Louisiana-Pacific Canada Ltd.

Tree Farm Licence 55

MANAGEMENT PLAN #5

Date: November 2016

Fernando Cocciolo RPF 2226

"*I certify that the work described herein fulfills the standards expected of a member of the Association of British Columbia Forest Professionals*"

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1 INTRODUCTION

This is the first Management Plan (MP) prepared for Tree Farm Licence 55 (TFL) to meet the requirements of the Tree Farm Licence Management Plan Regulation (B.C. Reg. 280/2009). This regulation, enacted by the provincial government in November 2009 (with associated amendments to the Forest Act), includes content requirements, submission timing and public review requirements for TFL Management Plans. These content requirements (in regulation) replace the MP content requirements listed in the tree farm licence document and reduce the duplication of Forest Stewardship Plan matters (objectives and strategies). The content item of the greatest interest is likely the timber supply analysis that will provide information to the Chief Forester of BC for the determination of the next Allowable Annual Cut (AAC) for TFL 55.

2 LOCATION AND DESCRIPTION

The TFL is situated in the Selkirk Mountains north of Revelstoke National Park between Goldstream River and Mica Creek along the eastside of the Revelstoke Reservoir. The gross area of the TFL 55 is estimated to be 92,642 hectares. Approximately 55,585 hectares of this or 58% is considered to be productive forest.

The City of Revelstoke is the largest community in the region and is a service and government administrative centre for the local economy. Highway 23, which traverses along the eastside of the Revelstoke Reservoir to Mica townsite, provides the primary access to the tree farm licence. The southwest corner of the TFL at Goldstream River is 85 kilometres north of Revelstoke. The overview map (Figure 1) highlights the boundaries of the TFL in relation to the surrounding communities and regional features.

TFL 55 lies in the interior wet-belt and is covered in part by three biogeoclimatic zones: alpine tundra, interior cedar-hemlock and Englemann spruce-subalpine fir. The forests are mixtures of predominately hemlock, cedar, Douglas-fir types at lower elevations with balsam-spruce types at higher elevations. The climate is characterized by warm summers and cool winters, marked by characteristically heavy rainfall and high levels of winter snowfall.

The AAC for TFL 55 in MP#4 was 90,000 m3 annually, of which 11,675 was apportioned to the British Columbia Timber Sales (BCTS) program. BCTS operates in the Stitt-Norman Wood and BMX-Bigfish areas.

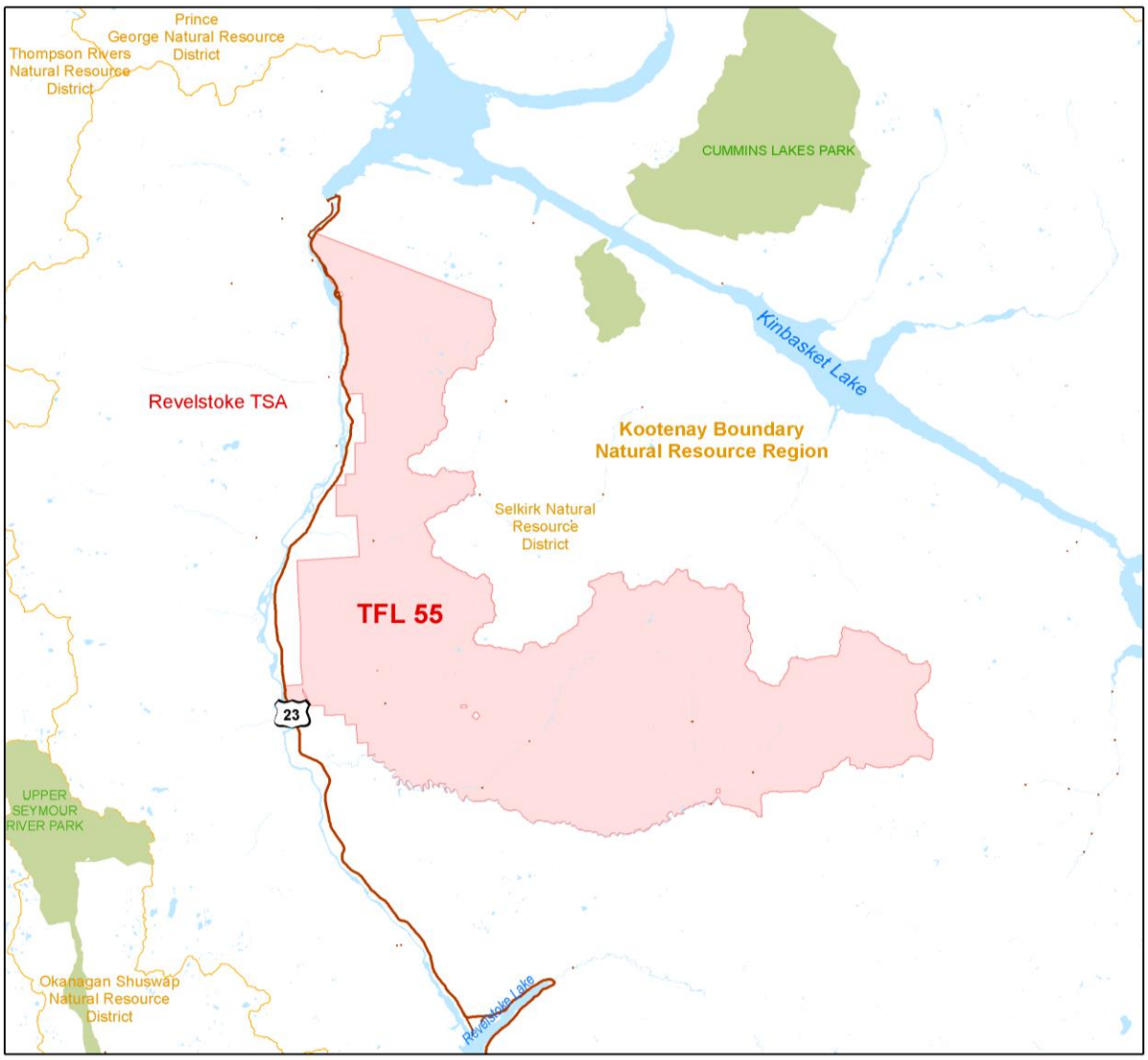

Figure 1 – Overview Map of TFL 55

3 TFL LICENCE HOLDER HISTORY

TFL 23 was first awarded to Celgar Development Company Ltd. on July 20, 1955 as Forest Management Licence 23. Forest Management Licence 23 covered 889,360 acres (359,923 ha), and extended from Mica Creek south to Castlegar in the Upper Columbia River/Arrow Lakes Valley. Although it was one of the largest TFLs in the province, only one-third was estimated to be harvestable timber. The remaining land consists of alpine tundra, mountain peaks, glaciers, scrubland, lakes, and rivers. In the 1970's, the Province of BC acquired ownership of the licence. A new company, Canadian Cellulose Company Ltd. (Cancel), was formed and assigned TFL 23. In 1992, TFL 23 was subdivided to create TFL 55 from the licence area north of Revelstoke, and a new TFL 23 to the south. Pope & Talbot Ltd. purchased the Castlegar sawmill and the TFL 23 assets from Westar's southern operations the same year. Westar

remained as the licence holder of TFL 55 until June 1993. Subsequently, TFL 55 was subdivided into a northern block that remained as TFL 55, and a southern block that became TFL 56. Evans Forest Products Ltd. became the new licensee of TFL 55 in June 1993. The new TFL 55 licence area extends from the Mica Creek in the north and is bounded by the Goldstream River to the south. TFL 55 is now held by Louisiana-Pacific Canada Ltd. while TFL 56 is held by the Revelstoke Community Forest Corporation.

Table 1 – TFL Licence Holders

Date	Licence Holder	Description
1955	Celgar Development Company Ltd.	Original Licence (Forest Management Licence 23)
1973	Canadian Cellulose Company Ltd. (Cancel)	TFL 23 assigned
1980	BC Timber Ltd.	Name change and assets became part of BRIC (British Columbia Investment Corporation).
1984	Wester Timber Ltd.	Name change
1992	Westar Timber	Subdivision of TFL 23 and creation of TFL 55. TFL 23 purchased by Pope & Talbot Ltd, Westar retained TFL 55.
1993	WestarTimber-Westshore Terminals	Subdivision of TFL 55 and creation of TFL56. TFL 56 purchased by the Revelstoke Community Forest Corporation
1993	Evans Forest Products Ltd.	Corporate Purchase
1999 to present	Louisiana-Pacific Canada Ltd.	Corporate Purchase

4 TFL CONSOLIDATIONS AND SUBDIVISIONS

The current TFL 55 is the result of a subdivision of the original TFL 23 in 1992 and a further subdivision in 1993 and creation of TFL 56.

5 MAJOR TFL 55 BOUNDARY CHANGES

Revisions were made to the TFL boundary in 1998 and 1999. The previous boundary was based on a manual interpretation of the metes and bounds description of the topographic features. Current government mapping standards use height of land line-work from the TRIM Watershed Atlas as well as Crown Lands (CDMS) cadastral mapping and TRIM planimetric features. Revisions resulted in a change of TFL area from 92,706 hectares in Management Plan 4 to 92,604 hectares, a decrease of 102 hectares.

6 PLANNING DOCUMENTS

The Forest Stewardship Plan (FSP) is a legal requirement under the Forest and Range Practices Act that states how LP plans to meet objectives set by government regarding

Soils, Wildlife, Biodiversity, Water and Fish, and Cultural Heritage Resources related to forest practices on TFL 55. The FSP term is five years but may be extended a further five years with the written notice of the minister in circumstances specified by the regulation. The current FSP term ends January 26, 2018. A link to the current FSP can be found here (scroll to the "Literature" section). http://lpcorp.com/sustainability/sustainable-forestry/

The Revelstoke Higher Level Plan Order (RHLPO) took effect March 25, 2005. The order and its amendments set out resource management objectives for biodiversity, old forests and grizzly bear habitat requirements. A compilation of previously published legal orders can be found here: http://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/natural-resource-use/land-water-use/crown-land/land-use-plans-and-objectives/legal-orders/revelstoke_rlup_luor_22dec2011consolidated.pdf

7 PUBLIC REVIEW STRATEGY

The opportunity to review and provide comments on the TFL55 Draft Management Plan #5 was based on a strategy approved by the Regional Executive Director for the Kootenay Boundary Region on October 2, 2015.

The draft timber supply analysis information package (IP) was made available for review and comment in March 2016. Notification emails and/or letters were sent out to all known stakeholders including affected First Nations indicating that the draft IP was available for review and comment for a period of 60 days along with information noting public viewing locations as well as other provisions to access copies of the IP. Advertisements were placed in the Revelstoke Review, Sicamous Eagle Valley News and the Salmon Arm Observer newspapers for a period of 2 consecutive weeks. No changes to the draft IP were required as a result of the review and comment process.

The draft Management Plan (MP) including the accepted IP and the Timber Supply Analysis Report was made available for review and comment in August 2016. Notification emails and/or letters were sent out to all known stakeholders including affected First Nations indicating that the draft IP was available for review and comment for a period of 60 days along with information noting public viewing locations as well as other provisions to access copies of the IP. Advertisements were placed in the Revelstoke Review, Sicamous Eagle Valley News and the Salmon Arm Observer for a period of 2 weeks. No changes to the draft MP were required as a result of the review and comment process.

The approved Public Review Strategy and Consultation documents can be found in Appendix C.

APPENDIX A

Timber Supply Analysis Report

Tree Farm Licence 55
Management Plan #5
Timber Supply Analysis Report

Presented To
Louisiana Pacific – Malakwa Division

Dated: November 2016

Ecora File No.: KE_15_060

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Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Notes/Revisions
1.01	23/08/2016	Miehm	LP Staff	Draft for public review
1.02	17/11/2016	Miehm	LP Staff / MFLNRO	Final version

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Appendix A Harvest Volume / VDYP6 / VDYP7 Comparison
Appendix B Summary of Dead Potential Volume

Acronyms and Abbreviations

BEC	Biogeoclimatic Ecosystem Classification
CMAI	Culmination Mean Annual Increment
DBH	Diameter – Breast Height
DIB	Diameter Inside Bark
LP	Louisiana Pacific
LRSY	Long-run Sustained Yield
MAI	Mean Annual Increment
MFLNRO	Ministry of Forests, Lands and Natural Resource Operations
MP	Management Plan
MSYT	Managed Stand Yield Table
NDT	Natural Disturbance Type
NROV	Natural Range of Variation
NSYT	Natural Stand Yield Table
RHLPO	Revelstoke Higher Level Plan Order
SIA	Site Index Adjustment (J.S. Thrower and Associates Ltd.)
SIBEC	Site Index Estimates by BEC Site Series
TFL	Tree Farm Licence
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation for Stand Yields
VDYP	Variable Density Yield Prediction
VRI	Vegetation Resources Inventory
WTP	Wildlife Tree Patch

1.0 Introduction

Louisiana Pacific Ltd. (LP) must complete a timber supply analysis for TFL 55 in conjunction with the Management Planning process that is required by legislation and the terms of the licence. An Information Package describing the spatial data, yield forecasts and management assumption that would underpin the timber supply analysis was prepared and submitted to the Ministry of Forest, Lands and Natural Resource Operations (MFLNRO) and was also advertised for public review. It was accepted by MFLNRO on 8 June 2016 as an adequate basis upon which to prepare timber supply forecasts for the TFL.

The next step in the timber supply analysis process is the preparation of a base case timber supply forecast. Timber supply is the quantity of timber available for harvest over time. It is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic environment that affect the availability of timber for harvest, change with time. Timber supply analysis is the process of assessing and predicting the current and future supply from a management unit. This has been done using Patchworks, a forest estate model that facilitates the preparation of data, application of management practices and other rules, and produces outputs describing the harvest flow and the future condition of the landbase with respect to timber and other resource values. The results are presented in this document (the Analysis Report), along with the results of many sensitivity analysis runs that examine the timber supply impacts of changes in management assumptions and model input.

This Analysis Report will be circulated for public review in conjunction with a draft of Management Plan (MP) #5 for the TFL. The MP will include a history of the TFL and a summary of the feedback received; the final versions of the Information Package and Analysis Report will be included as Appendices.

Once this second public review process is complete, these documents will be submitted to the Chief Forester to assist in making an AAC determination for the TFL. This information will be used by the Chief Forester of British Columbia in determining a permissible harvest level for TFL 55. Upon completion of that review, the AAC Rationale document will be appended to the finalized version of Management Plan #5.

2.0 General Description of the Land Base and Tenure

Tree Farm Licence 55 (TFL 55) is located in the Selkirk Mountains between the Revelstoke Reservoir and Kinbasket Lake (see Figure 2.1). The total area of the TFL is 92,642 hectares. Of this total, 53,585 hectares is considered to be productive forest land, and 29.7% (16,007 hectares) of that is available for timber harvesting.

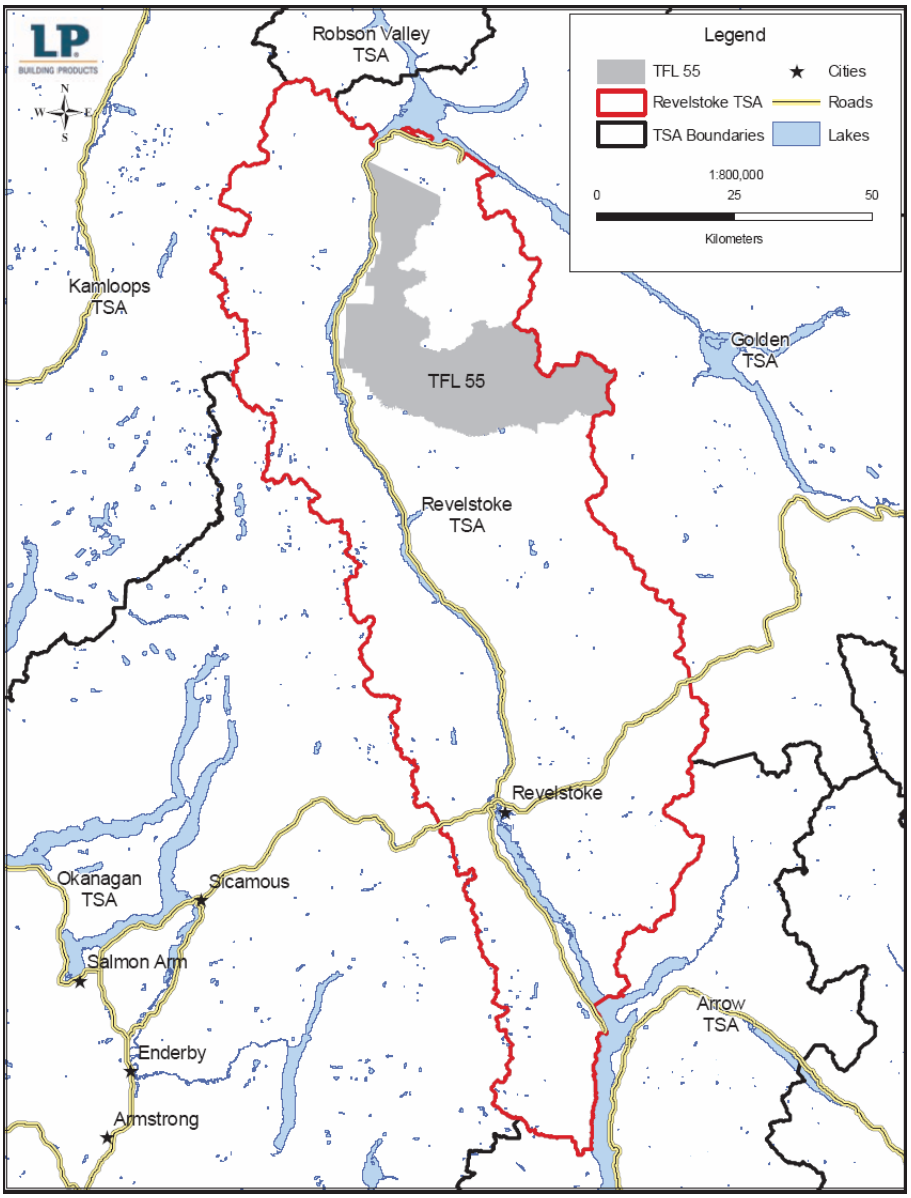

Figure 2.1 Location of TFL 55

3.0 Timber Flow Objectives

Forest cover objectives and the biological capacity of the net THLB will dictate the harvest level. There are however, a number of alternative harvest flows possible as many management objectives must be met.

In this analysis, the proposed harvest flow reflects a balance of the following objectives:

- Maintain or increase an initial harvest level of 90,000m^3/year for as long as possible;

- Decrease the periodic harvest rate in no greater than 10% steps when declines are required to meet all objectives on the land base;
- Achieve an even-flow long term supply over a 250-year time horizon; and
- Maintain a growing stock level at the end of the planning horizon that will support continuing operations.

The current AAC for TFL 55 is 90,000 m^3/year, including allocation to the British Columbia Timber Sales Program (BCTS). In addition, an allowance must be made for non-recoverable losses. Since the timber supply analysis is based on the net harvest plus NRLs, the initial gross harvest level for the Base Case analysis has been set to 90,916 m^3/year, providing a starting point for the analysis. (Unsalvaged loss calculations are described in the Information Package.)

4.0 Land Base Information

Table 4.1 show the derivation of the productive and timber harvesting land bases. A detailed description of the netdown process can be found in the Information Package appended to this document.

Table 4.1 Base Case Timber Harvesting Land Base Determination

	Management Plan #4		Management Plan #5		
Land Base Classification	**Area (ha)**	**Area Removed (ha)**	**Area (ha)**	**Area Removed (ha)**	**Conifer Volume (m^3 x 1000)**
Total Land Base	**92,744**		**92,642**		**11,205**
Ownership		38	38	38	
Total TFL	**92,706**		**92,604**		
Non-productive, Non-forest		36,801		38,125	
Roads		802		893	
Crown Forest Land Base	**55,103**		**53,585**		**11,205**
Inoperable		30,244		28,783	6,030
Operable Land Base	**24,859**		**24,802**		
Terrain		698		699	186
Riparian Reserves		810		645	183
Low Site		127		583	49
Deciduous		85		68	5
Wildlife Tree Patches		290		402	2
Caribou		-		6,362	2,198
OGMA		290		36	29
Non-merchantable		421			
NSR		87			
Timber Harvesting Land Base	**22,341**		**16,007**		**2,551**

Figure 6.1 summarizes the productive and net area of the TFL by 10-year age class.

Figure 4.1 Age Class Distribution

Table 4.2 and Figure 4.2 summarize the distribution of area by leading species for both the productive and timber harvesting land base. Approximately half of the THLB is made up of spruce-leading stands. Hemlock-, cedar-, and Douglas-fir make up most of the remaining THLB, in roughly equal amounts. Almost all of the THLB area without a leading species in the forest cover data is comprised of recently harvested stands

Table 4.2 Leading Species Distribution

Species Code	Productive Area (ha)	THLB (ha)
None	849.9	605.4
AC	167.5	47.4
AT	71.8	0.0
BA	26.1	25.3
BL	14,625.9	637.7
CW	5,516.2	2,204.0
EP	53.7	3.9
FD	603.3	389.8
FDI	2,487.6	1,053.6
H	283.5	31.4
HM	1,283.3	256.3

HW	6,171.7	2,402.6
PA	13.2	0.0
PL	48.8	23.1
S	3.0	1.3
SE	15,696.2	2,929.2
SW	31.6	20.8
SX	5,651.8	5,312.9

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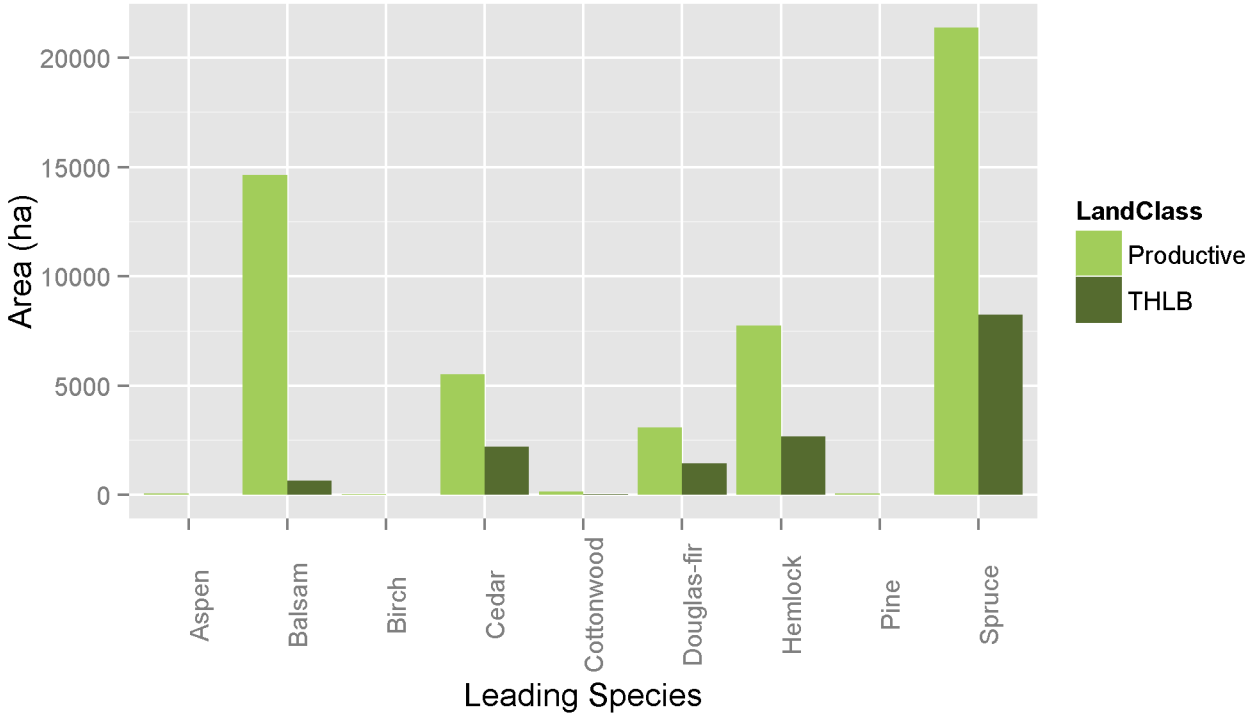

Figure 4.2 Leading Species Distribution

5.0 Timber Supply Analysis Methods

5.1 Model Description

Patchworks is a spatially explicit harvest scheduling optimization model developed by Spatial Planning Systems in Ontario. It has been used to develop spatially explicit harvest allocations to explore the trade-off between a broad range of conflicting management and harvest goals. Patchworks is a multiple-objective goal-programming model and can be described as consisting of two components:

1. A GIS interface with map viewer and viewer functions; and
2. A harvest scheduler that runs continuously in the background - searching for improvements in the allocation to improve the value of the objective function. The model seeks a solution that maximizes the value of the total objective function. The objective function will be made up of both the traditional (management plan) objectives and the additional requirements and indicators. In areas of timber management, the harvest schedule will be optimized (both the current and future forecasted land base) for timber flow requirements and to minimize the environmental risk, as measured by the established indicators.

5.2 Timber Supply Modelling

Timber supply analysis for the full two hundred and fifty (250) year planning horizon was carried out using *a* 250-year time horizon to ensure that short and medium term harvest targets do not compromise long term growing stock stability. This was modeled in fifty five-year periods. Modelled harvest levels included allowances for non-recoverable losses (NRLs). Harvest figures reported here include this amount (916 m^3/ha).

6.0 Timber Supply Analysis

This section provides an overview of the options that have been evaluated in the timber supply analysis.

6.1 Base Case

The base case reflects current management performance as of 2015. The analysis will incorporate the following:

- Vegetation resource inventory (VRI) updated with harvest blocks and other updates that have occurred since the original inventory mapping was completed;;
- Operability mapping – reviewed and slightly amended for this project – that shows where timber harvesting is operationally feasible;
- Ecosystem-based analysis units and silvicultural prescriptions;
- Improved managed stand site productivity estimates based on the most recent SIBEC data;
- Patch size modelling for the entire planning horizon;

- Application of current genetic gains to managed stand yields;
- Implementation of the Revelstoke Higher Level Plan Order (as amended in 2011); and
- Implementation of Mountain Caribou GAR Order U-3-005 (2009, amended 2010).

The base case timber supply scenario has been run for TFL 55 using the Patchworks forest estate model. The criteria laid out in the accepted Information Package have been adhered to.

The current harvest level of 90,000 m^3/year can be maintained for 10 years. It falls to 83,000 m^3/year for the next ten years. It then falls to the mid-term harvest level of 74,000 m^3/year for another ten years. This harvest level is maintained for 35 years, after which it begins to rise to the long-term sustainable level of approximately 85,000 m^3/year. The average harvest level of the final 100 years of the planning horizon is 84,500 m^3/year. Figure 6.1 shows this harvest level pattern.

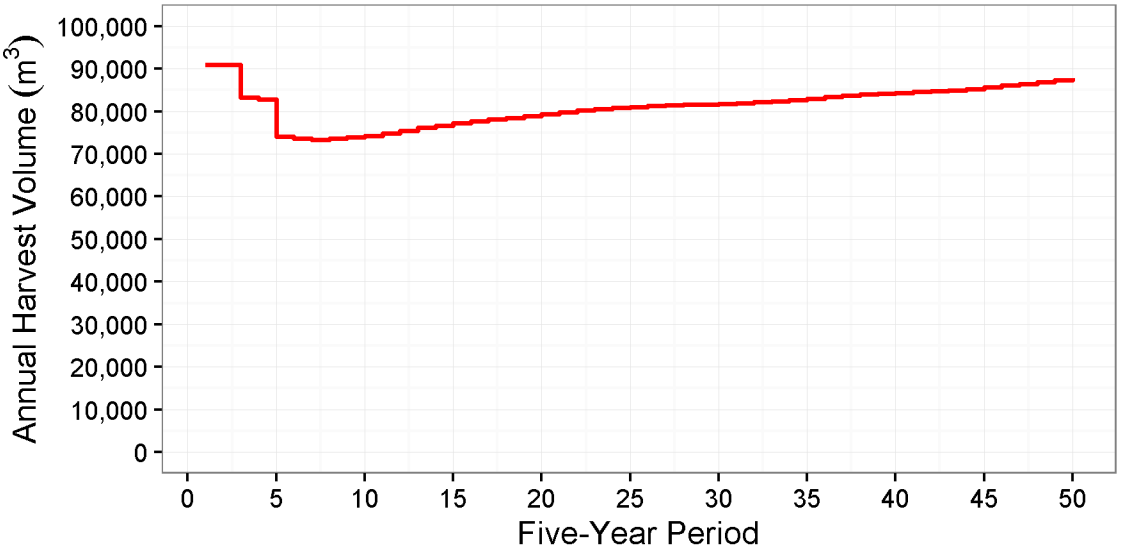

Figure 6.1 Annual Harvest Volume (m^3/year)

The ability to maintain the current harvest level is inextricably linked to estimates of current inventory volumes. The sensitivity run presented in Section 7.3.2 is based on the inventory volume estimate used for MP4 and shows a more optimistic view of short term timber supply.

In order to prevent the harvest scheduling model from depleting the growing stock levels at the end of the planning horizon, a minimum growing stock constraint was placed on the inventory volume on the THLB in the final five year period of the planning horizon. The normal growing stock (assuming an even age class distribution on the THLB from zero up to the MHA for each stand) was calculated. This value of 2.1 million cubic metres was set as the minimum growing stock that must remain at the end of the planning horizon. Figure 6.2 shows this growing stock pattern.

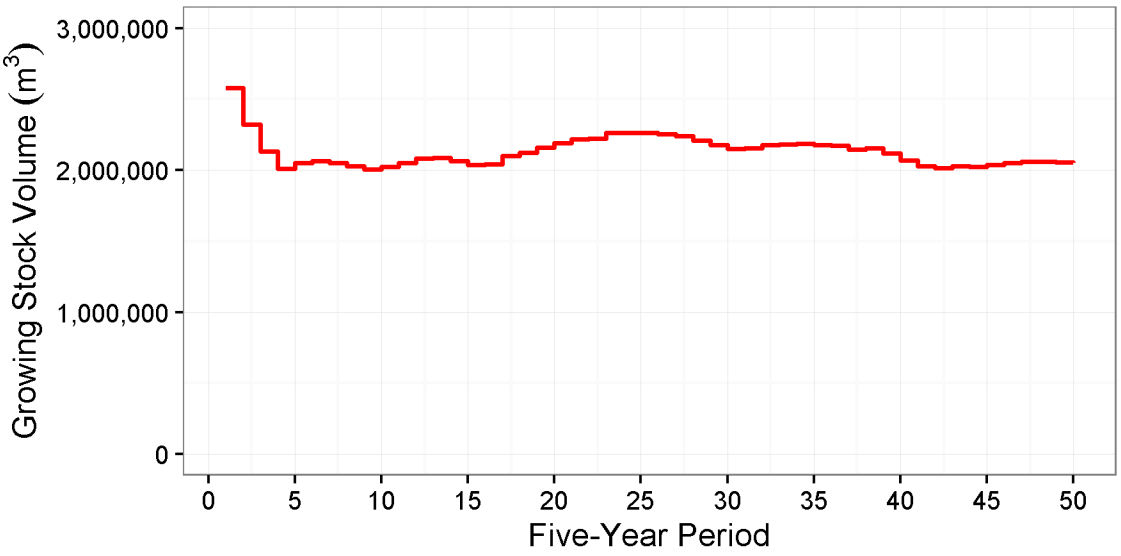

Figure 6.2 Growing Stock (m^3) on the THLB

Figure 6.3 shows how the age class distribution on the THLB changes over the planning horizon.

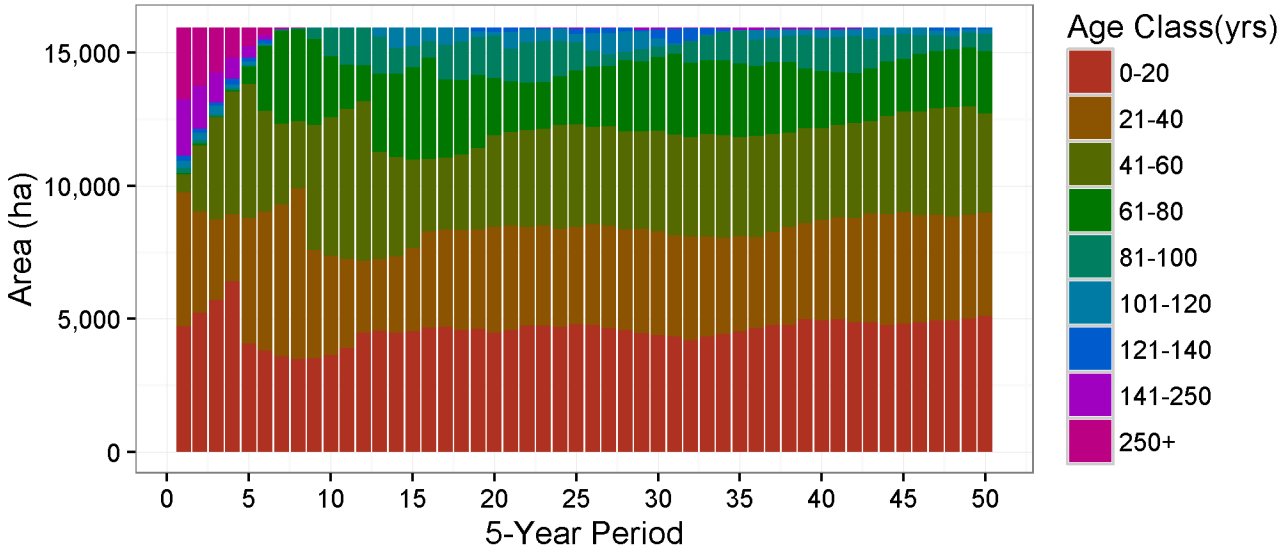

Figure 6.3 Age Class Distribution of the THLB

Over-mature stands (i.e. above MHA) are harvested over the first 35 years of the planning horizon. The area in the youngest age class increases while the harvest level is elevated, and the falls as the harvest level declines through the mid-term. After 50 years, the age class distribution is well-balanced for the remainder of the planning horizon.

Three harvest statistic summaries are particularly useful and commonly examined when considering timber supply dynamics for a forest tenure: average annual harvest area, average volume per hectare

harvested, and average harvest age. Changes in these parameters over the entire planning horizon are presented in the following three charts.

The average annual harvest area is 194 hectares over the entire 250-year planning horizon. The lowest annual harvest area is 169 hectares in period 7. Figure 6.4 shows these trends. Annual harvest area is high initially as the model targets lower volume old growth stands for conversion to higher-performing managed stands - the strategy that will maximize yield over the long term. Annual harvest area in the first five-year period is 266 hectares – and averages 246 hectares over the first ten years. It declines over the next four periods to the long-term average of approximately 191 hectares per year, as shown in Figure 6.4.

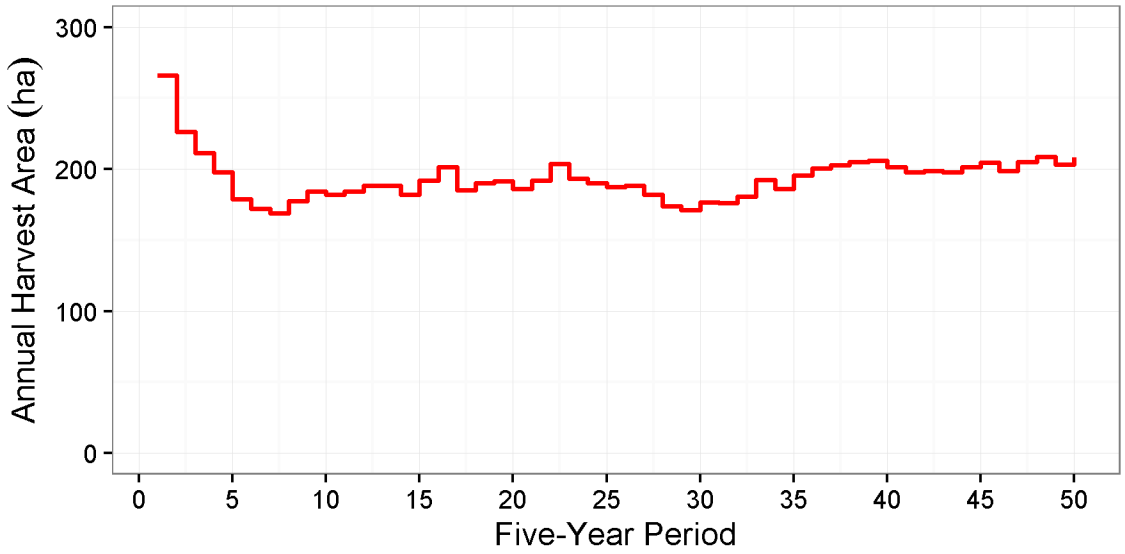

Figure 6.4 Average Annual Area Harvested (ha)

Annual harvest age is high initially as old growth timber on the THLB is logged. Average harvest age is 216 years for the first 30 years and then falls to a fairly stable level of 82 years for the remainder of the planning horizon (see Figure 6.5).

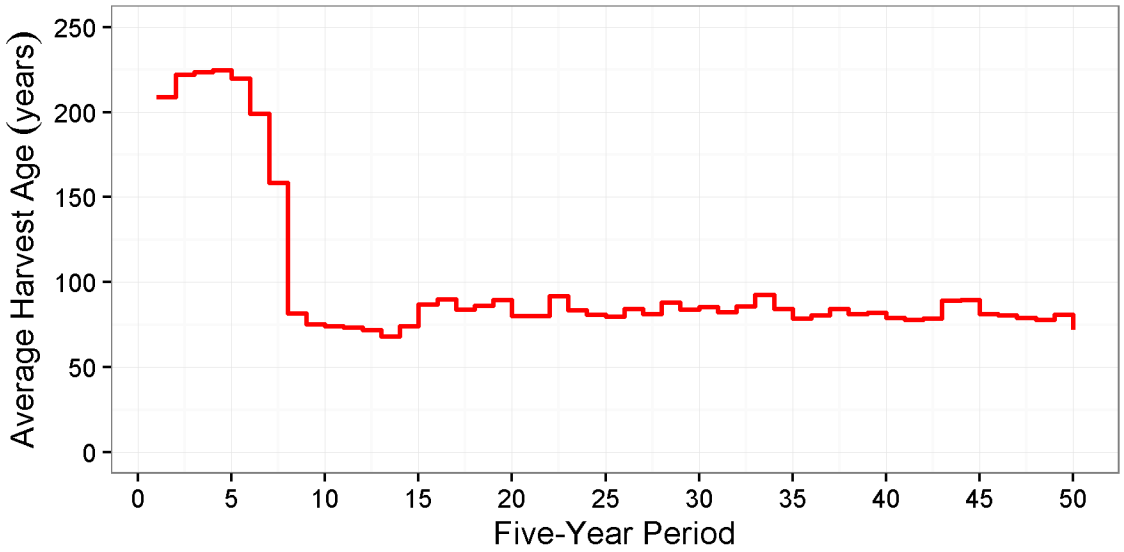

Figure 6.5 Average Harvest Age (years)

The higher initial harvest level is consistent with the age distribution of stands harvested over the past ten years, as shown in Table 6.1.

Table 6.1 Harvest Age Distribution – Last Ten Years

	Harvest Area (ha)					
	Age Class (Years)					
Year	<100	101-120	121-140	141-250	>250	Total
2015	2		13	80	119	213
2014	13		16	99	132	260
2013		3		104	159	267
2012		1	0	63	83	147
2011		34		70	41	146
2010	10	16	15	208	20	269
2009	1			80	20	101
2008		2		87	2	91
2007	3	30		98	8	138
2006		6		106	29	141
Distribution	2%	5%	2%	56%	35%	

Figure 6.6 shows how the average volume per hectare harvested varies over time. It is slightly above 336 m^3/hectare initially, and climbs to 435 m^3/hectare by period 7. It is stable for the remainder of the planning horizon, ranging between 386 and 476 m^3/hectare. The average over this period is 424 m^3/hectare.

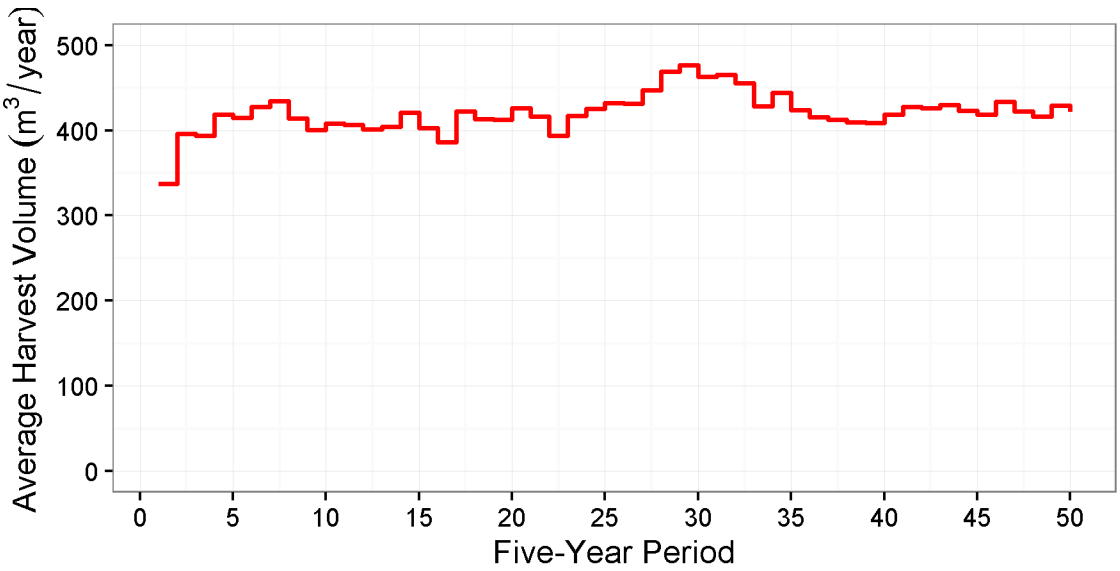

Figure 6.6 Average Harvest Volume (m^3/ha)

The harvest volume-per hectare is depressed at the start of the planning horizon as older, low-volume stands are converted to faster-growing managed stands. This support one of the model objectives – to maximize harvest volume over the entire planning horizon. Although the first-period harvest volume per hectare is low, it is not outside the range of harvest volume realized over the past ten years, as shown in Table 6.2.

Table 6.2 Harvest Area and Volume – Last Ten Years

Year	Volume (m^3)	Area (ha)	Volume (m^3/ha)
2015	81,202	213	381
2014	104,413	260	402
2013	122,186	267	458
2012	69,732	147	474
2011	61,368	146	421
2010	89,163	269	331
2009	43,159	101	428
2008	43,729	91	481
2007	58,812	138	426
2006	71,916	141	511
Total	745,680	1,773	421

The species composition of the harvest for the first six five-year periods is shown in Figure 6.7.

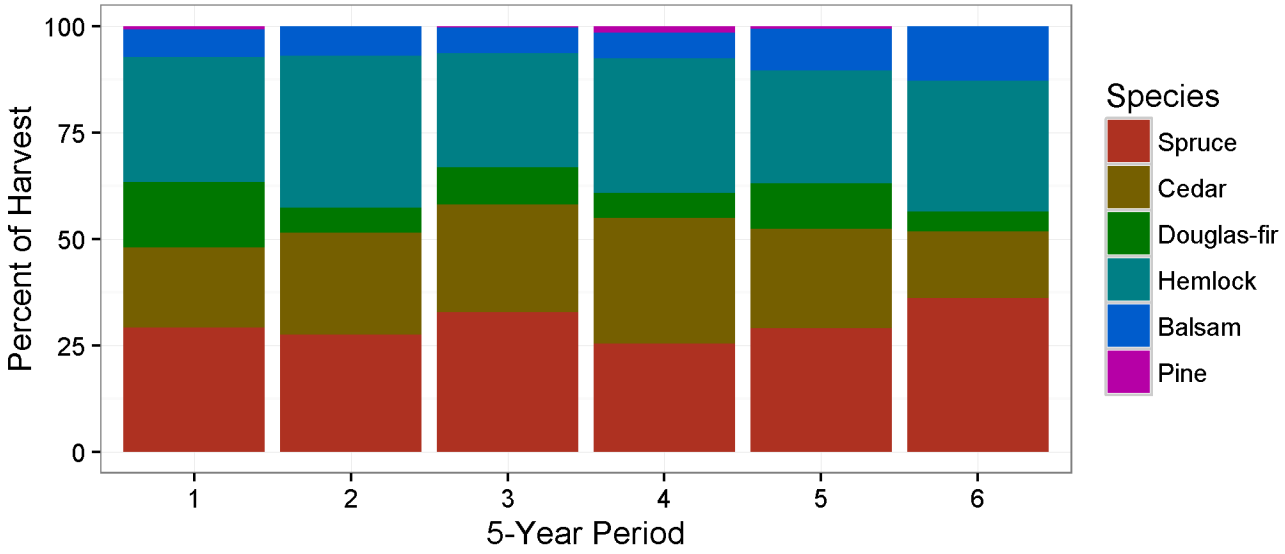

Figure 6.7 Harvest Species Composition by Period (%)

For comparison, the harvest species composition over the past ten year is summarized in Table 6.3.

Table 6.3 Harvest Species Composition – Last Ten Years

Year	Balsam	Cedar	Douglas-fir	Hemlock	Spruce	Pine
2015	22	25	3	20	30	0
2014	7	41	8	24	18	2
2013	8	44	2	18	27	1
2012	5	39	10	27	18	1
2011	12	30	12	26	19	1
2010	2	27	8	19	34	0
2009	4	19	2	40	35	0
2008	17	5	2	23	53	0
2007	2	38	4	40	15	1
2006	1	36	4	25	34	0

The only non-timber resource targets implemented in the base case are related to patch size. Patch size is managed by landscape unit. Patches in five seral categories (shrub/herb, pole/sapling, young, mature and old) are tracked, but targets are enforced for the first (shrub/herb) and last (old) seral stages only. Four patch size class targets are defined for each landscape unit / seral category. Figure 6 shows the patch size distribution over time for shrub/herb patches in the R17 LU. For each period, the percentage of area in each of the four patch size categories sums to 100%. The unshaded area of each of the charts indicates the target range. The ‘0 to 40 ha’, ‘80 to 250 ha’ and ‘> 250 ha’ targets are met for most of the planning horizon. The model has difficulty assembling ‘40 to 80 ha’ patches.

