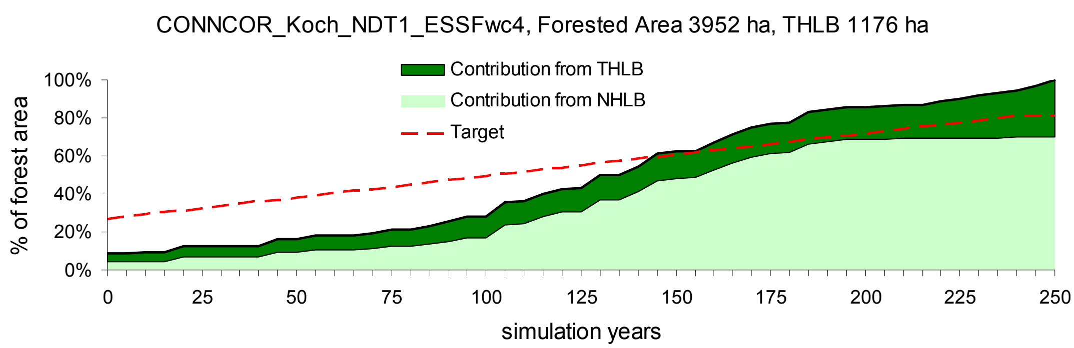

Figure 88: Old seral targets for the connectivity corridor targets in the Koch ESSFwc4 variant when natural disturbance and harvesting is not modelled.

As with the old seral targets, in practice the connectivity corridor targets are set and monitored at the BEC variant level within each Landscape Unit, despite areas within a Landscape Units being managed under more than one management unit (i.e. a TFL and a TSA). For modelling, the implicit assumption that seral objectives are equally distributed across management units may also be the cause of landscape connectivity being unachievable in some variants. This can be demonstrated with the sensitivity analysis where Valhalla Park is included in the non-harvestable land base for the Hoder Landscape Unit.

Valhalla Park

Figure 89 shows the connectivity corridor old seral targets for the Hoder ESSFwc1 variant when Valhalla Park is considered (top panel) and when only the TFL3 portion of the connectivity corridors are accounted for (bottom panel). When only the TFL3 portion is considered, both ESSF subzones (the ESSFwc1 variant is shown in Figure 89) are constrained from harvest for the entire timber supply projection.

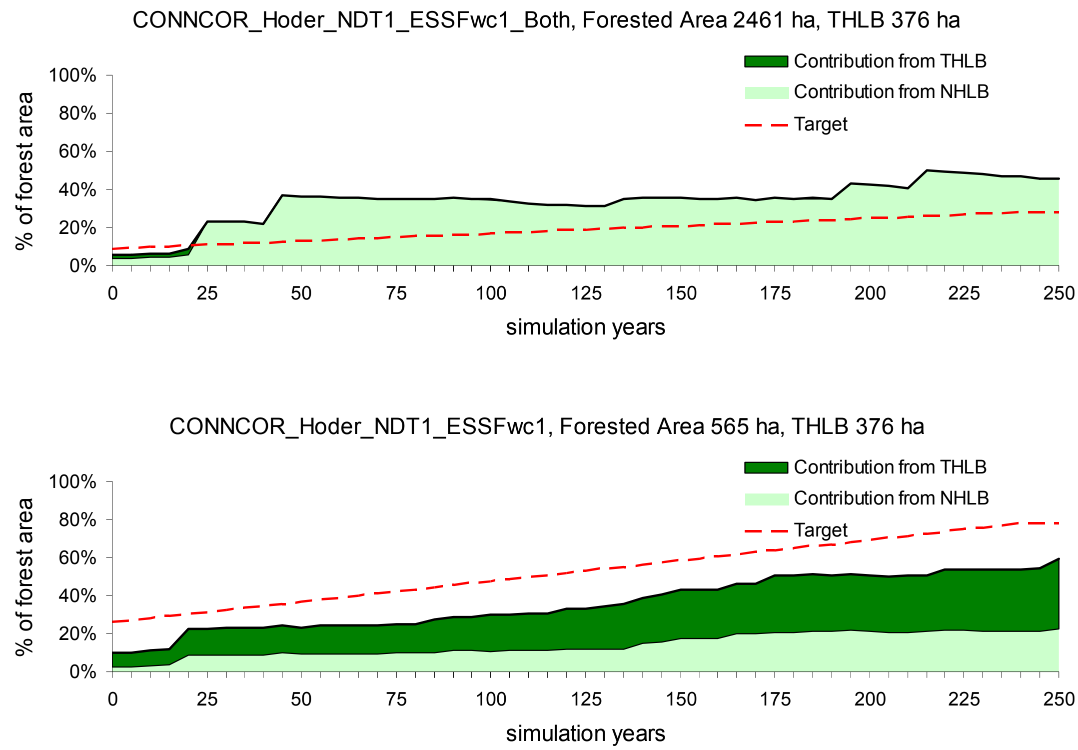

Figure 89: Old seral targets for the connectivity corridor in the Hoder ESSFwc1 variant when the Valhalla Park contribution is included (top panel) and when only the portion of the variant within TFL3 is considered (bottom panel).

Without accounting for the park contribution, there is a short fall in old seral area in connectivity corridors throughout most of the projection in the two ICH subzones found in the Hoder Landscape Unit. When the Valhalla Park area is included, timber supply is still constrained, but for shorter durations; the shortfall in old seral area in the connectivity corridors found in the Hoder ICHdw1 lasts until well into the long-term.

6.7 Adjacency and Green-up

Adjacency rules and green-up heights may potentially limit harvesting opportunities if areas under consideration for harvest are too close to a recently created cutblock. In past, typical practice in timber supply analysis has been to incorporate a general Integrated Resource Management (IRM) rule that is applied to areas not managed for other identified non-timber objectives like visual resources, ungulate habitat or domestic water. The general IRM objectives are applied semi-spatially, by limiting the amount of area can be below a given height, so that harvest units do not unintentionally appear as large contiguous openings.

The *Kootenay Boundary Higher Level Plan Order* (*KBHLP Order)* specifies the green-up height for all areas other than community watersheds, visually sensitive areas and Enhanced Resource Development Zones – Timber (ERDZ-T) to be 2.5 metres. The first sensitivity analysis examines the impacts of applying a 2.5 m green-up height to all areas other than community watersheds, visually sensitive areas and ERDZ-T zones. Consistent with the TSR2 analysis, the green-up sensitivity assumed a maximum allowable disturbance of 25% within each Landscape Unit.