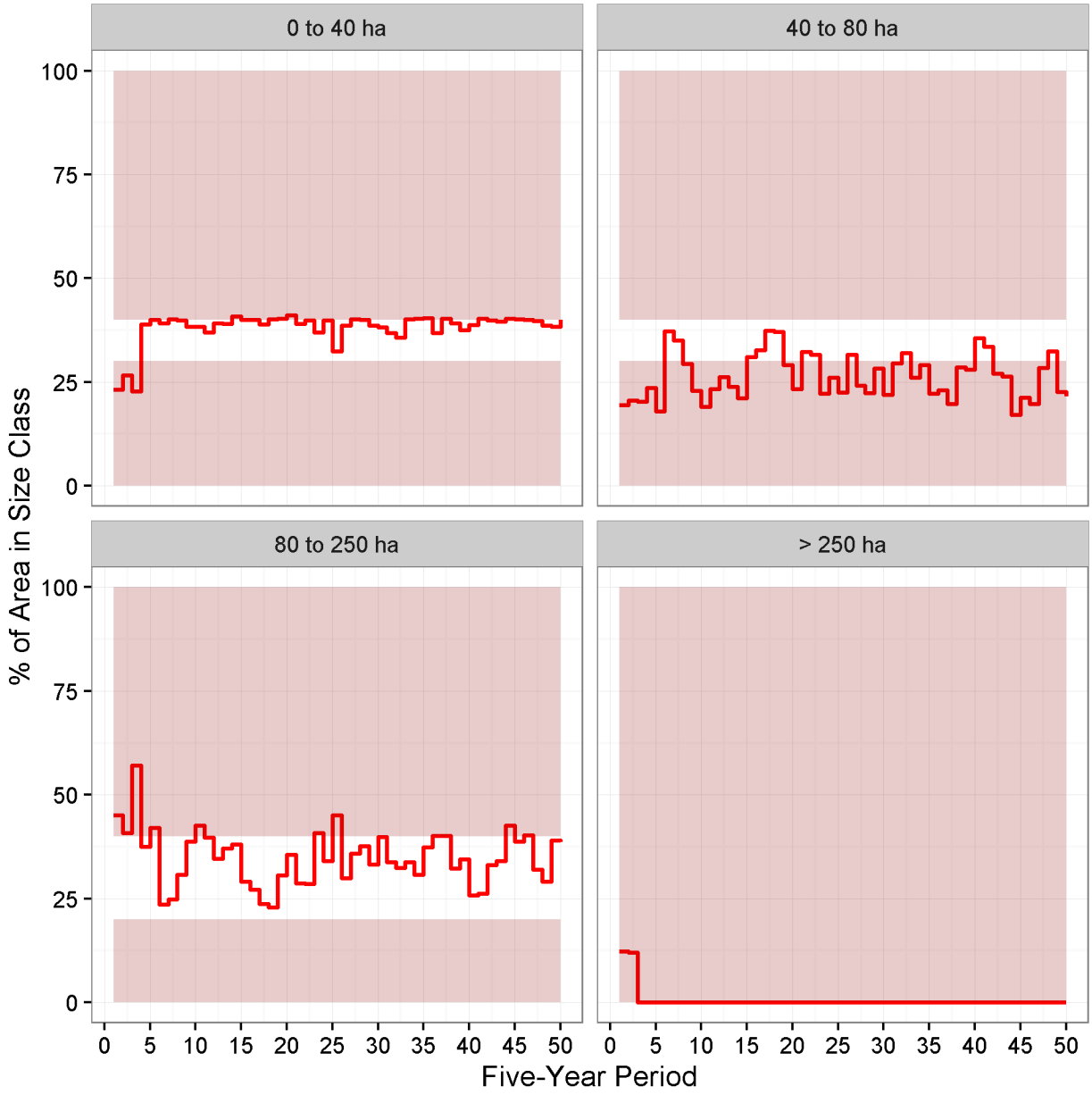

Figure 6.8 'Shrub/Herb' Patch Size Distribution in the R17 Landscape Unit (%)

Old patch targets in the R17 LU are not met. This is due to the fact that very little of the LU is THLB. Over the planning horizon, most of the productive area ends up in large, old patches, as shown in Figure 7. This is inevitable, and not necessarily a forest management problem.

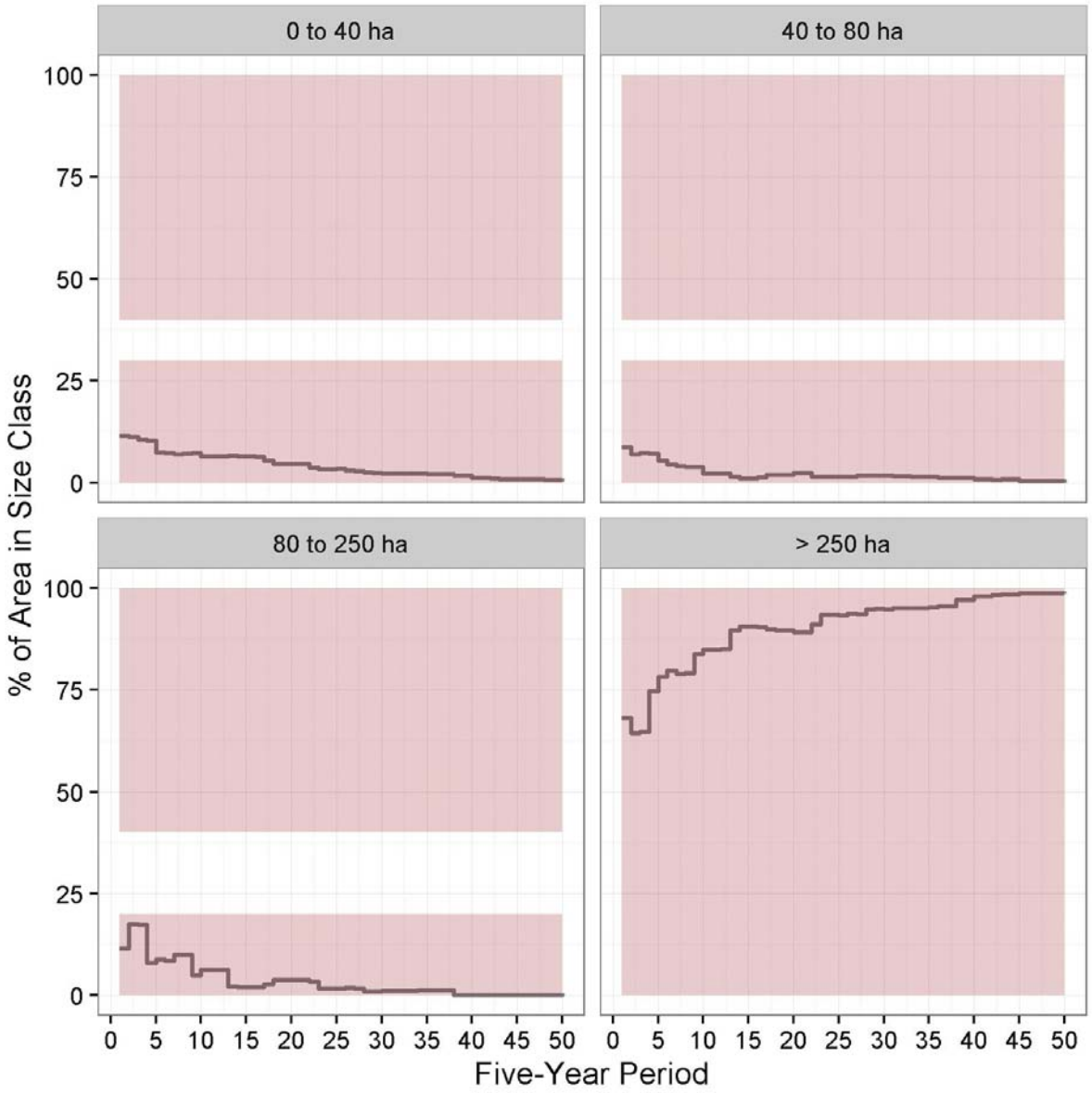

Figure 6.9 'Old' Patch Size Distribution in the R17 Landscape Unit (%)

The pattern for 'shrub/herb' patches in the R5 LU is similar to that seen in R17. '0 to 40 ha', '80 to 250 ha' and '> 250 ha' patch targets are met, and the '40 to 80' target is close, as shown in Figure 8

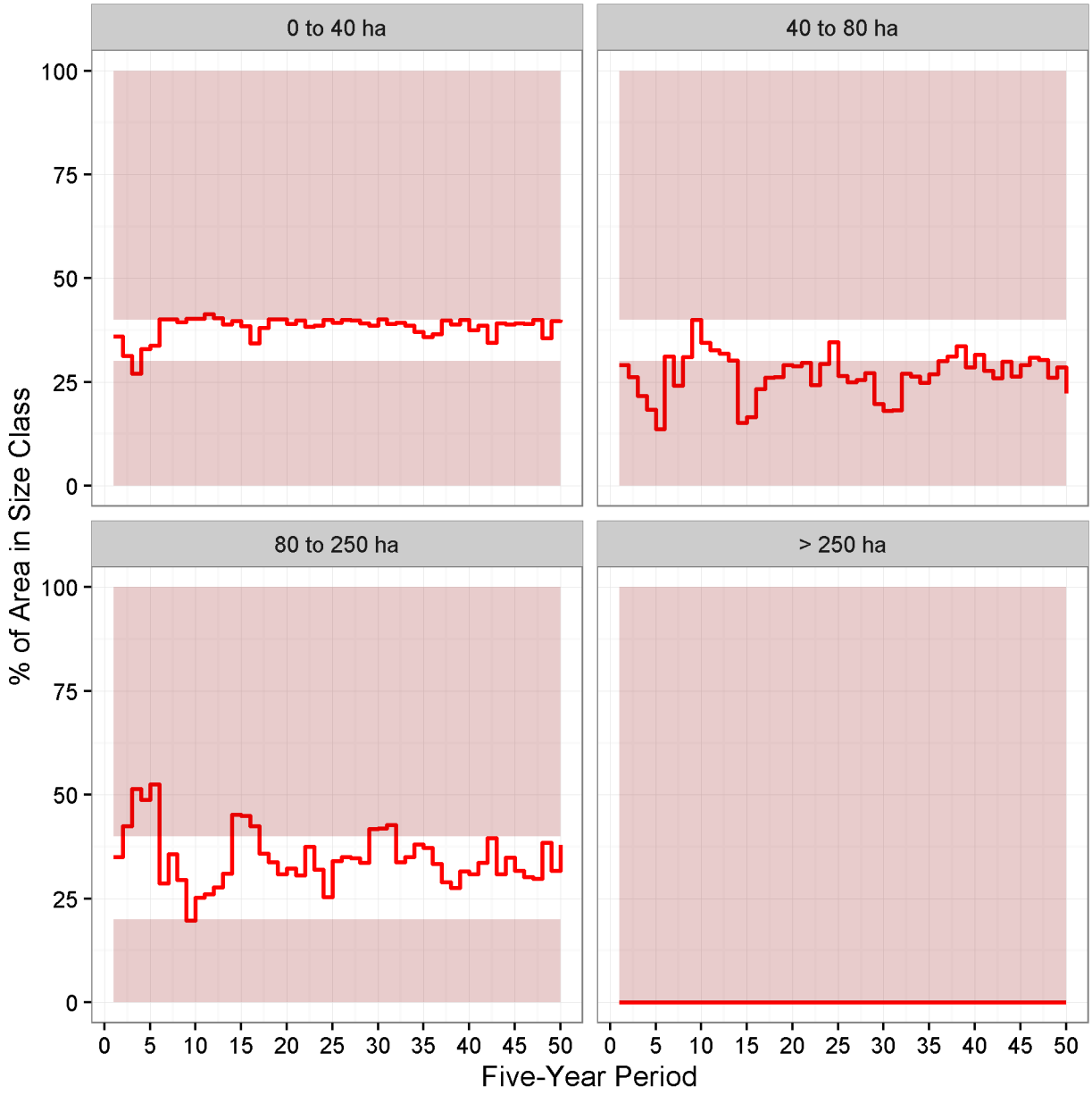

Figure 6.10 'Shrub/Herb' Patch Size Distribution in the R5 Landscape Unit (%)

The problem with mature patch management in R5 is also similar to that seen in R17 - but it is not as severe. The greater proportion of THLB in this LU provides flexibility to create patches less than 250 hectares in size (see Figure 9).

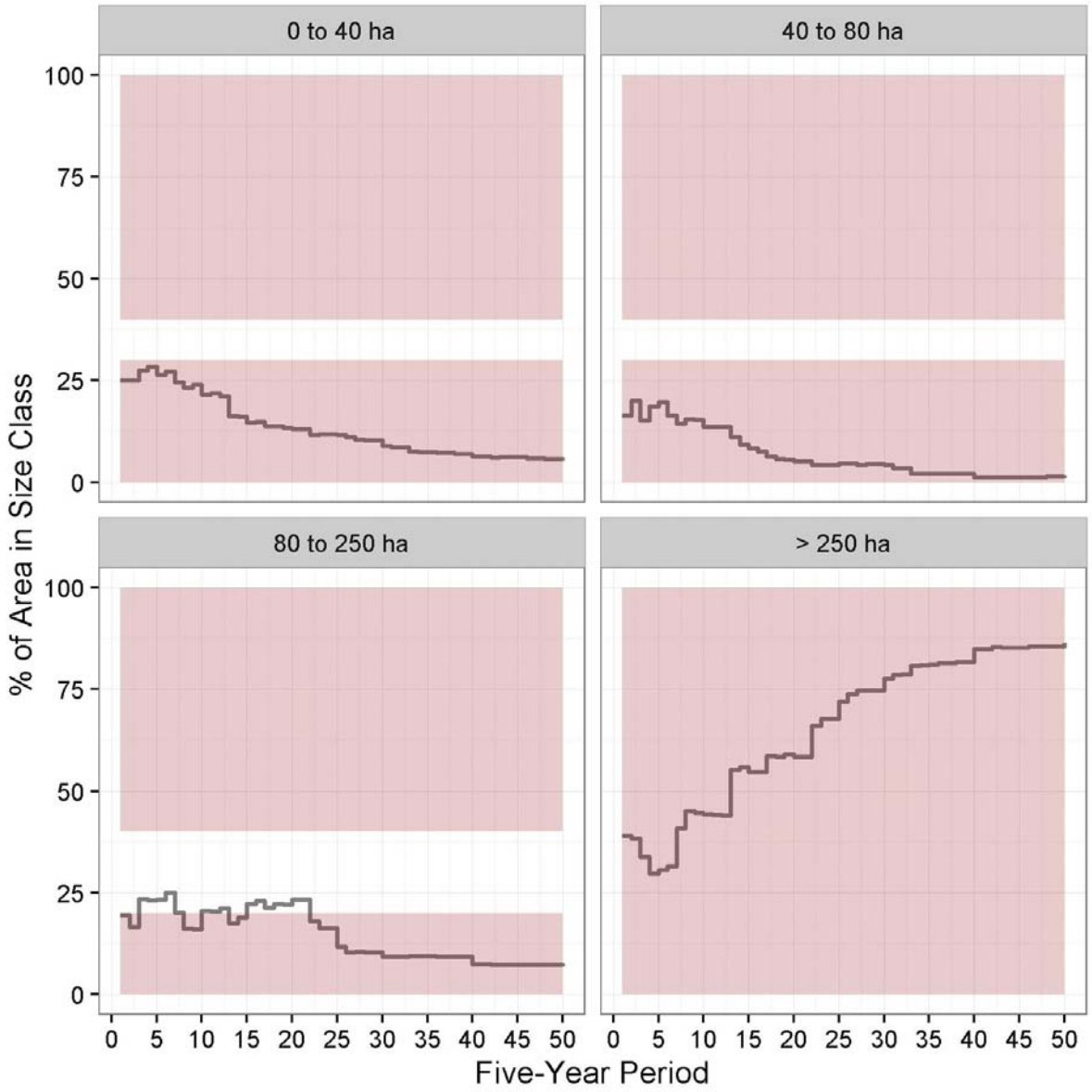

Figure 6.11 'Old' Patch Size Distribution in the R5 Landscape Unit (%)

7.0 Sensitivity Analysis

Sensitivity analysis provides a measure of the upper and lower bounds of the base case harvest forecast that reflects the uncertainty in the data and/or the management assumptions made in the base case. The magnitude of the increase and decrease in the sensitivity variable reflects the degree of uncertainty surrounding the assumption associated with that specific variable. This provides a way to gauge the extent to which the base case harvest level and other statistics might change with changes to input data and assumptions.

Table 7.1 summarizes the sensitivity analyses that will be performed for this analysis. For each scenario the data use and assumptions made will be documented.

Table 7.1 Sensitivity Analysis Runs

Scenario
Alternative Harvest Flow
Timber harvesting landbase +/- 5%
Natural stand yields +/- 10%
Managed stand yields +/- 10%
Minimum harvest ages +/- 10 years
Minimum harvest ages at 60 and 70 years
Increase / decrease genetic gains
Use SIA instead of SIBEC
Use VRI site index instead of SIBEC
Managed stand SI +/- 1 m
Add VRI Phase 2 Adjustment (VDYP 6)
IRM green-up constraint instead of patch size

7.1 Alternative Harvest Flow

Two alternative harvest flow variations of the base case have been run. The first finds the highest non-declining harvest level that can be sustained and continues it for as long as possible. Both scenarios result in lower short-term and higher medium-term harvest levels, but do not change the long-term timber supply situation. These results are shown in Figure 7.1.

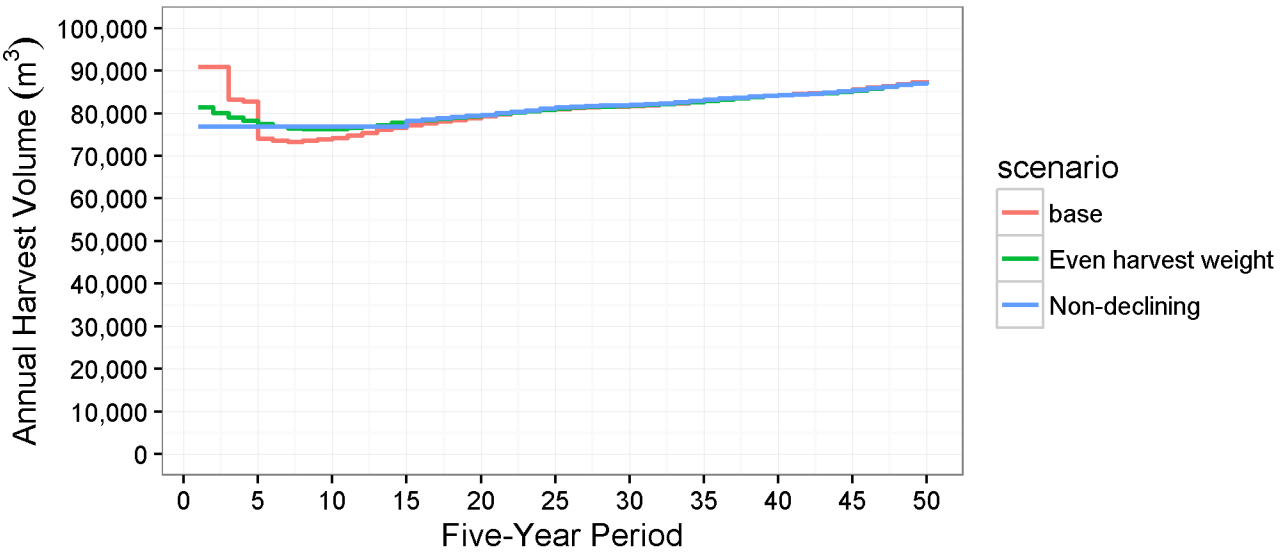

Figure 7.1 Alternative Harvest Flow

7.2 Timber Harvesting Land Base

The timber harvesting land base determined for the base case was 16,007 hectares. While this represents the best estimate of the portion of the land base on which forest operations are feasible in the long term, the true value cannot be known with great precision. To test the potential impact on timber supply of this uncertainty, the THLB was increased and decreased by 5%. The size of the productive, non-contributing land base was adjusted accordingly so that the total productive area of the TFL did not change. Figure 7.2 shows how the harvest level changes with changes in the size of the THLB.

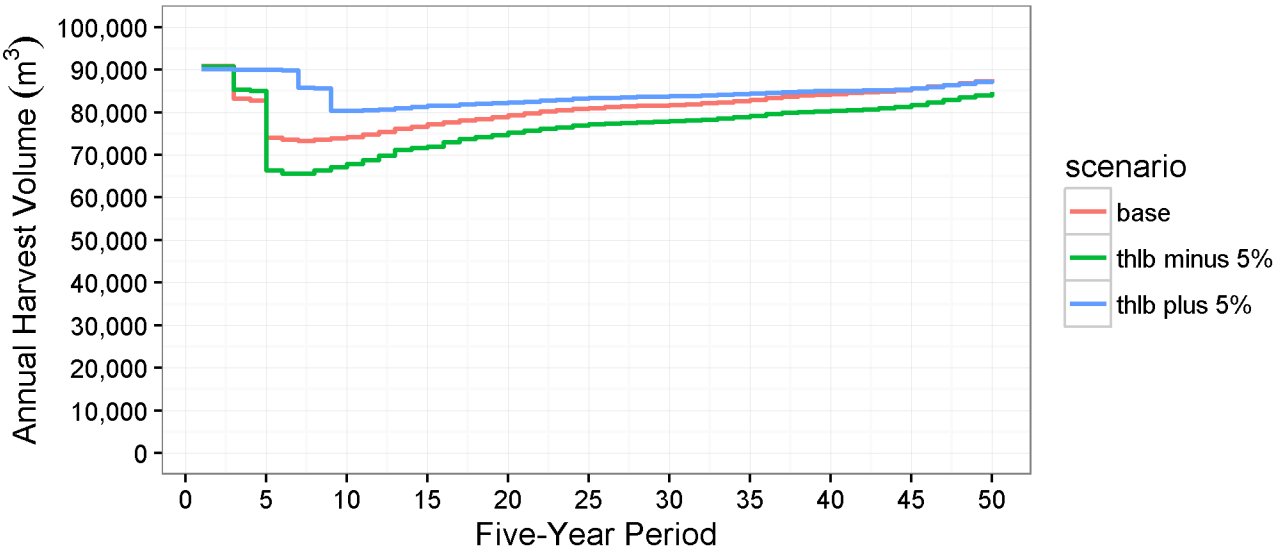

Figure 7.2 Harvest Level Impact of THLB Uncertainty

7.3 Stand Yield

Stand yields are developed from forest inventory data, silvicultural surveys and growth and yield model. Changes in stand yield assumptions can impact harvest levels in both the short and long term.

7.3.1 Natural Stands +/- 10%

Yield forecasts for natural stands were developed using VDYP7. If these yield estimates are increased and decreased by 10%, the harvest level changes as shown in Figure 7.3.

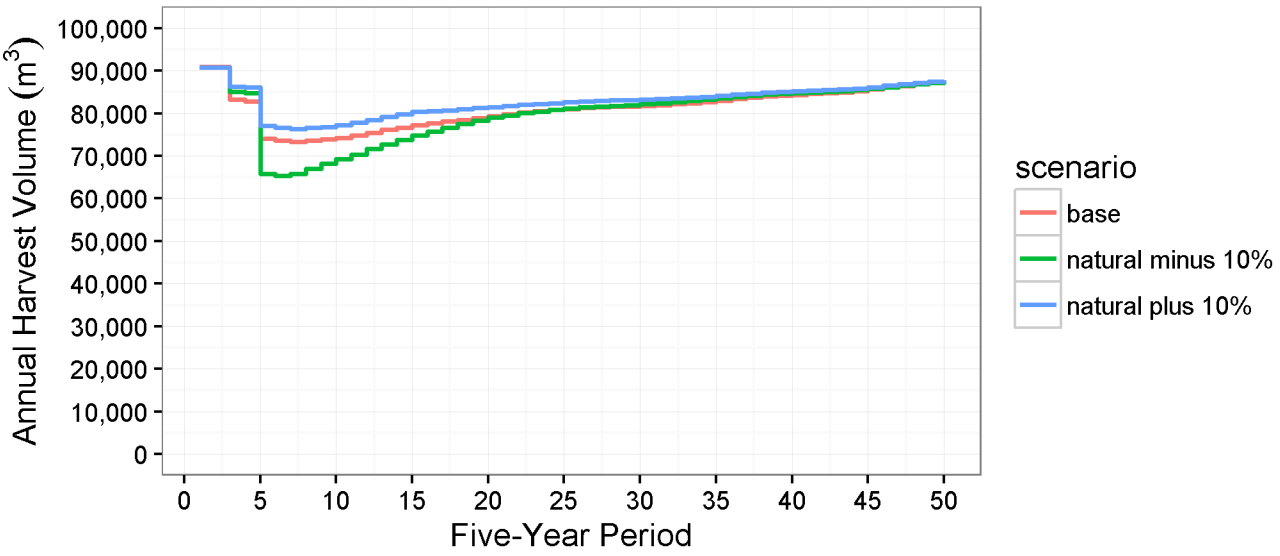

Figure 7.3 Harvest Level Impact of Natural Stand Yield Uncertainty

7.3.2 Natural Stands – VDYP Phase 2

There is considerable uncertainty regarding the current growing stock volume on TFL 55. As noted, the base case has been run using natural stand yield curves compiled with VDYP7. No Phase 2 adjustment has been applied. When the VDYP7 curves are replaced by Phase 2-adjusted VDYP6 yield curves, the short-term timber supply picture improves significantly. It is possible to maintain the current harvest level for 30 years before stepping down the mid-term harvest level. The long-term harvest levels are similar because both scenarios rely on the same managed stand yield tables.

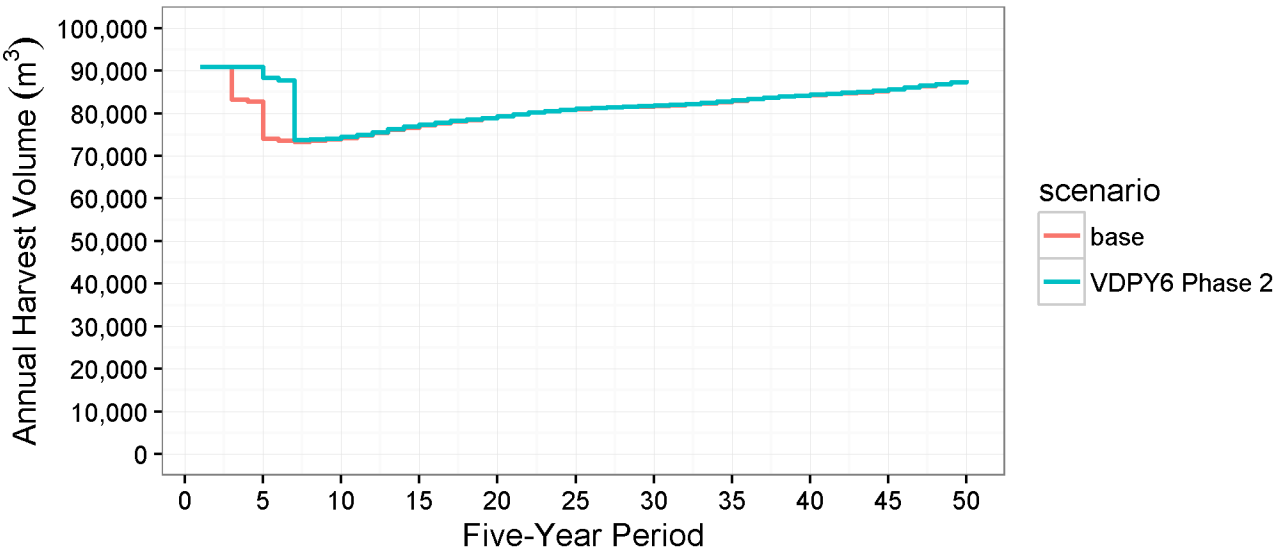

Figure 7.4 Harvest Level with VDYP6 Phase 2

7.3.3 Managed Stands +/- 10%

Managed stand yield estimate are compiled using BatchTIPSY Version 4.3. Changes in assumptions about managed yields (for both existing and future managed stands) to not have an immediate impact on harvest levels; their impact is seen in the medium and long term when those stands contribute to the harvest flow.

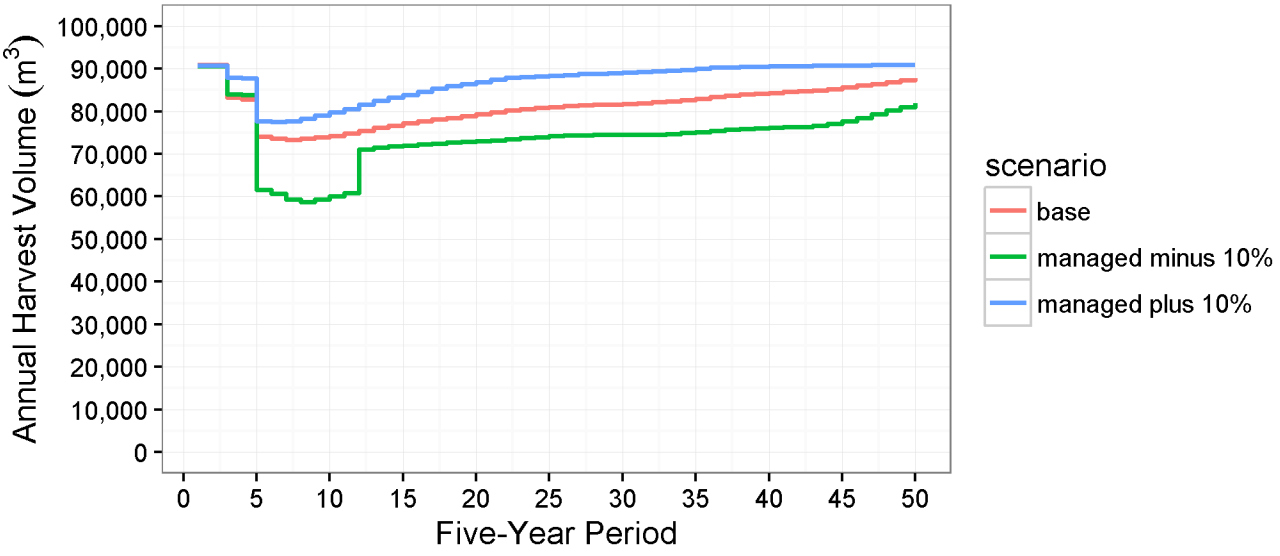

Figure 7.5 Harvest Level Impact of Managed Stand Yield Uncertainty

7.3.4 Genetic Gain

One of the inputs required to forecast the yields for future managed stands is an estimate of the genetic gain that will be realized on crop trees that originate from select seed. If assumed genetic gain is increased and decreased by 5%, the future harvest flow changes as shown in Figure 7.6

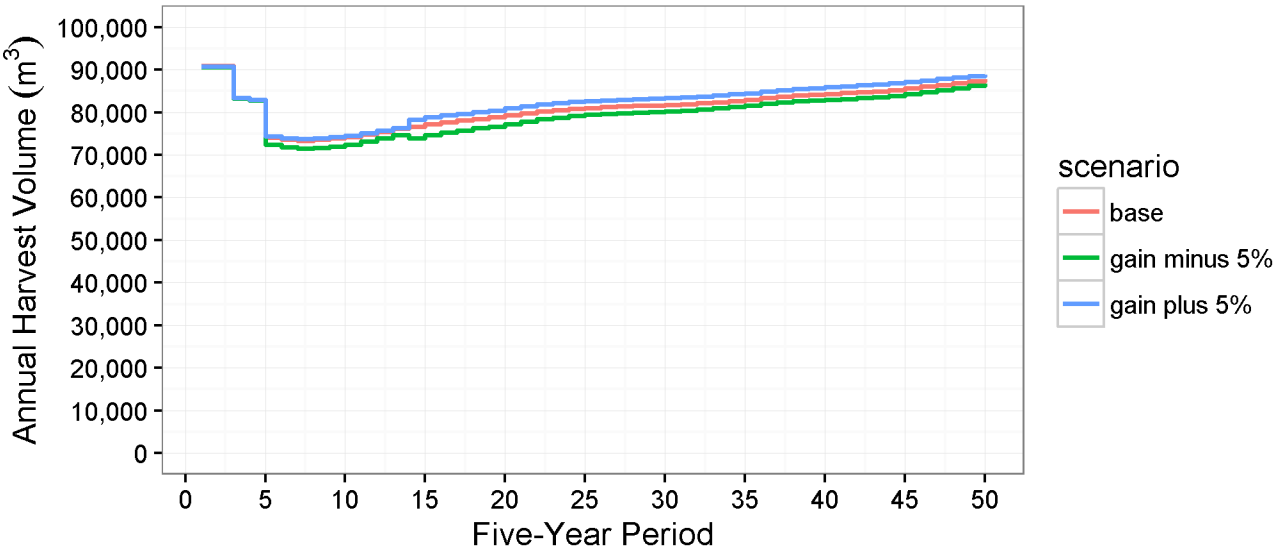

Figure 7.6 Harvest Level Impact of Genetic Gain Assumptions

7.4 Site Productivity

Site productivity is the major determinant of harvest levels in the long term. For the base case, VRI site index was used for natural stands (all stands that regenerated in 1970 or earlier) and SIBEC was used to develop managed stand yield tables. This set of sensitivity analyses examines the impact of changes in site productivity assumptions on harvest flow.

7.4.1 PSI Instead of SIBEC Site Index

Louisiana Pacific undertook a site index adjustment project in 2005. J. S. Thrower and Associated Ltd. completed the fieldwork and analysis. Preliminary potential site index (PSI) estimates – by site series – were developed based on expert knowledge of site productivity on the TFL. Field plots were established in the ICHvk1, ICHwk1 and ESSFvc BCG variants. Using this data, a ratio adjustment as developed applied to the starting 'expert' PSI estimates. These PSI estimates – unlike other site productivity estimates that could be use – are based on field data gathered on the TFL.

The impact of using PSI estimates in place of SIBEC is shown in Figure 7.7. Harvest levels in the latter half of the planning horizon are increased by between 6 and 8 percent..

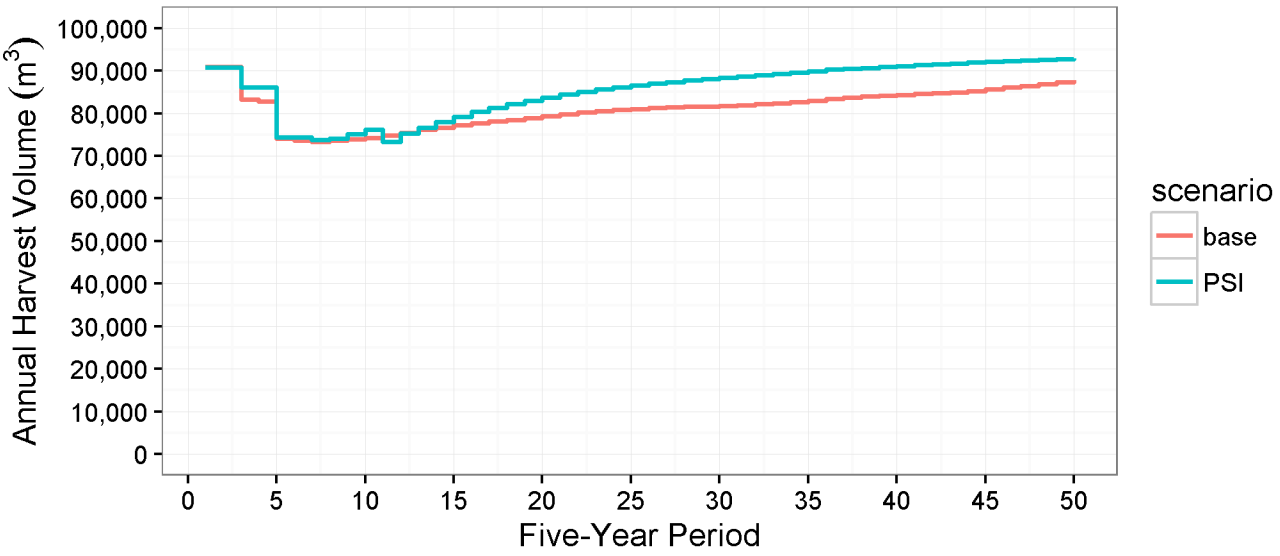

Figure 7.7 Harvest Level Impact of Using PSI for MSYT

7.4.2 VRI SI Instead of SIBEC

If VRI site index is used is place of SIBEC as a source of managed stand site productivity estimates, the impact on long-term timber supply is significant.

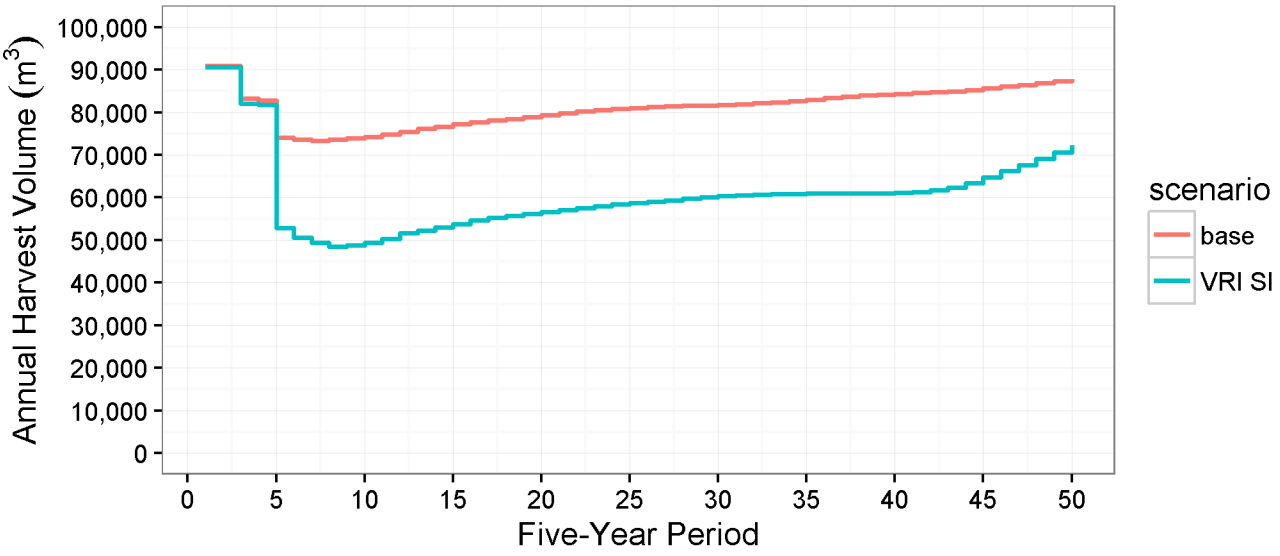

Figure 7.8 Harvest Level Impact of Using VRI SI for MSYT

7.4.3 Managed Stand SI +/- 1 m

To more clearly understand the impact of site productivity estimates on manage stand yield, site index was increase and decrease by 1 metre. The increase did not improve the timber supply situation significantly, but is decrease in site index adversely affects the mid-term timber supply, as shown in Figure 7.9.

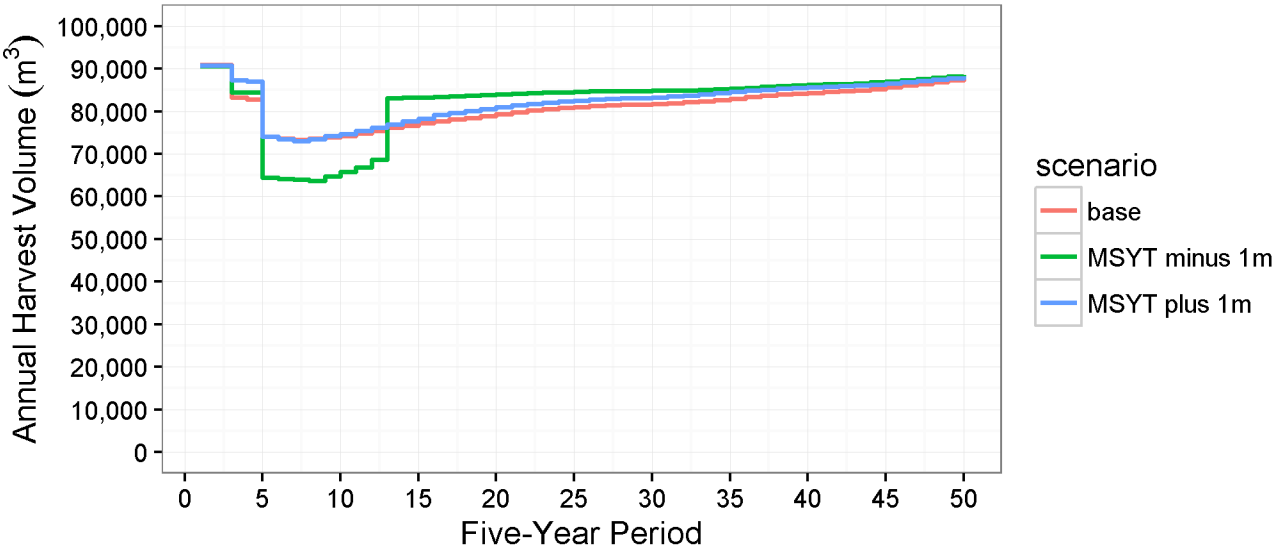

Figure 7.9 Harvest Level Impact of MSYT SI Variation

7.5 Management Assumptions

Since most the of non-timber resource values on TFL 55 are satisfied from stands outside of the THLB, few variations in management assumptions need to be explored. Two are presented here: the elimination of patch targets and changes in minimum harvest age assumptions.

7.5.1 IRM Instead of Patch Size

Harvest planning on TFL 55 is directed to achieving a target patch size distribution. The base case results show that, for the most part, those patch size target are being achieved. However, timber supply planning for most other forest tenures uses an integrated resource management constraint to distribution harvesting for strategic planning purposes. For this sensitivity run, patch size targets have been dropped and replaced with an IRM constraint. As Figure 7.10 shows, this change has virtually no impact on timber supply.

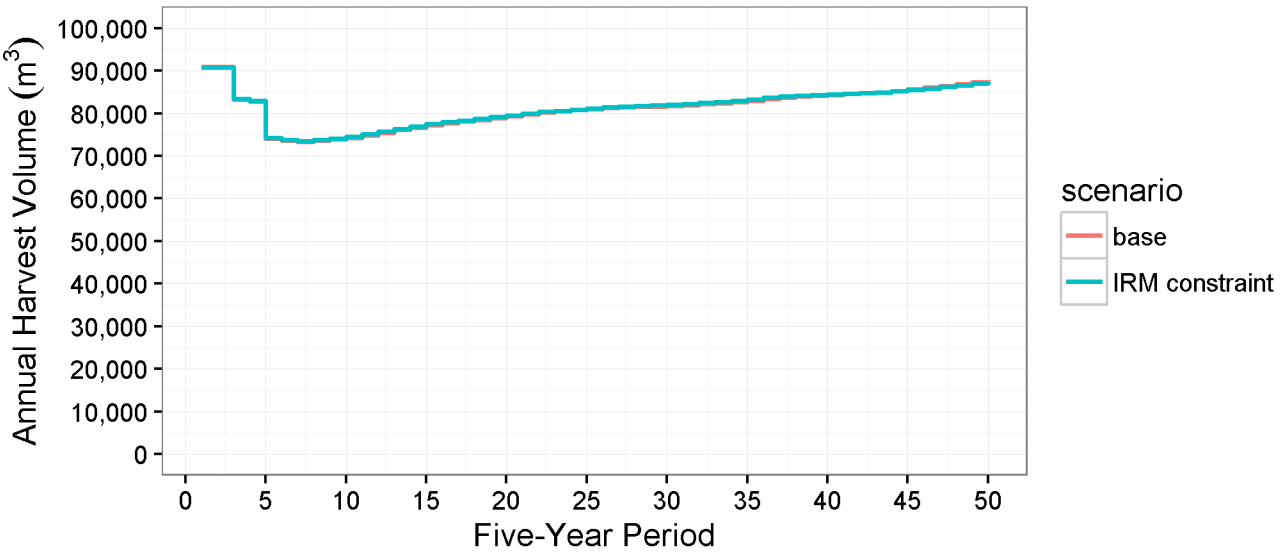

Figure 7.10 Harvest Level Impact – IRM Instead of Patch Size

7.5.2 Minimum Harvest Age Assumptions

Minimum harvest ages were varied (plus / minus 10 years) to gauge the impact on timber supply. Decreasing MHA does not affect harvest levels. However, increasing MHA by 10 years leads to a significant harvest shortfall in the midterm (after twenty years.) Figure 7.11 shows this pattern.

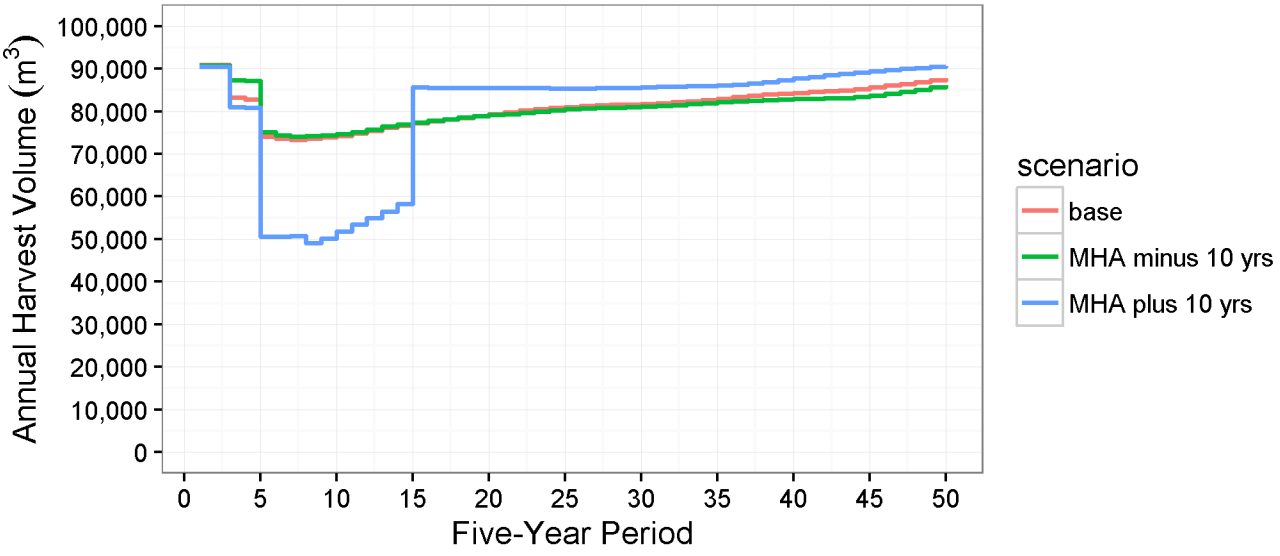

Figure 7.11 Harvest Level Impact of MHA 10-Year Changes

Sensitivity analyses with MHA fixed at 60 years and 70 years have also been completed. The results are shown in Figure 7.12

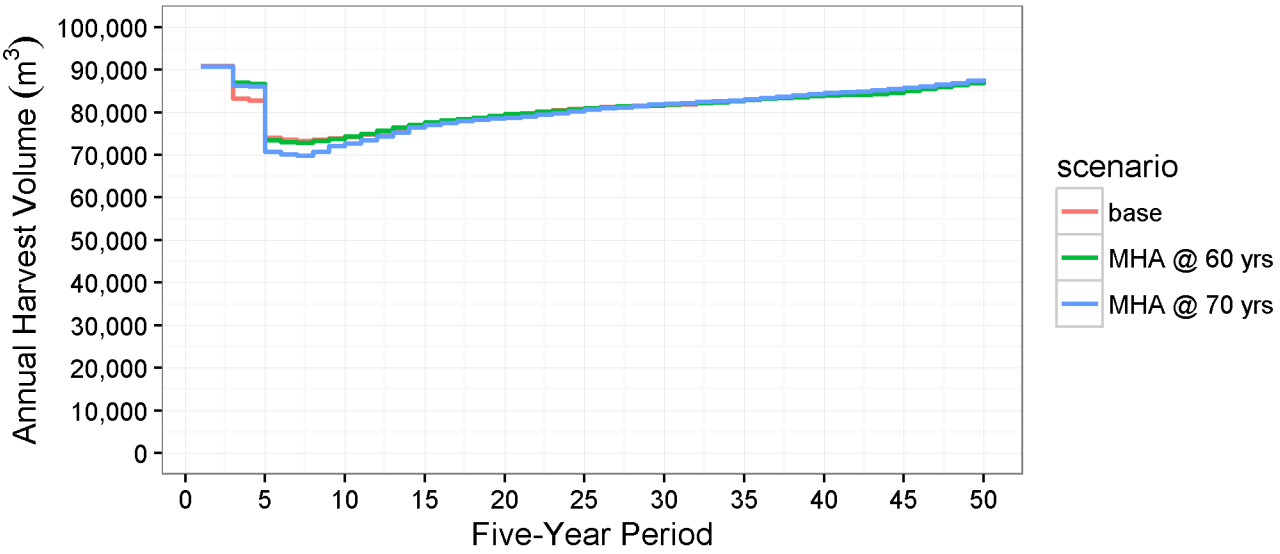

Figure 7.12 Harvest Level Impact of MHA at 60 and 70 Years

7.5.1 Preferred Inventory / Productivity Estimates

In an effort to better understand their land base and the forest that they manage, LP has invested in three significant data collection and analysis projects over the past 15 years - VRI Phase 2, potential site index, and CMI. The CMI project is a continuing effort with plot remeasurement scheduled for next year. The first to projects were undertaken to improve estimate of stand volumes and site productivity respectively. A separate sensitivity analysis was run for each of them. In this analysis, both adjustments have been applied. Natural stand volumes are based in Phase 2 adjusted VRI and managed stand yield tables are based on PSI. This improves timber supply in both the short and long term. This result is shown in Figure 7.13.

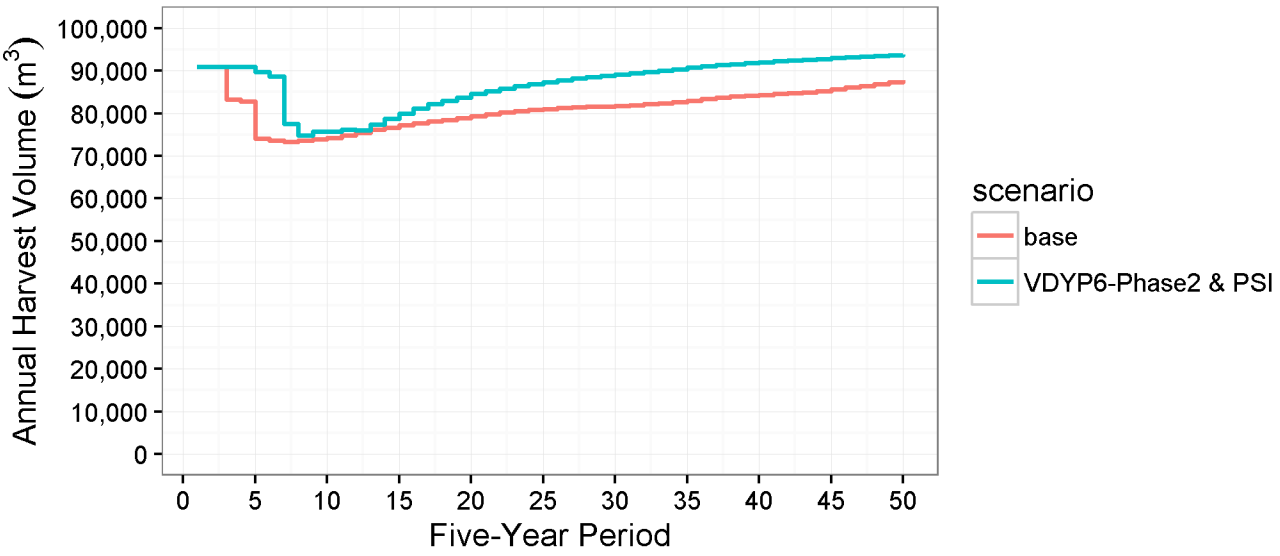

Figure 7.13 Recommended Harvest Scenario

8.0 Discussion of Results

The base case presented shows that a harvest level of 90,000 m^3/year is possible for the first ten years. This is a net harvest level after the allowance for non-recoverable losses has been taken into account. A review of the THLB growing stock trend and future age class distribution of the THLB shows that the initial harvest level is justified. An excess of older growing stock is harvested over the first thirty years of the planning horizon. After that point, the age class distribution is well-balanced. The growing stock at the end of planning horizon (2.1 million cubic metres) is sufficient to support continued operations at the sustainable long-term harvest level of 85,000 m^3/year.

Summary statistics of the harvest profile were compiled and presented. Average harvest age falls sharply as over-mature growing stock is harvest. The long term average harvest age of 82 years is slightly above the area-weighted average MHA of 80.3 years. Average harvest volume per hectare is slightly depressed initially (a modelling artifact that that can easily be managed on the ground) and is stable at operationally realistic levels.

The base case long-term harvest level is slightly higher than the LSRY calculated based on the future managed stand yield tables. This is the result of an initial age class distribution that is skewed to older stands, the absence of non-timber resource constraints within the THLB, and a slight drawdown in growing stock levels at the end of the planning horizon. For these reasons, the long-term harvest level presented in the base case might be slightly aggressive. Correcting for this overestimate would have no impact on short- and medium-term harvest levels.

The timber harvesting land base is much reduced from the analysis for the previous MP (MP4 in 2007). Although the previous THLB was larger, there were 5,601 hectares of age class 8 and 9 stands (i.e. older than 140 years) within THLB reserved aspatially for mountain caribou habitat. In MP 5 the

Mountain Caribou GAR order increased and spatialized caribou reserves for an area removal of 6,362 ha from the THLB. This reduction has impacted the ability to maintain the current AAC.

Landscape level biodiversity and caribou habitat are the primary non-timber resource objectives for which TFL 55 is managed. These are protected through removals from the THLB – OGMA's and the mountain caribou reserves (mentioned above) respectively. Consequently, relative to other forest management areas (Timber Supply Areas and TFL's), the THLB portion of TFL 55 is not heavily relied upon to meet other resource objectives. The harvest flow is regulated by the level of available growing stock above minimum harvest age. This is most constraining in the midterm – after the existing old growth has been exhausted and harvesting moves into the oldest of the existing managed stands. This constraint can be seen in the slight midterm depression in average harvest age in Figure 6.5.

Patch size targets have been used in place of an IRM constraint for this analysis. The original intention was to implement patch size targets for both 'shrub/herb' and 'mature' seral classes. This proved impractical in the latter case. Much of the productive land base is outside of the THLB and is aging continuously. This lead to significant old seral area in large (> 250 hectare) patches – a category with a target of zero hectares. While this is not necessarily an adverse result, it made achieving the other patch targets impossible. Old seral patch size performance is shown for the base case for information only – they have not been used to limit harvesting in any way.

Target ranges were enforced for 'shrub/herb' patches. It is worth noting that the land base is currently quite close to the target ranges for all patch sizes. The model does a good job of maintaining the landscape close to the target patch size distribution. The only exception to this is the '40-80' hectare class. Although it is close – and is clearly impacting the harvest schedule – the 30% minimum area in this class is being missed (very slightly) for much of the planning horizon. A review of the '0-40' hectare class shows that the model is finding much area in smaller, disjointed blocks that cannot readily be aggregated into larger patches. This problem might be mitigated somewhat by relaxing the definition of adjacency for patch creation. A threshold distance of 50 metres was used for this analysis. A larger threshold distance would allow the model to more easily assemble disjointed blocks into larger patches and might, perhaps, alleviate the '40-80' hectare issue observed in the base case.

The patch size charts shown in the base case results suggest that patch size creation was significantly affecting the harvest schedule. It is a bit surprising therefore that the timber supply situation did not improve when the patch size targets were replaced with an IRM constraint.

The base case shows that the current harvest level can be maintained for only ten years. This is a significant departure from the last timber supply analysis. It indicated that a 90,000 m3/year harvest level could be easily maintained for thirty years. The primary source of the discrepancy between the two runs is the estimate of the current inventory volume. The previous analysis used VDYP6 to estimate natural stand yields – and applied the Phase 2 adjustment that was based on a significant amount of field work collected on the TFL. This analysis used the current version of VDYP – VDYP7. Changes in the way that it incorporates stocking (stems/ha, basal area versus crown closure) prevent the Phase 2 data from being employed to adjusted volume estimates. This has a significant negative impact on short-term timber supply.

The base case relies on SIBEC estimate of productivity for MSYT construction. This is the provincial standard. However, LP has separate estimates of productivity (Potential Site Index – or PSI) that are

the based on locally collected field data. A sensitivity analysis run using these PSI estimate shows an increase in long-term timber supply.

The base case shows that the current harvest level can be maintained for ten years. Sensitivity analyses suggest that in could be continued for at least an additional ten years. The use of PSI in place of SIBEC to build MSYT's show that the potential long-term timber supply is greater than the 85,000 m^3/year shown in the base case. Non-timber resource values are being managed primarily through removals from the THLB. LP is adequately managing patch size distribution and it does not appear to be significantly impacting timber supply. The base case, as presented, is a conservative view of timber availability on TFL 55

Appendix A

Harvest Volume / VDYP6 / VDYP7 Comparison

Harvest Volume Comparison - Billed vs. VDYP6 vs. VDYP7

Actual Billed		VYPD 6 with Phase 2 adjustment	VDYP 7 2012/2013 projected		
Cutting Permit	**volume (m3/ha)**	**volume (m3/ha)**	**volume (m3/ha)**		
62	416	552			
92	543	571	459		
94	512	498	400		
97	460	542	412		
98	415	419	324		
182	465	366	data not available		
183	622	418	369		
184	492	426	379		
241	446	488	data not available		
242	455	406	data not available		
243	457	524	407		
362	390	466	data not available		
392	433	443	364		
512	495	401	data not available		
513	355	434	364		
514	403	493	365		
516	334	314	171		
571	390	514	data not available		
602	322	277	411		
Average	432	447			
permits with VDYP 7 data	425	442	374		
THLB Age Class	THLB VDYP 7 volume (m3/ha)	Billed to VDYP 7 ratio			
All Mature 80-250 + years	375	1.15			
80-140 yrs	363				
140-250 yrs	354				
250+	402				
			Actual Vol to VDYP 7 Factor	Actual Est Mature Volume	Difference
MP 5 VDYP 7 : THLB 80 to 250 + age Volume		2,540,479	1.15	2,921,551	381,072
MP 5 VDYP 7 : THLB 80 to 250 + age Area(ha)		6,770			
therefore est vdyp 7 does not account for 381,000 m3 mature THLB volume					

Appendix B

Summary of Dead Potential Volume

Summary of Dead Potential Volume

		Volume (m3)									Volume (m3/ha)		
	Net Area (ha)	Fdi	Cw	Hw	Sx	Bl	Pw,Pl	Decid	Total (Net)	Dead Potential (Net)	Net	Net Live	Net Dead Potential
182	121.3	32,310	6,353	5,675	5,482	234	1,139	396	51,601	136	425	424	1
183	44.9	331	131	15		108			2,198	585	488	475	13
184	115.8	11,464	18,875	8,685	3,590	811	1,042		53,786	1,491	477	464	13
241	125.5	1,026	15,612	22,299	5,437	782	637	311	48,023	874	383	376	7
242	2.3		216	289	156		83	62	806	-	350	350	-
243	95.8		4,197	1,196	1,070				39,400	82	411	410	1
244	17.4		2,479	4,233	577				63,630	222	487	474	13
302	48								19,826	159	413	410	3
362	218.9	874	29,257	19,941	44,954	18,201			101,470	4,697	464	442	21
391	36.6			16	4,611	5,694			10,578	-	289	289	-
392	281.6	3,031	3,730	1,630	2,242	369			121,988	4,011	433	419	14
513	232.7	6,618	4,927	5,324	578	208			98,360	2,250	423	413	10
514	129.1	-	413	234	2,166	922			48,446	1,508	375	364	12
515	184.3								61,450	3,883	333	312	21
516	27	75	1,536		1,917				9,294	555	344	324	21
571	165.2	3,076	31,544	13,656	20,041	3,667	758		72,743	802	440	435	5
602	119			65	19,669	12,866			33,481	758	281	275	6
603	251				40,913	41,917			90,126	4,373	359	342	17
62	43.3		5,629	7,015	5,023	2,858			20,530	407	474	465	9
92	60.6		1,031	1,172	893				30,399	222	502	498	4
94	73.7	88	2,880	1,116	272			8	35,774	222	485	482	3
97	47.8	677	358						22,782	1,405	477	447	29
98	75.5			12,382	8,456	4,832			30,271	911	401	389	12
Total	**2,517**	**59,570**	**129,168**	**104,943**	**168,047**	**93,468**	**3,659**	**777**	**1,066,962**	**29,553**	**424**		**12**
													2.76%

APPENDIX B

Accepted Timber Supply Analysis Information Package

Tree Farm Licence 55 Management Plan #5 Information Package

Presented To
Louisiana Pacific – Malakwa Division

Dated: November 2016

Ecora File No.: KE_15_060

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Version Control and Revision History

Version	Date	Prepared By	Reviewed By	Notes/Revisions
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1.02	05/02/2016	Miehm	LP Staff	Corrections following LP review
1.03	17/02/2016	Miehm	MFLNRO	Final Edit prior to submission
1.06	15/11/2016	Miehm	LP Staff	Final submission

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Appendix B Site Index Adjustment Report
Appendix C Harvest Profile – 2007 to 2014
Appendix D OGMA Delineation Report
Appendix E Operability Report
Appendix F Road Buffer Report

Acronyms and Abbreviations

BEC	Biogeoclimatic Ecosystem Classification
CMAI	Culmination Mean Annual Increment
DBH	Diameter – Breast Height
DIB	Diameter Inside Bark
LP	Louisiana Pacific
LRSY	Long-run Sustained Yield
MAI	Mean Annual Increment
MFLNRO	Ministry of Forests, Lands and Natural Resource Operations
MP	Management Plan
MSYT	Managed Stand Yield Table
NDT	Natural Disturbance Type
NROV	Natural Range of Variation
NSYT	Natural Stand Yield Table
RHLPO	Revelstoke Higher Level Plan Order
SIA	Site Index Adjustment (J.S. Thrower and Associates Ltd.)
SIBEC	Site Index Estimates by BEC Site Series
TFL	Tree Farm Licence
THLB	Timber Harvesting Land Base
TIPSY	Table Interpolation for Stand Yields
VDYP	Variable Density Yield Prediction
VRI	Vegetation Resources Inventory
WTP	Wildlife Tree Patch

1.0 Introduction

Tree Farm Licence 55 (TFL 55) is located in the Selkirk Mountains between the Revelstoke Reservoir and Kinbasket Lake (see Figure 1.1). At the time that the last Management Plan (MP #4 in 2005) was completed, the total area of the TFL was 92,706 hectares. Of this total, 55,103 hectares was considered to be productive forest land, and 38.3% (22,341 hectares) of that was available for timber harvesting.

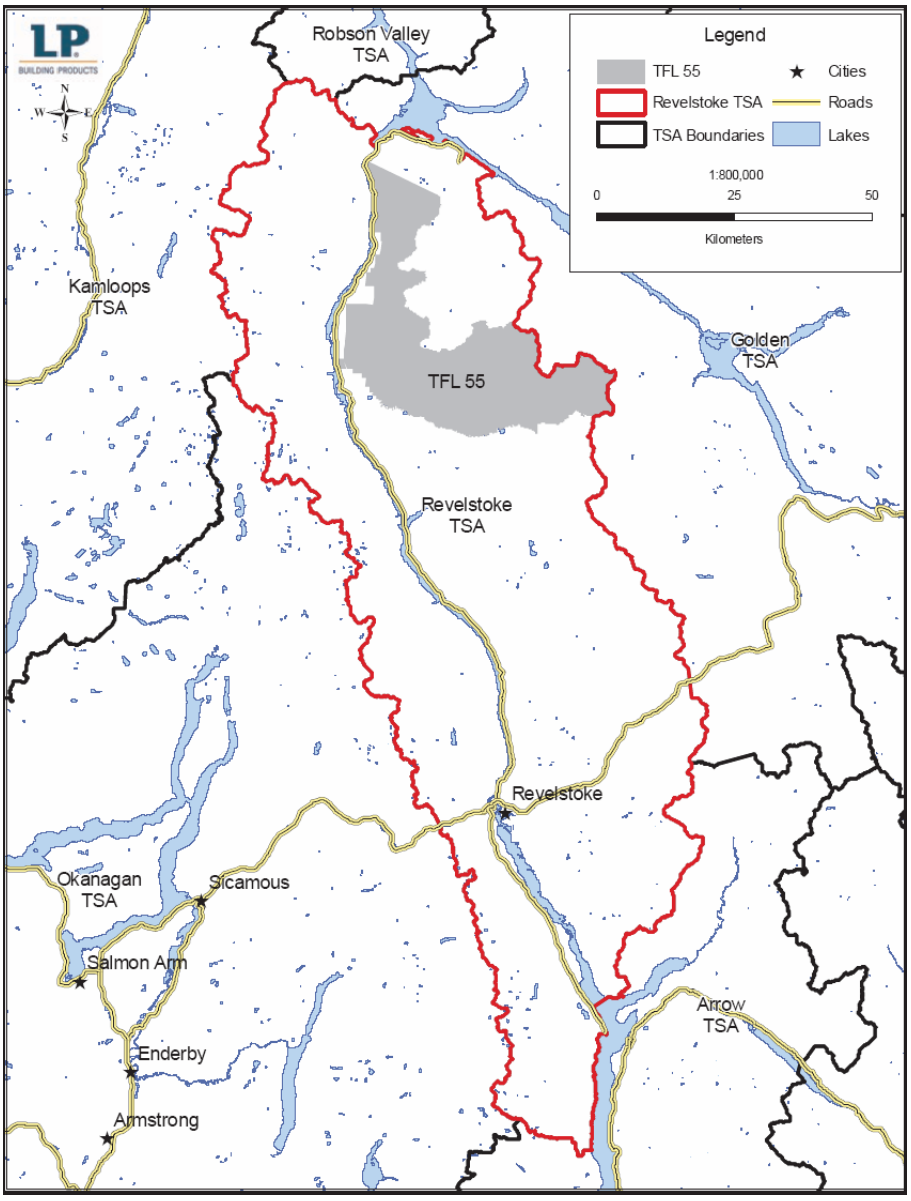

Figure 1.1 Location of TFL 55

This Information Package has been prepared on behalf of Louisiana Pacific Ltd. (LP) as part of the timber supply analysis for Management Plan No. 5 (MP#5) for TFL 55. It provides a summary of the inputs and assumptions made in preparing the timber supply analysis data model.

This document includes inventory and landbase summaries, growth and yield information, and management assumptions for timber and non-timber resources as they relate to timber supply. The Information Package allows the reader to consider the inputs and assumptions to be used in the timber supply analysis. These include:

- The documentation of inventory data and sources;
- Classification of the land base according to each hectare's contribution to management (harvest, resource management for wildlife, etc.);
- Land productivity estimates and prediction of stand growth and timber yield;
- Silviculture and harvesting regimes;
- Action taken to model multi-resource requirements; and
- Timber supply scenarios and sensitivity analyses to be evaluated.

The timber supply analysis involves modelling a Base Case that represents current management practices. In addition, a number of sensitivity analyses will also be conducted to test the impact of different assumptions on timber supply for TFL 55. All analysis simulations will be completed using Patchworks – a forest estate model that schedules timber harvesting in a manner that best meets environmental and timber flow objectives.

Upon acceptance by the British Columbia Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) Timber Supply Analyst, the assumptions and methodology provided in the Information Package will be used by LP to prepare and submit a timber supply analysis to the MFLNRO. All analysis results will be provided to the Chief Forester of British Columbia, or designate, for allowable cut determination.

Some of the inputs and assumptions included in the timber supply analysis will be based on information provided in the Revelstoke Higher Level Plan Order (BC MSRM 2005) as amended in 2011.

2.0 Timber Supply Analysis Process

The data summarized in this document is the most current available. Any assumptions made for modelling and forecasting purposes are consistent with current forest management practices on the TFL.

This Information Package will be advertised and made available for public review. The technical approach to modelling will be reviewed with staff from MFLNRO Forest Analysis and Inventory Branch (FAIB) before starting any forest estate modelling. Any necessary changes will be made to the document based on the feedback received.

This report will be included as Appendix I of the Timber Supply Analysis Report – which will itself be advertised and made available for publics review. Prior to that public review process, the Analysis Report must first be formally accepted by the Ministry for use in the AAC determination process.

The Analysis Report will be circulated for Public Review in conjunction with a draft of Management Plan #5 for the TFL. This MP will include a history of the TFL and a summary of the feedback received; the final versions of the Information Package and Analysis Report will be included as Appendices.

Once this second public review process is complete, these documents will be submitted to the Chief Forester to assist in making an AAC determination for the TFL. Once this is complete, the AAC Rationale document will be appended to the finalized version of Management Plan #5

3.0 Timber Supply Options / Sensitivity Analyses

This section provides an overview of the options that will be evaluated in the timber supply analysis.

3.1 Base Case

The base case reflects current management performance as of 2015. The analysis will incorporate the following:

- Vegetation resource inventory (VRI) (complete Phase 1 and Phase 2);
- Operability mapping that show where timber harvesting is operationally feasible;;
- Ecosystem-based analysis units;
- Improved managed stand site productivity estimates;
- Natural disturbance regimes in non –THLB stands;
- Patch size and seral stage modelling for the entire planning horizon;
- Application of current genetic gains to managed stand yields; and
- Implementation of the Revelstoke Higher Level Plan Order (as amended in 2011).

3.2 Sensitivity Analysis

Sensitivity analysis provides a measure of the upper and lower bounds of the base case harvest forecast that reflects the uncertainty in the data and/or the management assumptions made in the base case. The magnitude of the increase and decrease in the sensitivity variable reflects the degree of uncertainty surrounding the assumption associated with that specific variable. This provides a way to gauge the extent to which the base case harvest level and other statistics might change with changes to input data and assumptions.

Table 3.1 summarizes the sensitivity analyses that will be performed for this analysis. For each scenario the data use and assumptions made will be documented.

Table 3.1 Sensitivity Analysis Runs

Scenario
Timber harvesting land base +/- 5%
Natural stand yields +/- 10%
Managed stand yields +/- 10%
Minimum harvest ages +/- 10 years
Minimum harvest ages at 60 and 70 years
Increase / decrease genetic gains
Use SIA instead of SIBEC
Use VRI site index instead of SIBEC
Managed stand SI +/- 1 m
Add VRI Phase 2 Adjustment (VDYP 6)
IRM green-up constraint instead of patch size

If CMI remeasurement data is available (see Section 8.6) – and if it shows significant deviation from the MSYT-predicted height growth – a sensitivity analysis to examine timber supply impacts will be run.

3.3 Alternative Harvest Flows

It is expected that the initial harvest level for the TFL will be greater than the long-term, sustainable harvest level. Currently on the TFL, average harvest age is well above culmination age – the age at which maximum stand growth rate is reached. An accelerated harvest flow scenario that moves harvest age closer to culmination age over a shorter period than in the base case will be explored.

As an alternative to even flow, an effort will be made to find the highest initial harvest level that can be achieved without impacting long-term harvest levels – and subject to the constraint that the harvest level cannot fall more than 10% between consecutive decades.

4.0 Forest Estate Model

4.1 Model Description

Patchworks is a spatially explicit harvest scheduling optimization model developed by Spatial Planning Systems in Ontario. It has been used to develop spatially explicit harvest allocations to explore the trade-off between a broad range of conflicting management and harvest goals. Patchworks is a multiple-objective goal-programming model and can be described as consisting of two components:

1. A GIS interface with map viewer and viewer functions; and
2. A harvest scheduler that runs continuously in the background - searching for improvements in the allocation to improve the value of the objective function. The model seeks a solution that maximizes the value of the total objective function. The objective function will be made up of both the traditional (management plan) objectives and the additional requirements and

indicators. In areas of timber management, the harvest schedule will be optimized (both the current and future forecasted land base) for timber flow requirements and to minimize the environmental risk, as measured by the established indicators.

4.2 Timber Supply Modelling

Timber supply analysis for the full two hundred and fifty (250) year planning horizon will be carried out using Patchworks. Harvest blocks will be scheduled in fifty 5-year periods.

5.0 Current Forest Cover Inventory

This section describes base mapping, forest cover inventory, and other data used in the analysis.

5.1 Base Mapping

All spatial information is registered to the Terrain Resource Inventory Mapping (TRIM), North American Datum (NAD) 83 base. Inventory data has been prepared using the ArcGIS™ geographic information system (GIS).

5.2 Vegetation Resource Inventory

The current forest inventory (stand delineation and classification) was completed in 2002 by Atticus Resource Consulting Ltd – using aerial photography that was taken in 1997. Stand volumes were estimated (at that time) using VDYP 6. Over the intervening years, updates have been applied to the spatial forest cover data using information from the RESULTS silviculture tracking system. For this project, the version of the VRI released in December, 2014 has been used. The latest harvest blocks that appear in that dataset are from are from 2012. The data set for this analysis was updated with additional harvest information up to the end of 2015.

A „Phase 2" inventory attribute adjustment was completed in 2005 using methods detailed in *VRI Procedures and Standards for Data Analysis, Attribute Adjustment and Implementation of Adjustment in the Corporate Database* (MFLNRO, 2004). The field data for this project had been collected in 2002. 80 Phase 2 VRI plot clusters were established at randomly selected locations (within five strata) throughout the productive operable landbase of TFL 55. Using this information, the Phase 1 (i.e. photo-interpreted) age, height and volume were adjusted following VRI standard procedures in the Fraser Protocol. The ratios derived from this adjustment process are shown in Table 5.1

The adjustments were only calculated for stands over the age of 40 years. A detailed description of the VRI Phase 2 adjustment procedure is documented in *TFL 55 Vegetation Resources Inventory Statistical Adjustment* (Timberline, 2005). This adjustment procedure was carried out using VDYP6. This is problematic, for reasons that will be discussed in Section 8.0.

Table 5.1 Phase 2 Adjustment

Stratum	Height	Age	Volume
Balsam	1.03775	0.7919	1.0456
Cedar	0.9665	1.9918	1.3673
Hemlock	0.9057	1.1998	1.2636
Other (Fd)	0.9665	1.4871	1.3673
Spruce	0.9780	0.8080	1.0274

For the base case, natural stand yield tables will be generated using VDYP7 and the Phase 2 adjustments will not be applied. A sensitivity analysis will be run to test the impact of the Phase 2 adjustments. These yield curves will be generated using VDYP6.

5.3 Updating the Inventory Information

For this timber supply analysis the inventory has been updated for disturbances to January 1, 2016. The version of the VRI data available on the DataBC website was the starting point. Recent cutblocks that are not present in the VRI data were provided by Louisiana Pacific and have also been included in the analysis dataset. Updates have not been applied for any 2016 harvesting. The update procedure was designed only to capture recent disturbances for the purpose of this analysis; the VRI data itself was not formally updated. For the analysis, recently harvested blocks have been given an age 0 and put on the appropriate managed stand yield curve.

The forest inventory ages, heights and volumes have been projected to January 1, 2016.

5.4 Data Sources

Many sources of data were compiled to provide input to the timber supply analysis for TFL 55 MP No. 4. These are listed in Table 5.2 Data was used for three general purposes:

- to determine the productive and timber harvesting land base
- to identify resource management zones (RMZ"s) for the protection and modelling of non-timber resources; and
- to group together stands with similar growth characteristics (analysis units) in order to forecast managed stand yields.

The spatial resultant created by overlaying the input data sets is used to generate most of the input files required by the forest estate model.

Table 5.2 TFL 55 Source Data

DESCRIPTION	SOURCE
BEC Zones	Version 9, LRDW
Biodiversity Emphasis	Version 9, LRDW, LU
Blocks	LP 2015
Caribou Habitat	LP 2015
Contours	TRIM
Mapsheet index	LRDW
Landscape units	LRDW 2015
OGMA	LP 2015
Operability	LP 2005
Riparian buffers	Timberline
Road buffers	Ecora
Slope breaks	Timberline
Terrain	LP Pre-2005
TFL boundary	LP 2015
Forest cover non-productive code	LP Pre-2005
Ownership	LP Pre-2005
PEM	Timberline
Spatial wildlife tree patches	LP
VRI	2015 VRI

6.0 Description of the Land Base

6.1 Timber Harvesting Land Base Determination

Table 6.1 presents the results of the land base classification process to identify the timber harvesting land base (THLB). Individual areas may have several classification attributes. For example, stands within riparian reserve boundaries might also be classified as non-commercial. These areas would have been classified on the basis of this latter attribute, prior to the riparian classification. Therefore, in most cases the net reduction will be less than the total area in the classification. The order of the entries in Table 6.1 corresponds to the sequence in which the land base classifications were applied.

Table 6.1 Base Case Timber Harvesting Land Base Determination

	Management Plan #4		Management Plan #5		
Land Base Classification	**Area (ha)**	**Area Removed (ha)**	**Area (ha)**	**Area Removed (ha)**	**Conifer Volume (m^3 x 1000)**
Total Land Base	**92,744**		**92,642**		**11,205**
Ownership		38	38	38	
Total TFL	**92,706**		**92,604**		
Non-productive, Non-forest		36,801		38,125	
Roads		802		893	
Productive Land Base	**55,103**		**53,585**		**11,205**
Inoperable		30,244		28,783	6,030
Operable Land Base	**24,859**		**24,802**		
Terrain		698		699	186
Riparian Reserves		810		645	183
Low Site		127		583	49
Deciduous		85		68	5
Wildlife Tree Patches		290		402	2
Caribou		-		6,362	2,198
OGMA		290		36	29
Non-merchantable		421			
NSR		87			
Timber Harvesting Land Base	**22,341**		**16,007**		**2,551**

The total productive area on the TFL is 53,585 hectares and the THLB area is 16,007 hectares.

Table 6.2 summarizes the distribution of area and coniferous volume by 10-year age class for both the productive and net timber harvesting land base.

Table 6.2 Age Class Distribution

Age Class	MFLNRO Age Class	Productive Area (ha)	Productive Volume (m^3)	THLB Area (ha)	THLB Volume (m^3)
0-10	0-19	3,628.0	0	2,754.3	0
10-20	0-19	1,815.5	326	1,679.9	312
20-30	20-39	2,313.4	5,109	2,123.5	4,910
30-40	20-39	2,819.0	38,333	2,454.5	34,021
40-50	40-59	758.7	10,391	37.3	1,578
50-60	40-59	853.7	52,281	50.0	4,732
60-70	60-79	733.2	43,397	20.6	2,395
70-80	60-79	591.5	81,593	55.1	23,329
80-90	80-99	1,264.1	155,834	76.2	24,224
90-100	80-99	835.7	128,397	107.8	26,210
100-110	100-119	1,954.1	372,382	259.2	115,643
110-120	100-119	1,522.4	302,352	96.5	32,144
120-130	120-139	700.4	133,741	105.1	38,871
130-140	120-139	502.1	119,551	106.6	36,159

Age Class	MFLNRO Age Class	Productive Area (ha)	Productive Volume (m^3)	THLB Area (ha)	THLB Volume (m^3)
140-150	140-249	3,482.0	655,246	316.9	100,472
150-160	140-249	482.8	108,528	93.5	25,111
160-170	140-249	2,070.6	581,496	585.2	217,647
170-180	140-249	369.9	99,546	89.1	33,606
180-190	140-249	4,076.9	890,129	363.9	124,606
190-200	140-249	1,102.5	248,312	94.2	35,553
200-210	140-249	2,468.1	672,519	343.5	114,183
210-220	140-249	1,232.5	324,245	94.0	28,606
220-230	140-249	4,021.2	1,169,915	425.8	149,551
230-240	140-249	2,531.0	807,056	226.7	81,162
240-250	140-249	2,222.2	847,456	529.9	208,570
250+	250+	9,233.6	3,496,934	2,855.3	1,148,160
Total		**53,585.1**	**11,345,068**	**15,944.7**	**2,611,756**

Figure 6.1 summarizes the productive and net area of the TFL by 10-year age class.

Figure 6.1 Age Class Distribution

Table 6.3 and Figure 6.2 summarize the distribution of area by leading species for both the productive and timber harvesting land base.

Table 6.3 Leading Species Distribution

Species Code	Productive Area (ha)	THLB (ha)
None	849.9	605.4
AC	167.5	47.4
AT	71.8	0.0
BA	26.1	25.3
BL	14,625.9	637.7
CW	5,516.2	2,204.0
EP	53.7	3.9
FD	603.3	389.8
FDI	2,487.6	1,053.6
H	283.5	31.4
HM	1,283.3	256.3
HW	6,171.7	2,402.6
PA	13.2	0.0
PL	48.8	23.1
S	3.0	1.3
SE	15,696.2	2,929.2
SW	31.6	20.8
SX	5,651.8	5,312.9

Approximately half of the THLB is made up of spruce-leading stands. Hemlock-, cedar-, and Douglas-fir make up most of the remaining THLB, in roughly equal amounts. Almost all of the THLB area without a leading species in the forest cover data is comprised of recently harvested stands.

6.2 Total Area

The total area of TFL 55 is 92,642 hectares.

6.3 Ownership

Five small parcels totalling 38.5 hectares that fall within the outer TFL boundary are excluded from the TFL (see Table 6.4). Several small mining tenures and the Canadian Mountain Holidays helicopter ski lodge make up this exclusion.

Table 6.4 Non-TFL Land

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Excluded Ownership	38.5	0	38.5

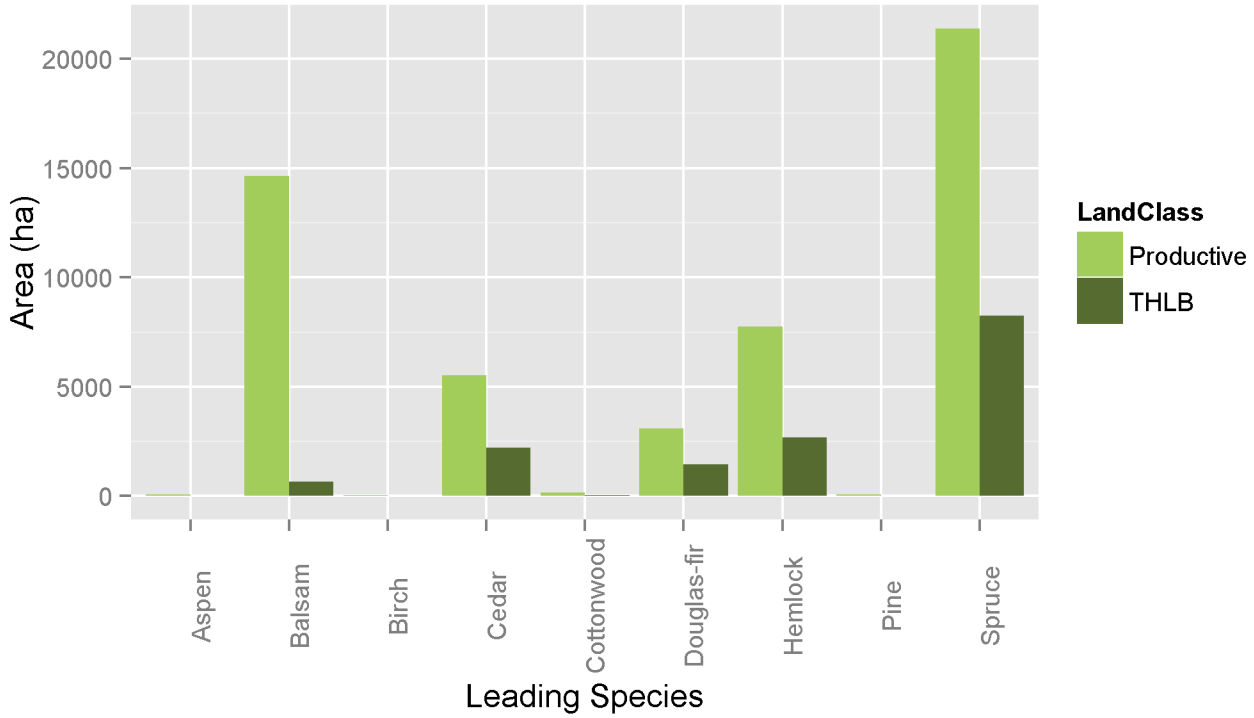

Figure 6.2 Leading Species Distribution

6.4 Non-Productive and Non-Forest

There are 36,801 hectares of non-productive non-forest land within the TFL. The VRI does not explicitly attribute non-productive land so this area was identified by selecting stands with a crown closure of less than 10% that are 30 years of age or older, and stands with as site index of less than 5 metres. In addition, BC land classification Level 1 “non-treed” was taken out as non-productive non-forest – but only if the stand had not previously been harvested.

Table 6.5 Non-Productive and Non-Forest Land

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Non-Productive and Non-Forest	38139.9	0	38124.8

6.5 Non-commercial

There are no non-commercial stands identified in the VRI.

6.6 Roads, Trails and Landings

Existing roads were identified by Louisiana Pacific and buffered 8.5 meters either side for a total of 17 meters. This buffer distance was used to be consistent with the Revelstoke TSR. In total 893.4 hectares of roads were identified and removed from the productive landbase. Future roads will be accounted for

by applying a 6% area reduction to the unroaded portion of the THLB at the time that the forest estate model files are constructed.

Table 6.6 Roads Trails and Landings

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Existing Roads	965.1	0	893.4

6.7 Inoperable

Louisiana Pacific updated their operability mapping in advance of MP#4. This coverage is still a realistic assessment of the physically and economically operable landbase and has been used for this timber supply analysis. The non-operable landbase was selected by removing all polygons classified as I, M, and N, as shown in Table 6.7. („I" is inoperable, „M" is marginal and „N" is the classification for miscellaneous factors such as the presence of a lodge or mining site.)

Table 6.7 Operable Landbase Summary

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
I	64806.3	28238.1	28238.1
M	639.3	545.0	545.0
N	38.4	0.0	0.0
Total	65484.0	28783.1	**28783.1**

In recent years, harvesting has been increasingly creeping into areas previously considered „inoperable". Table 7B of the 2014 Annual Report for the TFL show that, between 2007 and 2014, 4.4% of the area harvested fell above the existing operability line.

Louisiana Pacific has reviewed the operability mapping for the TFL and updated it by changing the classification to „operable" for one harvest block that has been laid out. (By default, the netdown process does not exclude inoperable areas if they have been previously logged.) The areas classified as „Marginal" were also reviewed – but were not added back into the operable land base. Only these minor changes were made to the operability map that was used for the last management plan.

6.8 Terrain Stability

Terrain stability mapping covers all of the TFL and classifies the landbase as "unstable", „potentially unstable", or „stable". ESA"s are not used to identify and net out areas with slope stability issues. Any proposed cutblock that falls into "unstable" or „potentially unstable" terrain is reviewed by a geotechnical engineer. If necessary, cutblock boundaries are amended.

„Potentially unstable" and „unstable" lands were partially removed from the timber harvesting landbase using percentages determined during the MP#3 analysis. LP staff feel that this is still a reasonable estimate of the proportion of unstable areas that will never be harvested.

As Table 6.8 shows, a total of 418.1 hectares was removed from the landbase for terrain concerns. Much of the area with terrain stability issues is netted out of the land base for other reasons. When the

netdown is complete, only 16.1% of „potentially unstable" and 4.0% of „unstable" areas are retained in the THLB. (Productive area is the denominator for this calculation.)

Table 6.8 Terrain Stability

Description	Gross (ha)	Productive (ha)	Netdown Percent	Area Removed (ha)
potentially unstable	16085.6	13066.0	10%	234.2
unstable	6889.9	4536.8	50%	183.9
Total	**22975.5**	**17602.8**		**418.1**

6.9 Riparian Reserve and Management Zones

Classified lakes, wetlands and streams were available for TFL 55. Reserve zones were buffered according to the rules in the Forest Practices and Planning Regulation. Management zones were buffered with an average retention level to allow them to be applied spatially. An average retention level of 25% was applied to all riparian management zones, irrespective of riparian classification, in determining the area to be removed from the net harvesting landbase. For the purposes of timber supply modelling, the management zone width as defined in the Riparian Management Area Guidebook was reduced by the management zone retention percentage and added to the reserve zone width to arrive at a composite buffer width, as shown in the table below.

GIS buffering techniques were then used to construct an effective riparian reserve zone inside of which harvesting activity was fully excluded. Note that the composite buffer width was applied to each side of stream features, and to the terrestrial side of wetland or lake features. Table 6.9 summarizes this process and the results.

Table 6.9 Riparian Management Buffer Widths

Riparian Class	Length (km)	Reserve Zone Width (m)	Management Zone Width (m)	Management Zone Retention (%)	Total Buffer Width (m)	Gross Area (ha)	Productive Area (ha)	Area Removed (ha)
Lakes								
L1		10	0	25	10	29.8	0.7	0.0
L3		0	30	25	7.5	31.3	2.4	0.1
Wetlands								
W1		10	40	25	20	525.0	54.2	45.7
W3		0	30	25	7.5	73.5	39.0	30.8
Streams								
S1		50	20	25	55	550.8	366.3	334.5
S2		30	20	25	35	396.6	195.1	130.4
S3		20	20	25	25	14.9	13.2	11.0
S4		0	30	25	7.5	31.3	16.5	8.0
S5		0	30	25	7.5	197.2	77.1	46.3
S6		0	20	5	1	1484.5	622.4	38.4
					Total			**645.3**

6.10 Low Site Productivity

Sites with low productivity were determined by calculating the net volume each stand would contain at 140 years old and removing it from the harvestable landbase if it did not achieve a minimum volume. All stands were removed if they did not achieve 150 m^3/ha. For the MP#4 analysis, cedar, hemlock stands were removed if they did not achieve a volume of 200 m^3/ha by year 140. This exception has not been applied for this analysis; the volume limit for all leading species is 150 m^3/ha. Stands with a logging history were not removed from the THLB - regardless of whether or not they met the minimum volume criteria. Table 6.10 summarizes this reduction.

Table 6.10 Low Site Productivity Reductions

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Low Site	21156.0	9700.8	583.3

6.11 Deciduous

All deciduous-leading stands were removed from the harvestable landbase – except in cases where the stand had a harvest history. Table 6.11 shows this reduction. Deciduous volume in conifer leading stands is accounted for as a yield curve reduction.

Table 6.11 Deciduous Stand Reduction

Inventory Type Group	Gross (ha)	Productive (ha)	Area Removed (ha)
Deciduous Leading	358.2	293.0	68.4

6.12 Non-merchantable Forest Types

For the MP#4 analysis, stands with a significant hemlock / balsam component were netted out of the timber harvesting landbase. In total, 421 hectares were removed for this reason. However, timber harvesting economics have changed over the intervening years, and these stands are no longer considered economically infeasible; they have not been netted out of the THLB for this analysis.

The harvesting performance tables in Appendix C provide evidence that hemlock stands are now more economically viable. The tables are reproduced from the TFL 55 2014 Annual Report. These were prepared specifically to allay the Chief Foresters concerns – expressed in the last AAC determination – regarding harvesting performance in hemlock stands. The first table (7A) shows that hemlock-leading stands make up 17% of the THLB, but that they constitute 27.8% of the area harvested between 2007 and 2014. The second table (7C) profiles the THLB by three hemlock concentration categories (40-60%, 60-80% and 80+%) and demonstrates that harvesting exceeds the targets for all three categories. The final table (7D) compares mature growing stock volumes (by species) to harvest volumes. The two sets of percentages are closely aligned. Hemlock harvest percentage is only slightly below the growing stock percentage – 25.3% versus 27.1%.

6.13 Stand-level Biodiversity (Wildlife Tree Patches)

Existing wildlife tree patches (WTPs) on TFL 55 have been explicitly mapped, and are incorporated into the spatial database for this analysis. A total of 395.1 hectares of existing WTPs have been removed from the THLB, but are retained in the modelling data set so that they may contribute to non-timber resource objectives. This is shown in Table 6.12. The approach to modelling future wildlife tree patches is described in Section 10.1.2.

Table 6.12 Wildlife Tree Patches

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
WTP	471.1	464.6	402.1

6.14 Caribou Habitat

Since the previous analysis, 18,838 hectares of caribou habitat has been established within the boundaries of TFL 55. In December 2008, Ungulate Winter Range (UWR) U-3-005 was established. No harvesting is permitting within this area. The net impact on the THLB is a reduction of 6,305 hectares, as shown in Table 6.13. This management area overlaps a significant portion of TFL 55.

Table 6.13 Caribou Habitat

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Caribou Habitat	18838.1	18359.3	6361.5

6.15 Old Growth Management Areas

In 2008 LP engaged Timberline Natural Resource Group to delineate OGMA"s that met government objectives for landscape-level biodiversity while minimizing harvest level impacts. A copy of the project report and be found in Appendix D. These OGMA"s cover 3,868 hectares across the entire TFL. Because they overlap significantly with netdowns for other reasons and resource values, the net impact on the THLB is only 35.6 hectares (as shown in Table 6.14). As noted in Section 10.1 (Forest Cover Objectives), these OGMA"s replace the landscape level biodiversity objectives (i.e. old seral constraints) that were modeled in the base case for the last timber supply analysis.