Current practice on TFL3 is to emulate natural disturbance patterns to the extent practicable. For this type of analysis, a sensitivity analysis was conducted using true spatial modelling and a heuristics algorithm. A discussion of the issues surround the use of spatial modelling to model patch sizes was presented in above in Section 4.3.2

6.7.1 Apply Traditional Green-up and Adjacency Rules.

Sensitivity Analysis

Apply traditional adjacency and green-up rules used in timber supply modelling. Under this approach, adjacency and green-up rules are applied areas outside of visually sensitive areas, community watersheds and ERDZ-T areas that limit the amount of THLB area in each Landscape Unit below 2.5 m in height to be no more than 25%.

Rationale

The traditional approach to adjacency and green-up provides a benchmark for how sensitive the land base is to operational adjacency. As discussed in Section 4.3.2, adjacency and green-up were not explicitly applied in the base case analysis.

Methods

In the timber supply model, a rule was set to ensure that a maximum of 25% of the THLB outside of visually sensitive polygons, community watersheds and ERDZ-T areas could be no more than 2.5 m in height. Since the target is applied in the timber supply model to the entire forested area of partially reduced polygons, the target was pro-rated to the proportion of THLB. For example, if the THLB comprised 80% of the forested area, then the maximum allowable area that could be below 2.5 m height was set to 20%.

Results and Discussion

Applying the traditional green-up and adjacency rules has no impact on timber supply. The base case harvest levels can be achieved at all periods of the timber supply projection, and there are no impacts to the achieved total short and medium term harvest levels (Table 34 and Figure 90).

Table 34: Sensitivity analysis summary – apply traditional adjacency and green-up rules used in timber supply modelling.

	Base Case	Sensitivity Analysis	Change	% Change
Long-term harvest level (m^3/yr)	72,500	72,500	0	0.0%
Medium-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Short-term harvest level (m^3/yr)	80,000	80,000	0	0.0%
Total short/medium-term harvest (000's m^3)	8,329	8,329	0	0.0%

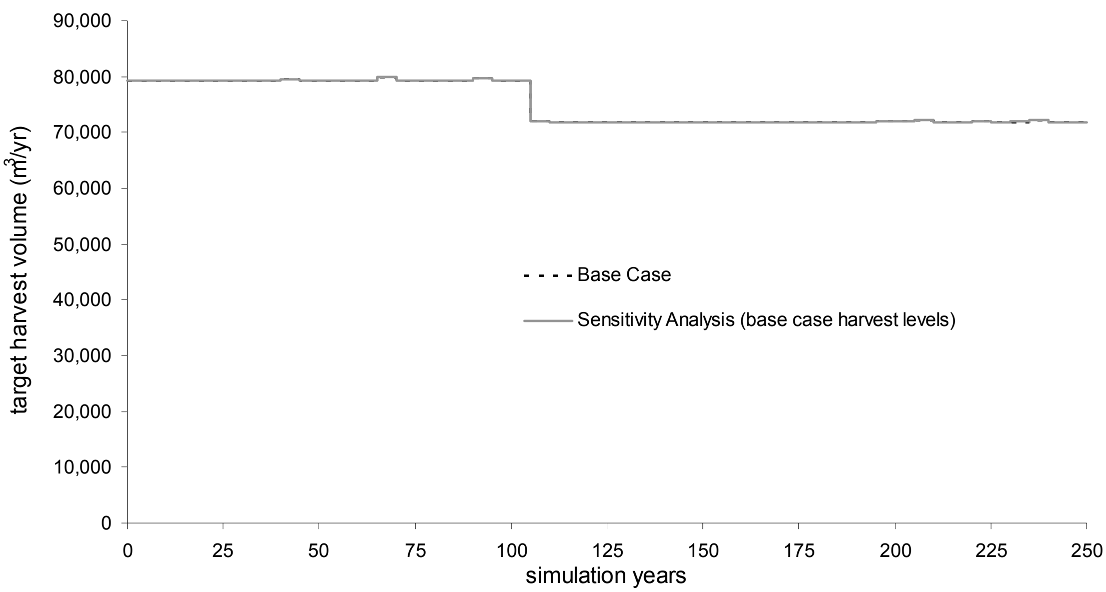

Figure 90: Total harvest forecast – apply traditional adjacency and green-up rules used in timber supply modelling.

Figure 91 shows no impact on either the total or mature growing stock of applying the tradition adjacency and green-up rules in comparison with the base case analysis.

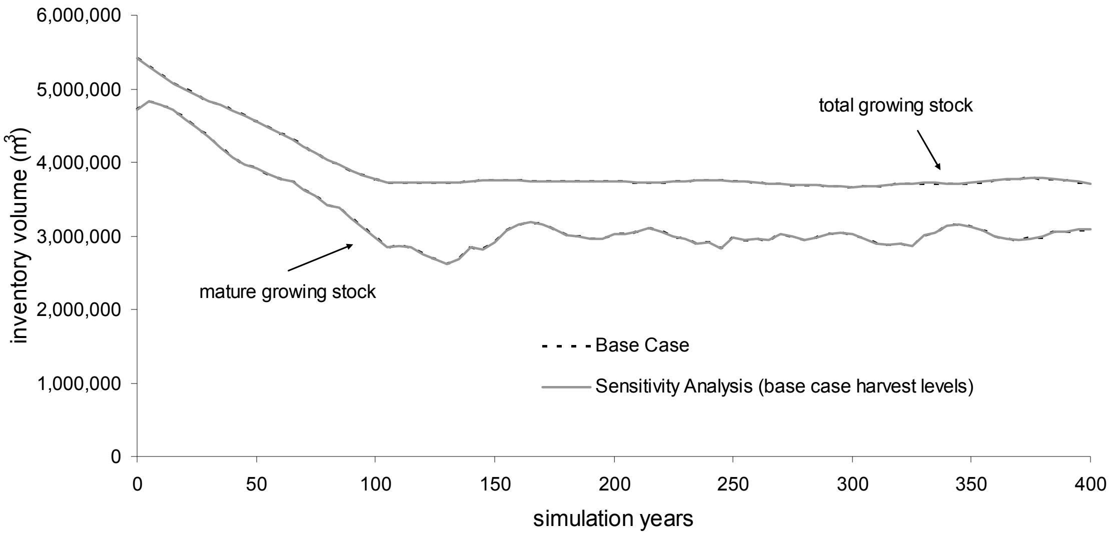

Figure 91: Sensitivity analyses growing stock – apply traditional adjacency and green-up rules used in timber supply modelling.

Figure 92 shows the targets applied to the unconstrained forested area[17] within each Landscape Unit. Harvesting is restricted if more than 25% of the THLB is less than 2.5 m in height in the unconstrained areas within each Landscape Unit. Timber supply is not limited when traditional adjacency and green-up rules are applied (Figure 92). Only the Perry Landscape unit has a very short 5-year period at year 235 where nearly 25% of the THLB is below 2.5 m green-up height.

[17] Unconstrained forested area refers to the THLB outside of visual areas, ERDZ-T areas or watersheds, as those areas have their own green-up height restrictions applied in the timber supply model.

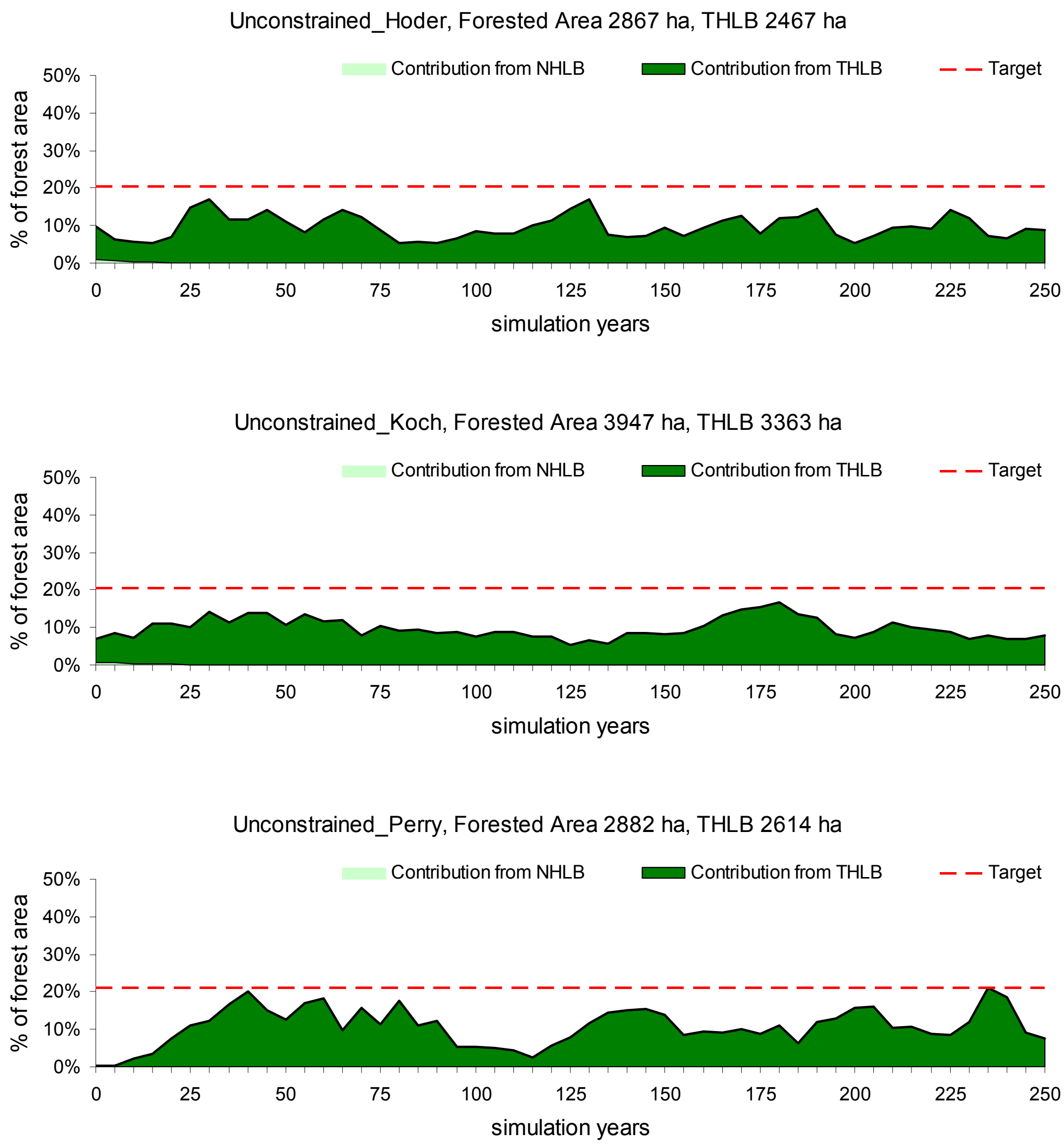

Figure 92: Proportion of unconstrained forested area less than 2.5 m in height for the Hoder (top panel), Koch (middle panel) and Perry (bottom panel) Landscape Units.

6.7.2 Apply an Early Seral Patch Strategy Using True Spatial Modelling and Heuristics.

Sensitivity Analysis

Use true spatial modelling and a heuristics algorithm to emulate natural disturbance patterns with targets for early seral patch distribution. Only early seral patches (stand age ≤20 years) are monitored for patch area distribution in TFL3. Patch targets are typically defined as an upper and lower range around the desired proportion of forested area by Landscape Unit, natural disturbance type and BEC zone. Details of the patch size targeting limits are provided in Section 10.2.1 of the *Information Package.*

Rationale

The traditional approach of modelling adjacency and green-up through simulation analysis was presented in 6.7.1; however current practice on the TFL is to emulate natural disturbance patterns to the extent practicable by monitoring the distribution of early seral patches. Modelling patch size distributions requires the use of true spatial modelling, using heuristic algorithms and targets to achieve the desired objectives, rather than constraints and a simulation modelling approach. A discussion about the limitations of using heuristics and spatial targets was presented above in Section 4.3.2.

Methods

A spatial adjacency file was incorporated into the timber supply model and the early seral patch size distribution targets were set for each of the natural disturbance types within each Landscape Unit[18], as discussed in Section 10.2.1 of the *Information Package.* Multiple run iterations (200 million) were conducted using the heuristics algorithm in the timber supply model, using a range of adjacency distances and cut-block size limits.

The minimum resolution of harvest forecasts was reduced by increasing the volume flow tolerance of the timber supply modelling from ±1% of the target harvest levels as in the base case and previous sensitivity analyses, to ± 5% (see discussion in Section 4.6.2 on the harvest level precision). In general, by increasing the volume flow tolerance, the probability is higher for the timber supply model to find an optimal solution. Correspondingly, the target harvest levels were set higher than the base case analysis so that at minimum, the model would try to meet the base case harvest level.

Unlike the time-step simulation modelling used for all previous analyses, conducting 200 million run iterations using heuristics modelling takes considerably more processing time with longer planning periods. As such, the growing stock output (and the model run) is only for the first 250 years, instead of 400 years as in the base case and previous sensitivity analyses.

Results and Discussion

The target harvest levels for the all periods were increased by 6.1% over the base case, but due to the lower harvest level resolution, the target increase did not have the same impact on the achieved harvest levels when using the heuristics algorithm to build the

[18] The ESSF zone comprises NDT1 and the ICH zone comprises NDT2 and NDT3 in all Landscape Units found in TFL3.

target patch size distributions. The achieved total harvest volume was 5.9% higher than the base case in the short-term, 1.6% higher in the medium term, and 2% higher in the long-term (Table 35). The achieved harvest levels are depicted graphically in Figure 93.