Table 6.14 Old Growth Management Areas

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
OGMA	4059.8	3867.9	35.6

6.16 Cultural Resources

No netdown has been applied for cultural heritage or archaeological resources. These are only infrequently encountered on the TFL, and can be managed at an operational level through the siting of wildlife tree patches and other reserves. This approach to management does not impact strategic timber supply.

7.0 Inventory Aggregation

In order to reduce the complexity of the forest description for the purpose of timber supply analysis, aggregation of individual forest stands is necessary.

7.1 Revelstoke Higher Level Plan Order

In March 2005 the Revelstoke Higher Level Plan Order was implemented as legislated in Section 3 of the Forest Practices code of British Columbia Act. The Order established resource management zones and objectives. The higher level plan order provides objectives for the mature and old seral requirements for TFL 55.

An amendment to the RHLPO was published and came into force in 2011. This order modified the mature seral definition and targets that were specified in the original order. The only changes relevant to TFL 55 are:

1. „mature + old" seral targets have been removed;
2. all references to an „operability line" have been deleted (previously, seral targets had to be met independently for areas above and below the line); and
3. a clarification that seral target must be met on the Crown Forest Land Base (CFLB) – not just on the THLB.

All of the foregoing would not factor into the base case run. With the removal or „mature + old" targets, and the replacement of old seral targets with spatially defined OGMA"s, there is no need to model retention constraints.

7.2 Ecosystem Types

Figure 7.1 shows the area in each BEC variant on TFL 55.

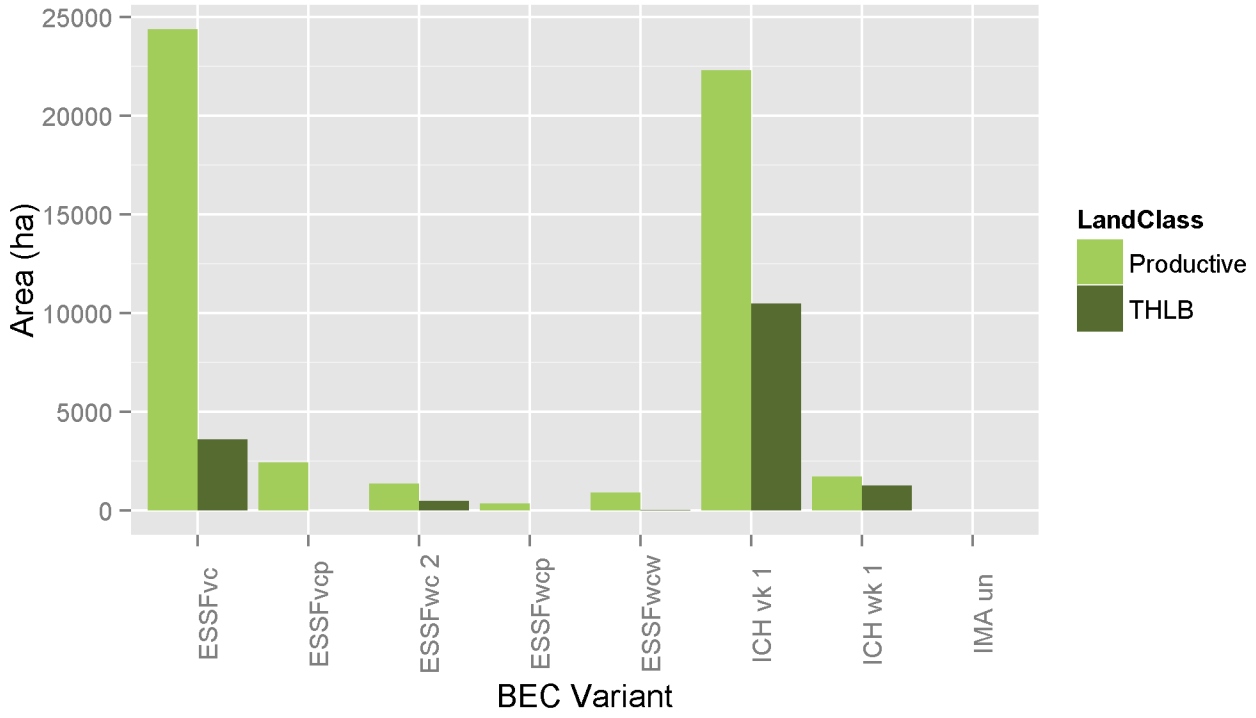

Figure 7.1 Area by BEC Variant

7.3 Landscape Units

Table 7.1 shows the areas in the two dominant landscape units on TFL 55.

Table 7.1 Landscape units on TFL 55

LU Code	Landscape Unit Name	Productive Area (ha)	THLB Area (ha)
R5	French	28217.9	8740.1
R17	Mica	25367.2	7204.6

7.4 Seral Zones

Table 7.2 summarizes the distribution of LU-BEC variants on TFL 55, and also shows the biodiversity emphasis option (BEO) assigned to each LU-BEC combination.

Table 7.2 Landscape Units, Ecosystem Types, and Biodiversity Emphasis

LU Code	Landscape Unit Name	BEC Variant	NDT	BEO	Productive Area (ha)	THLB Area (ha)
R5	French	ESSFvc	NDT1	Intermediate	268.7	3.2
R5	French	ESSFvc	NDT1	Low	13840.8	1808.0
R5	French	ESSFvcp	NDT5	Low	1292.0	1.6

LU Code	Landscape Unit Name	BEC Variant	NDT	BEO	Productive Area (ha)	THLB Area (ha)
R5	French	ICH vk 1	NDT1	Intermediate	3137.9	1827.4
R5	French	ICH vk 1	NDT1	Low	7979.8	3839.5
R5	French	ICH wk 1	NDT1	Intermediate	1006.6	789.1
R5	French	ICH wk 1	NDT1	Low	682.6	471.4
R5	French	IMA un	NDT5	Low	9.5	0.0
R17	Mica	ESSFvc	NDT1	Intermediate	226.7	162.7
R17	Mica	ESSFvc	NDT1	Low	10060.3	1627.8
R17	Mica	ESSFvcp	NDT5	Low	1162.1	0.0
R17	Mica	ESSFwc 2	NDT1	Low	1381.7	505.3
R17	Mica	ESSFwcp	NDT5	Low	370.7	1.0
R17	Mica	ESSFwcw	NDT1	Low	930.0	60.9
R17	Mica	ICH vk 1	NDT1	Intermediate	3621.1	1616.8
R17	Mica	ICH vk 1	NDT1	Low	7573.6	3208.9
R17	Mica	ICH wk 1	NDT1	Intermediate	40.8	21.1
R17	Mica	IMA un	NDT5	Low	0.0	0.0

7.5 Analysis Units

Stands are grouped into analysis units to reduce modelling complexity. For this analysis, an ecologically-based system for grouping stands into analysis units has been used. This approach was originally implemented for the last management plan because it integrates more closely with ecologically-based productivity estimates. Additionally, many management and silviculture treatment decisions are determined based on the ecological classification of the stand being treated.

Stands were grouped using the BEC system (PEM) at the site series level and (in some cases) further broken down by leading species. Site series/species combinations that only represent a small proportion of the landbase have been aggregated with a similar analysis unit. There are 25 existing managed stand analysis units and another set of 25 analysis units for the future managed stands (the later set includes genetic gains). Yield curves for existing natural stands have been generated on a stand-by-stand basis.

Table 7.3 shows the analysis unit definitions and the area in each analysis unit.

Table 7.3 Analysis Unit Definitions

	Analysis Unit Definition			Area (hectares)	
Analysis Unit	BEC Variant	Site Series	Species	Productive	THLB
1	ICHwk1	9,7,6	Spruce	177.8	91.6
2	ICHwk1	5	Spruce	175.0	144.9
3	ICHwk1	4	Hemlock-Cedar	153.1	122.2
4	ICHwk1	4	Douglas-fir	449.5	362.3
5	ICHwk1	4	Spruce	205.7	161.2
6	ICHwk1	1	Cedar	192.4	179.5

	Analysis Unit Definition			Area (hectares)	
Analysis Unit	BEC Variant	Site Series	Species	Productive	THLB
7	ICHwk1	1	Hemlock	107.0	80.8
8	ICHwk1	1	Spruce-Douglas-fir	97.7	79.7
9	ICHvk1	5	Spruce-Balsam	3,266.1	2,155.2
10	ICHvk1	5	Cedar-Hemlock	357.4	156.6
11	ICHvk1	4	Spruce-Balsam-Pine	3,873.4	1,700.1
12	ICHvk1	4,3	Cedar -Pine	3,465.5	1,113.7
13	ICHvk1	4	Douglas-fir	1,334.4	538.9
14	ICHvk1	4	Hemlock	3,202.2	1,032.9
15	ICHvk1	3,1	Spruce-Balsam-Hemlock	2,281.2	1,297.9
16	ICHvk1	1	Cedar	1,314.9	684.2
17	ICHvk1	1	Hemlock-Douglas-fir-Pine	3,071.7	1,433.3
18	ESSFwcw, & wc2	4,3	Spruce-Balsam	1,096.5	389.3
19	ESSFwcw & wc2	1	Spruce	1,662.5	288.1
20	ESSFvc	1	Balsam	8,685.3	388.7
21	ESSFvc	1	Cedar	236.1	100.1
22	ESSFvc	1	Hemlock	1,710.1	383.7
23	ESSFvc	1	Spruce	8,758.8	2,552.9
24	ESSFvc	6,4	Spruce	201.5	47.1
25	ESSFvc	3	All	7,499.9	460.0
			Totals	53,585.1	15,944.7

8.0 Growth and Yield

A stand"s growth in terms of height, diameter and volume is predicted using growth and yield models. The assumptions, inputs and outputs used in these models are documented in the following sections. Stands are either classified as natural or managed depending on their silviculture history and the origins of the stand. Stands that regenerated prior to1970 are considered to be „natural stands". Managed stands are those established in 1970 or later. Although 1987 is the year that legislated basic silvicultural obligations came into force, the program of basic silviculture on the TFL predates that by many years. Table 8.1 summarizes the area logged, planted and declared free-growing between 1970 and 1986.

Table 8.1 TFL 55 Silviculture Summary – 1970 to 1986

Activity	Area (ha)	Area (%)
Logged	3347.7	100
Planted	3034.7	91
Declared Free-Growing	3277.3	98

Managed stands are divided into two categories. Stands established between 1970 and 2004 have no genetic gain applied. Those established in 2005 and later have genetic gain applied for spruce and Douglas-fir.

Table 8.2 shows the area in each analysis that is current either „natural" or „managed".

Table 8.2 Analysis Unit Area – Natural and Managed Stands

Analysis Unit	Analysis Unit Definition			THLB Area (hectares)			
	BEC Variant	Site Series	Leading Species	Natural	Managed (Era 1)	Managed (Era 2)	Total
1	ICHwk1	9,7,6	Spruce	70.0	16.3	5.2	91.6
2	ICHwk1	5	Spruce	89.6	38.7	16.6	144.9
3	ICHwk1	4	Hemlock-Cedar	85.2	13.3	23.6	122.2
4	ICHwk1	4	Douglas-fir	177.0	61.9	123.4	362.3
5	ICHwk1	4	Spruce	48.2	100.1	12.9	161.2
6	ICHwk1	1	Cedar	61.8	47.6	70.1	179.5
7	ICHwk1	1	Hemlock	61.5	10.5	8.7	80.8
8	ICHwk1	1	Spruce-Douglas-fir	16.2	62.4	1.1	79.7
9	ICHvk1	5	Spruce-Balsam	389.2	1,454.4	311.6	2,155.2
10	ICHvk1	5	Cedar-Hemlock	81.8	54.1	20.7	156.6
11	ICHvk1	4	Spruce-Balsam-Pine	339.4	878.6	482.1	1,700.1
12	ICHvk1	4,3	Cedar-Pine	730.1	142.3	241.3	1,113.7
13	ICHvk1	4	Douglas-fir	208.9	315.1	14.9	538.9
14	ICHvk1	4	Hemlock	819.9	42.1	170.9	1,032.9
15	ICHvk1	3,1	Spruce-Balsam-Hemlock	131.7	950.1	216.1	1,297.9
16	ICHvk1	1	Cedar	477.2	103.9	103.0	684.2
17	ICHvk1	1	Hemlock-Douglas-fir-Pine	1,138.4	154.2	140.8	1,433.3
18	ESSFwcw	4,3	Spruce-Balsam	115.7	199.7	73.9	389.3
19	ESSFwcw	1	Spruce	100.7	64.4	123.0	288.1
20	ESSFvc	1	Balsam	257.2	101.1	30.4	388.7
21	ESSFvc	1	Cedar	29.0	35.3	35.9	100.1
22	ESSFvc	1	Hemlock	319.4	20.3	44.0	383.7
23	ESSFvc	1	Spruce	828.2	1,318.4	406.3	2,552.9
24	ESSFvc	6,4	Spruce	19.9	20.5	6.7	47.1
25	ESSFvc	3	All	299.0	90.0	71.0	460.0
			Totals	**6,895.2**	**6,295.3**	**2,754.3**	**15,944.7**

Stands with missing leading species (i.e. recently harvested) were assumed to have the most common leading species for each BEC zone, subzone, variant and site series combination for the following: ICHwk1/4, ICHwk1/1, ICHvk1/5, ICHvk1/4, ICHvk1/1, ESSFvc/1. For the remaining site series, analysis units are not broken out by species.

Natural stand yield has been modelled with Batch VDYP Version 7.29e. Managed stand (both existing and future) have been modelled using Batch TIPSY Version 4.3.

8.1 Site Productivity

The growth potential of modelled stands is quantified using site index. Site index is defined as the potential height of a site tree at breast height age 50 grown on the site.

8.1.1 VRI Site Index

The inventory site index from the VRI has been used to develop yield tables for all existing stands. VRI site index values are developed using the age and height attributes for each stand in the inventory which is at least 30 years old. Stands younger than 30 years of age at the time of inventory have a site index estimated directly by the photo interpreter.

Inventory site index estimates have been used to generate yield curves for all stands that regenerated in 1970 or earlier.

8.1.2 SIBEC Site Index

The Site Index by BEC Site Series - SIBEC Project was initiated by the provincial government in 1994. It has developed a database of field measurements that has been used to develop relationships between the ecological characteristics of a stand and its productivity. Data has been compiled to provide tree species site index estimates that reflect the average growth potential of tree species in forested site series. The inputs needed to use this database are biogeoclimatic subzone, site series and leading species. These are available from provincial BGC mapping, the TFL 55 Predictive Ecosystem Mapping project, and the VRI respectively.

SIBEC site index estimates have been used to generate yield curves for all stands that regenerated after 1970.

8.1.3 SIA Productivity Estimates

Louisiana Pacific undertook a site index adjustment project in 2005. J. S. Thrower and Associated Ltd. completed the fieldwork and analysis (see Appendix B). Preliminary potential site index (PSI) estimates – by site series – were developed based on expert knowledge of site productivity on the TFL. Field plots were established in the ICHvk1, ICHwk1 and ESSFvc BCG variants. Using this data, a ratio adjustment as developed applied to the starting „expert" PSI estimates.

The impact of using PSI (in place of SIBEC) to generate managed stand yield tables will be tested in a sensitivity analysis.

8.2 Utilization Levels

The utilization level defines the maximum height of stumps that may be left on harvested areas and the minimum top diameter (inside bark) and minimum diameter (dbh) of stems that must be removed from harvested areas. These factors are needed to calculate merchantable stand volume for use in the analysis. The utilization levels modelled are listed in Table 8.3. They reflect current standards and performance.

Table 8.3 Utilization Levels

Leading Species	Minimum DBH (cm)	Stump Height (cm)	Minimum Top DIB (cm)
Pine	12.5	30.0	10.0
All species	17.5	30.0	10.0

Note: DBH = diameter breast height, DIB = diameter inside bark

8.3 Volume Reductions

Standing inventory volumes include the deciduous component – but this volume is not currently being harvested or utilized. For the purposes of modelling, all yield tables are reduced by a percentage reflecting the deciduous component of the stand.

Yield tables will also be reduced to account for future wildlife tree patches. These reductions are discussed further in Section 10.3.1. The deciduous component of natural stands can contribute to the wildlife tree patch percentage.

8.4 VDYP Natural Stand Yield Tables

Natural stand yield tables (NSYTs) were developed using the batch version of VDYP (Version 7.29e). A separate yield curve has been run for each existing natural stand. The VDYP-generated yield curves include both coniferous and deciduous volumes. When these curves are loaded into the forest estate model, the volumes will be reduced to remove the deciduous component.

A second site of natural stand yield tables has been generated using VDYP 6. These will be used for a sensitivity analysis. The difference between the starting growing stock for MP#4 and MP#5 is significant, as is demonstrated in Table 8.4.

Table 8.4 MP#4 and MP#5 Growing Stock Comparison

Management Plan	Productive Area (ha)	Volume (m3)		
		VDYP 6 Unadjusted	VDYP 6 Adjusted	VDYP 7 Unadjusted
MP#4	55,103		16,262,127	
MP#5	53,585	13,570,805	14,405,444	11,303,974
MP#5 - Unlogged	53,585	14,345,256	15,231,352	11,969,679
MP#5 - Unlogged - Area-Adjusted	55,103	14,751,640	15,662,838	12,308,766

Some of the difference can be explained by logging in the intervening years, and by the slight change in the size of the productive land base. Most of the difference, however, appears to arise from the switch from VDYP 6 to VDYP 7. It is especially problematic that the Phase 2 adjustment factors (Appendix A) – which were calculated using VDYP 6 – cannot be applied to the VDYP 7 base case natural stand yield tables.

The VDYP 6 curves generated for the sensitivity analysis will be based on the Phase 2 adjusted data. These adjustment factors will affect the analysis as follows:

- Adjusted age and height are used to determine the inventory site index, which:
  - Are inputs to variable density yields program (VDYP) used for determining existing volumes used for the netdown (*i.e.* low site);
  - Are inputs to VDYP used for creating natural stand yield curves;
- Adjusted ages are updated and used as the starting age in the analysis; and
- Volume adjustment factors are a VDYP input that adjust the natural stand yield curves.

New minimum harvest ages values will be computed for each stand based on these new yield curves.

8.4.1 Decay, Waste, and Breakage

Decay waste and breakage (DWB) has been included in this analysis via VDYP, which uses DWB factors for each biogeoclimatic zone. Both VDYP and TIPSY apply these factors when compiling net volume for yield curve construction.

For the sensitivity analysis based on the Phase 2 volumes, decay, waste and breakage factors are recalibrated through the net volume adjustment factor (NVAF) process. These reflect actual ground-truthed volumes from the plots established on the TFL.

8.4.2 Dead Potential Volume

A minor shortcoming of VDYP (all versions) is that it does not account for „dead potential" volume in stands. These are standing dead trees that are tallied as tree class „3", „7" or „9" on a cruise tally card. MFLNRO has studied this matter, and on recent determinations the Chief Forester has dealt with it as an „upward pressure" in the final stages of setting the AAC. LP will review cruise data for the past several years and calculate the average dead potential volume found in recent cutting permits. If necessary, natural stands yield tables will be adjusted for this added volume and as sensitivity analysis will be run.

8.5 TIPSY Managed Stand Yield Tables

There are two sets of analysis units for managed stands specifically:

- 101 through 125 are future managed stands that include genetic gain; and
- 201 through 225 are existing managed stands that do not include genetic gain; and
- 301 through 325 are existing managed stands which have genetic gain applied.

Managed stand yield tables (MSYTs) were modelled using BatchTIPSY (Version 4.3). Table 8.5 presents the existing managed stand analysis units, species and site index values that were input to TIPSY during yield curve preparation. The SIBEC site indices shown in Table 8.5 are used for the MP#5 base case; a corresponding set of curves based on SIA site index will be generated for a sensitivity analysis.

8.5.1 Species Composition

Species composition for managed stands has been summarized by BEC subzone / variant from silvicultural records, and is shown in Table 8.5.

Table 8.5 Managed Stand Site Index and Species Composition

Analysis Unit	SIBEC SI (m)	sp1	sp2	sp3	sp4	sp5	pct1	pct2	pct3	pct4	pct5
1	21.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
2	24.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
3	18.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
4	24.7	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
5	21.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
6	19.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
7	20.3	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
8	24.0	Fd	Cw	Sx	Pw	Hw	32	29	25	12	2
9	21.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
10	18.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
11	24.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
12	18.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
13	27.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
14	18.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
15	21.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
16	21.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
17	24.0	Sx	Cw	Fd	Pw	Bl	50	30	10	6	4
18	12.0	Sx	Bl	Hm			68	23	9		
19	15.0	Sx	Bl	Hm			68	23	9		
20	15.0	Sx	Bl	Hm			68	23	9		
21	15.0	Sx	Bl	Hm			68	23	9		
22	12.0	Sx	Bl	Hm			68	23	9		
23	15.0	Sx	Bl	Hm			68	23	9		
24	18.0	Sx	Bl	Hm			68	23	9		
25	18.0	Sx	Bl	Hm			68	23	9		

8.5.2 Stand Density

Stands are planted to a target density of 1600 stems per hectare. Actual planting densities achieved are shown in Table 8.6. These actual densities have been used for TIPSY modelling purposes.

Table 8.6 Managed Stand Density at Free Growing

Silvicultural Era	Period	Planting Density Achieved (#/ha)
1	1970 - 2004	1525
2	2005 - 2015	1525
Future	2016 +	1525

8.5.3 Regeneration Delay

Regeneration delay is the time elapsed between harvesting and the establishment of a new stand of trees. The end of the regeneration delay is time zero for a yield table; it is the point in time when stand growth begins. Regeneration delay is two years for all species and has been modelled using the regeneration delay in Patchworks. This assumption has not changed from MP #4, and was confirmed by taking the arithmetic average regeneration delay for all blocks harvested since 2006.

8.5.4 Operational Adjustment Factors

OAF1 is used to represent reduced yield due to gaps in stocking; and OAF2 is used to represent decay and losses due to disease and pest when they are present in large magnitudes. OAF1 is a constant reduction factor that shifts the yield curve down whereas the influence of OAF2 increases with age and therefore alters the shape of the curve. For MP#4, standard operational adjustment factors were used: OAF1 was 15% and OAF2 was 5%. The same OAF values will be used for this analysis.

8.5.5 Genetic Gain

For MP#4, genetic gains for spruce were estimated to be 9% in the ICH and 8% in the ESSF. These factors were applied to future stands only; no genetic gain was assumed for existing managed stands. Actual genetic gains for the period from 2005 to 2012 have been reviewed, and the weighted average realized genetic gain is shown in Table 8.7. It is clear that actual genetic gains have exceeded MP#4 expectations – by approximately 5% for both spruce and Douglas-fir. It is likely that the estimates being used for this analysis will also prove – in hindsight – to have been conservative. Sensitivity analyses will be run to test the impact of different genetic gain assumptions on sustainable harvest levels.

Table 8.7 Average Genetic Gain – 2005 to 2012

BEC Subzone/Variant	Area Planted (ha)	'A' Class Seed Genetic Gain (Weighted Average (%)	
		Sx	Fd
ESSF (all)	537	15	
ICH vk1	797	12	4
ICH wk1	465	14	6

8.6 Change Monitoring Inventory

In the 2007 AAC rationale, the Deputy Chief Forester requested that LP:

> "monitor growth in natural and managed stands to assess its site productivity estimates and ensure the yield projections used in future

analyses appropriately reflect volumes per hectare realized in harvesting operations"

LP initiated a Change Monitoring Inventory (CMI) program in 2008. These plots are planned for remeasurement in the near future. This program has been focussed on managed stands.

Subject to time and resources being available, the CMI plots will be classified into the analysis units being used for this project. If remeasurement data is available, the growth trajectories of the individual plots (between the first and second measurements) will be compared to the MSYT generated by TIPSY yield table for each AU. In the absence of remeasurement data, height / age data from the original measurement will be compared to the growth predicted by the underlying MSYT.

9.0 Non-Recoverable Losses

Harvestable timber on TFL 55 is intermittently damaged by pests and natural disturbances. Where practical, this volume is recovered – but this is not always possible. Damage to timber caused by fire, wind, insects, diseases and other pests result in a loss of harvestable volume. This volume loss is difficult to quantify, although losses to insects and disease that normally occupy stands (endemic losses) are accounted for in empirical yield table estimates. Only timber damage above endemic levels needs to be accounted for in this section.

Unsalvaged losses for this analysis have been calculated based on the estimates used for MP#4. At that time, losses were estimated as follows:

- Fire losses were based on unsalvaged fire data between 1955 and 2004 for the TFL (THLB only);
- Insect losses were based on using the Forest Insect and Disease Survey (FIDS) information, local knowledge and professional judgment;
- Avalanche and windthrow were based on review of losses over the previous 15 years and professional judgment.

To those estimates, three adjustments have been made:

1) losses (in hectares) have been reduced in proportion to the decrease in the THLB area between MP#4 and MP#5;
2) In converting from area to volume lost, an updated estimate of the average mature volume on the TFL has been applied; and
3) the non-recoverable loss associated with prescribed burning has been dropped.

The annual unsalvaged losses are summarized in Table 9.1.

Table 9.1 Unsalvaged Losses

Cause	Unsalvaged Area (ha)	Unsalvaged Volume (m^3)
Wildfire	0.9	355
Hemlock Looper	0.4	148
Spruce Bark Beetle	0.4	148
Douglas-fir Bark Beetle	0.1	30
Insect Total	**0.8**	**325**
Windthrow	0.5	207
Avalanche	0.1	30
Total	**2.2**	**916**

This volume is assumed to be lost each year, and will be subtracted from the final harvest level across the entire planning horizon.

10.0 Integrated Resource Management

This section provides details on how the modelling methodology addresses non-timber resource requirements.

10.1 Forest Cover Objectives

Forest cover objectives will be implemented to model the following resource objectives:

- landscape level biodiversity
- stand-level biodiversity
- integrated resource management

These objectives will be met by controlling the future age class distribution of the forest. The rate of harvesting can be limited in order to achieve an age class distribution target by applying forest cover constraints when the forest estate model is run. Cover constraints typically work by capping the amount of area that can be moved to a young age class (i.e. harvested), or by insisting that a minimum amount of old timber exist at all times. Each has the effect of limiting the rate of harvest within the area to which it is applied. Many cover constraints can be enforced within a given model run, and each may apply to all or only to a specified portion of the landbase.

Cover constraints for caribou habitat – which were applied for the MP#4 timber supply analysis – will not be enforced. Ungulate Winter Range (UWR) U-3-005 was established in December 2008. This management area overlaps a significant portion of TFL 55. As no harvesting is permitted in this area, it has been entirely removed from the THLB. In January 2009, the parts of the *Revelstoke Higher Level Plan Order* that dealt with caribou were rescinded.

Landscape level biodiversity objectives (i.e. old seral constraints) will not be applied in the base case (as OGMA"s have been identified and netted out of the THLB). A sensitivity analysis may be run in which OGMA"s are returned to the THLB and old seral targets are enforced. In any event, no targets would be enforced for mature seral (as the RHLPO no longer requires them).

There are no visual quality objectives in force or community watersheds established on the TFL, so no modelling measures need to be taken on these accounts.

10.1.1 Landscape-Level Biodiversity

The management of landscape level biodiversity is legislated in the Revelstoke Higher Level Plan Order (2005) and the *Revelstoke Higher Level Plan Order Amendment 02* (2011). Seral zones are defined by Landscape Unit, biogeoclimatic subzone variant, biodiversity emphasis option (BEO) and natural disturbance type (NDT).

Within TFL 55, almost all of the productive land falls within NDT 1. The remainder falls into NDT 5 – but since NDT 5 has no THLB, no seral stage targets will be applied.

Table 10.1 shows the NDT 1 definition „Old" for each of the seral zones in TFL 55.

Table 10.1 Old and Mature Seral Definitions.

NDT	LU and BEC	Old (years)
1	ESSF	> 250
1	ICH	> 250

BEO can fall into three categories (Low, Intermediate, and High) and is the basis for establishing old seral target percentages. All of TFL 55 falls is classified as either „Low" or „Intermediate" BEO. The old seral targets are the same in either case – but in the „Low" BEO areas the target does not have to be met for 240 years. A relaxed target – one-third of the full target percentage – will be applied for the period prior to the 240-year mark in the planning horizon.

Table 10.2 shows the forest cover retention requirements for each of the seral zones in TFL 55. The old seral targets listed are the long-term targets.

Table 10.2 *Revelstoke Higher Level Plan Order* Old Seral Retention Targets

BEO	LU Code	LU Name	BGC Unit	Productive Area (ha)	THLB Area (ha)	Old Productive Area (ha)	Old THLB Area (ha)	Old Seral Target (%)	Old Seral Target (ha)
Intermediate	R5	French	ESSFvc	268.7	3.2	14.0	0.0	19	51.1
Intermediate	R5	French	ICH wk 1	1,006.6	789.1	109.4	98.3	13	130.9
Intermediate	R5	French	ICH vk 1	3,137.9	1,827.4	692.1	373.8	13	407.9
Intermediate	R17	Mica	ESSFvc	226.7	162.7	5.1	3.9	19	43.1
Intermediate	R17	Mica	ICH vk 1	3,621.1	1,616.8	975.1	208.6	13	470.7
Intermediate	R17	Mica	ICH wk 1	40.8	21.1	6.7	0.0	13	5.3
Low	R5	French	ESSFvc	13,840.8	1,808.0	1,624.1	346.2	19	2,629.8
Low	R5	French	ICH vk 1	7,979.8	3,839.5	2,580.0	1,190.4	13	1,037.4
Low	R5	French	ICH wk 1	682.6	471.4	21.9	13.6	13	88.7
Low	R17	Mica	ESSFvc	10,060.3	1,627.8	523.0	48.2	19	1,911.5

BEO	LU Code	LU Name	BGC Unit	Productive Area (ha)	THLB Area (ha)	Old Productive Area (ha)	Old THLB Area (ha)	Old Seral Target (%)	Old Seral Target (ha)
Low	R17	Mica	ESSFwcw	930.0	60.9	39.4	0.0	19	176.7
Low	R17	Mica	ESSFwc 2	1,381.7	505.3	138.7	2.4	19	262.5
Low	R17	Mica	ICH vk 1	7,573.6	3,208.9	2,503.2	569.8	13	984.6

The foregoing calculations and summaries provide input for a sensitivity analysis related to old seral targets. They will not be modeled in the base case because OGMA"s have been reserved to safeguard landscape level biodiversity.

The RHLPO seral targets were also meant to protect grizzly habitat. For TFL 55, this objective is primarily achieved through operational planning around avalanche chutes.

10.1.2 Stand-level Biodiversity

Stand level biodiversity is addressed in the analysis by reserving wildlife tree patches (WTP). A base target level of 7% was the starting point for these calculations. A portion of the WTPs can come from areas already removed from the THLB, and the remainder is removed at the time of harvest. In order to identify the net harvestable area requiring WTP reserves, productive stands netted out of the forest landbase were identified.

These stands were then given a 250-metre buffer to reflect half of the maximum acceptable distance between wildlife tree patches according to the Biodiversity Guidebook. THLB stands that did not fall within these buffers were deemed to require additional wildlife tree retention. Table 10.3 summarizes percentage reservations calculated.

Table 10.3 Wildlife Tree Retention Requirements

LU Code	LU Name	BGC Unit	THLB Area (ha)	WTP Required (ha)	WTP % Gross	WTP % Net
R17	Mica	ESSFvc	1,765.6	286.5	7	1.14
R17	Mica	ESSFvcp	0.0	0.0	7	0.00
R17	Mica	ESSFwc 2	494.4	113.0	7	1.60
R17	Mica	ESSFwcp	1.0	0.0	7	0.00
R17	Mica	ESSFwcw	61.7	6.0	7	0.68
R17	Mica	ICH vk 1	4,776.0	729.4	7	1.07
R17	Mica	ICH wk 1	20.6	0.0	7	0.00
R5	French	ESSFvc	1,832.3	311.9	7	1.19
R5	French	ESSFvcp	1.4	0.0	7	0.00
R5	French	ICH vk 1	5,673.8	497.3	7	0.61
R5	French	ICH wk 1	1,256.9	191.9	7	1.07
R5	French	IMA un	0.0	0.0	7	0.00
			15,883.8	**2,136.1**	**84**	**0.94**

THLB area is shown in the table by LU and BGC Unit. The next column shows the THLB area that does not fall within 250 metres of existing mature non- THLB stands. This is the area in which WTP"s must be established. The WTP gross requirement (7 %in every case) is multiplied by the ratio of WTP required to THLB area. The area-weighted WTP net requirement for the TFL as a whole is 0.94 percent – the figure shown in the lower right-hand corner of the table.

A one percent reduction will be applied to all curves in order to meet the portion of the WTP requirement expected to come from THLB stands.

10.1.3 Integrated Resource Management

The integrated resource management constraint is intended to distribute harvesting across the THLB and prevent spatially concentrated harvesting in short time span. It is often implemented with the intention of modelling three- or four-pass harvesting of an area. For the latest timber supply analysis for the Revelstoke TSA, a forest cover constraint that allowed no more than 25% of the THLB area to be below a stand height of two meters was enforced at the Landscape Unit level

The IRM zone will not be specifically modelled in this analysis because it does not drive strategic or operational planning on the TFL. Instead patch size targets will be modelled for the entire planning horizon (see Section 10.2). The proportion of the THLB that is below two metres in stand height will be tracked for information purposes only; no limits will be enforced.

10.2 Patch Size Objectives

All of the TFL will be managed as „natural disturbance type" one for patch size purposes. Patch size targets for NDT1 are shown in Table 10.4.

Table 10.4 Patch Size Targets for Natural Disturbance Type 1

Patch Size Class (ha)	Target Area (%)
0 to 40	30-40
40 to 80	30-40
80 to 250	20-40
> 250	0

Seral stage was defined by BEC from the Biodiversity Guidebook as shown in Table 10.5.

Table 10.5 Patch Seral Stage Definitions

Seral Class	Age Range	
	ICH	ESSF
Shrub/Herb	0 - 19	0 - 19
Pole/Sapling	20 - 39	20 - 39
Young	40 - 99	40 - 119
Mature	100 - 249	120 - 249
Old	250 +	250 +

Previous analyses by LP show that the target patch size is not currently being met. In an effort to move the land base towards the desired distribution, patches in all of the seral classes listed in Table 10.5 will be tracked. Since harvesting activities can only directly and immediately affect shrub/herb and mature/old seral patches directly, the targets for these classes only will be enforced during modelling.

10.3 Timber Harvesting

10.3.1 Minimum Harvest Age

The minimum harvest ages have been set at age at which 95% of CMAI is achieved providing that it has achieved a minimum volume and minimum DBH. The minimum volume is 150m^3/ha for all stands (MP#4 used a 200m^3/hectare limit for cedar- and hemlock-leading stands). The minimum DBH limit is 25 centimetres (stand quadratic mean diameter).

Table 10.6 summarizes the average minimum harvest age (MHA) attributes for the natural stand yield tables. This table has been compiled for information purposes only. Natural stand yield curves will be compiled for each VRI polygon based on its attributes. Minimum harvest age will also be calculated separately for each stand using criteria listed in the previous paragraph. Most natural stands are currently older than their minimum harvest age (i.e. they are currently harvestable).

Table 10.6 Minimum Harvest Age Attributes for Natural Stands

AU	Name	THLB (ha)	Min. Harvest Age (years)	Diameter (cm)	Volume (m^3/ha)	MAI (m^3/ha/yr)
1	ICHwk1-9,7,6-S	70.0	60	27.8	222	3.7
2	ICHwk1-5-S	89.6	70	29.6	201	2.9
3	ICHwk1-4-H-C	85.4	70	27.6	191	2.7
4	ICHwk1-4-S	177.0	70	26.0	152	2.2
5	ICHwk1-4-S	48.2	60	25.3	153	2.6
6	ICHwk1-1-C	61.8	80	27.4	222	2.8
7	ICHwk1-1-H	62.1	100	30.1	185	1.9
8	ICHwk1-1-S-Fd	16.2	70	28.0	245	3.5
9	ICHvk1-5-S-B	389.2	80	26.2	207	2.6
10	ICHvk1-5-C-H	95.7	80	29.6	202	2.5
11	ICHvk1-4-S-B-P	339.9	80	26.1	216	2.7
12	ICHvk1-4,3-C-Fd-P	730.2	80	26.9	162	2.0
13	ICHvk1-4-Fd	230.4	70	26.0	228	3.3
14	ICHvk1-4-H	822.0	90	28.3	169	1.9
15	ICHvk1-3,1-S-B-H	131.7	70	25.0	168	2.4
16	ICHvk1-1-C	477.2	70	26.2	158	2.3
17	ICHvk1-1-H-Fd-P	1,138.4	80	25.8	157	2.0
18	ESSFwcw, ESSFwc2-4,3-S-B	115.7	80	26.1	163	2.0
19	ESSFwcw, ESSFwc2-1-S	100.7	80	27.5	172	2.1

AU	Name	THLB (ha)	Min. Harvest Age (years)	Diameter (cm)	Volume (m^3/ha)	MAI (m^3/ha/yr)
20	ESSFvc-1-B	257.2	90	29.4	180	2.0
21	ESSFvc-1-C	29.0	80	27.7	215	2.7
22	ESSFvc-1-H	319.4	100	28.7	191	1.9
23	ESSFvc-1-S	829.7	90	26.3	178	2.0
24	ESSFvc-6,4-S	19.9	90	32.3	180	2.0
25	ESSFvc-3-All	299.1	80	26.0	169	2.1

wTable 10.7 summarizes the attributes for 95% CMAI for the TIPSY yield tables representing future managed stands and existing managed stands established in 2005 or later.

wTable 10.7 Minimum Harvest Age Attributes for Future Managed Stands and Existing Managed Stands (Era 2)

Analysis Unit	Name	THLB (ha)	Min. Harvest Age (years)	Volume (m^3/ha)	Diameter (cm)	MAI (m^3/ha/yr)
101	ICHwk1-9,7,6-S	106	72	376	25.0	5.2
102	ICHwk1-5-S	145	61	396	25.5	6.5
103	ICHwk1-4-H-C	204	91	377	25.1	4.1
104	ICHwk1-4-S	498	59	401	25.6	6.8
105	ICHwk1-4-S	385	72	376	25.0	5.2
106	ICHwk1-1-C	243	83	372	25.0	4.5
107	ICHwk1-1-H	127	76	378	25.1	5.0
108	ICHwk1-1-S-Fd	110	61	396	25.5	6.5
109	ICHvk1-5-S-B	2,632	68	376	25.0	5.5
110	ICHvk1-5-C-H	257	83	374	25.0	4.5
111	ICHvk1-4-S-B-P	2,658	57	382	25.1	6.7
112	ICHvk1-4,3-C-Fd-P	1,206	83	374	25.0	4.5
113	ICHvk1-4-Fd	718	49	388	25.2	7.9
114	ICHvk1-4-H	1,130	83	374	25.0	4.5
115	ICHvk1-3,1-S-B-H	1,574	68	376	25.0	5.5
116	ICHvk1-1-C	741	68	376	25.0	5.5
117	ICHvk1-1-H-Fd-P	1,837	57	382	25.1	6.7
118	ESSFwcw, ESSFwc2-4,3-	964	133	357	25.0	2.7
119	ESSFwcw, ESSFwc2-1-S	563	103	364	25.0	3.5
120	ESSFvc-1-B	418	103	364	25.0	3.5
121	ESSFvc-1-C	427	103	364	25.0	3.5
122	ESSFvc-1-H	743	133	357	25.0	2.7
123	ESSFvc-1-S	3,430	103	364	25.0	3.5
124	ESSFvc-6,4-S	53	82	366	25.0	4.5
125	ESSFvc-3-All	534	82	366	25.0	4.5

Table 10.8 summarizes for existing managed stands.

Table 10.8 Minimum Harvest Age Attributes for Existing Managed Stands (Era 1)

AU	Name	THLB (ha)	Min. Harvest Age (years)	Volume (m^3/ha)	Diameter (cm)	MAI (m^3/ha/yr)
201	ICHwk1-9,7,6-S	21.5	70	384	25.1	5.5
202	ICHwk1-5-S	55.3	59	371	25.0	6.3
203	ICHwk1-4-H-C	36.8	89	366	25.0	4.1
204	ICHwk1-4-S	185.3	71	422	26.2	5.9
205	ICHwk1-4-S	113.0	70	368	25.1	5.3
206	ICHwk1-1-C	117.7	82	398	25.0	4.9
207	ICHwk1-1-H	18.7	73	384	25.4	5.3
208	ICHwk1-1-S-Fd	63.5	59	365	25.1	6.2
209	ICHvk1-5-S-B	1,766.1	70	358	25.1	5.1
210	ICHvk1-5-C-H	60.9	86	430	26.1	5.0
211	ICHvk1-4-S-B-P	1,360.2	58	360	25.0	6.2
212	ICHvk1-4,3-C-Fd-P	383.4	85	379	25.2	4.5
213	ICHvk1-4-Fd	308.5	62	436	26.7	7.0
214	ICHvk1-4-H	210.9	85	396	25.5	4.7
215	ICHvk1-3,1-S-B-H	1,166.1	69	364	25.1	5.3
216	ICHvk1-1-C	207.0	71	429	26.1	6.0
217	ICHvk1-1-H-Fd-P	294.9	61	357	25.0	5.9
218	ESSFwcw, ESSFwc2-4,3-S-	273.6	136	338	25.0	2.5
219	ESSFwcw, ESSFwc2-1-S	187.4	107	346	25.0	3.2
220	ESSFvc-1-B	131.5	109	347	25.0	3.2
221	ESSFvc-1-C	71.2	107	451	26.5	4.2
222	ESSFvc-1-H	64.3	143	347	25.0	2.4
223	ESSFvc-1-S	1,723.3	108	346	25.0	3.2
224	ESSFvc-6,4-S	27.2	85	355	25.0	4.2
225	ESSFvc-3-All	160.9	90	353	25.0	3.9

Table 10.9 shows the LRSY estimates for TFL 55.

Table 10.9 LRSY Estimates for Natural and Managed Stands

THLB Area (ha)	Natural		Managed	
	Average CMAI (m^3/ha/yr)	LRSY (m^3/yr)	Average CMAI (m^3/ha/yr)	LRSY (m^3/yr)
15,945	2.8	44,506	5.0	80,493

10.3.2 Silviculture Systems

The purpose of this section is to document the silviculture management regimes that are applied on the TFL and how these regimes are reflected in the analysis. The analysis assumes that a clear cut or patch cut silviculture system is carried out in every case throughout the TFL. There has been no reduction for shading applied to managed stand yields in areas that are harvested using a patch cut silviculture system.

10.3.3 Initial Harvest Rate

The current AAC for TFL 55 is 90,000 m^3/year, including allocation to the British Columbia Timber Sales Program (BCTS). In addition, an allowance must be made for non-recoverable losses. As the timber supply analysis is based on the net harvest plus NRLs, the initial gross harvest level for the Base Case analysis will be set to 90,916 m^3/year, providing a starting point for the analysis. (See Table 9.1 for unsalvaged loss calculations.)

10.3.4 Harvest Rule

Patchworks schedules harvesting is a way that best meets the specified timber and resource objectives through a process of simulated annealing. As such, no simple „harvest rule" can be enunciated. However, during the analysis, the harvest profile (e.g. the species, age and volume class distribution of the harvested volume) will be compared to the profile of the available timber and any discrepancies will be investigated and explained.

10.3.5 Harvest Flow Objectives

In all phases of the analysis, the harvest flow will reflect a balance of the following objectives:

- Maintain the current harvest level for as long as possible;
- Limit changes in harvest level to less than 10% of the level prior to the reduction; and
- Achieve a maximum stable long-term harvest level and while having a stable growing stock profiles.

Forest cover requirements and biological capacity of the THLB will ultimately dictate the harvest level determined in the analysis.

10.3.6 Disturbing the Non-THLB

When modelling, the entire productive landbase is available to fulfill various landbase requirements (i.e. caribou and seral requirements). Traditionally, the only form of disturbance modelled is timber harvesting in the THLB. This is a concern because eventually in the model all the non-THLB becomes old and can lead to the non-THLB fulfilling an unrealistic portion of forest cover requirements, thereby reducing the impact on the THLB. In reality, there will be some level of natural disturbance within the non-THLB.

This section describes the theoretical process of disturbing the non-THLB used in the modeling of this analysis. The intentions are to achieve the early, mature and old seral percentages for each BEC variant in accordance with the natural range of variation (NROV) defined in the Biodiversity Guidebook.

The method used for this analysis is to: impose a seral requirement on the non-THLB of each BEC variant, which will force the non-THLB to achieve a seral zone distribution similar to the NROV from the Biodiversity Guidebook. From the non-THLB, the model will recruit the oldest stands first in order to achieve seral requirements as soon as possible. Then, the model forces an annual harvest disturbance to the non-THLB of each BEC zone using the oldest first harvest rule. The size of the disturbance will be determined from the disturbance frequency in the Biodiversity Guidebook

This process has been carried out by:

1. Determining the BEC zones and their area breakdown in TFL 55;
2. Using the *Biodiversity Guidebook* to determine the NDT, disturbance interval, mature and old age for each BEC zone;
3. Estimate the seral stage distribution following the *Biodiversity Guidebook* procedure (Appendix 4);
4. Determine the appropriate seral requirement (mature and old) for each BEC zone; and
5. Determine the annual disturbance for each BEC zone.

Table 10.10 provides the summary information for the BEC zones in TFL 55. All BEC variants shown are NDT 1.

Table 10.10 Summary Information for BEC Zones

BEC Variant	Disturbance Interval	Old Age	Productive Area	THLB Area
ESSFvc	350	250	20,794.9	3,601.7
ESSFwc 2	350	250	876.4	505.3
ICH vk 1	250	250	11,819.8	10,492.7
ICH wk 1	250	250	448.3	1,281.6

The seral stage distribution is estimated using the negative exponential equation from Appendix 4 of the Biodiversity Guidebook. The negative exponential equation uses disturbance interval and gives the percent older than the input age:

Percent older than specified age = exp (-age/return interval)

Table 10.11 shows the seral stage distribution for the two fire return intervals that occur in TFL 55 (250 years and 350 years).

Table 10.11 Seral Stage Distribution for Fire Return Intervals of 250 years and 350 years

Age	250		350	
	Greater than	Less than	Greater than	Less than
20	92%	8%	94%	6%
40	85%	15%	89%	11%
60	79%	21%	84%	16%
80	73%	27%	80%	20%
100	67%	33%	75%	25%
120	62%	38%	71%	29%
140	57%	43%	67%	33%
160	53%	47%	63%	37%
180	49%	51%	60%	40%
200	45%	55%	56%	44%
220	41%	59%	53%	47%
240	38%	62%	50%	50%
250	37%	63%	49%	51%

Table 10.12 shows the area that will be disturbed each year in each BEC zone and also shows the seral zone requirements that will be placed on the BEC zones in order to achieve the desired NROV.