Table 35: Sensitivity analysis summary – apply an early seral patch distribution strategy using true spatial modelling and heuristics.

	Base Case	Sensitivity Analysis*	Change	% Change
Long-term harvest level (m^3/yr)	72,500	76,921	4,421	6.1%
Medium-term harvest level (m^3/yr)	80,000	84,877	4,877	6.1%
Short-term harvest level (m^3/yr)	80,000	84,877	4,877	6.1%
Total long-term harvest (000's m^3)	10,421	10,632	211	2.0%
Total medium-term harvest (000's m^3)	6,347	6,450	103	1.6%
Total short-term harvest (000's m^3)	1,981	2,098	117	5.9%

* The precision of the sensitivity analysis is ± 5%

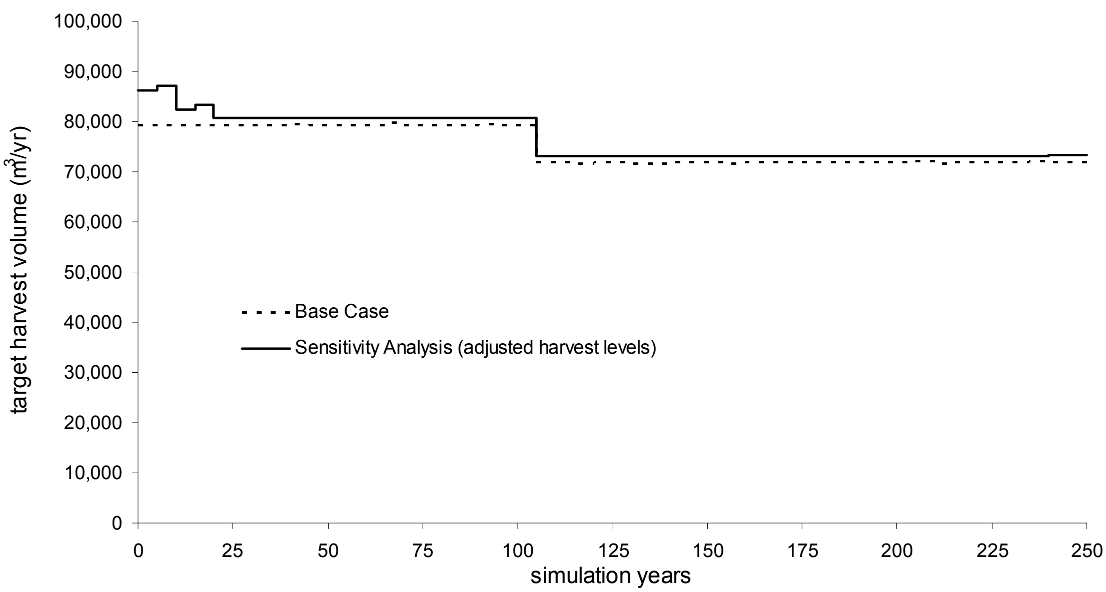

Figure 93: Total harvest forecast – apply an early seral patch distribution strategy using true spatial modelling and heuristics.

Since the objective of this sensitivity was to create patches in appropriate size distributions, the criterion of a stable growing stock was relaxed somewhat, as shown in Figure 94. The slight growing stock decline in the long-term may be a result of the higher harvest levels applied to the land base, however it is somewhat erroneous to make that comparison directly since the growing stock is a result of modelling for the patch size target objectives as well as the increased harvest level.

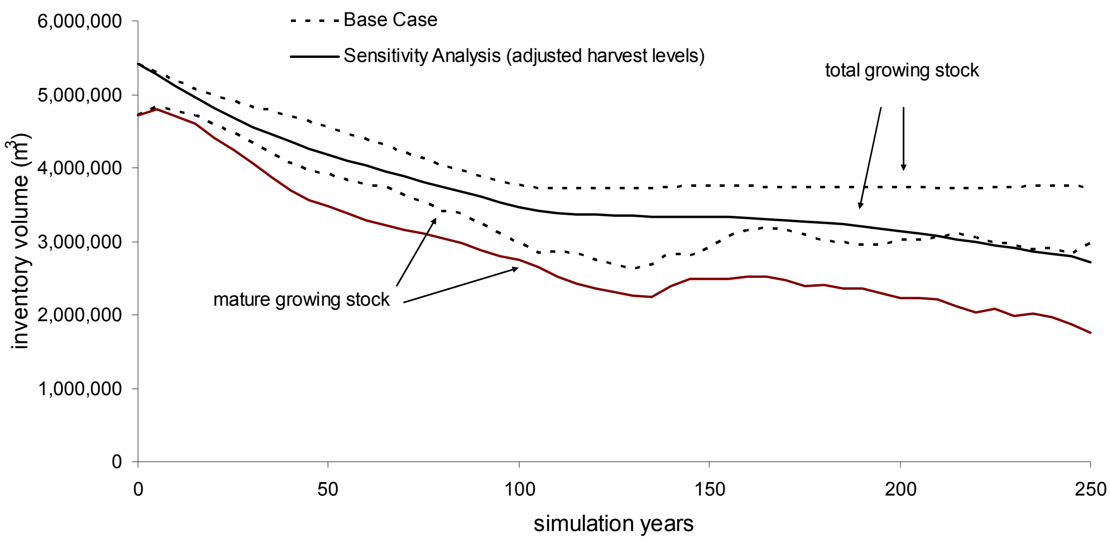

Figure 94: Sensitivity analysis growing stock (250 years) – apply an early seral patch distribution strategy using true spatial modelling and heuristics.

Using the heuristics approach to model early seral patch size distribution shows a favourable trend towards meeting the patch targets across all NDTs in each of the landscape units, provided harvesting (or natural disturbance in the non-harvestable land base) occurred somewhat concurrently. When examining the output over time for the early seral patch size distribution, it is important to consider the fact that the reported early seral patches are only comprised of stands up to 20 years of age, and therefore grow out of the reporting as stands age. Furthermore, what determines a patch is a function of the inter-opening distance. Analyses were conducted under a range of inter-opening distances ranging between 50 m and 100 m, measured as the boundary to boundary distance of opening. In practice however, inter-opening distances are typically a function of the actual harvest block or natural disturbance opening widths (i.e. distance is defined as a half-block width to adjacent blocks). For this strategic level analysis, a 50 m distance was used between resultant polygon boundaries, as this distance provided the most adequate results.