Table 10.12 Disturbance Levels and Mature and Retention Requirements in non-THLB.

BEC Zone	Disturbance Interval (yrs)	Annual Disturb (%)	Annual Dist (area in ha)	Old Seral Requirement
ESSFvc	350	0.29%	60.3	49% > 250
ESSFwc2	350	0.29%	2.5	49% > 250
ICHvk1	250	0.40%	47.3	37% > 250
ICHwk1	250	0.40%	1.8	37% > 250

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Appendix A

Vegetation Resources Inventory Statistical Adjustment

TFL 55

VEGETATION RESOURCES INVENTORY

STATISTICAL ADJUSTMENT

TIMBERLINE FOREST INVENTORY CONSULTANTS LTD.

Prepared for:

Louisiana Pacific

Prepared by:

Timberline Forest Inventory Consultants Ltd.

Kelowna, B.C.

Project Number: 7051008

October 2005

Timberline
Forest Inventory Consultants

August 17, 2005

7051008-1-1

Malakwa Division
4872 Lybarger Road
Malakwa BC V0E 2J0

Attention: Fernando Cocciolo, R.P.F.
Area Forest Manager

Reference: *TFL 55 VRI Statistical Adjustment*

Please accept this final report for the above-mentioned project.

It has been our pleasure working with you.

Yours truly,
TIMBERLINE FOREST INVENTORY CONSULTANTS LTD.

Kelly Sherman, R.P.F.
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EXECUTIVE SUMMARY

Louisiana Pacific has completed a Vegetation Resources Inventory for Tree Farm Licence 55 (TFL 55). The main objective of the Phase 2 inventory adjustment is to statistically adjust Phase 1 inventory age, height and resulting VDYP generated volume. The Phase 2 adjustment has been completed by Timberline Forest Inventory Consultants and this report details the methodology used.

The Phase 2 adjustment for the TFL 55 VRI was carried out using methods detailed in *VRI Procedures and Standards for Data Analysis, Attribute Adjustment and Implementation of Adjustment in the Corporate database* (MoF 2004).

Table I shows the weighted ratios that have been used to adjust each of the strata. The adjustments have only been applied to stands over the age 40.

Table I Phase 2 Adjustment

Stratum	Height	Age	Volume
Balsam	1.0378	0.7919	1.0456
Cedar	0.9665	0.9918	1.3833
Hemlock	0.9057	1.1997	1.2310
Other (Fd)	0.9665	1.4871	1.3833
Spruce	0.9780	0.8080	0.9905

Table II shows the inventory statistics after the adjustment for stands over age 40.

Table II Adjusted Strata Means

Strata	Area (ha)	Height (m)	Age (yrs)	Site Index (m)	Volume 2003 m^3/ha
Balsam	3,477	23	150	13	224
Cedar	4,583	35	283	16	680
Hemlock	5,801	29	264	12	489
Other	2,225	27	169	15	387
Spruce	8,972	32	184	16	356
Totals	**25,058**	**30**	**214**	**14**	**430**

Table III shows the inventory statistics prior to the adjustment for stands over the age 40.

Table III Unadjusted Strata Means

Strata	Area (ha)	Height (m)	Age (yrs)	Site Index (m)	Volume 2003 m^3/ha
Balsam	3,477	22	189	10	205
Cedar	4,583	36	285	17	510
Hemlock	5,801	32	220	15	440
Other	2,225	28	116	18	292
Spruce	8,972	33	228	15	373
Totals	**25,058**	**31**	**221**	**15**	**383**

Table IV shows the percent change for the adjusted inventory.

Table IV Percent Change for Adjusted Inventory

Strata	Area (ha)	Height (%)	Age (%)	Site Index (m)	Volume 2003 m^3/ha
Adjusted Area	100%	96%	97%	97%	112 %

Table V reports the sampling error for the height, age and net volume.

Table V Strata Sampling Error

Strata	Height	Age	Volume
Balsam	22.9	27.9	47.5
Cedar	7.4	21.2	26.7
Hemlock	10.4	18.6	22.1
Other	22.3	36.7	48.1
Spruce	6.7	11.3	16.0
All strata	**4.4**	**8.2**	**10.6**

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Appendix 1 Vegetation Resource Inventory Ground Sampling Report

1.0 DESCRIPTION OF THE INVENTORY UNIT

1.1 Introduction

Tree Farm Licence 55 (TFL 55) is located in the Selkirk Mountains between the Revelstoke Reservoir and Kinbasket Lake. The TFL is approximately 93,000 hectares with 45,000 hectares of productive forest and 19,782 hectares of timber harvesting landbase according to Management Plan No. 3 (Sterling Wood Group, June 2000).

The Biogeoclimatic (BEC) zones that exist within TFL55 are listed in Table 1.1 below. All BEC Zones are of Natural Disturbance Type (NDT) 1 except for Parkland (ESSFvvp and ESSFvcp) that is NDT 5 (Forest Practices Code 1995). The most common zones are ICHvk1 and ESSFvc, which together make up just over 90% of the total area

Table 1.1 Area by BEC Zone

BEC	Area (ha)
ICHwk1	1,266
ESSFvv	251
ESSFwc2	488
ESSFvvp	6
ESSFvc	8,819
ICHvk1	14,677
ESSFvcp	209
Total	25,718

A comprehensive vegetation inventory commenced in 2002, based on a Chief Forester's recommendation in the 1996. Atticus Resources Consulting carried out the Phase 1 VRI, which was completed by 2002. Atticus also did the Phase 2 sampling plan and the Phase II ground sampling in the fall and early winter of 2002. This project compiles the ground sampling data and statistically adjusts the vegetation inventory. This project represents one of several projects that are being completed prior to Management Plan No. 4.

1.2 Objectives

The main objective of the Phase 2 inventory adjustment is to statistically adjust Phase 1 inventory age, height and resulting VDYP generated volume. Age and height are estimated using air photos and contain an interpretation bias. Volume generated using VDYP contains a volume bias because, which result from:

1. VDYP estimates decay waste and breakage using FIZ and PSYU which are "averaged" values (note: this bias can be removed by calculating a volume adjust factor from the Net Volume Adjustment Factor sampling collected during the ground portion of Phase 2); and
2. Additional model error associated with taper equations, local fit and the many other variables used to estimate volume (note: these biases can be removed by adjusting the VDYP volume with the ground volumes).

This section details the vegetation resources inventory data set and the ground sample information used to perform the adjustments.

1.3 Vegetation Resources Inventory (VRI) Landbase

TFL 55 encompasses 92,700 hectares of land with 54,444 hectares classified vegetated treed. The remaining 38,000 hectares is broken down between vegetated non-treed and non-vegetated (See Table 1.2).

Table 1.2 TFL 55 Vegetation Netdown

Landbase Description	Area (ha)	Percent
Vegetated Treed	54,444	59%
Vegetated Non-Treed	32,884	35%
Non-Treed	5,372	6%
Total	**92,700**	100%

The vegetated treed inventory was further broken down into strata for ground sampling based upon species within the operable landbase. Of the 54,444 ha of vegetated treed land only 26,646 ha were within or touching the operability line as shown in Table 1.3.

Table 1.3 Broad Strata Summary

Strata	Area (ha)	Percent
Balsam	3,477	13.4%
Cedar	4,583	19.2%
Hemlock	5,801	23.0%
Other	2,225	8.5%
Spruce	8,972	35.9%
Total/Average	**25,058**	**100.0%**

Once the strata were defined, the standards required that each of the strata be further separated in sub-strata, based on volume. However, in this case volume had not yet been assigned to the inventory file (assigned separately by the MSRM). In discussions between Atticus and the Ministry it was decided that the photo interpreted attribute basal area would be used for sub-stratification. The target was less than 15 substrata overall with a maximum of three substrata (low to high basal area) per main species strata (Atticus, 2003). Table 1.4 illustrates the final strata and sub-strata used.

Table 1.4 Final Strata, Sub-Strata Summary

Strata	Sub-strata	Area (ha)	Percent	# Plots
Spruce	Spruce1	2,730	28.5%	9
	Spruce2	3,165	33.0%	10
	Spruce3	3,699	38.5%	12
Total Spruce		**9,593**	**100.0%**	**31**
Balsam	Balsam1	1,755	47.1%	6

Strata	Sub-strata	Area (ha)	Percent	# Plots
	Balsam2	1,969	52.9%	6
Total Balsam		**3,725**	**100.0%**	**12**
Cedar	Cedar1	900	19.0%	3
	Cedar2	1,778	37.5%	6
	Cedar3	2,066	43.5%	6
Total Cedar		**4,745**	**100.0%**	**15**
Hemlock	Hemlock1	1,371	23.1%	4
	Hemlock2	2,108	35.5%	7
	Hemlock3	2,458	41.4%	8
Total Hemlock		**5,937**	**100.0%**	**19**
Other	Other	2,646	100.0%	8
Total Other		**2,646**	**100.0%**	**8**

2.0 DESCRIPTION OF PHASE I AND PHASE II ISSUES

2.1 Unadjusted Inventory

The unadjusted inventory contained an average stand height of 28.7 meters, age of 197.4 years, site index of 14.4 meters, volume at 12.5 cm dbh utilization level of 341.9 m^3/ha and volume at 17.5 cm of 330.2 m^3/ha. There is a difference in total area of 248 ha between Atticus' summaries and Timberline Forest Inventory Consultants summaries. This is due to recently harvested blocks that were "erased" from the inventory when the depletions were cut in by the Ministry. This will not affect the results of this analysis. The population was obtained by selecting only those vegetated treed stands that were within or touched the operability line and were greater than 40 years old. See Table 2.1.

Table 2.1 Unadjusted Inventory Statistics

Strata	Area (ha)	Height (m)	Age (yrs)	Site Index (m)	Volume 12.5 m^3/ha	Volume 17.5 m^3/ha
Balsam	3,477	25.8	194.4	10.5	227.9	214.9
Cedar	4,583	35.4	287.0	16.4	513.0	507.7
Hemlock	5,801	29.2	220.8	15.1	450.0	440.3
Other	2,225	27.4	117.1	18.5	312.6	296.1
Spruce	8,972	32.1	230.4	14.8	387.9	379.8
Total/Average	**25,058**	**28.7**	**197.4**	**14.4**	**341.9**	**330.2**

Note: Averages area area-weighted averages

2.2 Ground Plot Data

Table 2.2 shows a summary of Inventory and ground data for each of the Phase 2 ground plots.

Table 2.2 Phase 2 Ground Plots Summary Table

Phase 2						Phase 1					BEC	Elevation	Adj. applied		
Sample Number	Sub-stratum	Leading Species	Age	Height	Volume	Leading Species	Second Species	Age	Height	Volume			Age	Height	Volume
1	Spruce1	SXW	33	11	17	SX	BL	25	6	0	ICHvk1	1261	N	N	N
2	Spruce1	SXW	28	8	3	SX	CW	24	6	0	ICHvk1	1096	N	N	N
3	Spruce1	SX	25	9	18	SX	BL	156	21	164	ICHvk1	1349	Y	N	Y
4	Spruce1	SE	138	39	465	SE	BL	236	36	150	ICHvk1	.	Y	Y	Y
5	Spruce1	SX	165	31	378	SE	BL	246	35	421	ICHvk1	.	Y	Y	Y
6	Spruce1	SE	154	42	252	SE	BL	271	40	449	ICHvk1	.	Y	Y	Y
7	Spruce1	SXW	194	34	224	SE	BL	246	35	375	ICHvk1	.	Y	Y	Y
8	Spruce1	SXW	173	40	506	SE	BL	266	39	454	ICHvk1	1232	Y	Y	Y
9	Spruce1	SXW	150	36	398	SE	CW	206	33	440	ICHvk1	.	Y	Y	Y
10	Spruce2	BL	182	20	366	SE	BL	146	25	298	ESSFwc2	.	Y	Y	Y
11	Spruce2	HM	325	26	369	SE	BL	246	28	310	ESSFvc-	1641	Y	Y	Y
12	Spruce2	SXW	222	33	441	SE	BL	256	29	316	ESSFvc-	.	Y	Y	Y

Phase 2						Phase 1					BEC	Elevation	Adj. applied		
Sample Number	Sub-stratum	Leading Species	Age	Height	Volume	Leading Species	Second Species	Age	Height	Volume			Age	Height	Volume
13	Spruce2	BL	221	29	379	SE	BL	226	28	340	ESSFvc-	1721	Y	Y	Y
14	Spruce2	HM	196	25	413	SE	BL	246	28	294	ESSFvc-	.	Y	Y	Y
15	Spruce2	BL	145	31	353	SE	BL	156	23	284	ESSFvc-	.	Y	Y	Y
16	Spruce2	SXW	213	41	267	SE	BL	266	35	392	ICHvk1	.	Y	Y	Y
17	Spruce2	SXW	264	35	355	SE	BL	236	34	368	ESSFvc-	1537	Y	Y	Y
18	Spruce2	SE	189	38	368	SE		186	38	470	ICHvk1	.	Y	Y	Y
19	Spruce2	HM	283		384	SE	BL	266	33	380	ESSFvc-	1549	Y	N	Y
20	Spruce3	SE	264	42	440	SE	HW	256	35	508	ESSFvc-	.	Y	Y	Y
21	Spruce3	SX	203	37	602	SE	BL	236	40	411	ICHvk1	.	Y	Y	Y
22	Spruce3	SXW	264		372	SE	BL	306	34	391	ESSFvc-	.	Y	N	Y
23	Spruce3	BL	140	25	313	SE	BL	206	30	385	ICHvk1	1162	Y	Y	Y
25	Spruce3	FDI	106	25	244	SE	PL	106	28	326	ICHvk1	1240	Y	Y	Y
26	Spruce3	FDI	91	30	230	SE	PL	106	28	326	ICHvk1	.	Y	Y	Y
27	Spruce3	SXW	122	34	557	SE	BL	226	36	466	ICHvk1	.	Y	Y	Y
28	Spruce3	SXW	139	28	335	SE	HW	276	35	433	ICHvk1	.	Y	Y	Y
29	Spruce3	SXW	101	28	439	SE	FDI	106	28	320	ESSFvc-	.	Y	Y	Y
30	Spruce3	FDI	107	23	139	SE	HW	156	33	492	ICHvk1	.	Y	Y	Y
31	Spruce3	HW	102	16	95	SE	CW	106	28	382	ESSFvc-	.	Y	Y	Y
32	Balsam1	HM	143	4	0	BL		36	4	0	ESSFvc-	.	N	N	N
33	Balsam1	SXW	21	5	0	SX	BL	146	23	208	ICHvk1	.	N	N	Y
34	Balsam1	BL	87	18	55	BL	SE	96	16	119	ESSFvc-	.	Y	Y	Y
35	Balsam1	BL	86	18	177	BL	SE	106	14	87	ESSFvc-	1875	Y	N	Y
36	Balsam1	BL	133	24	311	BL	SE	226	23	208	ESSFvc-	.	Y	Y	Y
37	Balsam1	BL	164	27	92	BL	SE	186	25	266	ESSFvc-	1878	Y	Y	Y
38	Balsam2	BL	197	20	203	BL	SE	176	25	190	ESSFvc-	1682	Y	Y	Y
39	Balsam2	BL	97	17	78	BL	SE	206	20	181	ESSFvc-	1999	Y	Y	Y
40	Balsam2	BL	168	24	240	BL	SE	236	28	291	ESSFvc-	.	Y	Y	Y
41	Balsam2	SE	62	22	175	BL	HW	116	10	30	ESSFvc-	.	Y	Y	Y
42	Balsam2	BL	160	24	269	BL	SE	156	26	266	ESSFvv-	1823	Y	Y	Y
43	Balsam2	BL	166	25	526	BL	SE	156	26	266	ESSFwc2	1400	Y	Y	Y
44	Cedar1	SE	123	32	280	CW	AC	86	20	152	ICHvk1	.	Y	Y	Y
45	Cedar1	SXW	83	21	52	CW	SE	106	22	232	ICHwk1	722	Y	Y	Y
46	Cedar1	CW			1017	CW	SE	306	35	501	ICHvk1	1115	N	N	Y
47	Cedar2	HW	142	30	247	CW	HW	206	33	385	ICHvk1	960	Y	Y	Y
49	Cedar2	HW	251	30	353	CW	HW	256	33	452	ICHvk1	.	Y	Y	Y
50	Cedar2	CW	354	33	734	CW	HW	306	37	535	ICHvk1	.	Y	Y	Y
51	Cedar2	CW	179	38	1179	CW	HW	306	36	523	ICHvk1	697	Y	Y	Y
52	Cedar2	CW	254	32	603	CW	HW	256	33	504	ICHvk1	910	Y	Y	Y
53	Cedar3	HW	281	37	610	CW	HW	281	38	503	ICHvk1	.	Y	Y	Y
54	Cedar3	HW	198	28	566	CW	SE	256	33	479	ICHvk1	1062	Y	Y	Y
55	Cedar3	CW	213	38	301	CW	HW	256	35	544	ICHvk1	744	Y	Y	Y
56	Cedar3	CW	404	32	801	CW	HW	256	35	530	ICHvk1	1245	Y	Y	Y
57	Cedar3	CW	522		1121	CW	HW	331	39	550	ICHvk1	1146	Y	N	Y

Phase 2						Phase 1					BEC	Elevation	Adj. applied		
Sample Number	Sub-stratum	Leading Species	Age	Height	Volume	Leading Species	Second Species	Age	Height	Volume			Age	Height	Volume
58	Cedar3	CW	252	40	563	CW	HW	381	41	569	ICHvk1	798	Y	Y	Y
59	Hemlock1	FDI	20	5	0	HW	FDI	26	8	1	ICHvk1	756	N	N	N
61	Hemlock1	HM	274	18	477	HM	BL	236	25	331	ESSFvc-	1852	Y	Y	Y
62	Hemlock1	HM	367		407	HW	SE	271	33	473	ESSFvc-	1670	Y	N	Y
63	Hemlock2	HW	200	32	472	HW	CW	126	25	311	ICHvk1	.	Y	Y	Y
64	Hemlock2	HW	298		287	HW	SE	236	32	494	ICHvk1	.	Y	N	Y
65	Hemlock2	FDI	107	28	433	HW	CW	106	29	341	ICHvk1	1109	Y	Y	Y
66	Hemlock2	HM	257	27	439	H	SE	271	35	513	ESSFvc-	.	Y	Y	Y
67	Hemlock2	SXW	63	21	226	HW	CW	136	33	409	ICHvk1	.	Y	Y	Y
68	Hemlock2	CW			810	HW	CW	381	52	581	ICHvk1	.	N	N	Y
69	Hemlock2	CW	301	30	701	HW	CW	206	30	375	ICHvk1	.	Y	Y	Y
70	Hemlock3	CW	134	35	532	HW	CW	256	38	532	ICHvk1	.	Y	Y	Y
71	Hemlock3	CW			386	HW	CW	186	32	466	ICHvk1	856	N	N	Y
72	Hemlock3	HW	240	24	434	HW	CW	146	25	354	ICHvk1	643	Y	Y	Y
73	Hemlock3	CW	584	41	237	HW	CW	306	37	523	ICHvk1	.	Y	Y	Y
74	Hemlock3	HW	381	23	411	HW	CW	281	35	514	ICHvk1	957	Y	Y	Y
75	Hemlock3	HW	281	37	573	HW	CW	236	34	474	ICHvk1	860	Y	Y	Y
76	Hemlock3	HW	309	34	800	HW	CW	256	35	493	ICHvk1	.	Y	Y	Y
77	Hemlock3	HW	186	42	1089	HM	SE	276	37	592	ICHvk1	1326	Y	Y	Y
79	Other	AC	44	22	81	AC		56	18	26	ICHvk1	792	N	N	N
81	Other	FDI	112	27	434	FDI	EP	96	25	189	ICHwk1	947	Y	Y	Y
82	Other	HW	239	29	190	FD	HW	146	30	337	ICHvk1	.	Y	Y	Y
83	Other	BL	90	27	602	FDI	SE	106	28	360	ESSFvc-	1491	Y	Y	Y
84	Other	HW	237	22	516	FD	HW	146	32	369	ICHvk1	.	Y	Y	Y
85	Other	CW	244		669	FDI	SE	126	33	444	ICHwk1	661	Y	N	Y

3.0 DESCRIPTION OF DATA SCREENING PROCESS

The Phase 2 adjustment for the TFL 55 VRI was carried out using methods detailed in *VRI Procedures and Standards for Data Analysis, Attribute Adjustment and Implementation of Adjustment in the Corporate database* (MoF 2004).

3.1 Compilation and Net Volume Adjustment Factors

JS Thrower and Associates compiled the Phase 2 ground data and calculated the net volume adjustment factors (NVAF). There were 63 trees sampled, which were distributed as shown in Table 3.1.

Table 3.1 Sample size for NVAF

Stratum	Sample Size
Dead	4
Immature	10
Mature-C	12
Mature-H	12
Mature-Others	25

Note: The cedar and hemlock were combined for sampling and then post stratified.

3.2 Statistical Adjustment

The adjustment process was carried out following Section 4 of the *VRI Procedures and Standards for Data Analysis, Attribute Adjustment and Implementation of Adjustment in the Corporate Database* (MoF 2004).

The process involves first determining appropriate adjustment ratios for the age and height. Then using VDYP the adjusted volume is calculated. The adjusted volume is then compared to the Phase 2 ground volumes to determine and appropriate volume adjustment ratio.

3.3 Post Stratification

There was a considerable amount of investigating options done to find appropriate post stratification. Variables such as age, biogeoclimatic zones, height and site index were all considered for stratification.

No post stratification was done except that Cedar and Douglas-fir have been combined for the volume and height adjustments. There were only 5 plots in Douglas-fir stands and they were very similar to the cedar stands in terms of volumes and heights. For the age adjustment they have been adjusted separately because they are distinctly different (i.e. age adjustment for cedar is 0.9918 and Douglas-fir is 1.4487. Sam Otukol of the Ministry of Forests stated that it is preferable to use the same strata for age, height and volume adjustments; however he agreed that this was an exception.

In addition sample clusters that have an age below 40 (Phase 1 or Phase 2 age) have been removed from the sample. When the samples below that age 40 were excluded from the analysis the error associated with the adjustment was reduced considerably. This removed plots 1,2,3,32,33, and 59. Plot 79 was removed from other because it was the only ‘other’ that was not Douglas-fir.

3.4 Calculating Adjustment Factors

The method used for adjustment factors is the ratio of means (ROM) for all three adjustments; age, height and volume. The observations were weighted appropriately because the selection probabilities were unequal amongst the sub strata.

4.0 PRESENTATION OF RESULTS

4.1 Net Volume Adjustment Factors

The NVAF ratios are shown on Table 4.1.

Table 4.1 NVAF Ratios and Sampling Error

Stratum	Sample Size	Avg. NVAF Volume (m3)	Avg. VRI Volume (m3)	NVAF Ratio	95% Sampling Error (Absolute)	SE %
Dead	4	2.9613	2.1418	1.291	0.604	29.4
Immature	10	0.2881	0.2919	0.987	0.063	8.9
Mature-C	12	6.7724	7.6007	0.858	0.138	25.2
Mature-H	12	2.0007	1.9594	1.049	0.111	16.7
Mature-Others	25	3.8241	3.6243	1.021	0.064	15.1

The NVAF factors have been approved by Will Smith. It was suggested that LP Canada consider destructively sampling about eight more tree to bring the sampling error in cedar and hemlock to 10%. Using the original strata, which combined cedar and hemlock, the sampling error was less than 10%. However, the difference in NVAF between cedar and hemlock (6.7724 versus 2.0007) was too large to ignore, so the strata was split.

4.2 Age Adjustment

Table 4.2 shows the weighted ratio of means for the age adjustment for each of the strata.

Table 4.2 Age Adjustment Ratios

Stratum	Age Adjustment Ratio
Balsam	0.7919
Cedar	0.9918
Hemlock	1.1997
Douglas-fir	1.4871
Spruce	0.8080

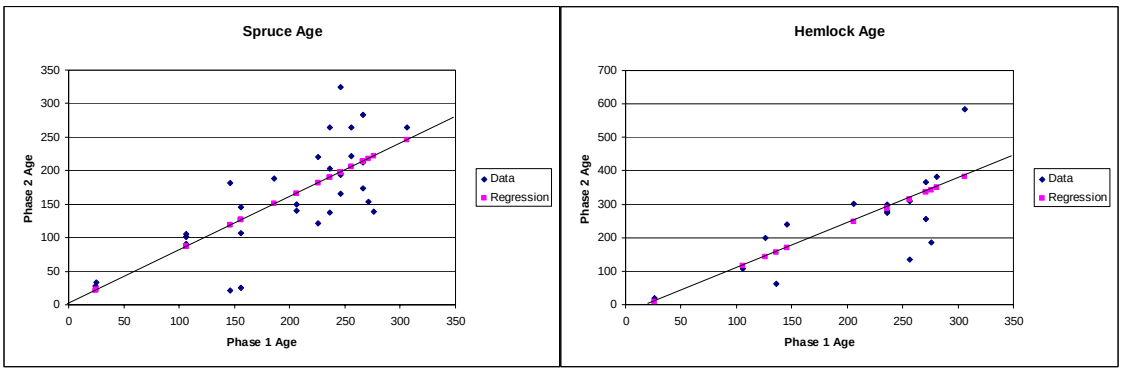
The method used for weighting the adjustment ratios has been shown in Table 4.3.

Table 4.3 Determining Area weighted Adjustment Ratio for Age (Spruce Stratum)

Phase 2 Sample	Substratum		# of Sample Clusters	Weight *	Age	
	Name	Area			Phase 2	Phase 1
9	Spruce1	2730	7	390	150	206
4			7	390	138	236
5			7	390	165	246
7			7	390	194	246
8			7	390	173	266
6			7	390	154	271
3			7	390	25	156
10	Spruce2	3165	10	316	182	146
15			10	316	145	156
18			10	316	189	186
13			10	316	221	226
17			10	316	264	236
11			10	316	325	246
14			10	316	196	246
12			10	316	222	256
19			10	316	283	266
16			10	316	213	266
31	Spruce3	3699	11	336	102	106
25			11	336	106	106
26			11	336	91	106
29			11	336	101	106
30			11	336	107	156
23			11	336	140	206
27			11	336	122	226
21			11	336	203	236
20			11	336	264	256
28			11	336	139	276
22			11	336	264	306
Weighted Sum- the sum of each weight/age product					**1,649,608**	**2,041,670**
Weighted Adjustment Ratio (Phase 2 weighted sum / Phase 1 weighted sum)						**0.8080**

Note: Weight is the area in each substratum divided by the number of sample clusters in that substratum.

A regression was used to analyse the relationship between the Phase 1 and Phase 2 inventory age (See Figure 4.1).



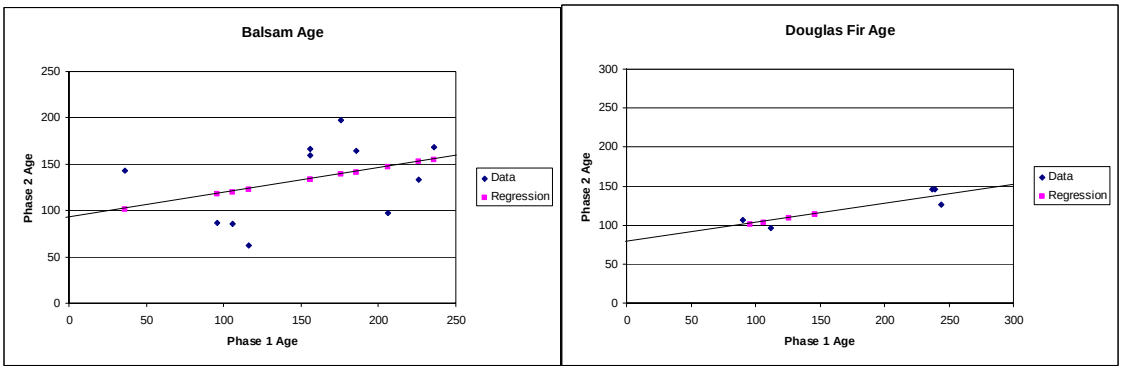


Figure 4.1 Phase 1 versus Phase 2 age

4.3 Height Adjustment

Table 1.1 shows the weighted ratio of means for the height adjustment for each of the strata.

Table 4.4 Height Adjustment Ratios

Stratum	Height Adjustment Ratio
Balsam	1.0378
Cedar	0.9665
Hemlock	0.9057
Douglas-fir	0.9665
Spruce	0.9780

The method used for the weighted adjustment is the same as that used for the age adjustment (See Table 4.3).

A regression was used to analyse the relationship between the Phase 1 and Phase 2 inventory height (See Figure 4.2).

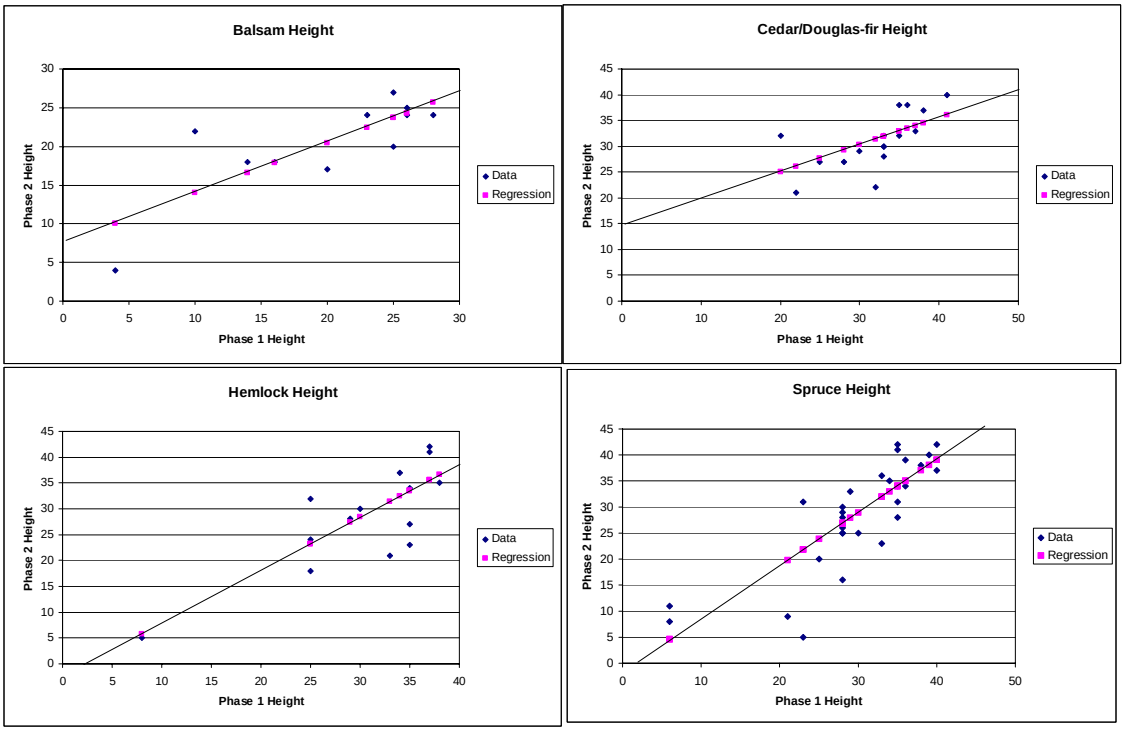


Figure 4.2 Phase 1 versus Phase 2 height

4.4 Volume Adjustment

Using the adjusted age and height as inputs a new volume was calculated with VDYP. This new volume is compared to Phase 2 volume to determine the volume adjustment factor, which is simply a ratio of means between the Phase 2 and adjusted Phase 1 volume (See Table 4.5).

Table 4.5 Volume Adjustment Ratios

Stratum	Volume Adjustment Ratio
Balsam	1.0456
Cedar	1.3833
Hemlock	1.2310
Douglas-fir	1.3833
Spruce	0.9905

5.0 SAMPLING ERROR

5.1 Sampling Error

Table 5.1 shows the sampling error for each of the strata, which were calculated by Sam Otukol of the Ministry of Forests. As per ministry standards, the sampling error was calculated using the weighted ratios for the volume adjustment. The sampling error for height and age was determined without including the weighting.

Table 5.1 Sampling Error

Stratum	Height	Age	Volume
Balsam	22.9	27.9	47.5
Cedar	7.4	21.2	26.7
Hemlock	10.4	18.6	22.1
Other	22.3	36.7	48.1
Spruce	6.7	11.3	16.0
All strata	**4.4**	**8.2**	**10.6**

6.0 SUMMARY AND CONCLUSIONS

6.1 Summary

6.1.1 Adjustment Summary

Table 6.1 shows the weighted adjustments that have been applied to the inventory.

Table 6.1 Phase 2 Weighted Adjustment

Stratum	Height	Age	Volume
Balsam	1.0378	0.7919	1.0456
Cedar	0.9665	0.9918	1.3833
Hemlock	0.9057	1.1997	1.2310
Douglas-fir	0.9665	1.4871	1.3833
Spruce	0.9780	0.8080	0.9905

The adjustments have been applied to all stands in the strata that are over 40 years old.

6.1.2 Adjusted Inventory

Table 6.2 shows the inventory statistics after the adjustment for stands over the age 40.

Table 6.2 Adjusted Inventory Statistics

Strata	Area (ha)	Height (m)	Age (yrs)	Site Index (m)	Volume 2003 m^3/ha
Balsam	3,477	23	150	13	224
Cedar	4,583	35	283	16	680
Hemlock	5,801	29	264	12	489
Other	2,225	27	169	15	387
Spruce	8,972	32	184	16	356
Totals	**25,058**	**30**	**214**	**14**	**430**

Table 6.3 shows the percent change in the inventory statistics after the adjustment.

Table 6.3 Adjusted versus Unadjusted Inventory Statistics

Strata	Area (ha)	Height (%)	Age (%)	Site Index (m)	Volume 2003 m^3/ha
Adjusted Area	100%	96%	97%	97%	112%

6.2 Conclusions/Discussion

6.2.1 Age, Height, and Site Index

On average the age, height, and site index have decreased slightly but essentially remained almost unchanged. Height decreased 4 %, age decreased 3 % and site index decreased 3 %. The

adjustments applied to specific stratum were much more significant but on average the changes were minimal.

The site index is an indirect adjustment in that it is recalculated using VDYP following the age and height adjustment.

6.2.2 Volume Adjustment

The net increase in the total volume of the inventory is 12 %. There is a slight decrease in the stratum “Other” but a significant increase for the other stratum. The largest volume increase are found in the Cedar/Douglas-fir stratum (38%) and the Hemlock stratum (23%).

6.2.3 Implications

The increase in volume from the Phase 2 VRI adjustment is expected to introduce upward pressure on the short and mid term timber supply of TFL 55.

7.0 SAMPLING PLAN

The original VRI ground sample inventory project implementation plan (VPIP) is appended below.

8.0 REFERENCES

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Appendix 1 - VRI Ground Sampling Report

Appendix B

Site Index Adjustment Report

TFL 55 Site Index Adjustment

Final Report

Prepared for

Michael Copperthwaite, RPF
Louisiana Pacific Canada Ltd.
Malakwa, BC

Project: LPA-002

December 12, 2005

Executive Summary

This Site Index Adjustment (SIA) project provides ground-based estimates of potential site index (PSI) for second growth stands of hybrid spruce (Sx) and interior Douglas-fir (Fd) in the Interior Cedar Hemlock (ICH) and lower Engelmann Spruce Sub-alpine Fir (ESSF) biogeoclimatic zones on Tree Farm Licence (TFL) 55. The statistical adjustment method used in this project is similar to that used in the Vegetation Resources Inventory (VRI) where preliminary estimates are adjusted based on the results of ground sampling. Preliminary PSI estimates were developed using expert knowledge of productivity trends on the TFL and were assigned to each resultant polygon of the forest cover and Predictive Ecosystem Map (PEM) coverages. Eighty-three (83) plot clusters were installed in the ICHvk1, ICHwk1, and the ESSFvc below 1,500 m to provide ground-based estimates of PSI for each of the sample eco-polygons. Finally, a ratio adjustment was applied to the preliminary PSI estimates to reduce potential bias. The results of the statistical adjustment show that the area-weighted adjusted PSI for Sx is 23.1 m and Fd is 23.4 m.

From the results of this project, we recommend that Louisiana Pacific Canada Ltd.:

1. Use the PSI estimates to build managed stand yield tables to support the timber supply analysis for Management Plan 4.
2. Establish a growth & yield monitoring program on the TFL. A monitoring program will provide a broad-level check of growth & yield attributes used in Management Plan 4, identify potential problems with growth & yield model predictions, and help develop more accurate managed stand yield tables for use in subsequent timber supply analyses.
3. Use Ministry of Forests and Range site index conversion equations to estimate the site indexes of other species. Where possible, use Sx as the reference species. If conversion equations do not exist for all species, Site Index Biogeoclimatic Ecosystem Classification (SIBEC) estimates will more closely represent actual growth than the inventory site indexes.

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1. INTRODUCTION

1.1 BACKGROUND

Growth & yield practitioners in BC generally accept that site indexes estimated from old-growth stands underestimate the growth of post harvest regenerated (PHR) stands regenerating on the same sites. This trend has been repeatedly confirmed in projects completed by government and forest licensees throughout BC.[1,2,3,4] Old-growth site indexes represent conditions of the current stand and reflect historical events (suppression, height growth damage, partial cutting regimes) rather than the potential site productivity. Thus, when old-growth site indexes are applied to future PHR stands in timber supply modeling, the growth & yield of these stands are generally underestimated. In the last timber supply review for Louisiana Pacific Canada Ltd.'s (LP) Tree Farm Licence (TFL) 55, the Chief Forester acknowledged this underestimate of site index: [5]

> *" The inventory audit suggests that site indices for immature stands were underestimated in the inventory. While I note the licensee staff have conducted a preliminary review of the data, I encourage them [LP] to continue to refine the site productivity data for young stands on the TFL over the term of this determination. Any additional data can be used for the next timber supply analysis for TFL 55."*

1.2 PROBLEM STATEMENT

The Ministry of Forests and Range (MOFR) has reduced the allowable annual cut (AAC) on TFL 55 by 10% since 1992. A further decrease of 50% is forecasted over the next 25 years. LP believes that this reduced long-term harvest level is lower than the potential that can be supported by the landbase. LP thus initiated this Site Index Adjustment (SIA) project to improve the estimated growth & yield of PHR stands on the TFL.

1.3 OBJECTIVES

The objective of this project was to:

> *Develop reliable estimates of potential site index (PSI) for second growth stands of spruce (Sx) and Douglas-fir (Fd) in the Interior Cedar Hemlock (ICH) and lower Engelmann Spruce-Subalpine Fir (ESSF) biogeoclimatic zones on TFL 55.*

LP intends to use the PSI estimates to build managed stand yield tables to support the proposed area-based timber supply analysis for Management Plan (MP) 4.

---

[1] We have completed Site Index Adjustment projects for TFLs 5, 6, 8, 15, 18, 30, 33, 35, 37, 38, 45, 46, 47, 52, 53, 54, the Merritt, Adams Lake, Hope, and Okanagan IFPA areas, and the Fraser TSA.

[2] Nussbaum, A.F. 1998. Site index adjustments for old-growth stands based on paired plots. Working paper 37. Ministry of Forests Research Program. Victoria, BC. 21 pp.

[3] Ministry of Forests. 1997. Site index estimates by site series for coniferous tree species in British Columbia. Site Productivity Working Group, B.C. Min. For. and Forest Renewal BC. 265 pp.

[4] Second approximation MOF SIBEC estimates are approved for timber supply analysis: www.for.gov.bc.ca/hre/sibec/index.htm

[5] Ministry of Forests. 2001. Tree Farm Licence 55. Rationale for allowable annual cut (AAC) determination. B.C. Min. For. Victoria, BC. Effective April 18, 2001. 56 pp.

1.4 Project Team

This project was completed, following methods outlined in the MOFR-approved sample plan,[6] by J.S. Thrower and Associates Ltd. (JST) for Mike Copperthwaite, *RPF* and Fernando Cocciolo, *RPF* of LP. The JST team was Dan Turner, *RPF* (project manager), Guillaume Thérien, *PhD* (senior biometrician), Scott MacKinnon, *FIT* (crew leader), and Tara McCormick, *BSc* (technical support). This report will be submitted to the MOFR Forest Analysis & Inventory Branch for review and approval of results in the upcoming timber supply analysis.

Figure 1. Crew leader Scott MacKinnon measuring the height of a sample tree in plot cluster Fd-1 (DBH=10.8 cm, Height=7.7 m, Age=9 years, and SI=33 m).

[6] J.S. Thrower & Associates Ltd. 2005. Site index adjustment for Tree Farm Licence 55. Sample plan. Contract report for Louisiana Pacific Canada Ltd. Malakwa, BC. June 30, 2005. 13 pp.

2. METHODS

2.1 SIA PROCESS

This SIA project was completed in three major steps:

1. **Preliminary PSI Estimates** – were developed for Sx and Fd for the forested ecosystems delineated in the Predictive Ecosystem Mapping (PEM) on TFL 55.[7]
2. **Site Index Sampling** – was completed to measure actual site index in PHR Sx and Fd stands at random locations across the operable landbase.
3. **Statistical Adjustment** – the preliminary PSI estimates were statistically adjusted based on the relationship between the predicted and ground-based site indexes.

2.2 TARGET AND SAMPLE POPULATIONS

The target population is the area where the statistical adjustment will be applied based on the results of field sampling. The target population is 19,672 ha (approximately 79% of the operable TFL area, Table 1) and included all areas in the operable productive forest in the ICH and areas below 1,500 m in the ESSFvc.[8] Sx and Fd were the target species as they are the most important management species on the TFL.[9]

The sample population is a subset of the target population where stand conditions were suitable for estimating the site index of Sx and Fd from height and breast height (BH) age measurements. The sample population was 3,460 ha (18% of the target population) and included Sx-leading polygons between 14-40 years in the ICH and 16-40 years in the ESSFvc, and Fd-leading polygons between 11-40 years of age.[10]

Table 1. Area distribution of the target and sample (shaded) populations by leading species and age class.

Ldg	Age Class										Total Area	
Spp	1a*	1b*	2	3	4	5	6	7	8	9	*ha*	*%*
Sx	1,509	1,616	1,409	56	153	103	191	112	1,619	2,129	*8,897*	*45*
Cw	315		71	0	2	8	32	8	614	2,909	*3,961*	*20*
H	197		69	23	14	156	185	255	1,264	1,925	*4,089*	*21*
Fd	117	246	189	0	71	68	488	144	138	32	*1,493*	*8*
NSR	687										*687*	*3*
Decid	99		52	30	18	22	14	28	37		*300*	*2*
Bl	19		3	0	1	20	7	4	182	0	*235*	*1*
Pl	8						1				*9*	*0*
Total	*3,187*	*1,626*	*1,793*	*110*	*260*	*378*	*917*	*551*	*3,855*	*6,996*	*19,672*	
%	*16*	*8*	*9*	*1*	*1*	*2*	*5*	*3*	*20*	*36*		

*Age class 1 was divided into areas too young to sample (1a) and areas old enough to sample (1b).

[7] Timberline Forest Inventory Consultants Ltd. 2005. Predictive ecosystem Mapping of Tree Farm Licence 55 – Final Report. Contract report for Louisiana Pacific Canada Ltd. Malakwa, BC. November 2005. 21pp.

[8] The sample plan reported slightly different areas for the target and sample populations (19,821 ha and 3,546 ha, respectively) than given in this report. These area differences resulted from the exclusion of 149 ha in the final analysis, due to missing PEM information.

[9] Sx-leading silviculture regimes have been the most dominant over the past 20 years, and Fd-leading regimes have become more important in the recent past (pers. comm., Michael Copperthwaite, *RPF* and Fernando Cocciolo, *RPF* of LP).

[10] The intent was to sample Sx- and Fd-leading managed stands that were a minimum of 10 and 5 years of age at BH, respectively.

2.3 Sample Size & Selection

The sample population was divided into two lists based on leading species. The lists were sorted by elevation, and samples were selected using a random start, with probability proportional to area, and with replacement. Sixty (60) Sx-leading sample polygons were systematically selected from the Sx sample population. Once selected, the Sx sample polygon list was randomized. The first 40 plots made up the sample (batch 1), and two additional batches of 10 plots were available, if required. The first 50 Sx samples were completed (first two batches).[11]

Fifty-six (56) Fd samples were selected. Only 28 Fd-leading polygons were available for sampling. Two plot locations were selected in each of these polygons. The first batch, which included the first plot location per polygon, was completed. The second set of plot locations was randomized, and the first 12 samples were established, for a total of 40 established samples.

Sample plots were randomly located in each of the 116 selected polygons using a 5 m grid in our Geographic Information System (GIS).

2.4 Preliminary PSI Estimates

Preliminary estimates were developed by Tara McCormick and Guillaume Thérien to reflect the potential productivity, expressed as site index, of managed stands growing on TFL 55 (Table 2). Preliminary PSIs were based on SIBEC estimates but were modified to reflect the local conditions on TFL 55 and the expected trends in productivity among site series. Dennis Lloyd, *RPF* (Research Ecologist, MOFR, Southern Interior Forest Region) reviewed the preliminary estimates, and his suggestions were incorporated. The impacts of elevation and aspect on site index were also incorporated into the preliminary PSI estimates (Appendix II).

Table 2. Preliminary PSI estimates by subzone, site series, and species.

Site	Sx			Fd	
Series	ESSFvc	ICHvk1	ICHwk1	ICHvk1	ICHwk1
01	21.0	26.0	26.0	27.0	27.0
02	14.0	17.0	17.0	18.0	18.0
03	18.0	21.0	22.0	22.5	24.0
04	23.0	24.0	23.0	26.0	24.0
05	17.0	23.0	28.0	21.0	29.0
06	12.0	19.0	23.0	15.0	21.0
07		22.5	25.0	17.0	27.0
08		22.5	20.0	15.0	15.0
09		12.0	12.0	10.0	10.0
TP		18.0		15.0	

2.5 Random Sampling

Field sampling was completed between July 6 and August 10, 2005 by JST field crews, following methods described in the MOF-approved sample plan (Figure 2).[12] Each sample was a cluster of five 100 m^2 (5.64 m radius) plots. Site tree selection followed MOF SIBEC standards,[13,14] thus suitable site trees included the largest diameter, dominant or co-dominant Sx or Fd tree in each quadrant, that was live, standing, and without damage or suppression affecting more than 5% of height growth. Site trees could not be veterans or residuals from a previous stand.

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[11] The first batch was completed under budget, hence we completed the second batch with the remaining funds.

[12] J.S. Thrower & Associates Ltd. 2005. Site Index Adjustment for Tree Farm Licence 55: Sample Plan. Contract report for Louisiana Pacific Canada Ltd., Malakwa, BC. June 30, 2005. 13 pp.

[13] The minimum SIBEC age criteria of 10 years at BH was modified to 5 years BH for this project.

[14] Province of British Columbia. 2000. SIBEC Sampling and Data Standards version 5.1. BC Ministry of Forests Site Productivity Working Group. Victoria, BC. http://www.for.gov.bc.ca/hre/sibec/documents/standards.pdf

2.6 Quality Assurance

Quality assurance (QA) of the field measurements was completed by JST staff to ensure appropriate standards were achieved. Dan Turner, *RPF* completed a random audit of three plot clusters on July 12, 2005 at the end of the first 10-day shift. Bob Cavlek, *FIT* and Tysen LeBlanc, *BNRSc* completed another random audit of five plot clusters on July 27-29, 2005. Both audits showed that plot location, site tree selection, height measurements, and age measurements met all specified standards (Appendix III).

2.7 Analysis

Preliminary estimates of Sx and Fd PSI were statistically adjusted to reduce potential bias in the predicted estimates. The adjustment ratio was computed using the average field PSI and preliminary PSI estimates of each cluster. Separate ratios were computed for Sx and Fd. The ratios were then applied to the eco-polygon based preliminary Sx and Fd PSI estimates to compute the adjusted PSI estimates for the target population.

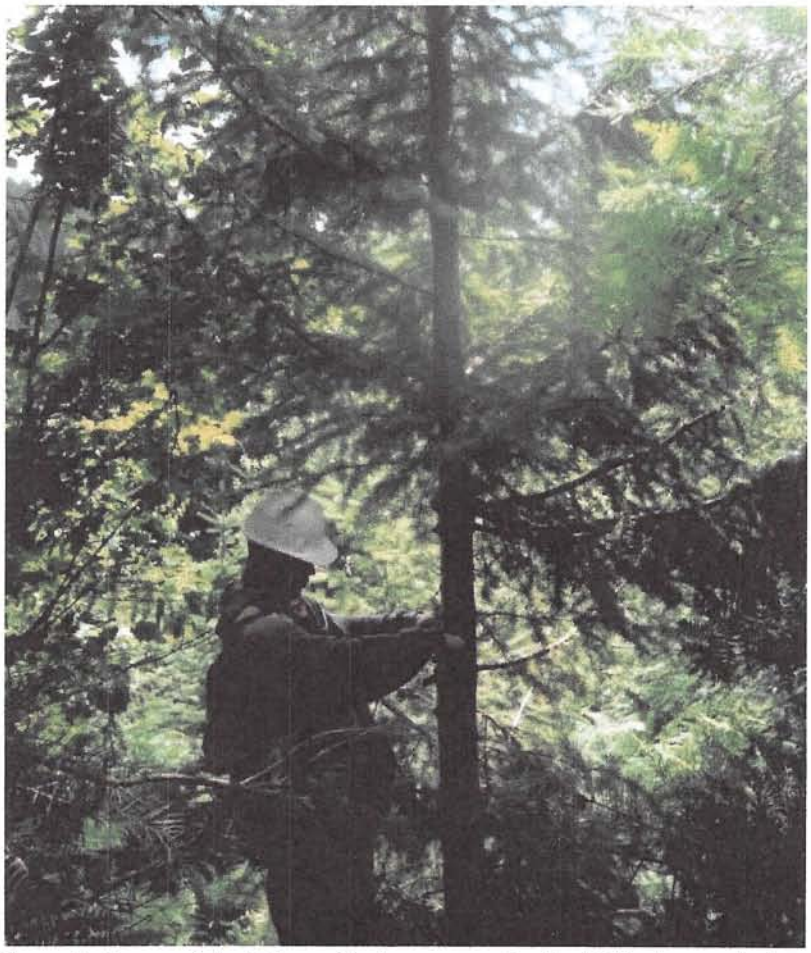

Figure 2. Crew assistant Shawn Corrigan measuring the DBH of a sample tree in plot cluster Fd-1 (DBH=10.8 cm, Height=7.7 m, Age=9 years, and SI=33 m).

3. RESULTS

3.1 PRELIMINARY PSIs

Application of the preliminary PSIs to the target population resulted in an overall average of 22.4 m for Sx and 23.4 m for Fd (Table 3). Subzone-level PSIs were slightly higher in the ICHwk1 than the ICHvk1 due to the application of the elevation model. Predicted site index ranged from a minimum of 9 m to a maximum of 30 m for both species.

Table 3. Preliminary PSI statistics for the TFL 55 target population.

Subzone	Area[a]		Sx PSI (m)				Fd PSI (m)				Elevation (m)			
	(ha)	%	Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
ICHvk1	14,790	*78*	22.8	11.5	27.0	2.1	23.3	8.5	28.0	2.8	1,088	588	1,450	77
ICHwk1	1,666	*9*	23.7	12.0	29.0	4.1	24.0	10.0	30.0	5.1	742	580	1,099	45
ESSFvc	2,408	*13*	18.8	9.2	23.9	1.7	-	-	-	-	1,454	1,280	1,500	13
Total	*18,864*		*22.4*	*9.2*	*29.0*	*2.7*	*23.4*	*8.5*	*30.0*	*3.1*	*1,104*	*580*	*1,500*	*96*

[a] PSI estimates are only applied to forested site series within the target population.

3.2 FIELD PSI

Sx Samples

One hundred and ten (110) Sx trees were sampled in 60 plot clusters. Forty-seven (47) of the plot clusters were Sx-leading and 13 were Fd-leading. Three (3) of the 50 Sx-leading samples were rejected due to unsuitability for site index sampling (Appendix IV).

Table 4. Number of trees per cluster.

No. Trees	No. Clusters			
Per Cluster	Sx	%	Fd	%
1	28	47	20	61
2	19	32	8	24
3	9	15	5	15
4	3	5	0	0
5	1	2	0	0

Sx was sampled with an average of 1.8 trees/cluster (Table 4). The field site index of Sx ranged from 12.1 to 29.5 m, with an average of 23.3 m (Table 5). Site index was sampled over a range of 640 to 1,500 m in elevation. The average age of Sx sample trees was 14 years at BH. Twenty-two (22) percent of the Sx clusters were <10 years old at BH (Table 6); however, the average field site index of clusters <10 years was very similar to that of clusters ≥10 years old at BH (23.5 and 23.3 m, respectively).

Table 5. Field sample statistics (n = number of sample clusters and SD = standard deviation).

Spp	Subzone	n	Site Index (m)				Elevation (m)				BH Age (yrs)			
			Avg	Min	Max	SD	Avg	Min	Max	SD	Avg	Min	Max	SD
Sx	ICHvk1	49	23.5	17.1	29.5	2.6	1,145	701	1,393	187	13	5	22	4
	ICHwk1	4	22.6	12.1	28.9	7.4	796	640	1,054	191	23	7	60	25
	ESSFvc	7	22.2	19.5	26.3	2.2	1,464	1,434	1,500	32	12	8	18	3
	Total	*60*	*23.3*	*12.1*	*29.5*	*3.0*	*1,159*	*640*	*1,500*	*225*	*14*	*5*	*60*	*7*
Fd	ICHvk1	24	26.6	15.4	38.0	5.2	909	701	1,111	131	15	8	67	11
	ICHwk1	9	23.0	14.2	30.8	6.5	744	657	979	113	24	8	66	24
	Total	*33*	*25.7*	*14.2*	*38.0*	*5.7*	*864*	*657*	*1,111*	*145*	*18*	*8*	*67*	*16*

Fd Samples

Fifty-one (51) Fd trees were sampled in 33 plot clusters. Thirty-two (32) of the plot clusters were Fd-leading and one was Sx-leading. The remaining eight assessed Fd clusters did not provide Fd observations: four clusters only contained Sx site trees, and four were rejected due to unsuitability for site index sampling (Appendix IV).

Table 6. Number of clusters with average BH age < 10 years.

Avg. BH Age of Cluster	No. Clusters			
	Sx	%	Fd	%
5	1	2	0	0
6	0	0	0	0
7	1	2	0	0
8	5	8	4	12
9	6	10	1	3
≥10	47	78	28	85

Fd was sampled with an average of 1.5 trees/cluster (Table 4). The field site index of Fd ranged from 14.2 to 38.0 m, with an average of 25.7 m (Table 5). Site index was sampled over a range of 657 to 1,111 m in elevation. The average age of sample trees was 18 years at BH. Eighty-five (85) percent of Fd clusters had ≥10 years of height growth over BH (Table 6); however, the 15% of clusters younger than 10 years at BH had a considerably higher average field site index than the clusters ≥10 years (30.6 and 24.8 m, respectively).

3.3 Comparison of Target Population and Sample

The Sx sample well represents the area distributions of the target population by subzone, elevation class, and BEC site series (Figure 3, Figure 4). As expected, the Fd sample is more concentrated in lower elevation areas of the target population where it is planted and where the Fd PSI estimates will be applied in timber supply modeling. Fd is rarely planted over 1,200 m elevation.[15] The Fd sample was also more concentrated in the submesic site series of the ICHvk1 rather than the zonal site when compared to the target population.

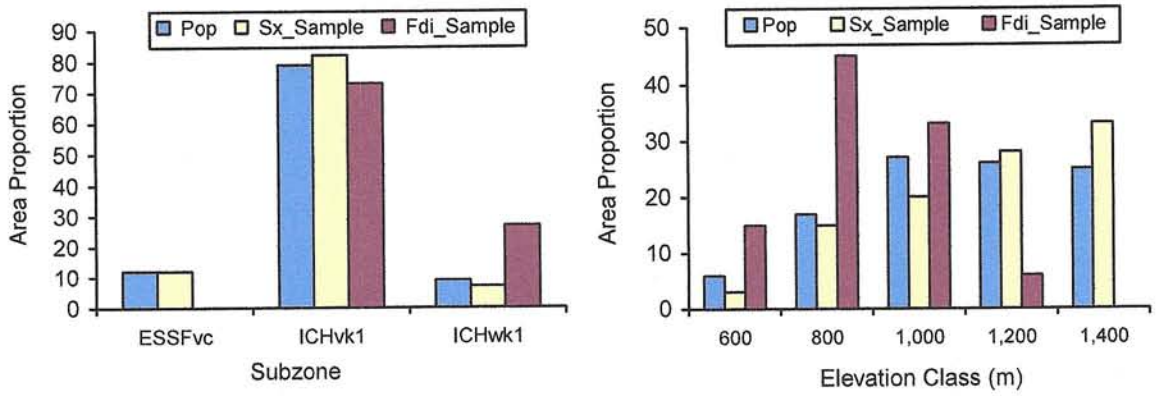

Figure 3. Area distribution of target population and realized Sx and Fd samples by subzone and elevation class.

[15] Pers. Comm. December 2005. Michael Copperthwaite, *RPF* and Fernando Cocciolo, *RPF*. LP. Malakwa, BC.

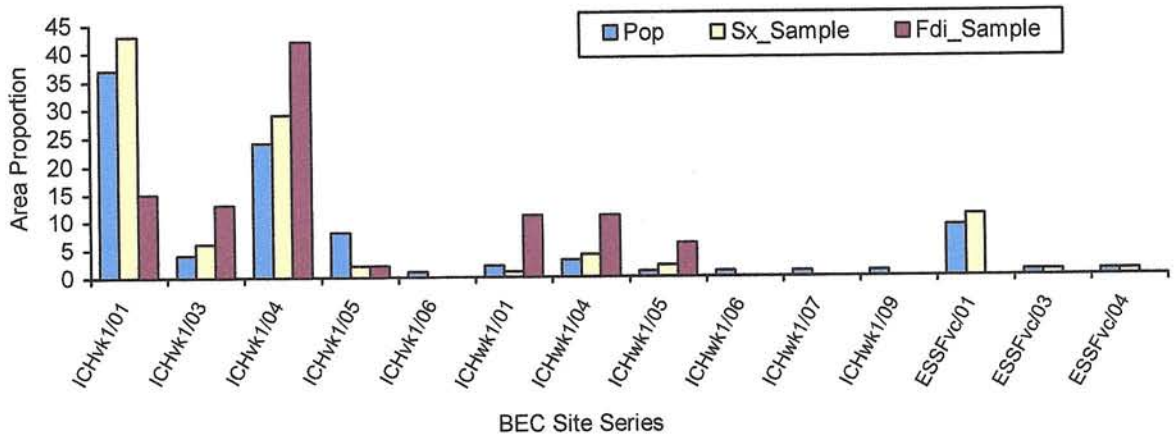

Figure 4. Area distribution of target population and realized sample by BEC site series.

3.4 Sx Statistical Adjustment

The ratio of means (ROM) adjustment equation showed that the preliminary Sx PSI under-predicted the average field PSI by 3%. The area-weighted mean preliminary PSI of the target population increased from 22.4 m to 23.1 m. The ranges in predicted and field PSI of the sample were similar, 17.5 to 25 m and 17.0 to 29.5 m, respectively. The sampling error of the average adjusted population was ±0.8 m at the 95% confidence level (Table 7, Figure 5), thus much lower the target of ±1.5 m.

Table 7. Sx and Fd adjustment statistics.

	Sx	Fd
No. of plot clusters	60	33
Sample mean prelim PSI (m)	22.6	25.6
Sample mean field PSI (m)	23.3	25.7
ROM	1.030	1.001
R-squared	3.1	19.6
% Sampling Error of ROM	3.5	7.3
Population prelim PSI (m)	22.4	23.4
Population adjusted PSI (m)	23.1	23.4
95% Sampling Error (m)	0.8	1.7
95% Confidence Interval (m)	[22.3][23.9]	[21.7][25.1]

3.5 Fd Statistical Adjustment

The overall average predicted and field PSIs of the Fd sample were virtually the same: the ROM was 1.001. Therefore, field sampling did not result in an adjustment of the preliminary Fd estimates and the area-weighted mean PSI remained at 23.4 m. Predicted PSI estimates of the sample ranged from 22 to 28 m; whereas the field site index ranged from 14 to 30 m. The sampling error of the mean was ±1.7 m at the 95% confidence level, resulting in a slightly higher sampling error than the targeted ±1.5 m (Table 7, Figure 5).

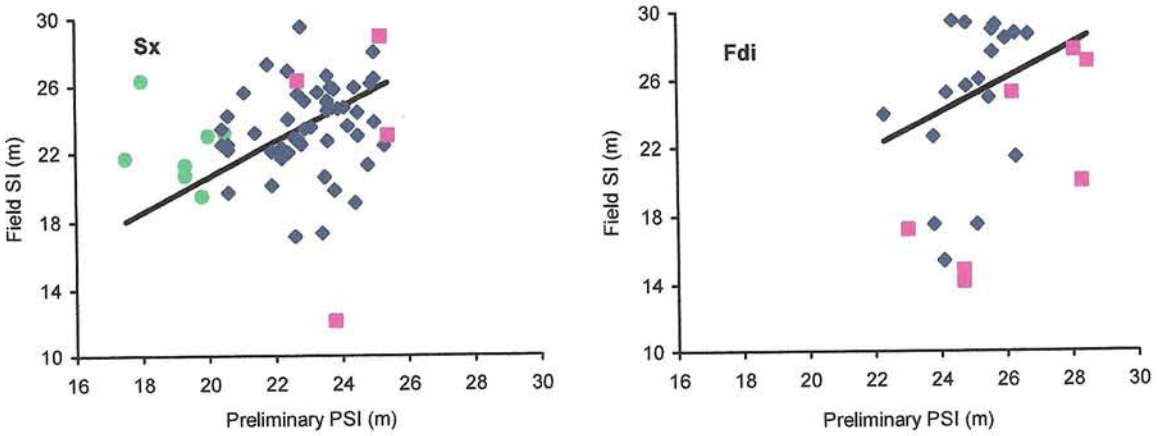

Figure 5. Relationship between average field and preliminary PSI for the Sx and Fd samples (ICHvk1-blue diamond; ICHwk1-pink square; ESSFvk-green circle). The thick black line shows the average PSI for a polygon of a given preliminary SI.

3.6 Application of Results

Area-weighted average adjusted PSI estimates can be calculated for the forest cover polygons in the target population based on their component PEM eco-polygons. LP should use the forest cover polygon level PSI estimates for existing and future managed stands in the yield table process.

4. DISCUSSION

4.1 Variation Between Preliminary & Field SI

There is variation in the relationship between preliminary and field PSI of Sx and Fd (Figure 5). There are four sources contributing to the variation: within-polygon variation, within site-series variation, model error, and mapping error. The bias from these sources is removed in the SIA process, but the variation is included in the overall sampling error of the adjustment.

a) Within-polygon variation in PSI

The PSI of trees and groups of trees varies among areas within polygons. The within-polygon variation in PSI is probably the most important source of variation contributing to the overall sampling error of the adjustment ratio. Field PSI estimates of Sx and Fd were based on an average of 1.8 and 1.5 trees/cluster, respectively. Estimates were based on a single tree in about 50% of the Sx clusters and 60% of the Fd clusters. This increased the variability of the cluster-level PSI estimates as there is a greater likelihood that the estimated field PSIs reflected individual micro-sites rather than average plot productivity. Using a smaller number of trees in the average field PSI estimate for a plot increases the measurement error at the plot level. This variation in the measurement error is only one component of the unexplained variation.

We investigated the impact of including non-standard site trees in the analysis. These additional trees ("O trees") were sampled in subplots where the largest diameter site tree was not suitable, and met all SIBEC site tree selection criteria with the exception of being the largest diameter. The number of Sx trees increased by about 50% over the standard analysis and the number of Fd trees nearly doubled (Table 8). Inclusion of non-standard trees resulted in similar ROM adjustment ratios (1.028 for Sx and 0.989 for Fd); however, the sampling error for Fd decreased to ±1.5 m. The sampling error for Sx remained constant.

Table 8. Number of trees, including non-standard trees, per cluster.

No. Trees Per Cluster	No. Clusters			
	Sx		Fd	
	Standard	Non-Standard	Standard	Non-Standard
1	16	16	7	7
2	13	26	7	14
3	13	39	8	24
4	11	44	7	28
5	7	35	4	20
All	*60*	*160*	*33*	*93*

b) Within site-series variation

The preliminary PSI estimates are developed to reflect the average PSI for each site series. However, site productivity within a site series varies in response to differences in moisture and nutrient availability, as depicted by the edatopic range of the site series. For example, in TFL 55, the observed range of Sx field PSIs on a given site series was between 7 and 10 m.[16] The observed range of Fd field PSI on a given site series was even larger, between 13 to 15 m (Table 9). This variation accounts for some of the differences between predicted and field PSI estimates.

[16] Site series presented in the Table 9 are based on the field classification of clusters. Only clusters located in pure site series were included in the summary. Only site series with >3 clusters were presented.

Table 9. Range of field PSI by field site series.

Field	Sx Field Site Index (m)						Fd Field Site Index (m)					
Site Series	n	Avg	Min	Max	Diff	SD	n	Avg	Min	Max	Diff	SD
ICHvk1/01	24	24.4	19.7	29.5	9.8	2.6	11	28.9	22.6	38.0	15.4	4.3
ICHvk1/04	9	24.3	22.0	29.5	7.5	2.4	6	25.4	17.5	32.0	14.5	5.6
ICHwk1/04							4	20.3	14.2	27.0	12.8	6.7
ESSFvc/01	8	22.2	19.5	26.3	6.8	2.2						

c) Model Error

Model error is the bias in the preliminary PSI estimates at the site series level. The assumption is that the bias is consistent across subzone and site series; hence, one adjustment equation per species is applied throughout the target population. There is a possibility of localized bias where the adjustment is not the same across all areas, but the sample was not large enough for post-stratification of the results. We believe that the potential differences would be small as the preliminary estimates were reasonable between subzones and site series. The overall bias from the model error is removed in the SIA, but the variation of the site-series level bias is included in the overall variation of the adjustment.

Another source of variation due to model error resulted from the possible bias in the Fd growth intercept equation for trees younger than 10 years at BH, as seen in the higher average field PSI in this group compared to trees over 10 years (section 3.2).

d) Mapping Error

Preliminary estimates are applied to the landbase using the site series and aspect modifiers delineated in the PEM and the elevation from TRIM. Mapped attributes for any point or polygon will not perfectly reflect actual conditions on the ground; subsequently, the predicted PSI will also not reflect exactly what is on the ground. This source of variation is included in the overall sampling error for the adjustment, and potential bias from mapping error is removed in the SIA through the statistical adjustment process.

The mapping error is exaggerated on this landbase due to the resolution of some of the mapped units. There was no xeric forested unit typed in the PEM project; consequently, these poorer productivity sites were included in the subxeric mapped unit (the ICHvk1/03 and ICHwk1/04 units). There is a considerable difference in productivity between the two distinct units; thus, lumping them into one unit will add to the observed variation. The effect of this can be observed in the scattergram, where the bias in predicted PSI is larger on clusters where field site index is low (Figure 5).

A third mapping error results from the site series composition is aspatial in the PEM eco-polygon. Ninety-two (92) percent of the eco-polygons in the target population (18,169 ha) are mapped as complex site series in the PEM database. In these eco-polygons, the preliminary PSI estimate is a weighted average of the constituent site series. When a plot is established in one of these polygons, the site series proportions within the 500 m^2 plot may differ from the site series proportions for the entire eco-polygon. In this sample, 96% plots were located in polygons mapped with complex site series based on the PEM; however, only 25% of the plots were classified as complexes based on the field site series (*i.e.*, 75% of plots were in areas of pure site series within the sampled polygons). Differences in site series distributions within individual polygons will also introduce variation into the relationship between the field measurements and the preliminary PSI estimate.

4.2 Comparison of Adjusted PSI & Inventory Site Index

The overall average adjusted PSI estimate is 4.2 m (about 22%) higher than indicated in the inventory for both Sx and Fd-leading stands in the target population (Table 10). The upward shift in PSI estimates does not indicate a change in the productivity of the landbase, but rather reflects the bias in the inventory site index. The magnitude of increase over inventory site index, averages by subzone, and the overall average seem reasonable for this landbase and are similar to other SIA projects completed in the BC Interior (Table 11).[17]

Table 10. Comparison of inventory and adjusted site index.

Ldg Spp	Subzone	Area (ha)	Site Index (m)		Difference	
			Inventory	Adj PSI	(m)	(%)
Sx	ICHvk1	4,702	18.6	23.2	4.6	25%
	ICHwk1	489	20.8	23.0	2.2	10%
	ESSFvc	1,502	15.8	19.4	3.6	23%
	Sx Total	*6,692*	*18.2*	*22.4*	*4.2*	*23%*
Fd	ICHvk1	995	20.1	24.1	4.0	20%
	ICHwk1	344	20.2	25.2	5.0	25%
	Fd Total	*1,340*	*20.1*	*24.4*	*4.2*	*21%*

Table 11. Average adjusted PSI by subzone by source.

Landbase	ICHwk1		ICHvk1	
	Sx PSI (m)	Fd PSI (m)	Sx PSI (m)	Fd PSI (m)
TFL 55	23.0	25.2	23.2	24.1
TFL 33	24.9	26.0	-	-
Okanagan wet-belt	-	22.8	-	-
SIBEC[a]	24.0	24.0	24.0	24.0

[a] estimate for zonal site

4.3 Risks & Uncertainty for Timber Supply

The adjusted PSI estimates are unbiased estimates of site productivity, thus represent a significant improvement over the inventory site indexes (for which no accuracy measure exists). The measure of uncertainty around the average PSI is estimated at ± 0.8 m for Sx and ± 1.7 m for Fd. The MOFR raised concerns over Fd sampling during development of the sampling plan.[18] We acknowledge that there is greater uncertainty in the Fd estimates than the Sx estimates due to the smaller sample size and higher sampling error; however, we believe the estimates are reasonable based on the results from the non-standard analysis and comparisons with Fd PSI estimates from adjacent landbases and SIBEC.[4]

The best method to ensure that PSI estimates obtained from the SIA project adequately measure the site productivity on TFL 55 is to undertake a growth & yield monitoring program. In a growth & yield monitoring program, randomly located permanent sample plots are established and re-measured in targeted stands with a known frequency, such as 5 or 10 years. The monitoring program provides an early warning system if the observed site index estimates deviate from the SIA PSI estimates used in the timber supply analysis. The results of this program could be useful to further justify assumptions around minimum harvest age, green-up, and adjacency in the area-based timber supply analysis.

[17] Other PSI increases resulting from SIA projects completed in the BC Interior include: Merritt TSA at 28%, Adams Lake IFPA at 31%, TFL 33 at 29%, TFL 15 at 29%, TFL 8 at 24%, and TFL 18 at 23%.

[18] Pers. Comm. June 2005. Albert Nussbaum, *RPF*, MoFR – Analysis Section, Victoria, BC.

5. RECOMMENDATIONS

From the results of this project, we recommend that LP:

1. Use the PSI estimates to build managed stand yield tables to support the timber supply analysis for MP 4.
2. Establish a growth & yield monitoring program on the TFL. A monitoring program will provide a broad-level check of growth & yield attributes used in MP 4, identify potential problems with growth & yield model predictions, and help develop more accurate managed stand yield tables for use in subsequent timber supply analyses.
3. Use MOFR site index conversion equations to estimate the site indexes of other species. Where possible, use Sx as the reference species. If conversion equations do not exist for all species, SIBEC estimates will more closely represent actual growth than the inventory site indexes.

APPENDIX I – STUDY AREA

TFL 55 is located approximately 120 km north of Revelstoke, BC. LP manages their TFL operations from Malakwa and the TFL is administered by the Columbia Forest District office in Revelstoke. The gross area of the TFL is approximately 92,200 ha and is characterized by sharp peaks, glaciers, and deep, narrow, forested valleys. The elevation of the TFL ranges from 600 m to 2,000 m primarily at a western aspect overlooking the Revelstoke Reservoir. The TFL receives almost 1,337 mm of annual precipitation.

The target population is 79% of the operable TFL landbase. The target population is comprised of 62% ICHvk1, 10% ESSFvc, and 7% ICHwk1.

Description	Area (ha)	TFL %	Oper %
Entire TFL	92,864	100	
Inoperable	67,857	73	
Operable	25,007	27	100
ESSFwc2/vv/vcp	663	1	3
ESSFvc >1,500 m	4,523	5	18
Missing PEM label	149	0	1
Target Pop	*19,672*	*21*	*79*
ICHvk1	15,485	17	62
ICHwk1	1,749	2	7
ESSFvc ≤1,500 m	2,438	3	10

APPENDIX II – SITE INDEX MODIFIERS

The following site index modifiers were applied to the preliminary PSI estimates (Table 2) to account for the impacts of aspect and elevation on site index:

Criteria				SI Modifier
PEM Modifier	Spp	Subzone	Elev. (m)	
k (cool)	Both	All	All	Deduct 2.0 m
w (warm)	Both	All	All	Add 1.0 m
NA	Fd	ICHvk1	>900	Deduct 0.009 m for every meter above 900
NA	Fd	ICHwk1	>800	Deduct 0.009 m for every meter above 800
NA	Sx	ESSFvc	>1,300	Deduct 0.007 m for every meter above 1,300
NA	Sx	ICHvk1	>900	Deduct 0.007 m for every meter above 900
NA	Sx	ICHwk1	>800	Deduct 0.007 m for every meter above 800

APPENDIX III – SIBEC SAMPLING STANDARDS

Data Type	Tolerance
Site tree selection	No error
Height to DBH	actual ± 5cm
DBH	actual ± 0.1cm or 1%, whichever is greater
Total tree height	actual ± 20 cm or 2%, whichever is greater
BH age	if age < 50 no error, otherwise 1year
Notes	must have comments where accepting a damaged sample tree

APPENDIX IV – LIST OF REJECTED SAMPLES

Reason for Rejection	Plot No.	Subzone	Site Series	PEM ID (Polygon_ID)	VRI ID (Mapstand)	Inv.SI (m)	Inv.Age (yrs)
Damage causing >5% height loss was noted on all the potential site trees							
	Fd05	ICHvk1	04(9)03(1)	1000095	83D008_2407	25	21
	Fd30	ICHvk1	04(9)03(1)	1000081	83D008_2405	25	21
	Sx50	ICHvk1	01(7)04(2)03(1)	1003586	82M077_2439	22	39
The growth rates of the potential site trees were impacted by an overstory (suppression)							
	Fd07	ICHvk1	04(8)03(2)	1000270	82M098_1003	21	34
	Fd38	ICHvk1	04(8)03(2)	1000270	82M098_1003	21	34
	Sx09	ICHvk1	01(9)04(1)	1003335	82M077_2431	21	31
	Sx31	ESSFvc	01(10)	1001812	82M087_2034	18	24

Appendix C

Harvest Profile – 2007 to 2014

The tables below are taken from the 2014 Annual Report for TFL 55. They are included here to show harvesting performance in hemlock-leading stands.

Table: 7A - Harvest Profile – MP4 (using VRI inventory component)

		Hectares Harvested on TFL						
Leading Species	**MP4 profile THLB area by leading species**	**2007-2011**	**2012**	**2013**	**2014**		**Cumulative Total (ha):**	**% of Total Cut**
Balsam	7%	88	4.3	22.7	21.6		136.6	11.0
Cedar	18%	201.4	62.8	84.4	67.0		415.6	33.5
Douglas- Fir	8%	81.1	2	5.5	18.5		112.6	9.1
Hemlock	17%	166	38.5	69.5	70.8		344.8	27.8
Spruce	50%	208.7	37.8	26.1	82.3		230.7	18.6
Total:	**100**	**745.2**	**145.4**	**266.6**	**260.2**		**1240.3**	**100**

Table: 7C – Harvest Profile by Inventory Hemlock Content

			Hectares Harvested						
THLB	**THLB (Ha) MP4**	**% of THLB**	**2007-2011**	**2012**	**2013**	**2014**		**Cumulative Total (ha):**	**% of Total Cut**
Mature Timber	15744		667.2	147.2	266.5	260.2		1341.1	
>80% Hemlock	0		60.7	0	2.7	0.7		64.1	4.8
60-79% Hemlock	1335	8%	88.7	7.3	18.6	26.3		140.9	10.5
40-59% Hemlock	1389	9%	94.8	19.6	37.8	9.3		161.5	12.0

Table: 7D - MP4 Mature Species Profile vs. Harvest by Species

		Volume Harvest by Species						
Species	**MP4 Mature Species profile THLB**	**2007-2011**	**2012**	**2013**	**2014**		**Cumulative Total :**	**Harvest % by species**
Balsam	8.0%	28,361	3,560	9,469	7,311		48,701	8.2
Cedar	29.3%	74,603	27,317	54,728	42,729		199,377	33.6
Douglas- Fir	6.6%	17,748	6,764	2,938	8,127		35,577	6.0
Hemlock	27.1%	83,741	19,114	22,000	25,416		150,271	25.3
Spruce	28.3%	89,873	12,456	32,481	19,393		154,203	26.0
Pine/Decid	0.7%	1436	716	964	2,069		5,185	0.9
Total:	**100%**	**296,032**	**69,927**	**122,580**	**105,045**		**593,314**	**100%**

Appendix D

OGMA Delineation Report

TFL55 OGMA OPTIMIZATION
CARIBOU FOCUS

PROJECT SUMMARY REPORT

DRAFT COPY

Prepared for:

Louisiana Pacific
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1.0 INTRODUCTION

This analysis was conducted by Timberline Natural Resource Group (Timberline) for Louisiana Pacific (LP). The purpose of this report is to document the process used to optimize the spatial location of old growth management areas (OGMA) for tree farm licence (TFL) 55. The process involved:

1. Ranking the entire timber harvest landbase (THLB) according to the OGMA ranking criteria;
2. Evaluating existing OGMAs that are on the THLB against the remainder of the THLB;
3. Selecting an appropriate threshold to define an acceptable OGMA; and
4. Relocating the rejected OGMA area into the THLB using caribou zones to focus OGMA relocation.

The process made the assumption that there is a fixed budget for the THLB. Using that budget, it relocates the OGMAs to areas within the THLB that are considered more desirable according to the ranking criteria.

There are four scenarios documented in this report:

1. OGMA optimization;
2. Landscape Unit (LU) constrained OGMA relocation;
3. LU/BEC and Hardwire constrained OGMA relocation; and
4. LU/BEC with Hardwired OGMAs and excluded THLB.

The OGMA relocation scenario moves existing OGMAs that are below a certain stand rank threshold with no control as to where the model can redistribute the new OGMAs to. The second scenario introduces LU control to this scenario- i.e. total OGMA area within each LU is constant before and after relocation. The third scenario introduces two new controls, firstly LU/BEC control. Total OGMA area within each LU/BEC combination is constant before and after relocation. Secondly, a list of hardwired OGMAs was provided by LP. These OGMAs were not available for relocation. The fourth scenario introduces areas in the THLB that are not available to relocate OGMAs into.

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2.0 METHODOLOGY

2.1 RANKING PARAMETERS

The first step in the relocation process was to rank each stand based upon desirable attributes for OGMAs. The ranking criteria were provided by LP and modified by Timberline.

The criteria used to rank each stand in TFL55 for this analysis are listed below:

1. Hemlock > 80%, age class 8 and 9;
2. Hemlock/Balsam > 80%, age class 8 and 9;
3. Hemlock > 60%, age class 8 and 9;
4. Slope > 80%;
5. Caribou zone;
6. Unstable terrain and potentially unstable terrain;
7. Distance from existing and proposed roads;
8. Distance to highway 23;
9. Adjacency to non-timber harvesting landbase (THLB);
10. Currently mapped LP wildlife tree patches (WTPs);
11. Volume less than 250 m^3/ha at age 140 years;
12. Lower height classes for age classes 8 and 9; and
13. Lower site index for future managed stands.

The ranking scheme worked such that more desirable OGMA attributes were assigned higher values. The maximum value for one criterion was 3 and the minimum value was zero. Applied across the THLB, this relocation shifts OGMAs from lower ranked, less desirable locations, to higher ranked or more desirable locations. The ranking scheme used for each variable is listed below.

2.1.1 Un-merchantable stands- Hemlock and Balsam

For stands in age class 8 and 9 with the dominant species in hemlock and/or balsam, the ranking scheme is shown below in Table 2-1.

Table 2-1 Hemlock/ Balsam ranking scheme

Species	Percentage in Species	Threshold Age	Ranking Scheme
Hemlock	>80	140	3
Hemlock/Balsam	>80	140	3
Hemlock	>60	140	2

2.1.2 Slope > 80%

Stands with over 80% slope were assigned 3 points.

2.1.3 Caribou zone

Stands within the caribou management zone have been assigned 3 points with the intention of pushing OGMAs into these locations.

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2.1.4 Unstable terrain and potentially unstable terrain

In the TFL 55 Management Plan 4 (MP4), potentially-unstable and unstable terrain was partially removed from the THLB using the terrain inventory. The land that was not removed was assigned a ranking score as shown below in Table 2-2.

Table 2-2 Unstable and potentially unstable terrain ranking scheme

Terrain	Ranking scheme
Unstable	3
Potentially Unstable	2

2.1.5 Distance from existing and proposed roads

Stands further from the road are considered more desirable as OGMAs. The ranking of stands according to their distance from roads is shown below in Table 2-3.

Table 2-3 Distance from roads ranking scheme

Distance from roads	THLB Area (ha)	Ranking scheme
< 0.5 km	459	0
0.5 - 1 km	116	1
1.0 - 1.5 km	147	2
> 1.5 km	359	3

2.1.6 Distance to highway 23

Stands further from highway 23 are considered more desirable as OGMAs. The ranking of stands according to their distance from highway 23 is shown below in Table 2-4.

Table 2-4 Distance from highway 23 ranking scheme

Distance from Hwy 23	THLB Area (ha)	Ranking scheme
< 0.5 km	10	0
0.5 - 1 km	19	1
1.0 - 1.5 km	15	2
> 1.5 km	1,038	3

2.1.7 Adjacency to non-THLB

Adjacency to the non-THLB is a desirable characteristic for OGMAs and stands that were identified as adjacent were assigned 3 points.

2.1.8 Currently mapped LP WTPs

The efficiencies made possible by overlapping OGMAs and WTPs make locating OGMAs in WTPs desirable. Stands that were identified to be WTPs were assigned 3 points.

2.1.9 Volume less than 250 m^3/ha at age 140 years

In order to capture the fact that harvesting in low volume stands is undesirable, stands with volume less than 250 m^3/ha were assigned a score of 2 points.

2.1.10 Lower height classes for age classes 8 and 9

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For stands that are over 140 years old, lower height classes are less desirable for harvest and therefore are a more desirable location for OGMAs. The amount of THLB area and ranking scheme for each height class is shown below in Table 2-5.

Table 2-5 Height class ranking scheme

Height Class	Area THLB (ha)	Ranking scheme
0,1	1	-
2	33	3
3	1908	2
4	9887	1
>=5	1894	0

2.1.11 Lower site index for future managed stands

For existing stands that are harvested, it is desirable for future site index to be higher in the THLB and therefore lower in OGMAs. The site index ranges from 13 to 28 and the distribution in TFL55 MP4 is shown in Figure 2.1.

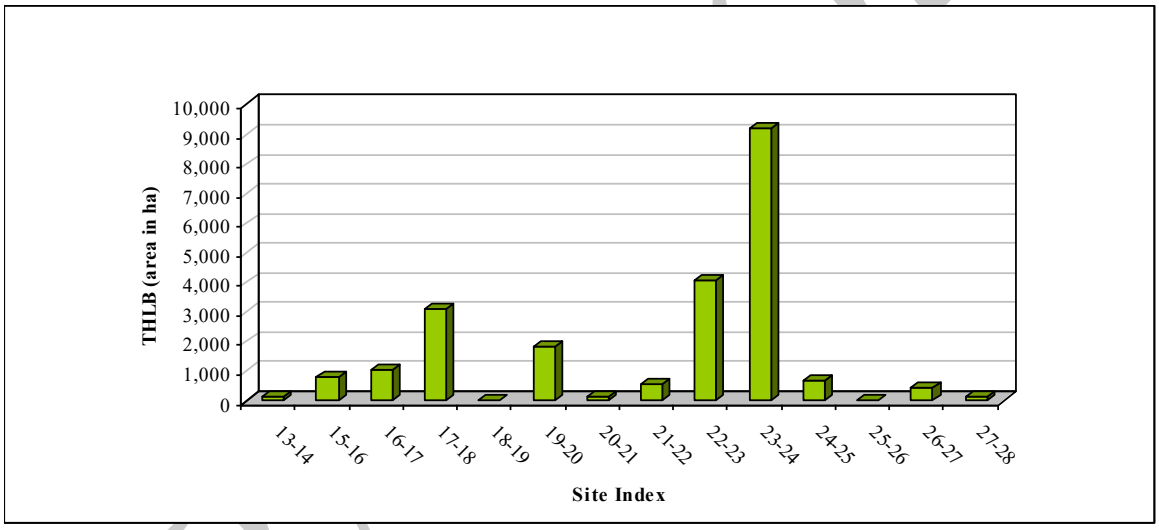

Figure 2.1 Distribution of site index from MP4

The ranking scheme for site index is shown in Table 2-6 below.

Table 2-6 Site Index for future stands ranking scheme

Site Index range	Ranking scheme
< 17	3
17-21	2
21-25	1
>= 25	0

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3.0 RESULTS

3.1 THLB Total Stand Rank Summary

Total stand rank is the cumulative score of all the previously mentioned criteria and was generated for each stand. The higher the cumulative stand value, the better OGMA it will make according to the criteria. The area by stand value for the THLB (net of existing OGMAs) is summarized in Table 3-1. The productive landbase has been shown in the tables for interest, however the relocation process only occurred on the THLB.

Table 3-1 Area by cumulative stand rank for THLB

Rank	Area (ha)	
	THLB	Productive
21	1	1
20	24	36
19	57	68
18	213	229
17	522	559
16	1,137	1,173
15	1,287	1,346
14	1,677	1,757
13	1,982	2,030
12	1,468	1,547
11	1,684	2,005
10	1,676	2,115
9	1,311	1,903
8	381	2,090
7	289	3,179
6	259	4,702
5	39	3,936
4	11	3,416
3	0	4,846
2	0	3,587
1	0	708
0	0	2,997
FDP area	240	281
logged area	7,001	7,579
Total non-existing OGMA area	21,259	52,092

3.2 Existing OGMA Summary

Total stand value was also summarized for existing OGMAs. This is a gauge of how the current OGMAs evaluate based upon the relocation criteria. This is shown in Table 3-2. From this evaluation we can pick a level where we begin to move OGMAs to locations that better satisfy our criteria.

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Table 3-2 Area by cumulative stand rank for existing OGMAs

Rank	Area (ha)	
	THLB	Productive
22	6	6
21	1	1
20	21	22
19	51	53
18	79	85
17	108	117
16	79	87
15	131	143
14	121	126
13	117	122
12	125	136
11	118	190
10	105	238
9	11	111
8	6	107
7	2	240
6	1	322
5	0	235
4	0	140
3	0	363
2	0	163
1	0	1
Total OGMA area	1,081	3,011

Table 3-3 through Table 3-7 summarise existing OGMA area by ageclass, BEC, LU, current and caribou operability line respectively.

Table 3-3 Existing OGMA Area by Ageclass

Ageclass	Area (ha)	
	THLB	Productive
0	0	0
1	0	0
2	0	0
3	0	0
4	0	0
5	0	0
6	0	0
7	0	0
8	529	1,773
9	552	1,238

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Table 3-4 Existing OGMA Area by BEC

BEC	Area (ha)	
	THLB	Productive
ESSFvc	346	1,534
ESSFwc2	0	63
ECHvk1	701	1,340
IChwk1	35	74

Table 3-5 Existing OGMA Area by LU

LU	Area (ha)	
	THLB	Productive
R17	723	1,508
R5	358	1,503

Table 3-6 Existing OGMA Area by Current Operability Line

Current Operability	Area (ha)	
	THLB	Productive
Inoperable	0	1,627
Operable	1,081	1,384

Table 3-7 Existing OGMA Area by Caribou Operability Line

Caribou Operability Line	Area (ha)	
	THLB	Productive
Inoperable	0	1,627
Operable	1,081	1,384

3.3 Finding the Threshold and Area to Move

By comparing the area in each stand rank between the OGMAs and the THLB, a cut off point in the rankings is selected. Above this point, it is accepted that OGMAs are satisfactory and will not be moved in the reselection process. Below this point OGMAs are not satisfactory in terms of the given criteria and will be moved to higher ranked areas.

The threshold for this process was set at a stand rank of over 14. Stands with a stand rank of 15 and above were accepted as satisfactory OGMAs and were not looked at for relocation. This is an area of 475 ha (44% of total existing OGMA area). Stands with a stand rank of 14 and below were moved in the relocation process. This is a possible area of 606 ha (56 % of total existing OGMA area). As will be explained in the next section, this area will be reduced for the hardwired OGMA scenario.

3.4 Threshold for Hardwired OGMA Scenario

From total OGMA area, LP selected areas designated not to be relocated (hardwired). In order to prevent fragmentation of existing OGMAs during the hardwiring process- if part of an OGMA was selected for hardwiring by LP, it was assumed that the whole OGMA was to be hardwired.

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A summary of this area by rank is shown in Table 3-8. There are a total of 738 ha of current OGMAs THLB hardwired. This is 68% of the current total OGMA THLB area. Hardwired OGMAs with a stand rank of 15 and above (364 THLB ha) are accepted as satisfactory and not looked at for relocation. Hardwired OGMAs with a stand rank of 14 and less (373 THLB ha) would otherwise be relocated but are instead designated not to be moved. This means that the possible relocation area decreases from 606 THLB ha to 233 THLB ha (606-373). This is the amount of area moved in the hardwired OGMA scenario.

Table 3-8 Hardwired OGMA area by rank

Stand Rank	Area (ha)	
	THLB	Productive
22	6	6
21	1	1
20	18	19
19	45	47
18	53	59
17	72	77
16	67	73
15	104	111
14	84	87
13	84	88
12	93	100
11	41	106
10	59	162
9	6	21
8	6	41
7	1	84
6	1	113
5	0	52
4	0	5
3	0	30
2	0	6
1	0	1
Total	738	1,290

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4.0 UNCONSTRAINED OGMA RELOCATION SCENARIO

4.1.1 Moved Area Summary Pre and Post Relocation

It is useful to compare the characteristics pre and post relocation for the areas that were moved. This section summarises the change in area by stand rank for each parameter. Table 4-1 shows the area moved by stand rank pre and post relocation. There is a slight increase in moved OGMA area of 5 ha.

Table 4-1 Area by stand rank in moved OGMAs pre and post relocation

	THLB Area (ha)	
Stand Rank	**Before**	**After**
21	0	1
20	0	24
19	0	57
18	0	213
17	0	316
14	121	0
13	117	0
12	125	0
11	118	0
10	105	0
9	11	0
8	6	0
7	2	0
6	1	0
Total	606	611

Figure 4.1 shows that the area of stands with Hemlock > 60% over age 140 approximately doubled- increasing from 22 ha to 46 ha. There are not large areas in Hemlock because a lot of area was removed from the THLB in the netdown and classified as non-merchantable. Non-merchantable stands were defined as stands that are greater than 80% hemlock or balsam and are greater than 140 years of age in MP4.

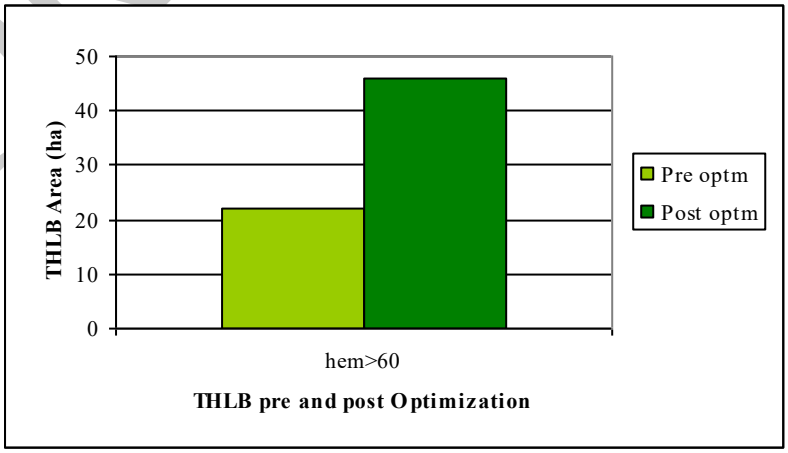

Figure 4.1 Area by Hemlock category in moved OGMAs pre and post relocation

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Table 4-2 shows the area with slope greater than 80% in moved OGMAs pre and post relocation. There is minimal area in this classification because most of the area with slope > 80% would have been removed in the MP4 netdown.