A sample of the patch modelling results for the NDT2 found in the Koch Landscape Unit is presented in Figure 95. This is a relatively large NDT unit in TFL3 at 11,468 ha, and about 67% of this area is comprised of THLB. In the Koch NDT2, all three patch targets tend to be met in a fairly consistent manner throughout the later half of the medium-term and the entire long-term portion of the projection when patch size distribution is a target objective. Under the base case, the 0-40 ha patches are overrepresented, while the 41-80 ha patches are under represented. The 80-250 ha patch sizes are within the target range for a short period around the 75^{th} year and periodically through the later half of the long-term.

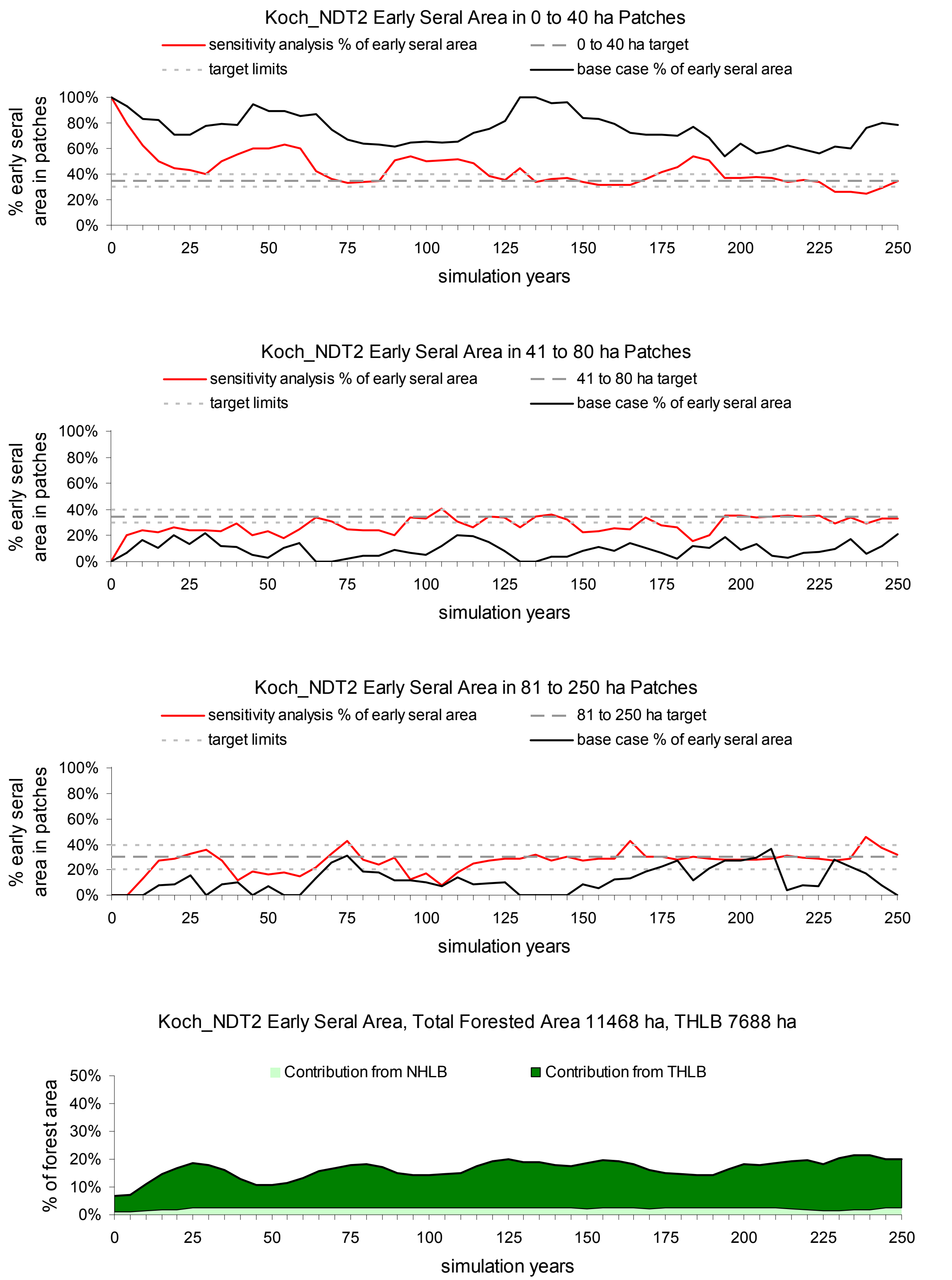

Figure 95: Koch NDT2 base case and sensitivity analysis patch size distributions for: 0-40 ha (top panel), 41-80 ha (2nd from top) and 81-250 ha (3rd from top). The sensitivity analysis proportion of early seral area is shown in the bottom panel.

There are some general trends in the patch size across all Landscape Unit and NDT types. The early seral component tends to be overrepresented in the 0-40 ha patch size, and underrepresented in both the 41-80 ha and the 81-250 ha patch sizes. In general, patch size distribution is improved when the patch targets are enforced in the timber supply model, even though the targets may not always be met.

In some cases, such as the Hoder NDT2, the patch targeting has resulted in a fairly consistent meeting of the targets throughout much of the forecast, in all three patch size categories. In other areas, such as the Koch NDT1 patch targeting has improved the trend towards meeting the targets across all three size categories, even though the actual targets may not be met in some of the size categories. In smaller areas such as the Perry NDT1, patch targeting is much more variable and oscillates widely around the targets in both the base case and to a lesser degree when targeting is employed, in all three patch size categories. Since harvesting (or natural disturbance) is required to meet these early seral patch target objectives, if areas are constrained for other non-timber objectives then early seral patch targets may be too difficult to achieve.

This sensitivity analysis showed that improvements can be made to the patch size objectives while the risk to timber supply is relatively low. Although this sensitivity analysis was conducted using strategic level assumptions and parameters, patch targeting could likely be refined with a more robust adjacency distance based on operational harvest units and adjacency distances calculated as a function of harvest block or natural disturbance opening widths.

6.8 Summary of Sensitivity Analyses

Table 36 shows the general results of the sensitivity analyses on the harvest forecast, relative to the base case. The projected base case harvest levels were 80,000 m^3 per year in the short and medium terms, declining to 72,500 m^3 per year in the long term by year 110. The total achieved harvest volume in the base case throughout the short and medium-term was approximately 8,329,000 m^3. The general scale column in Table 36 ranks the relative importance to timber supply of the sensitivity analysis results. A detailed discussion of the findings for each of the sensitivity analyses were presented in the appropriate Section shown in Table 36.

Table 36: Summary of the harvest level impacts of the sensitivity analyses relative to the base case harvest levels (continued on following page).