Table 4-2 Area in slope >80% in moved OGMAs pre and post relocation

	THLB Area (ha)	
Slope	**Pre relocation**	**Post relocation**
Slope > 80%	7	8
Slope < 80%	599	603

Figure 4.2 shows the movement of area by caribou zone for the moved OGMA area pre and post relocation. Area has moved out of the ICH-Operable into the ESSF-Operable.

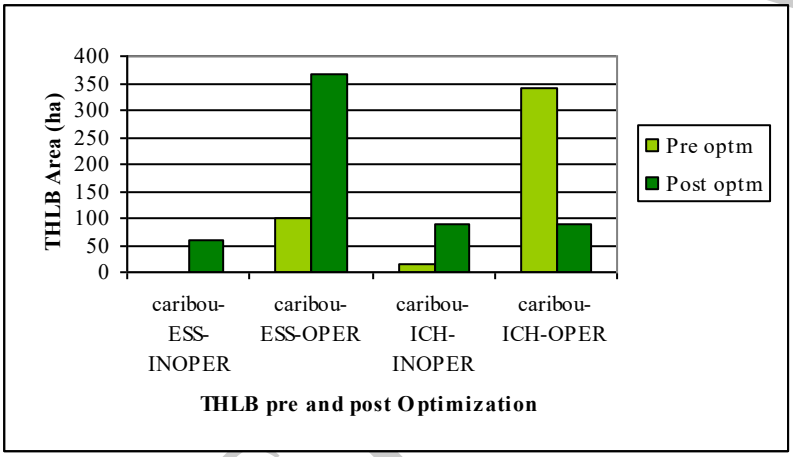

Figure 4.2 Area in Caribou zone in moved OGMAs pre and post relocation

Figure 4.3 shows the movement of area into potentially unstable and unstable terrain after relocation.

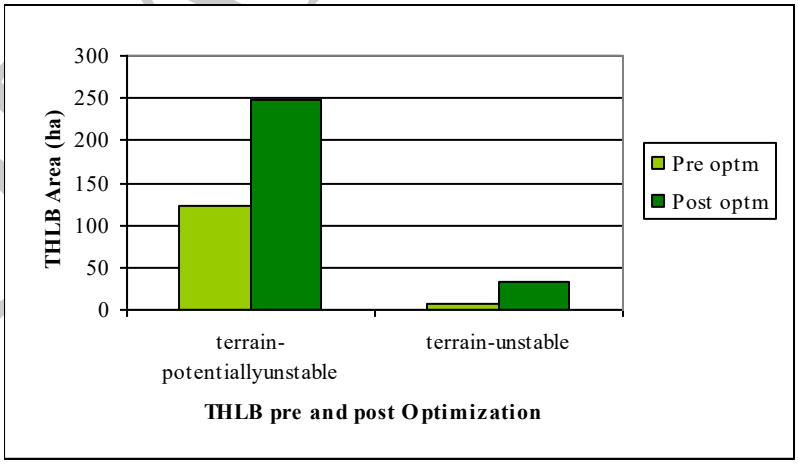

Figure 4.3 Area in Unstable Terrain in moved OGMAs pre and post relocation

Figure 4.4 shows the movement of area by distance from nearest road. There is a distinct shift in the area less than 500 m from a road to greater than 1500 m from a road.

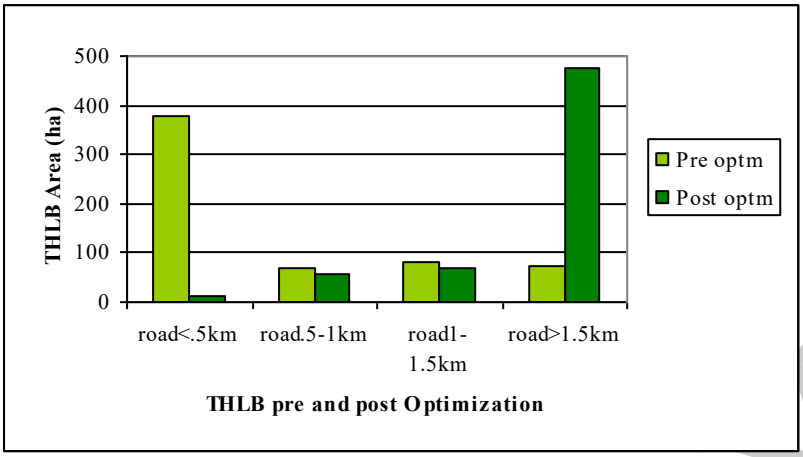

Figure 4.4 Area by road locality in moved OGMAs pre and post relocation

Figure 4.5 shows that all the moved area post relocation is greater than 1.5 km from Highway 23. This small shift is reflective of the position of the highway relative to the landbase.

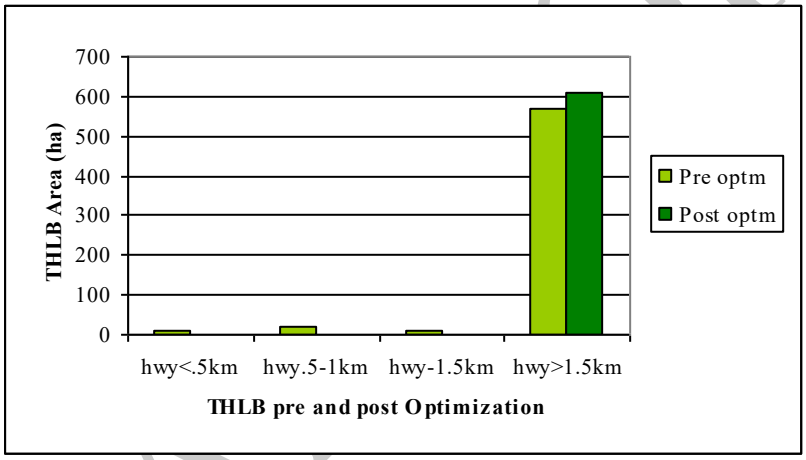

Figure 4.5 Area by distance to Hwy 23 in moved OGMAs pre and post relocation

Table 4-3 shows the movement of area from 45% adjacent to the non-THLB to 99% adjacent to the non-THLB after relocation.

Table 4-3 Area by Adjacency to non-THLB in moved OGMAs pre and post relocation

	THLB Area (ha)	
Adjacency to non-THLB	**Before**	**After**
Adjacent	271	609
Not Adjacent	335	2

Table 4-4 shows that there is a small movement of 30 ha out of stands with volume > 250 m^3/ha at age 140 after relocation.

Table 4-4 Area by volume >250 m^3/ha in moved OGMAs pre and post relocation

	THLB Area (ha)	
Volume at age 140	**Before**	**After**
Volume > 250 m3/ha	600	575
Volume < 250 m3/ha	6	36

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Figure 4.6 shows the movement of area out of height class 4 and into height class 5, post relocation- reflecting the pressure towards shorter existing stands over age 140.

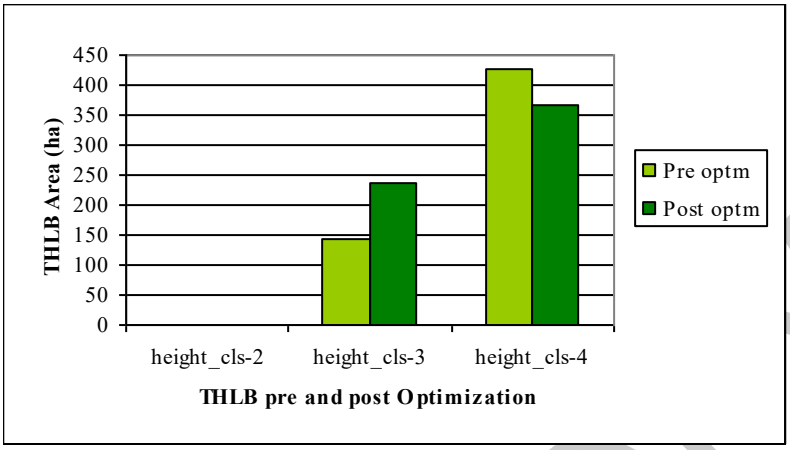

Figure 4.6 Area by height class >140 years in moved OGMAs pre and post relocation

Figure 4.7 shows the movement into stands with a lower future site index and out of stands with a higher future site index post relocation.

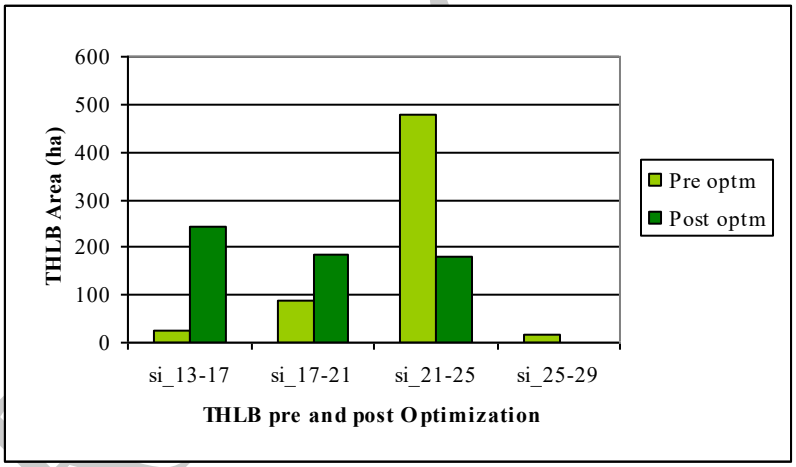

Figure 4.7 Area by future site index in moved OGMAs pre and post relocation

Figure 4.8 shows that a small area of 40 ha moved from age class 9 to age class 8 in the relocation process.

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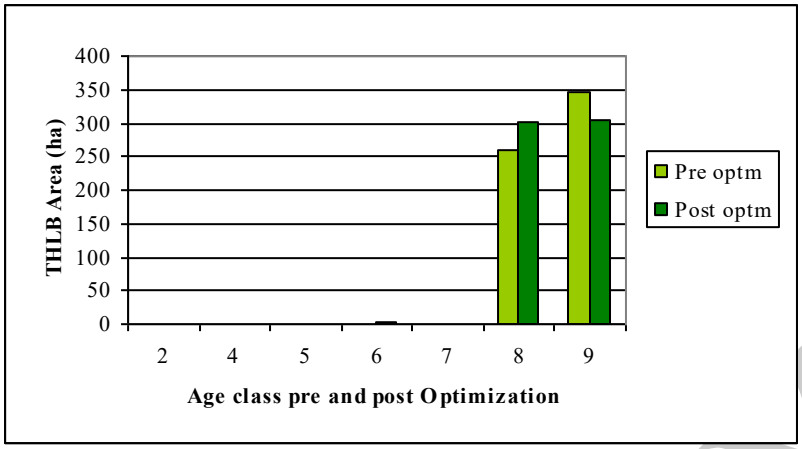


Figure 4.8 Area by Age class in moved OGMAs pre and post relocation

Figure 4.9 shows the area by leading species in the moved OGMA areas pre and post relocation.

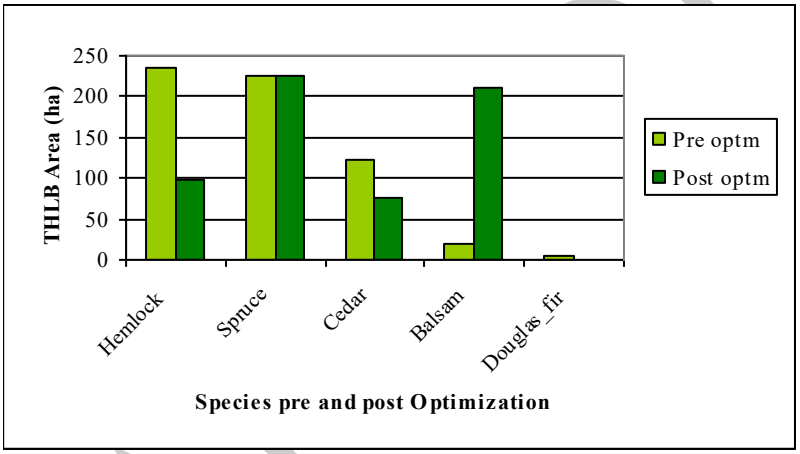
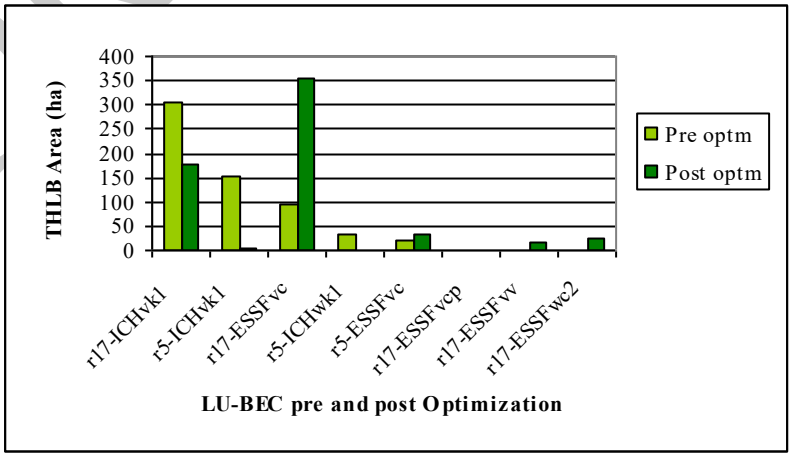


Figure 4.9 Area by Leading Species in moved OGMAs pre and post relocation

Figure 4.10 shows the movement of area between LU-BEC combinations after relocation. By BEC, there is a shift out of ICH and into the ESSF which mirrors the movement in the caribou zones shown above. By LU, there is a shift out of r5 and into r17.



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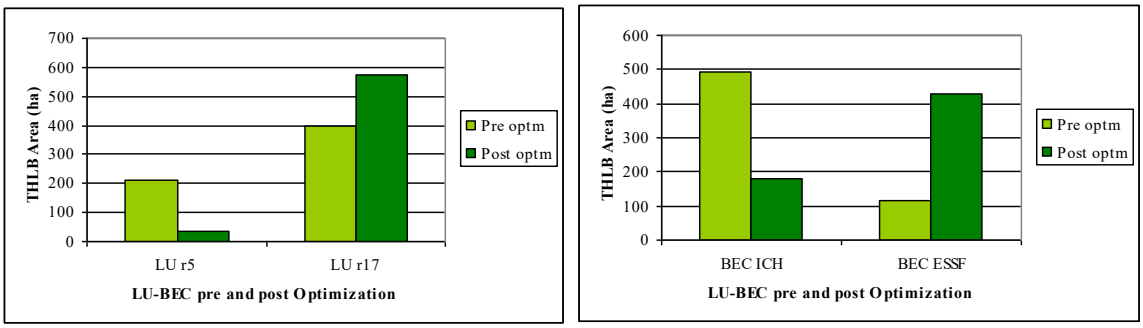

Figure 4.10 Area by LU-BEC in moved OGMAs pre and post relocation

4.1.2 Unconstrained OGMA Relocation Discussion

During the first relocation, there was movement of OGMAs from low ranked undesirable stands to better ranked desirable stands. All ranking parameters saw a shift of area in the direction anticipated from the weighting. Criteria with a significant change were; hemlock > 60%, caribou zones, height classes, site index, terrain, distance from road and LU-BEC. The change in the LU distribution was seen as undesirable from a political viewpoint because the OGMA area moved post relocation was pushed out of LU r5. Therefore another second relocation was run with area being able to move within LU but not between.

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5.0 OGMA RELOCATION WITHIN LU SCENARIO

5.1.1 Moved Area Summary Pre and Post Relocation

The same threshold (stand rank = 15) and area moved (606 ha) was used as in the previous relocation. There is a slight increase in moved OGMA area of 7 ha. Table 5-1 shows the area moved by stand rank pre and post relocation.

Table 5-1 Area by stand rank in moved OGMAs pre and post relocation

	THLB Area (ha)	
Stand Rank	**Before**	**After**
21	0	1
20	0	24
19	0	57
18	0	213
17	0	221
16	0	97
14	121	0
13	117	0
12	125	0
11	118	0
10	105	0
9	11	0
8	6	0
7	2	0
6	1	0
Total	606	613

Figure 5.1 shows that the area of stands with Hemlock > 60% over age 140 increased from 22 ha to 73 ha.

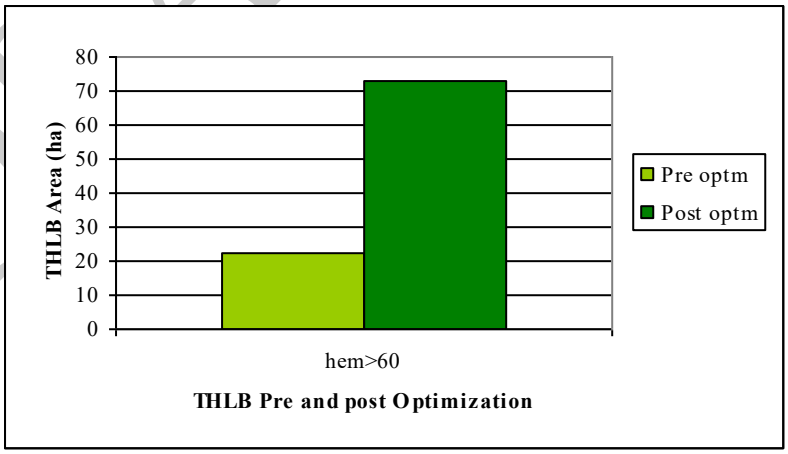

Figure 5.1 Area by Hemlock category in moved OGMAs pre and post relocation

Table 5-2 shows the area with slope greater than 80% in moved OGMAs pre and post relocation.

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Table 5-2 Area in slope >80% in moved OGMAs pre and post relocation

Slope	THLB Area (ha)	
	Before	After
Slope > 80%	7	22
Slope < 80%	599	591

Figure 5.2 shows the movement of area by caribou zone for the moved OGMA area pre and post relocation. Area has moved out of the ICH-Operable into the ESSF-Operable.

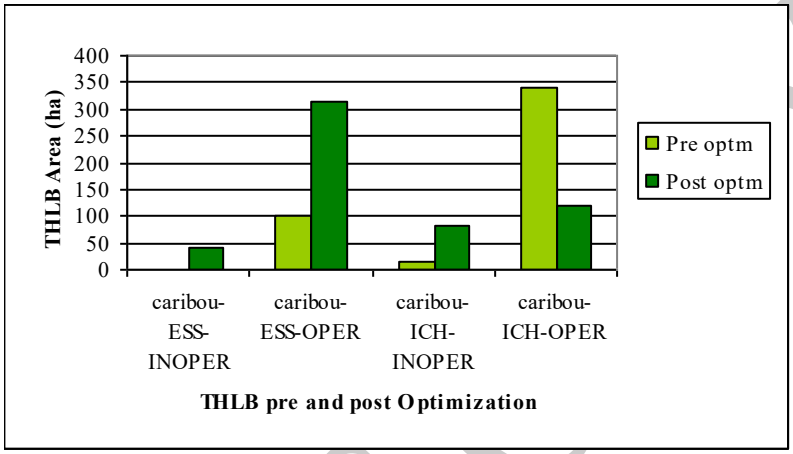

Figure 5.2 Area in Caribou zone in moved OGMAs pre and post relocation

Figure 5.3 shows the movement of area into potentially unstable and unstable terrain after relocation.

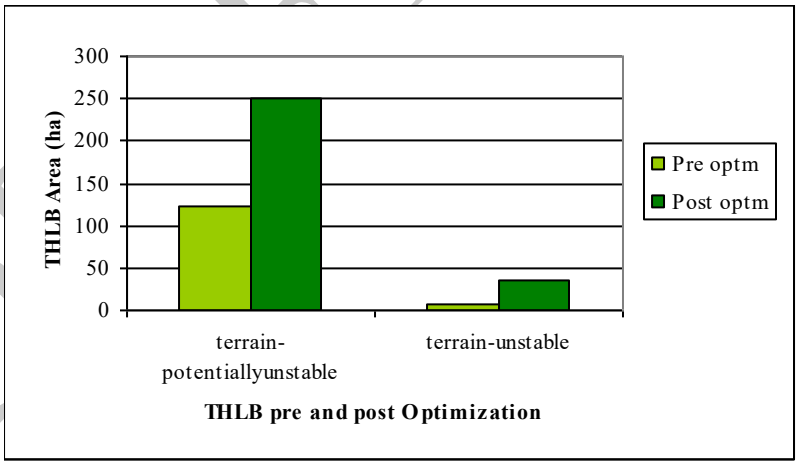

Figure 5.3 Area in Unstable Terrain in moved OGMAs pre and post relocation

Figure 5.4 shows the movement of area by distance from nearest road. There is a distinct shift in the area less than 500 m from a road to greater than 1500 m from a road.

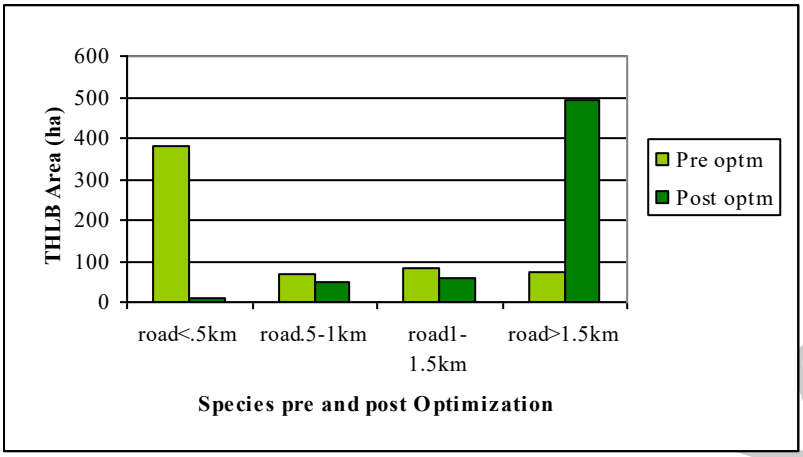

Figure 5.4 Area by road locality in moved OGMAs pre and post relocation

Figure 5.5 shows that all the moved area post relocation is greater than 1.5 km from Highway 23. This small shift is reflective of the position of the highway relative to the landbase.

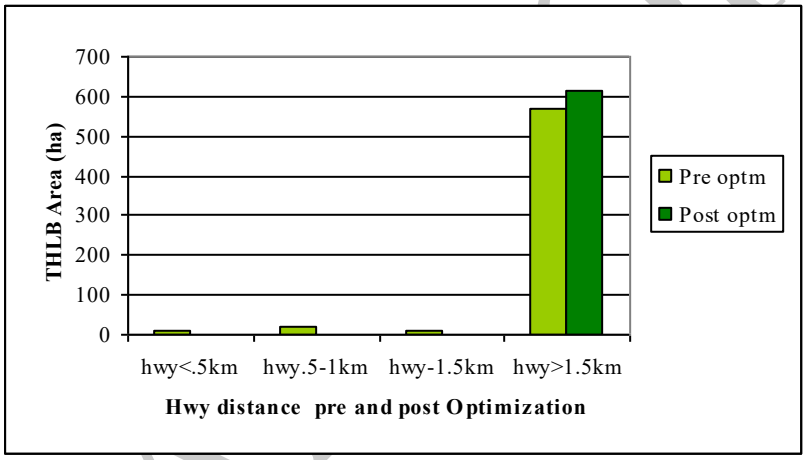

Figure 5.5 Area by distance to Hwy 23 in moved OGMAs pre and post relocation

Table 5-3 shows the movement of area from 45% adjacent to the non-THLB to 98% adjacent to the non-THLB after relocation.

Table 5-3 Area by Adjacency to non-THLB in moved OGMAs pre and post relocation

	THLB Area (ha)	
Adjacency to non-THLB	**Before**	**After**
Adjacent	271	601
Not Adjacent	335	12

Table 5-4 shows that there is a small movement out of stands with volume > 250 m^3/ha at age 140 after relocation.

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Table 5-4 Area by volume >250 m^3/ha in moved OGMAs pre and post relocation

	THLB Area (ha)	
Volume at age 140	**Before**	**After**
Volume > 250 m3/ha	600	577
Volume < 250 m3/ha	6	36

Figure 5.6 shows the movement of area out of height class 4 and into height class 5, post relocation- reflecting the pressure towards shorter existing stands over age 140.

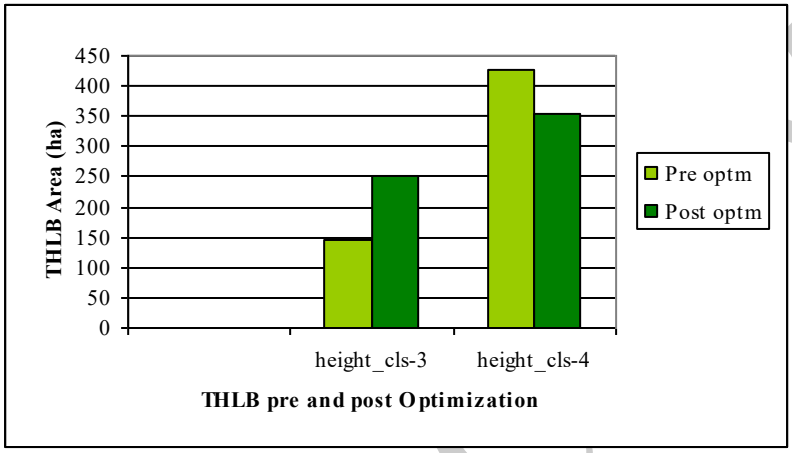


Figure 5.6 Area by height class >140 years in moved OGMAs pre and post relocation

Figure 5.7 shows the movement into stands with a lower future site index and out of stands with a higher future site index post relocation.

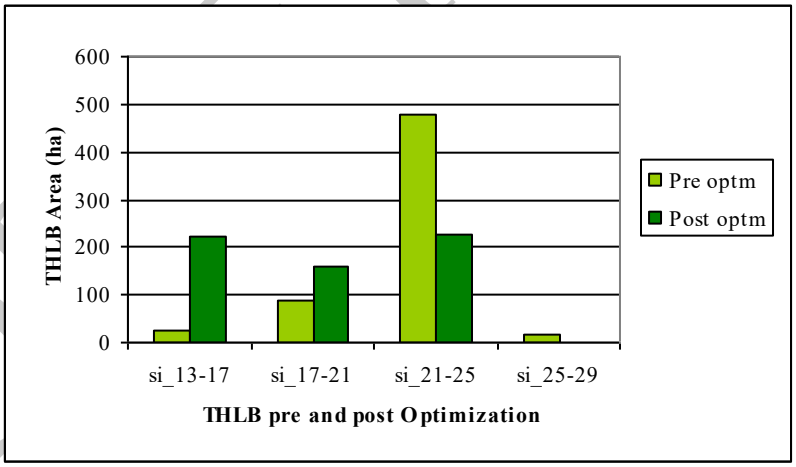


Figure 5.7 Area by future site index in moved OGMAs pre and post relocation

Figure 5.8 shows that a small area of 39 ha moved from age class 9 to age class 8 in the relocation process.

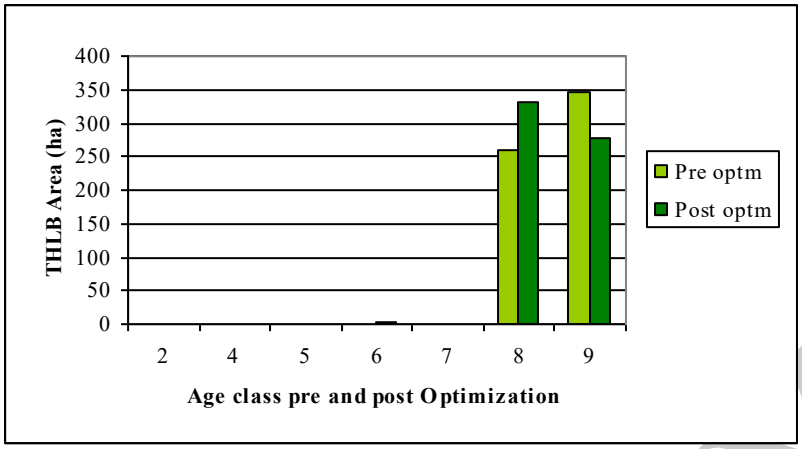


Figure 5.8 Area by Age class in moved OGMAs pre and post relocation

Figure 5.9 shows the area by leading species in the moved OGMA areas pre and post relocation.

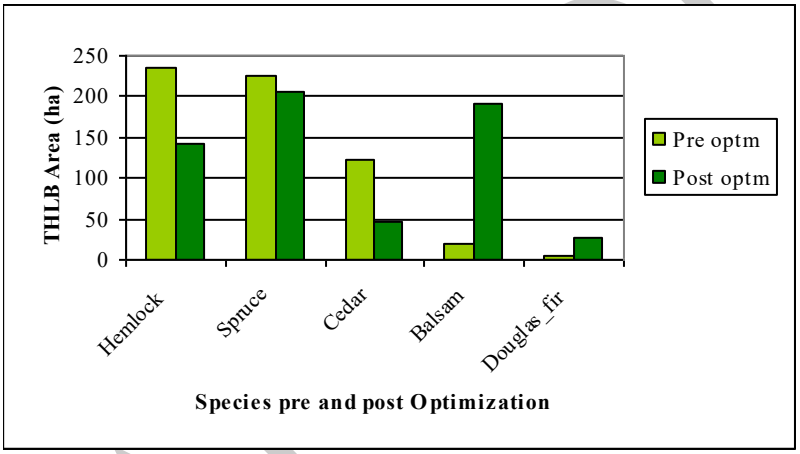
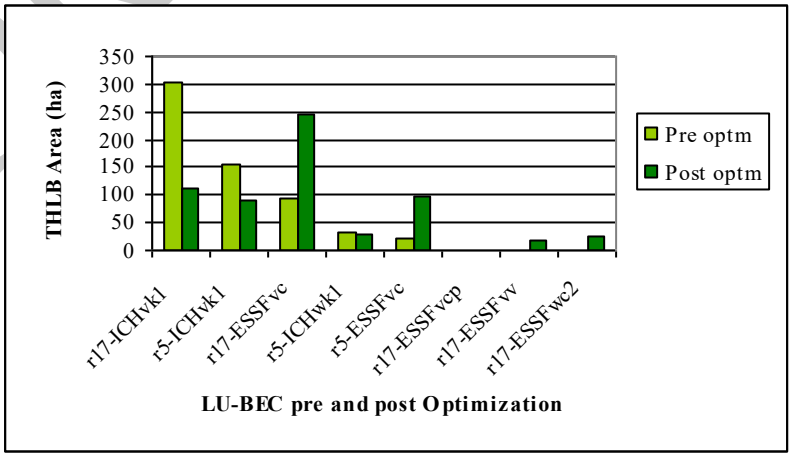


Figure 5.9 Area by Leading Species in moved OGMAs pre and post relocation

Figure 5.10 shows the movement of area between LU-BEC combinations after relocation. Due to the LU control in this scenario, there is no movement between LUs. By BEC, there is a shift out of ICH and into ESSF.



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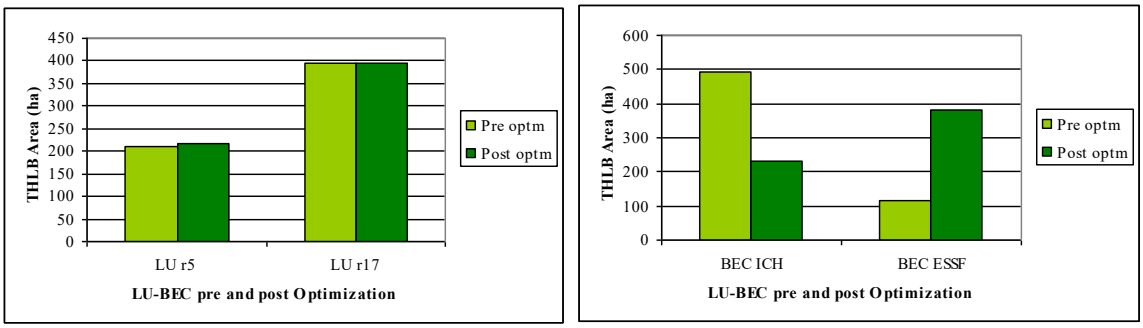

Figure 5.10 Area by LU-BEC in moved OGMAs pre and post relocation

5.1.2 OGMA Relocation within LU Scenario Discussion

The LU constraint (OGMAs can only move within a LU but not between) did not negatively impact any of the ranking criteria except that future site index shift is not as pronounced. In some cases, such as Hemlock > 60%, slope >80% and height class, there is positive impact. There is still a large shift between area in the ICH and ESSF that will be constrained in the next scenario.

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6.0 OGMA RELOCATION WITHIN LU/BEC WITH HARDWIRED OGMA SCENARIO

6.1.1 Moved Area Summary Pre and Post Relocation

The same threshold (stand rank = 15) was used as in the previous relocations. However, the area to be moved is decreased because of the presence of hardwired OGMAs with stand rank below 15. As outlined in section 3.4 "Threshold for Hardwired OGMA Scenario", the area able to be relocated is decreased to 233 THLB ha. Table 6-1 shows the area moved by stand rank pre and post relocation. There is a small increase in OGMA area moved pre to post relocation of 30 THLB ha.

Table 6-1 Area by stand rank in moved OGMAs pre and post relocation

Stand Rank	THLB Area (ha)	
	Before	After
21	0	1
20	0	23
19	0	44
18	0	37
17	0	76
16	0	83
14	37	0
13	34	0
12	32	0
11	77	0
10	46	0
9	6	0
7	1	0
Total	233	263

Figure 6.1 shows that the area of stands with Hemlock > 60% over age 140 increased from 17 ha to 41 ha.

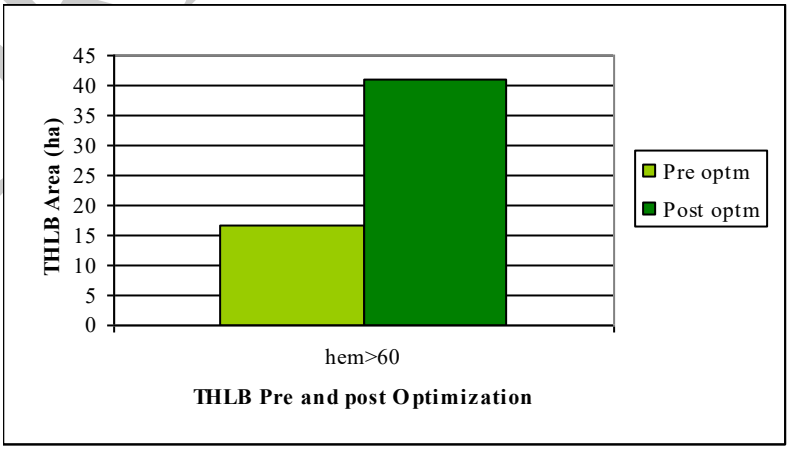

Figure 6.1 Area by Hemlock category in moved OGMAs pre and post relocation

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Table 6-2 shows the area with slope greater than 80% in moved OGMAs pre and post relocation.

Table 6-2 Area in slope >80% in moved OGMAs pre and post relocation

	THLB Area (ha)	
Slope	**Before**	**After**
Slope > 80%	0	25
Slope < 80%	232	238

Figure 6.2 shows the movement of area by caribou zone for the moved OGMA area pre and post relocation. Area has moved into all caribou zones post optimization.

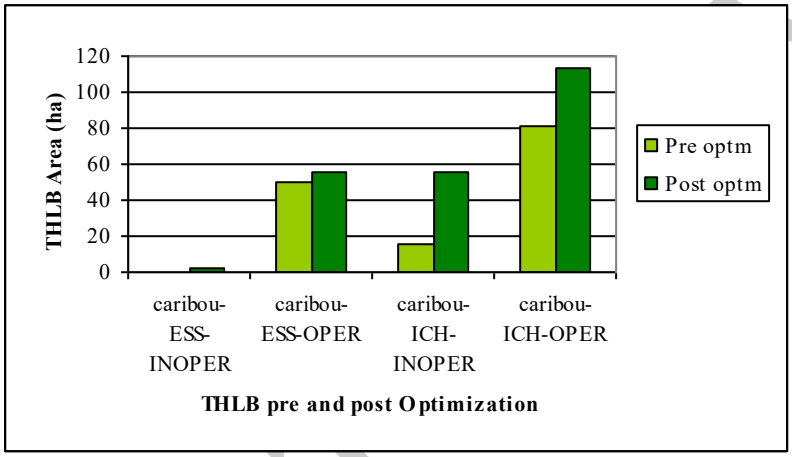

Figure 6.2 Area in Caribou zone in moved OGMAs pre and post relocation

Figure 6.3 shows the movement of area into potentially unstable and unstable terrain after relocation.

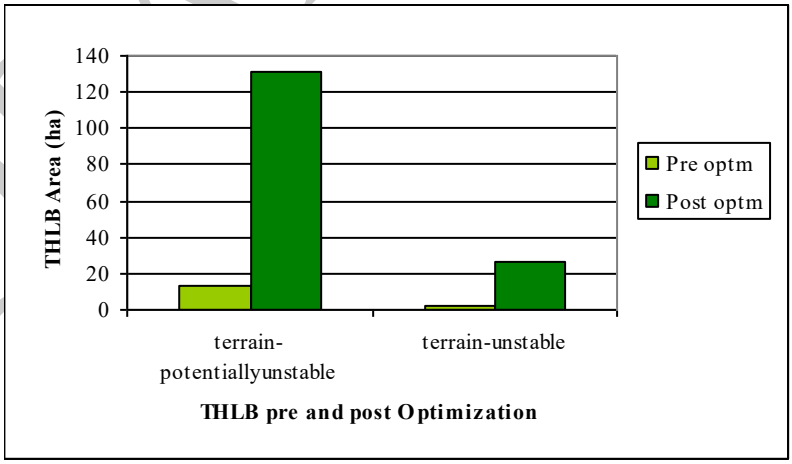

Figure 6.3 Area in Unstable Terrain in moved OGMAs pre and post relocation

Figure 6.4 shows the movement of area by distance from nearest road. There is a distinct shift in the area less than 500 m from a road to greater than 1500 m from a road.

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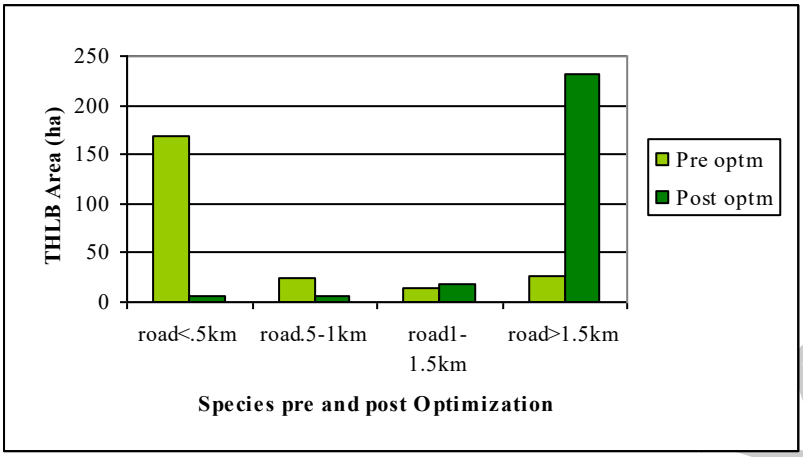

Figure 6.4 Area by road locality in moved OGMAs pre and post relocation

Figure 6.5 shows that all the moved area post relocation is greater than 1.5 km from Highway 23. This small shift is reflective of the position of the highway relative to the landbase.

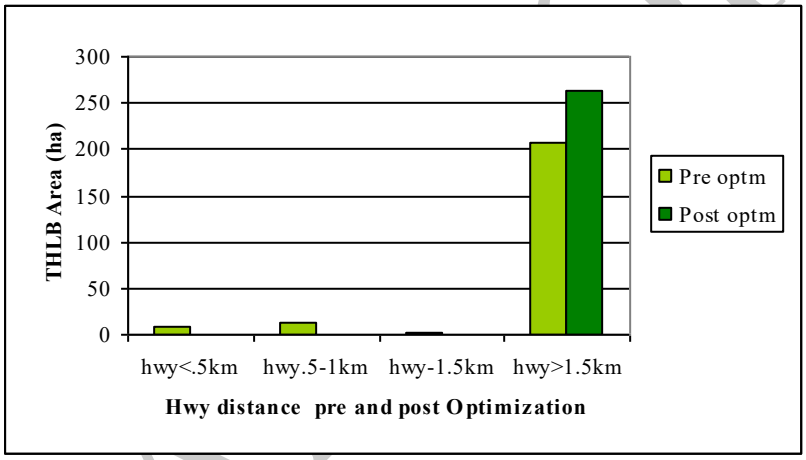

Figure 6.5 Area by distance to Hwy 23 in moved OGMAs pre and post relocation

Table 6-3 shows the movement of area from 64% adjacent to the non-THLB to 100% adjacent to the non-THLB after relocation.

Table 6-3 Area by Adjacency to non-THLB in moved OGMAs pre and post relocation

	THLB Area (ha)	
Adjacency to non-THLB	**Before**	**After**
Adjacent	143	263
Not Adjacent	90	0

Table 6-4 shows that there is a movement out of stands with volume > 250 m^3/ha at age 140 after relocation.

Table 6-4 Area by volume >250 m^3/ha in moved OGMAs pre and post relocation

	THLB Area (ha)	
Volume at age 140	**Before**	**After**
Vol > 250 m3/ha	227	263
Vol < 250 m3/ha	5	0

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Figure 6.6 shows that there is a small movement of area into of height class 3 and height class 4, post relocation.

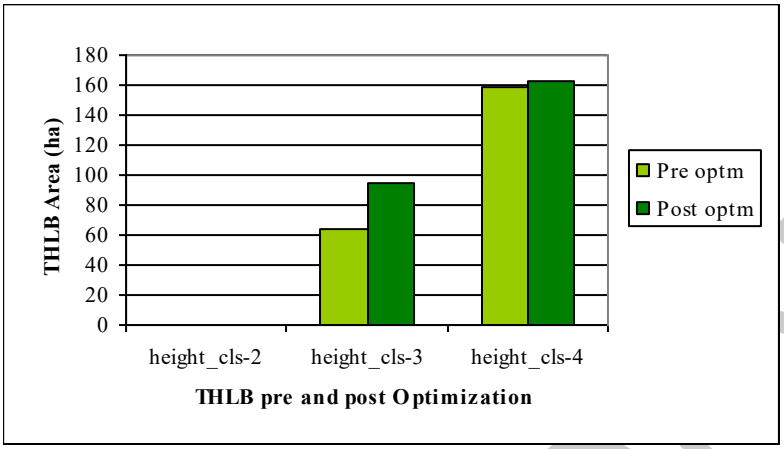

Figure 6.6 Area by height class >140 years in moved OGMAs pre and post relocation

Figure 6.7 shows the movement into stands by future site index. The shift into stands with lower future site index is not as pronounced here as in previous scenarios with area moving into site index 21-25 and out of site index 17 to 21.

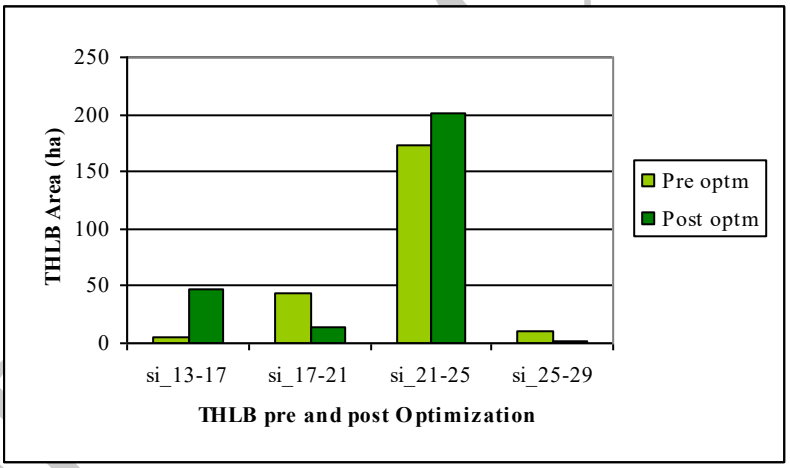

Figure 6.7 Area by future site index in moved OGMAs pre and post relocation

Figure 6.8 shows an increase in area in age class 9 following relocation of 33 ha. Again, this was different to the trend in the other scenarios and may be mostly due to the increase in area relocated of 30 ha.

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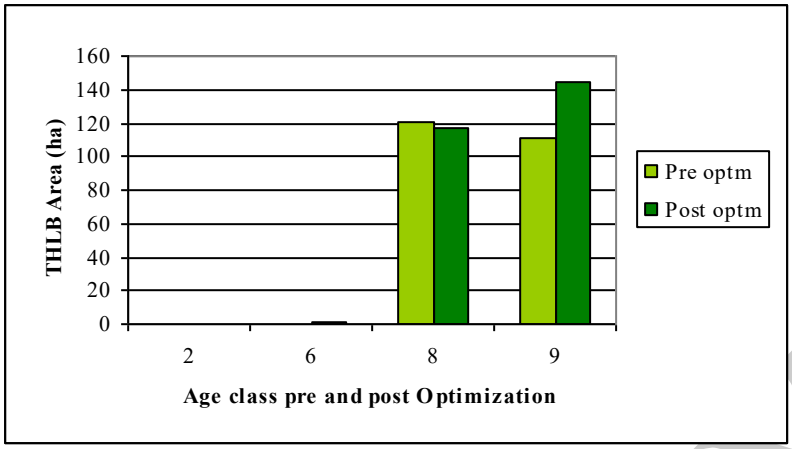


Figure 6.8 Area by Age class in moved OGMAs pre and post relocation

Figure 6.9 shows the area by leading species in the moved OGMA areas pre and post relocation.