Section	Sensitivity Analysis	Var-iance	Long Term Harvest Level	Medium-Term Harvest Level	Short-Term Harvest Level	Short & Medium-Term Total Harvest	General Scale
6.2	**Land Base Assumptions**						
6.2.1	Partition the harvest in "Alternate" operability areas	·	·	·	·	-0.1%	·
6.2.2	Remove "Alternate" operability areas from the THLB.	·	-4.0%	·	·	-0.1%	-
6.2.3	Increase the THLB by 10%	·	+8.3%	+10.0%	+10.0%	+10.0%	+ +
6.2.4	Reduce the THLB by 10%	·	-7.5%	·	·	-0.6%	-
6.2.5	Remove permanently deactivated roads from the THLB	·	·	·	·	·	·
6.3	**Site Productivity**						
6.3.1	Adjust SI for managed stands by ±10%	+10%	+17.3%	+6.3%	+6.3%	+6.3%-	+ + +
		-10%	-15.5%	·	·	-0.2%	- -
6.3.2	Adjust SI for managed stands by ±2.5 m	+2.5 m	+30.3%	+18.1%	+18.1%	+18.1%	+ + +
		-2.5 m	-25.0%	·	·	-0.3%	+ + +
6.3.3	Old Growth Site Index (OGSI) adjustment for managed stands	·	+17.9%	+6.9%	+6.9%	+6.8%	+ + +
6.3.4	PEM derived SIBEC site index adjustment	·	+47.1%	+33.3%	+33.3%	+33.2%	+ + +
6.4	**Growth and Yield**						
6.4.1	Reduce existing stand yield volumes by 10%	·	·	·	·	·	·
6.4.2	Reduce future managed stand yield volumes by 10%	·	-10.0%	·	·	·	- -
6.4.3	Adjust genetic gain to 2008-2018 FGC Forecast	·	+8.7%	·	·	-0.1%	+

Section	Sensitivity Analysis	Var-iance	Long Term Harvest Level	Medium-Term Harvest Level	Short-Term Harvest Level	Short & Medium-Term Total Harvest	General Scale
6.4.4	Armillaria root-rot impacts on Douglas-fir in the ICH zone	Low	-7.7%	.	.	.	- -
		Mod	-10.8%	.	.	.	- -
		High	-16.1%	.	.	.	- - -
6.4.5	Apply Provincial mountain pine beetle forecasts	.	.	.	.	.	.
6.5	**Modelling Rules**						
6.5.1	Prioritize MPB susceptible stands for harvest	.	.	.	.	.	.
6.5.2	Minimum harvest age	95% MAI	.	.	.	.	.
		-10 yr	.	.	.	.	.
		+10 yr	.	.	.	.	.
6.5.3	Change harvest priority rule to oldest first	.	-1.7%	.	.	.	.
6.6	**Forest Cover Constraints**						
6.6.1	Adjust green-up in visually sensitive areas ±1.5 m	+1.5 m	.	.	.	.	.
		-1.5 m	.	.	.	.	.
6.6.2	Adjust the allowable disturbance percent in visually sensitive areas.	High	.	.	.	.	.
		Low	-2.5%	.	.	.	-
6.6.3	Return DRAFT OGMAs to the THLB without connectivity.		+4.6%	+7.0%	+7.0%	+6.9%	+ -
		Park	+4.6%	+7.0%	+7.0%	+6.9%	+ -
6.6.4	Return DRAFT OGMAS to the THLB and apply connectivity corridors.		-5.0%	+4.0%	+4.0%	+3.9%	+ -
		Park	-2.5%	+4.0%	+4.0%	+3.7%	+ -
6.7	**Adjacency & Green-up**						
6.7.1	Apply traditional adjacency and green-up rules.	.	.	.	.	.	.
6.7.2	Apply an early seral patch strategy using true spatial modelling and heuristics.	.	2.0% *	1.6% *	5.9% *	2.6%	+

* Achieved total volume is reported since the resolution of the achieved versus target harvest levels was reduced by increasing the volume flow tolerance from ±1% to ±5% for heuristics modelling.

7 Conclusions

The existing growing stock of TFL3 is comprised of approximately 5.4 million m^3, of which 56% is currently at or above the minimum harvest age and therefore eligible to be harvested. This robust growing stock allows for a short and medium term harvest level of 80,000 m^3 per year that exceeds the LRSY of 76,612 m^3 per year by 4%. The harvest level must decline to the long-term harvest level (LTHL) of 72,500 m^3 per year by year 110 to stabilize the growing stock. Once the LTHL is met, the growing stock remains at an equilibrium level throughout the remainder of the timber supply forecast.

The base case analysis showed that 203 ha per year were harvested on average, with a co-efficient of variation at 4%. This relatively constant annual harvest area corresponded with an average yield at harvest of 410 m^3/ha in the short-term, 389 m^3/ha over the medium-term and 355 m^3/ha on average throughout the long-term. Depending upon how the average stand age at harvest is calculated, the average harvest age was around 230 years in the short term, approximately 160 years in the medium term and by the long-term, the average stand age at harvest was 130 years, nearly 100 years younger than in the short-term portion of the projection.

Forest cover constraints due to visual resources (VQOs) are constraining harvest to some degree throughout the projection. Ungulate Winter Range snow interception areas are constraining harvest over the medium and long-term portions of the forecast only, while the domestic watersheds periodically constrain harvest throughout the forecast. Biodiversity objectives for Mature+Old stands are managed as non-spatial targets; these are constraining the timber supply but not significantly since the areas in question are small.

Old seral targets are managed through agreed upon draft OGMAs in the base case. The OGMAs are removed from the THLB. The Hoder and Koch Landscape Units have a low biodiversity emphasis option, and therefore the biodiversity targets and OGMAs reflect a 2/3rd drawdown. A recruitment strategy was modelled in the base case to meet the full biodiversity targets in these two Landscape Units after 3 rotations (240 years). Timber supply was constrained in the ESSFwc1 variant of the Hoder Landscape unit due to old seral targets, but only for the final 20 years of the 250-year projection. Old seral targets were not constraining in the Koch Landscape Unit. The Perry Landscape Unit has an intermediate biodiversity emphasis option, therefore the full biodiversity targets were assumed to have been met with the draft OGMAs.

Uncertainties were evaluated for their impacts on timber supply throughout the forecast and where appropriate, for their influence on non-timber resources. When evaluating the relative importance of these uncertainties, it is important to consider whether the uncertainties pose a risk to timber supply in the short-term, or whether the risk can be mitigated somewhat when it occurs further out in the forecast in the long-term. The uncertainties are discussed with regards to their impacts on timber supply.

7.1 Uncertainties Posing No Risk to Timber Supply

The base case harvest forecast appears to be fairly resilient to a number of uncertainties evaluated through sensitivity analyses. In general, this resiliency can be attributed to the abundance of the growing stock, the relatively small magnitude of the uncertainty, or to a combination of both.

There is no risk to the timber supply in the base case of partitioning 5% of the harvest volume to the 2,101 ha of THLB area classified as "alternate" operability. Removing the 247 km of permanently deactivated roads from the THLB by assuming the roads were never rehabilitated also showed no discernable impact on timber supply since these roads only amount to a net reduction of 215 ha to the THLB, or a -0.8% change.

If the existing inventory volumes are overestimated by 10%, an ample growing stock still remains with no impact on the harvest levels at any point in the forecast. A similar situation exists if the current Provincial mountain pine beetle forecasts are applied to susceptible pine stands in TFL3. Prioritizing pine leading stands for harvest when the Provincial mountain pine beetle forecasts are applied also has no impact on the harvest levels at any point in the forecast, but does improve the growing stock slightly over a non-prioritized harvest. This can be attributed to the fact that based on the Provincial pine beetle forecast, susceptible Pine only makes up about 10% of the THLB inventory volume in TFL3.

The timber supply in TFL3 is not sensitive to changes in the minimum harvest ages when the base case minimum ages are varied by ±10 years or when the ages are set to the age at 95% of culmination MAI. The average age at harvest was similar and there remains an abundant mature component to the growing stock under any of the minimum harvest age scenarios. Timber supply was neither constrained nor overestimated by the minimum harvest age assumptions.

Despite the evidence that the visual polygons are constrained in the base case, increasing or decreasing the visually effective green-up height by 1.5 m does not change the harvest levels at any point in the forecast. Setting the allowable disturbance percent in visually sensitive areas to the maximum allowable level does not change the harvest forecast either, indicating that although the base case is constrained, relaxing the constraints in visual polygons with a lower visual absorption capacity will not improve the timber supply forecast at any point in the projection.

Applying the traditional green-up and adjacency rules by limiting the amount of THLB area (outside of visual areas, domestic watersheds and ERDZ-T zones) below 2.5 m in height in each Landscape Unit to be no more than 25% did not have any effect on timber supply or on the growing stock throughout the entire forecast.

7.2 Uncertainties with a Downward Pressure on Timber Supply

The uncertainties with a downward pressure on timber supply are generally comprised of significant reductions to the THLB, more constraining forest cover requirements for non-timber resources or to lower yield estimates attributed to low site productivity, overestimation of yields or to volume losses associated with disease.

Due to the abundant growing stock, none of the uncertainties with a downward pressure impact timber supply in the short or medium-term portions of the forecast. All downward pressures on timber supply only impact the harvest levels in the long-term.

Removing the areas classified as "alternate" operability from the THLB reduces the current standing inventory by 9.7% and requires a 4% reduction to the LTHL.

If the THLB is overestimated by 10%, then the base case harvest level is 7.5% too high in the long-term. However, the base case harvest levels could be maintained throughout the short and medium-terms of the forecast if the THLB is overestimated, thereby posing no short or medium-term risks to timber supply.

If the VRI site indices are overestimated, then timber supply impacts will be felt in the long-term. A 10% overestimation of site indices will require the base case LTHL to decrease by 15%. Similarly, if there is a 2.5 m upwards bias in the inventory site indices, then the base case LTHL must be reduced by 25% in order to be sustainable.

While an overestimation of the existing inventory made no difference to the forecasted harvest levels, if the future managed stand yield tables were overestimated by 10%, a corresponding 10% reduction would be required to the base case LTHL.

In the base case, there is evidence that the visual polygons are constraining timber supply to some degree. While no discernable impacts to timber supply were found by increasing or reducing the visually effective green-up height, a 2.5% reduction to the base case LTHL would be required if the permissible alteration percent limits were set to the lowest value of each VQO category. This is an unlikely scenario given the current policy for managing visual quality objectives (see Government of B.C., 1996).

The TFL3 land base is slightly sensitive to harvest scheduling rules. In the base case, a 'relative oldest first rule' was applied. If the alternate scheduling rule of prioritizing the oldest stands for harvest is applied, there is a minor 1.7% reduction to the base case LTHL.

The most significant downward pressure on timber supply can be attributed to the endemic Armillaria root rot. Armillaria is known to exist on TFL3; however the growth and volume loss has not been quantified explicitly to date. The timber supply impacts of applying three Armillaria severity levels (low, moderate and high) to managed Douglas-fir stands in the ICH zone were evaluated. Changes were not required to the base case short and medium-term harvest levels, however the base case LTHL required a 7.7% reduction under low severity, a 10.8% reduction under moderate severity and a 16.1% reduction if the severity level was indeed high. Since growth and yield adjustments were only available to explicitly examine Armillaria on Douglas-fir stands in the ICH zone, it remains to be seen what the impacts will be if Armillaria is a significant cause of growth loss and mortality on other species and/or BEC zones in TFL3.

7.3 Uncertainties with a Confounding Pressure on Timber Supply

By returning the draft OGMAs to the THLB, ignoring the connectivity corridor requirements and managing for old seral attributes in a non-spatial manner, harvest levels can increase 7% over the short and medium-terms and increase by 4.6% in the long-term. These increased harvest volume appear to be a function of greater flexibility awarded by the non-spatial targets. Since managing for connectivity corridors is a requirement under the *KBHLP* Order, capturing these increases to harvest levels is unlikely.

When the draft OGMAs were returned to the THLB and the connectivity corridor requirements were considered; the impacts on timber supply were confounding. In the short and medium-term, a 4% increase to the base case harvest levels could be had. In the long-term, managing for old seral attributes non-spatially resulted in a downward pressure on timber supply of 5%. This downward pressure to the LTHL was reduced to 2.5% when the Valhalla Park contribution to old seral was considered in the Hoder Landscape Unit.

7.4 Uncertainties with an Upward Pressure on Timber Supply

Generally, an upward pressure on timber supply can be expected if the THLB is increased. If the THLB was underestimated by 10% due to the assumptions regarding partially removed stands, then the base case harvest level is 10% below the true value in the short and medium terms and 8.3% too low in the long-term.

The favourable genetic worth forecasts provided by the Forest Genetics Council result in no changes to harvest levels in the short and medium term, but an 8.7% increase to the base case LTHL as more productive future managed stands become eligible for harvest.

Employing true spatial modelling and a heuristics algorithm to emulate natural disturbance patterns with early seral patch distribution resulted in a higher harvest level across all portions of the forecast. In the short-term, the total achieved harvest was 5.9% higher than the base case, in the short-term, 1.6% higher in the medium-term and 2.0% higher by the long-term. Along with the increases in achieved harvest volumes, early seral patch size distribution was generally improved.

The most prominent upward pressure on timber supply reflects uncertainties around the VRI site productivity estimates and the corresponding impact on managed stand yield volumes. Statistically valid and localized site index estimates as an alternative to the VRI values are not currently available for TFL3. Four examples of increasing the existing VRI site index were evaluated, resulting in an increase to the LTHL ranging from 17.3% to 47.1%. More productive managed stands also meant less reliance on the existing inventory to carry the majority of the harvest profile until the long-term, therefore a non-declining even flow harvest could be projected under each of the site productivity examples. Based on these timber supply impacts and the general recognition that inventory site indices derived from mature or decadent stands are underestimated (Nigh, 1998; Nussbaum, 1998), an upward pressure on timber supply may be expected if it is determined that the true estimates of site productivity are actually higher then the site index estimates found in the VRI.

7.5 Recommendations for the Next Timber Supply Analysis

At present, the VRI site index estimates are the best information available, and accordingly were applied to the managed stand yield estimates in the base case. The site productivity sensitivity analyses demonstrated that significant gains could be had to timber supply, in the short, medium and long-term if the true site productivity was actually higher than the VRI site index estimates. Given the general consensus about site index estimates derived from old stands, any work to improve site productivity estimates will most likely have a favourable impact on timber supply.

Depending upon the infection severity level of Armillaria root rot in TFL3, the adverse impacts on managed stand yields attributed to Armillaria may result in significant reductions to timber supply in the long-term. Any local information that provides better growth and yield reductions attributed to Armillaria root rot beyond the generalized, ICH zone Douglas-fir OAFs currently available in TIPSY will provide a more accurate estimate of future stand yields at subsequent timber supply reviews.

The Forest Genetics Council forecasts for genetic worth appear to be favourable for timber supply. It is suggested that the seed program and genetic worth expectations for the seed transfer zones within TFL3 be monitored closely, so that any new empirically tested seed improvement information can be incorporated into the next timber supply review.

It may be appropriate to review the operability classification of TFL3 to better reflect both operational practice and economic (based on stand quality & value) viability. Under the current assumptions, a partitioned harvest in the “alternate” operability areas will not have an impact on the base case harvest levels, however harvesting in these areas may not be economically viable. Removing the “alternate” operability areas entirely reduces the THLB standing inventory by 9.7% and results in a 4% reduction to the long-term harvest level. Economically unfeasible areas currently classified as “operable” may also be of interest for review.

The inventories used for this analysis reflect the best information available at the current time, but there were a number of data inconsistencies in the VRI that became apparent while the resultant coverage was developed for this analysis. These are discussed in detail in Section 5 of the *Information Package;* however the issues are primarily a result of missing or incorrect information about harvest depletions. Repairing and continuously reconciling this basic information retains both the utility and the asset value of the forest inventory for TFL3.

This analysis used a time-step simulation approach for modelling along with spatial inventory information in a manner consistent with most volume based (as opposed to area based) timber supply reviews conducted in the Province. It was demonstrated through a sensitivity analysis that natural disturbance patterns could be emulated, resulting in favourable improvements to the patch size distribution while maintaining (or even slightly increasing) timber supply. While true spatial timber supply analysis is not a requirement for the timber supply review process to date, both environmental and operational gains can likely be had with spatial modelling at a more tactical level.

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Appendix 1 – Information Package

Tree Farm Licence 3 Timber Supply Analysis Report Information Package (November 2008) is attached separately.

Appendix 2 – List of Acronyms

Acronym	Desription
AAC	Allowable Annual Cut
ABFD	Arrow-Boundary Forest District
BCLCS	British Columbia Land Classification Scheme
BEC	Biogeoclimatic Ecosystem Classification
CFLB	Crown Forested Land Base
DBH	Diameter at Breast Height
DWB	Decay, Waste and Breakage
ECA	Equivalent Clearcut Area
ERDZ-T	Enhanced Resource Development Zone – Timber
ESA	Environmentally Sensitive Area
EVQO	Existing Visual Quality Objective
FESL	Forest Ecosystem Solutions Ltd.
FIP	Forest Inventory Planning
FIZ	Forest Inventory Zone
FPPR	Forest Planning and Practices Regulation
FRPA	Forest Range and Practices Act
FSOS	Forest Simulation Optimization System
GAR	Government Actions Regulation
GIS	Geographic Information System
GW	Genetic Worth
ILMB	Integrated Land Management Bureau
IRM	Integrated Resource Management
ITG	Inventory Type Group
KBHLP	Kootenay Boundary Higher Level Plan
KBHLP - IS	Kootenay Boundary Higher Level Plan Implementation Strategy
LRDW	Land and Resource Data Warehouse
LU	Landscape Unit
MAI	Mean Annual Increment
MoE	Ministry of Environment
MoFR	Ministry of Forests and Range
NDT	Natural Disturbance Type
NHLB	Non-Harvestable Land Base
NSR	Not-Sufficiently Restocked
NVAF	Net Volume Adjustment Factor
OAF	Operational Adjustment Factor
OGMA	Old Growth Management Areas
OGSI	Old Growth Site Index
PFT	Problem Forest Types

Acronym	Desription
RMA	Riparian Management Area
RMZ	Riparian Management Zone
RRZ	Riparian Reserve Zone
SCFP	Springer Creek Forest Products Ltd.
SI	Site Index
SPAR	Seed Planning and Registry
TASS	Tree and Stand Simulator
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolate Stand Yield
TRIM	Terrain Resource Inventory Mapping
TSIL	Terrain Survey Intensity
TSR	Timber Supply Review
VAC	Visual Absorption Capacity
VDYP	Variable Density Yield Projection
VEG	Visually Effective Greenup
VN	Vegetated – Non-Treed
VQO	Visual Quality Objective
VRI	Vegetation Resources Inventory
VT	Vegetated –Treed
WTR	Wildlife Tree Retention

Appendix 3 – List of Tree Species

Species Code	Common Name	Scientific Name
Conifers		
Bl	subalpine fir (balsam)	*Abies lasiocarpa*
Cw	western redcedar	*Thuja plicata*
Fd	Douglas-fir	*Pseudotsuga menziesii*
Hm	mountain hemlock	*Tsuga mertensiana*
Hw	western hemlock	*Tsuga heterophylla*
Lt	tamarack	*Larix laricina*
Lw	western larch	*Larix occidentalis*
Pa	whitebark pine	*Pinus albicaulis*
Pl	lodgepole pine	*Pinus contorta*
Pw	western white pine	*Pinus monticola*
Py	ponderosa pine	*Pinus ponderosa*
Se	Engelmann spruce	*Picea engelmannii*
Sw	Western white spruce	*Picea glauca*
Sx	hybrid spruce	*Picea hybrids*
Sxw	hybrid white spruce	*Picea engelmannii x glauca*
Broad-leaved trees		
Act	black cottonwood	*Populus balsamifera ssp. trichocarpa*
Acb	balsam poplar	*Populus balsamifera ssp. balsamifera*
At	trembling aspen	*Populus tremuloides*
Ep	common paper birch	*Betula papyrifera*