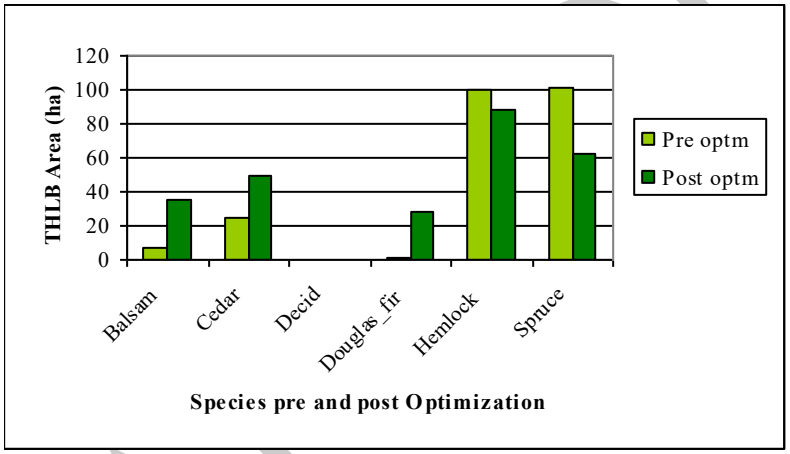
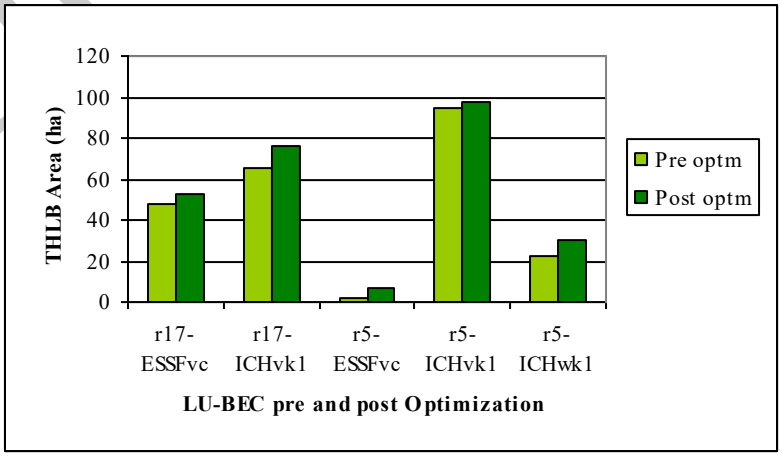


Figure 6.9 Area by Leading Species in moved OGMAs pre and post relocation

Figure 6.10 shows the movement of area between LU-BEC combinations after relocation. Due to the LU control in this scenario, there is no loss in area by LU. Because the scale on the LU graph is fine, the increase of 30 ha post relocation makes those columns look large. The BEC graph also shows a similar trend but due to the scale the increase in area is not as pronounced.



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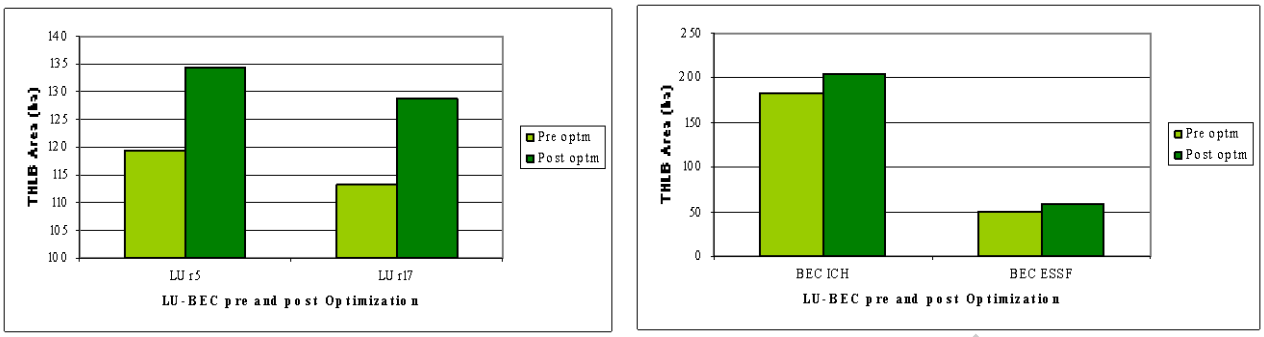

Figure 6.10 Area by LU-BEC in moved OGMAs pre and post relocation

6.1.2 OGMA Relocation within LU/BEC with Hardwired OGMA Discussion

The differences in this scenario are hard to compare directly to the other two because two additional factors were added- the BEC constraint and the hardwired OGMA areas. The increase of 30 ha between pre and post relocation area may make some of the graphs hard to interpret. This increase in area is large when compared to 5 and 7 ha in the other two scenarios. This occurs because as stands are grouped into new OGMAs, the aggregation tool stops when it reaches its area budget. This means that there will be a small over-allocation for each area budget. Since this scenario included an area budget for each LU/BEC combination- this over-allocation was magnified in comparison to the other scenarios.

There are some differences in the characteristics of the area shift due to the LU/BEC control and hardwiring when compared with the previous scenario; the movement between species, future site index, age class and caribou zones are all affected.

6.1.3 Summary of total OGMA area after LU/BEC and hardwired relocation

After relocation of 233 ha, total OGMA area is the sum of post-relocation OGMA area, hardwired OGMA area and existing accepted OGMA area (with stand rank 15 and above). Of the accepted OGMA area, 364 ha are hardwired. This is a total area of 1,111 ha as shown in Table 6-5.

Table 6-5 Total OGMA area after LU/BEC hardwired relocation

OGMA Summary	THLB ha
Relocated OGMA	263
Hardwired OGMA with stand rank <15	373
Acceptable OGMA (>= 15 rank)	475
Total	1,111

Table 6-6 through Table 6-10 compare the total OGMA area pre and post relocation by ageclass, BEC, LU, current operability line and caribou operability line. Ageclass showed an increase in ageclass 9- due largely to the inclusion of the extra 30 ha.

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Table 6-6 Total OGMA area pre and post LU/BEC Hardwire relocation by Ageclass

Ageclass	LU/BEC control and Hardwiring		Existing OGMAs	
	THLB (ha)	Productive (ha)	THLB (ha)	Productive (ha)
0	0	0	0	0
1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	2	3	0	0
7	0	0	0	0
8	525	883	529	1,773
9	584	829	552	1,238

In each BEC, area increased slightly due to the aggregation rule as explained above. No individual BEC decreased in area due to BEC control in this scenario. The same holds true for area by LU (Table 6-8).

Table 6-7 Total OGMA area pre and post LU/BEC Hardwire relocation by BEC

BEC	LU/BEC control and Hardwiring		Existing OGMAs	
	THLB (ha)	Productive (ha)	THLB (ha)	Productive (ha)
ESSFvc	355	765	346	1,534
ESSFwc2			0	63
ICHvk1	714	890	701	1,340
IChwk1	42	60	35	74

Table 6-8 Total OGMA area pre and post LU/BEC Hardwire relocation by LU

LU	LU/BEC control and Hardwiring		Existing OGMAs	
	THLB (ha)	Productive (ha)	THLB (ha)	Productive (ha)
R17	739	1,260	723	1,508
R5	373	455	358	1,503

All OGMA THLB area is operable by definition, and productive area above the operability line is far less post relocation (Table 6-9). This is reflective of the fact that there is a relatively smaller amount of productive non-THLB area in the hardwired OGMAs.

Table 6-9 Total OGMA area pre & post LU/BEC Hardwire relocation- Current Op. Line

Current Operability	LU/BEC control and Hardwiring		Existing OGMAs	
	THLB (ha)	Productive (ha)	THLB (ha)	Productive (ha)
Inoperable	0	327	0	1,627
Operable	1,111	1,388	1,081	1,384

Table 6-10 Total OGMA area pre and post LU/BEC Hardwire relocation- Caribou Op. Line

Caribou Operability Line	LU/BEC control and Hardwiring		Existing OGMAs	
	THLB (ha)	Productive (ha)	THLB (ha)	Productive (ha)
Inoperable	81	1,704	131	476

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Operable	994	1,283	975	1,220

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7.0 OGMA RELOCATION WITHIN LU/BEC WITH HARDWIRING AND EXCLUSIONS

This scenario has LU/BEC control and hardwired OGMAs identical to the previous scenario. Additional to this there are also areas of THLB that are excluded from allowing OGMA relocation into because of future development. The area of THLB exclusion 75 ha THLB and 86.5 ha productive area.

7.1.1 Moved Area Summary Pre and Post Relocation

The same threshold (stand rank = 15) was used as in the previous relocations. The area able to be relocated is 233 THLB ha. Table 7-1 shows the area moved by stand rank pre and post relocation. There is a small increase in OGMA area moved pre to post relocation of 1 THLB ha.

Table 7-1 Area by stand rank in moved OGMAs pre and post relocation

Stand Rank	THLB Area (ha)	
	Before	After
21	0	1
20	0	18
19	0	45
18	0	37
17	0	53
16	0	80
14	37	0
13	34	0
12	32	0
11	77	0
10	46	0
9	6	0
7	1	0
Total	233	234

Figure 6.1 shows that the area of stands with Hemlock > 60% over age 140 increased from 17 ha to 59 ha.

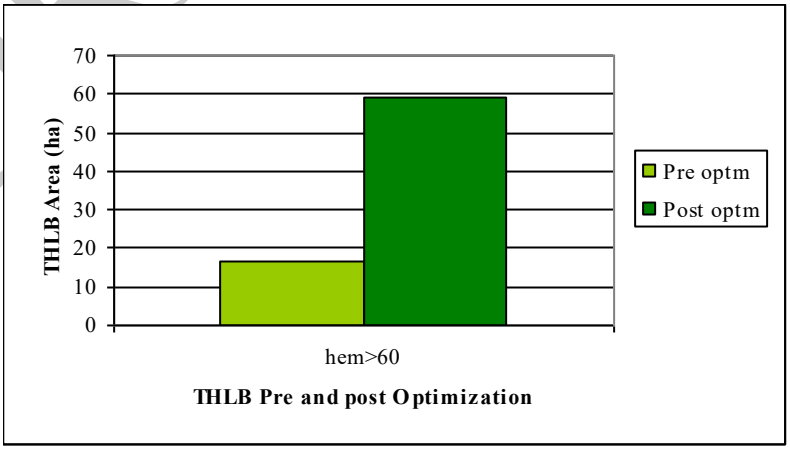

Figure 7.1 Area by Hemlock category in moved OGMAs pre and post relocation

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Table 7-2 shows the area with slope greater than 80% in moved OGMAs pre and post relocation.

Table 7-2 Area in slope >80% in moved OGMAs pre and post relocation

	THLB Area (ha)	
Slope	**Before**	**After**
Slope > 80%	0	30
Slope < 80%	232	204

Figure 7.2 shows the movement of area by caribou zone for the moved OGMA area pre and post relocation. There is a small movement into all caribou zones post optimization.

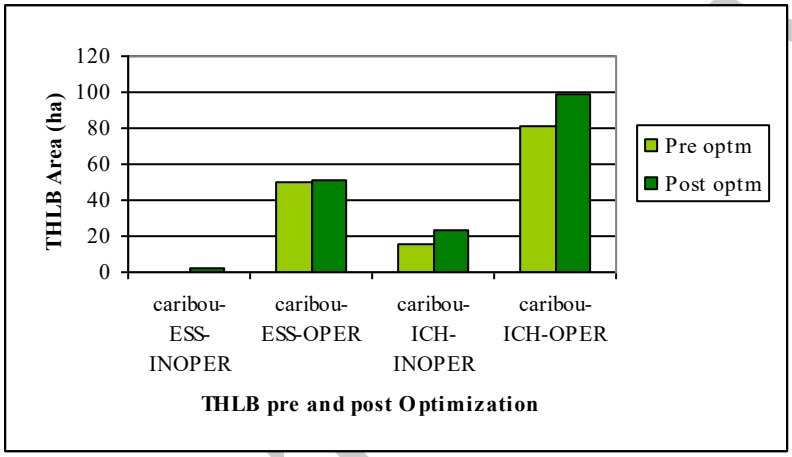

Figure 7.2 Area in Caribou zone in moved OGMAs pre and post relocation

Figure 7.3 shows the movement of area into potentially unstable and unstable terrain after relocation.

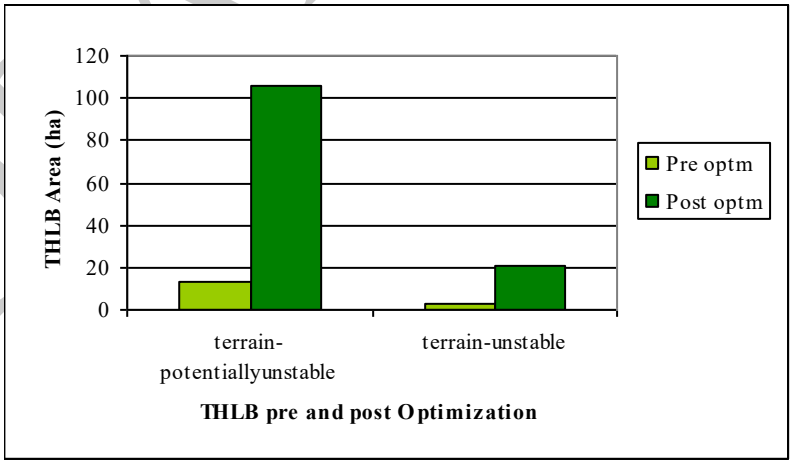

Figure 7.3 Area in Unstable Terrain in moved OGMAs pre and post relocation

Figure 7.4 shows the movement of area by distance from nearest road. There is a distinct shift in the area less than 500 m from a road to greater than 1500 m from a road.

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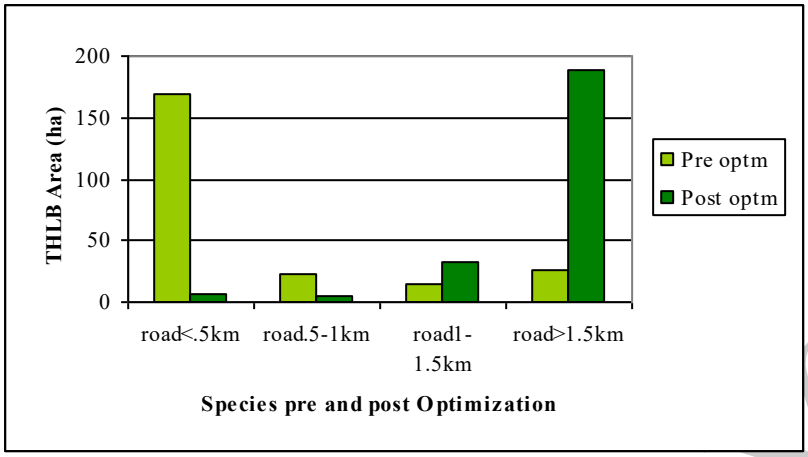

Figure 7.4 Area by road locality in moved OGMAs pre and post relocation

Figure 7.5 shows that all the moved area post relocation is greater than 1.5 km from Highway 23. This small shift is reflective of the position of the highway relative to the landbase.

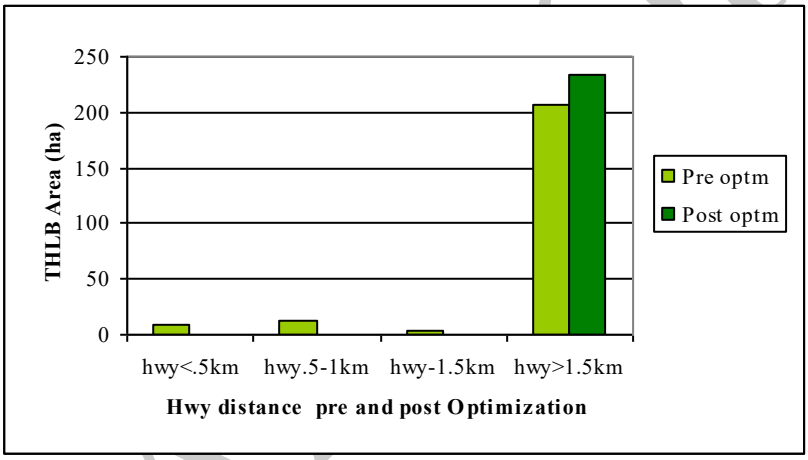

Figure 7.5 Area by distance to Hwy 23 in moved OGMAs pre and post relocation

Table 7-3 shows the movement of area from 63% adjacent to the non-THLB to 100% adjacent to the non-THLB after relocation.

Table 7-3 Area by Adjacency to non-THLB in moved OGMAs pre and post relocation

	THLB Area (ha)	
Adjacency to non-THLB	**Before**	**After**
Adjacent	143	233
Not Adjacent	90	1

Table 7-4 shows that there is a slight movement into stands with volume > 250 m^3/ha at age 140 after relocation.

Table 7-4 Area by volume >250 m^3/ha in moved OGMAs pre and post relocation

	THLB Area (ha)	
Volume at age 140	**Before**	**After**
Vol > 250 m3/ha	227	233
Vol < 250 m3/ha	5	0

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Figure 7.6 shows that there is movement of area into height class 3 and out of height class 4, post relocation.

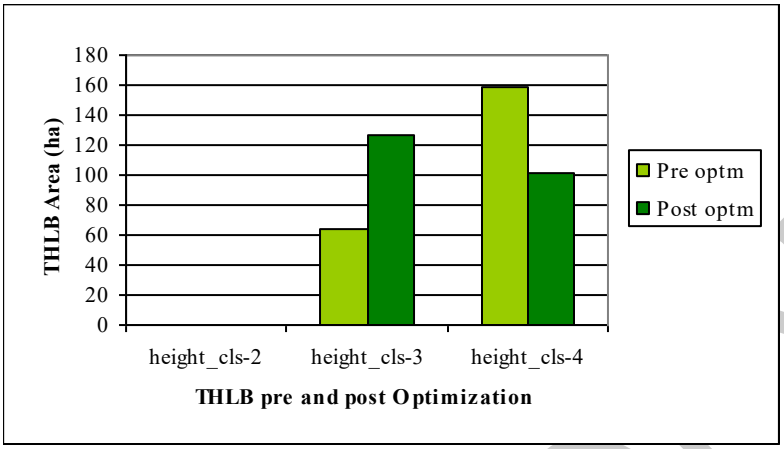

Figure 7.6 Area by height class in moved OGMAs pre and post relocation

Figure 7.7 shows the movement into stands by future site index. There is a shift of area into site index 13-17 and out of site index 17-21. Site index 21-25 area remains relatively constant.

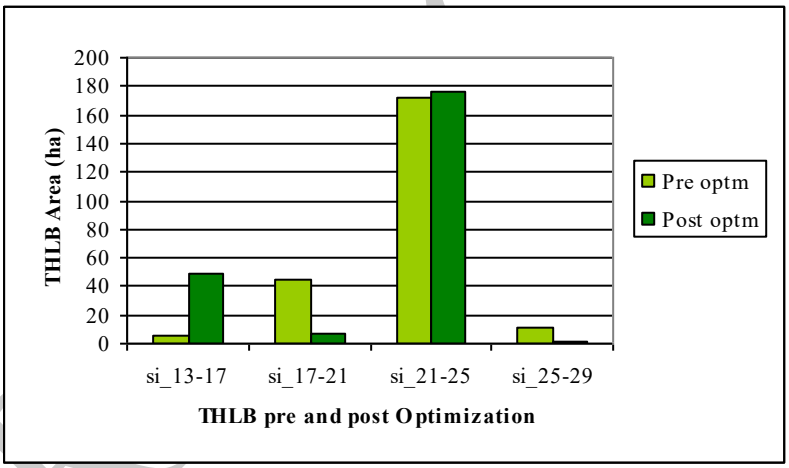

Figure 7.7 Area by future site index in moved OGMAs pre and post relocation

Figure 7.8 shows that the area in ageclass 8 and 9 are relatively constant.

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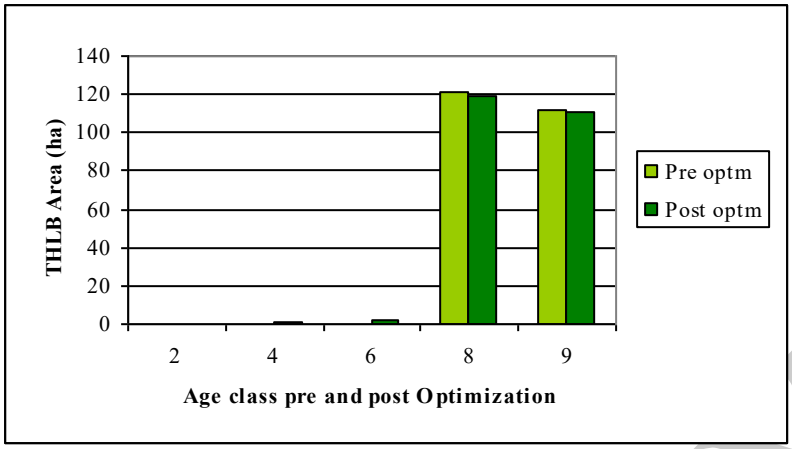


Figure 7.8 Area by Age class in moved OGMAs pre and post relocation

Figure 7.9 shows the area by leading species in the moved OGMA areas pre and post relocation.

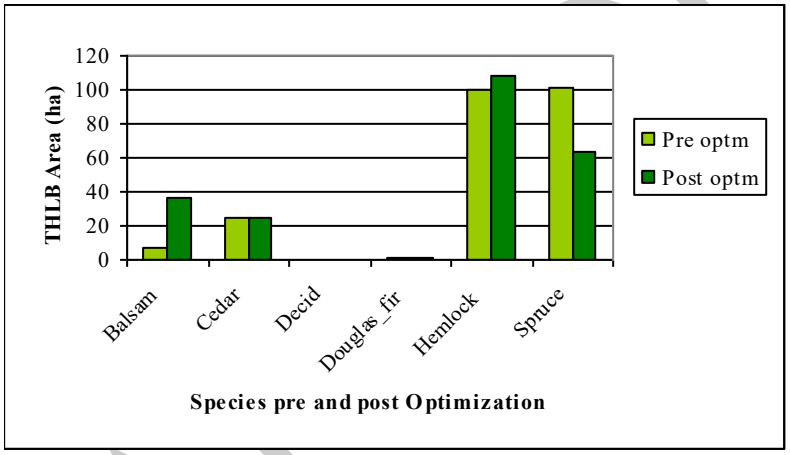
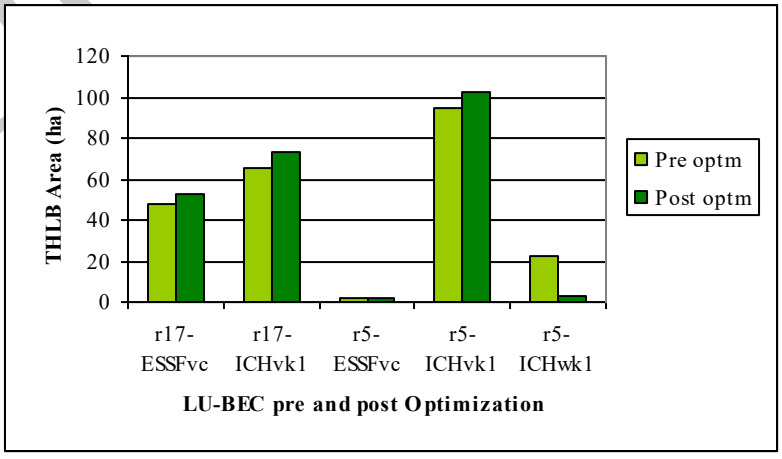


Figure 7.9 Area by Leading Species in moved OGMAs pre and post relocation

Figure 7.10 shows the movement of area between LU-BEC combinations after relocation. There is small variation in area by LU pre versus post relocation- the area in LU R5 decreases by 11ha and the area in LU R17 increases by 11 ha. The BEC graph shows that areas are very constant after relocation.



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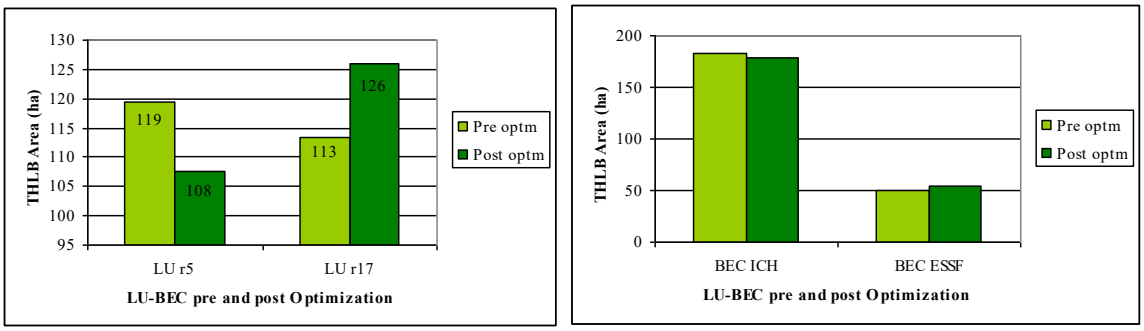

Figure 7.10 Area by LU-BEC in moved OGMAs pre and post relocation

7.1.2 Relocation within LU/BEC with Hardwired OGMA & THLB Exclusions Discussion

The summary statistics in the section above show much the same trends as previous scenarios. Given the fact that relocation was under LU control, the THLB area by LU pre and post relocation is not as constant as may be expected with 11 ha being removed from LU R5.

This occurs because OGMAs are formed in such a way that the aggregation tool keeps adding area until a given budget is achieved. In this case, the last polygon added in a given budget put that budget over the limit by 11 ha. The algorithm does not look around for a polygon that fits the budget exactly but accepts the slight over achievement. The magnitude of over achievement would be no different if it was for a budget of 100 ha or 10,000 ha and in fact this area is negligible when taken as a percentage of total LU area (see Table 7-8).

7.1.3 Total OGMA area summary after LU/BEC with hardwired OGMA and THLB Exclusion relocation

After relocation of 233 ha, total OGMA area is the sum of post-relocation OGMA area, hardwired OGMA area and existing accepted OGMA area (with stand rank 15 and above). Of the accepted OGMA area, 364 ha are hardwired. This is a total area of 1,082 ha as shown in Table 7-5.

Table 7-5 Total OGMA area after LU/BEC hardwired relocation

OGMA Summary	THLB ha
Relocated OGMA	234
Hardwired OGMA with stand rank <15	373
Acceptable OGMA (>= 15 rank)	475
Total	1,082

Table 7-6 through Table 7-10 compare the total OGMA area pre and post relocation by ageclass, BEC, LU, current operability line and caribou operability line. THLB area by ageclass is very constant.

Table 7-6 Total OGMA area pre and post LU/BEC Hardwire relocation by Ageclass

	Relocated OGMAs with LU/BEC control and Hardwiring		Existing OGMAs	
Ageclass	**THLB (ha)**	**Productive (ha)**	**THLB (ha)**	**Productive (ha)**
0	0	0	0	0

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1	0	0	0	0
2	0	0	0	0
3	0	0	0	0
4	0	0	0	0
5	0	0	0	0
6	2	4	0	0
7	0	0	0	0
8	528	880	529	1,773
9	551	794	552	1,238

THLB area in each BEC, is relatively constant. ICHwk1 area decreased by 20 ha but was partly countered by an increase in ICHvk1 of 15 ha as shown in Table 7-7.

Table 7-7 Total OGMA area pre and post LU/BEC Hardwire relocation by BEC

	Relocated OGMAs with LU/BEC control and Hardwiring		Existing OGMAs	
BEC	**THLB (ha)**	**Productive (ha)**	**THLB (ha)**	**Productive (ha)**
ESSFvc	351	756	346	1,534
ESSFwc2	0	0	0	63
ICHvk1	716	891	701	1,340
IChwk1	15	31	35	74

LU R17 increased by13 ha THLB and R5 decreased by 12 ha. These fluctuations are small when taken as a percentage of total LU area (Table 7-8).

Table 7-8 Total OGMA area pre and post LU/BEC Hardwire relocation by LU

	Relocated OGMAs with LU/BEC control and Hardwiring		Existing OGMAs	
LU	**THLB (ha)**	**Productive (ha)**	**THLB (ha)**	**Productive (ha)**
R17	736	1,255	723	1,508
R5	346	423	358	1,503

All OGMA THLB area is operable by definition, and productive area above the operability line is far less post relocation (Table 7-9). This is reflective of the fact that there is a relatively smaller amount of productive non-THLB area in the hardwired OGMAs.

Table 7-9 Total OGMA area pre & post LU/BEC Hardwire relocation- Current Op. Line

Current Operability	**Relocated OGMAs with LU/BEC control and Hardwiring**		**Existing OGMAs**	
	THLB (ha)	**Productive (ha)**	**THLB (ha)**	**Productive (ha)**
Inoperable	0	327	0	1,627
Operable	1,082	1,351	1,081	1,384

Table 7-10 Total OGMA area pre and post LU/BEC Hardwire relocation- Caribou Op. Line

Caribou Operability Line	**Relocated OGMAs with LU/BEC control and Hardwiring**		**Existing OGMAs**	
	THLB (ha)	**Productive (ha)**	**THLB (ha)**	**Productive (ha)**
Inoperable	102	444	131	476

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Operable	974	1,215	975	1,220

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8.0 RELOCATION OF OGMAS INTO UPDATED CARIBOU ZONES

Caribou linework has been updated and incorporated into the resultant database. In order to minimize the timber supply impact of the new caribou areas, OGMAs on the THLB and not within the updated caribou zones are to be moved into the caribou areas.

The total area of OGMAs on the THLB and not within the updated caribou zones is listed below.

Table 8-1 OGMA Requiring Relocation

LU	BEC	PHA	NHA
r17	ESSFvc	235	234
r17	ESSFvv	10	9
r17	ESSFwc2	22	22
r17	ICHvk1	104	98
r17	ICHwk1	3	3
r5	ESSFvc	58	54
r5	ICHvk1	239	230
r5	ICHwk1	120	120
	Total	**790**	**769**

A further 769 ha of THLB has been identified outside the caribou zone and needs to be moved off the THLB. OGMAs have been summarized by landscape unit and biogeoclimatic zone (BEC), in order to maintain the OGMA targets identified by the RHLP.

A map of the caribou zones has been created and reviewed with LP staff resulting in a few areas to focus on for OGMA redeployment.

In order to redeploy ogmas into the caribou zones we needed to determine how much area was available under the new caribou zones that were suitable for OGMAs. In other words, we needed to determine the potential area for OGMA relocation. The table below summarizes areas this area.

Table 8-2 Potential OGMA Area

LU	BEC	ACLS	PHA	NHA
r17	ESSFvc	9	217	137
r17	ICHvk1	9	1,558	1,356
r17	ICHwk1	9	0	0
r17	ESSFvc	8	1,994	1,849
r17	ESSFvcp	8	1	0
r17	ESSFvv	8	1	0
r17	ESSFwc2	8	7	7
r17	ICHvk1	8	1,416	1,309
r17	ICHwk1	8	14	8
r17	ESSFvc	7	64	62
r17	ESSFvv	7	53	50
r17	ESSFwc2	7	21	20
r17	ICHvk1	7	16	15
r5	ESSFvc	9	16	14
r5	ICHvk1	9	106	98
r5	ICHwk1	9	18	17
r5	ESSFvc	8	148	137

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r5	ICHvk1	8	173	148
r5	ICHwk1	8	50	43
r5	ESSFvc	7	5	5
r5	ICHvk1	7	0	0

8.1 CARIBOU LINEWORK RESULTS

The objective for the OGMAs using the updated caribou linework was to move OGMAs in the timber harvestable landbase to areas designated as caribou habitat. The table below highlights the results.

Table 8-3 OGMAs Beneath Caribou Linework

LU	BEC	caribou	Operability	Gross		Productive		Net	
				Original	Updated	Original	Updated	Original	Updated
r17	ESSFvc	caribou	A	259	330	247	330	234	319
r17	ESSFvc	increment	A	101	10	101	10	97	10
r17	ESSFvc	caribou	L	0	0	0	0	0	0
r17	ESSFvc		A	-	24	-	12	-	-
r17	ESSFvc		I	107	107	107	107	-	-
r17	ESSFvc	caribou	I	265	265	265	265	-	-
r17	ESSFwc	increment	A	38	88	38	88	37	87
r17	ESSFwc		A	10	0	10	0	9	-
r17	ESSFwc		I	12	12	12	12	-	-
r17	ESSFwc2	increment	A	22	43	22	43	22	42
r17	ESSFwc2		A	18	1	18	1	17	-
r17	ESSFwc2		I	63	63	63	63	-	-
r17	ICHvk1	caribou	A	588	687	588	687	537	631
r17	ICHvk1	caribou	I	115	124	106	124	98	0
r17	ICHvk1		A	124	11	124	2	0	0
r17	ICHvk1		I	43	43	38	38	-	-
r17	ICHwk1	caribou	A	4	9	4	9	3	9
r17	ICHwk1		A	1	2	1	1	0	-
r5	ESSFvc	caribou	A	66	123	66	123	57	110
r5	ESSFvc		A	68	10	67	9	54	-
r5	ESSFvc		L	0	-	0	-	0	-
r5	ESSFvc		I	902	902	895	895	-	-
r5	ESSFvc		M	26	26	26	26	-	-
r5	ESSFvc	caribou	I	10	10	10	10	-	-
r5	ESSFvcp		I	78	78	78	78	-	-
r5	ESSFvcp	caribou	I	15	15	15	15	-	-
r5	ICHvk1	caribou	A	327	430	326	430	230	406
r5	ICHvk1		A	167	88	167	88	159	-
r5	ICHvk1			0	-	-	-	-	-
r5	ICHvk1		I	273	273	265	265	-	-
r5	ICHvk1		M	14	14	13	13	-	-
r5	ICHvk1	caribou	I	0	0	0	0	-	-
r5	ICHvk1	caribou	M	6	6	6	6	-	-
r5	ICHwk1	caribou	A	139	76	139	76	120	71
r5	ICHwk1		A	12	19	12	19	10	-

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r5	ICHwk1		I	12	12	12	12	-	-
r5	ICHwk1		M	0	0	0	0	-	-
r5	ICHwk1	caribou	M	1	1	1	1	-	-
			Total	**3,887**	**3,902**	**3,845**	**3,860**	**1,684**	**1,685**

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Appendix E

Operability Report

TFL 55

2005 Operability Report

Prepared by: Louisiana-Pacific Canada, Forest Resource Division

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4	**Age Class by Volume**

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3	**Final 2005 Operability**

Operability Report

1.0 Purpose

The purpose of the operability mapping is to define the gross operable timber landbase for TFL 55 to:

- Redefine operability based on criteria that reflects the short term to mid-term operability potential of the productive landbase.
- Provide a operable landbase to be used in the timber supply analysis for management plan 4.

As part of TFL 55 timber supply analysis, a re-assessment of the existing (1999) operability line was conducted this summer. The objective was to accurately define the gross operable landbase for the TFL.

2.0 Operability Classes

The operability classes have been classified as either Operable conventional or Inoperable.

Operable conventional reflects the area and terrain LP currently considers operable. Harvest methods include ground based or cable (grapple or tower) systems. No helicopter or long line systems were included in this classification.

Inoperable areas are areas that have or can grow merchantable size timber but due to low volumes, species composition, or inaccessibility are not currently economical to log using the above noted conventional harvest systems.

3.0 Methodology

The methodology for preparing the operability classification included the approach set out below:

1 – The first step in this process began using a GIS process to identify suitable timber types near the operability line. These polygons were overlaid with the ortho photo's and potential areas were highlighted.

2. – A helicopter overview flight of the highlighted areas was conducted to further refine or reject the possible areas.

3 – The helicopter-adjusted areas were overlain again on ortho-photos and transferred to air-photos for interpretation.

4 – An experienced local layout/engineering consultant was retain to field verify the areas. The decision to reject or retain the polygon was based upon;

- Access potential
- Species composition
- Harvest system (ground-based, grapple and highlead cable)

An operable area was defined as an area that can produce a merchantable stand of timber that is physically accessible at a feasible cost. Hemlock leading stands as well as area requiring a helicopter logging systems were rejected. A summary report was produced for each unit.

Summary

The new operability line is illustrated in Map 3, 2005 Operability Map at 1: 275,000 scale. Hardcopy maps at 1:75,000 are also available.

The following tables summarize the results of the operable area additions to TFL 55.

Table 1 Area Summary of 2005 Additional Operable Hectares

	(ha)
1. Total identified by helicopter	2796
2. Field verified	1779
3. Area above 1999 operability line existing field layout or CP	257
4. Total additional area to THLB (2 + 3)	**2036**

Table 2 Landbase Summary

Landbase Classification	MP 3 Area	MP4 Area	Difference
Total Landbase	**92,700**	**92,744**	**44**
Ownership	-	38	38
Total TFL	**92,700**	**92,706**	6
Non-productive, Non-forest	47,300	36,801	(10,499)
Roads	858	802	(56)
Productive Landbase	**44,542**	**55,103**	**10,561**
Non-commercial	5	-	(5)
Alpine Tundra	40	-	(40)
Inoperable	22,551	30,244	8,326
Operable Landbase	**21,946**	**24,859**	**2,913**
Terrain	551	698	147
Riparian Reserves	433	810	387
Low Site	121	127	6
Deciduous	164	85	(79)
Non-merchantable	508	421	(87)
NSR	555	87	(468)
Wildlife Tree Patches	386	290	(96)
Timber Harvesting Landbase	**19,228**	**22,341**	**3,113**

* The Timber Harvest Landbase has increased by 3113ha, which includes new operability mapping, changes in timber inventory classification (VRI) and updated net downs.

Table 3- Age class by Volume Distribution of 2005 additional Operable Hectares

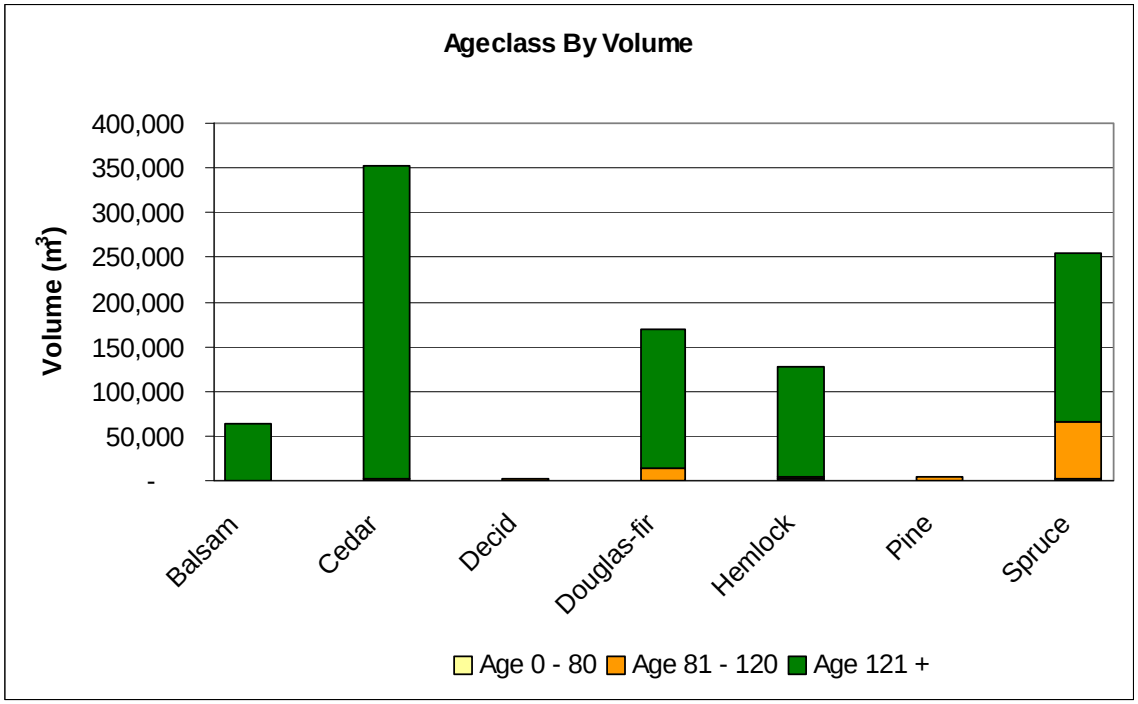
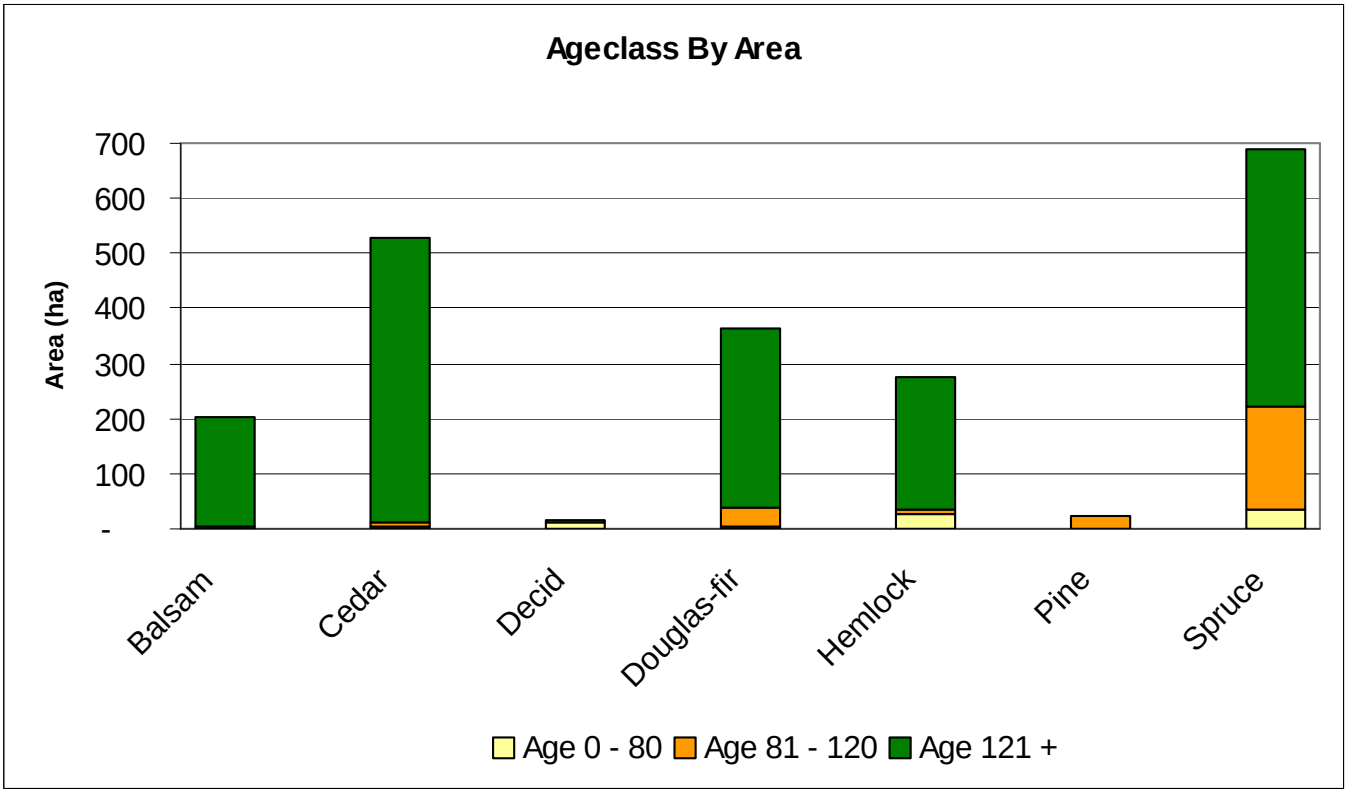
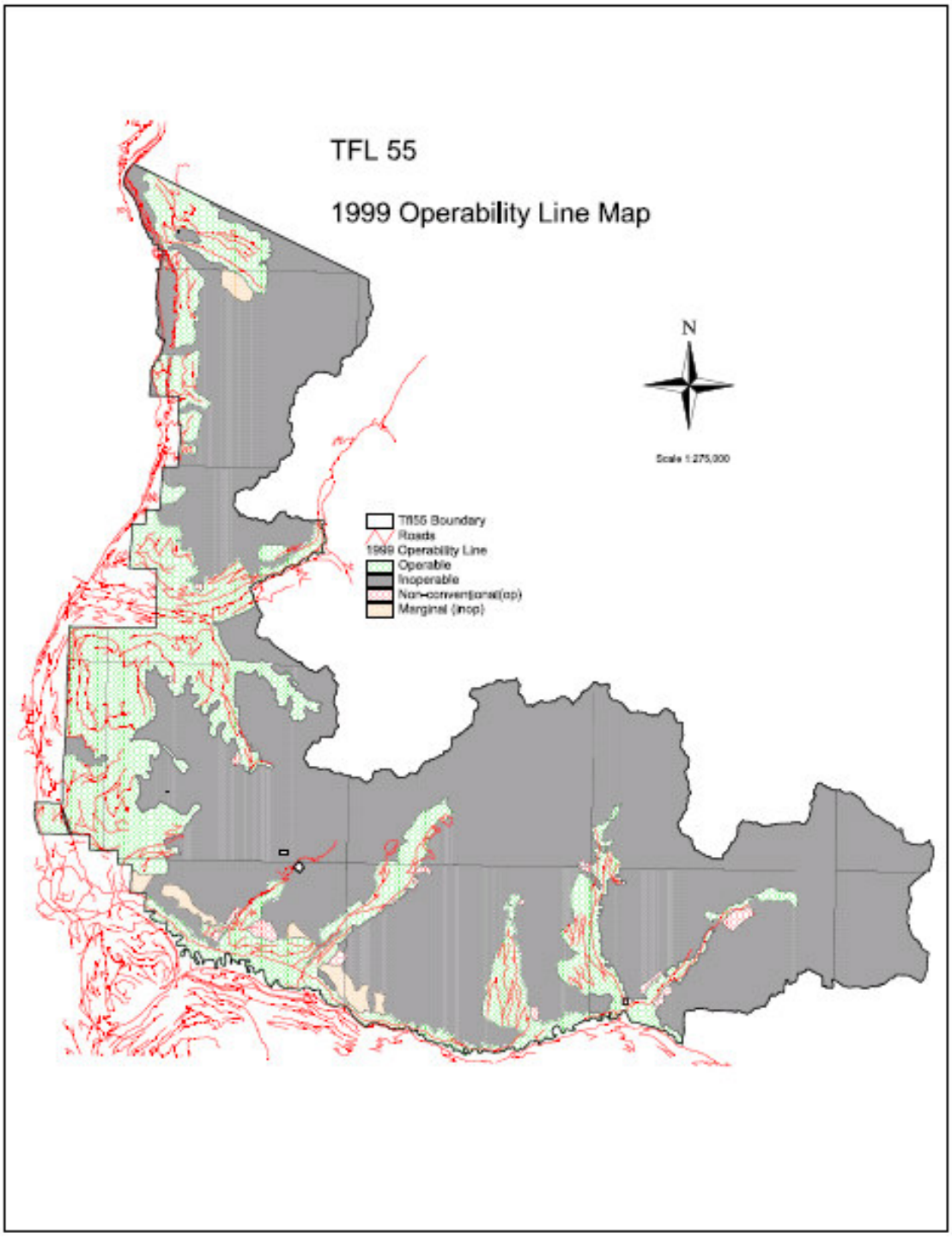
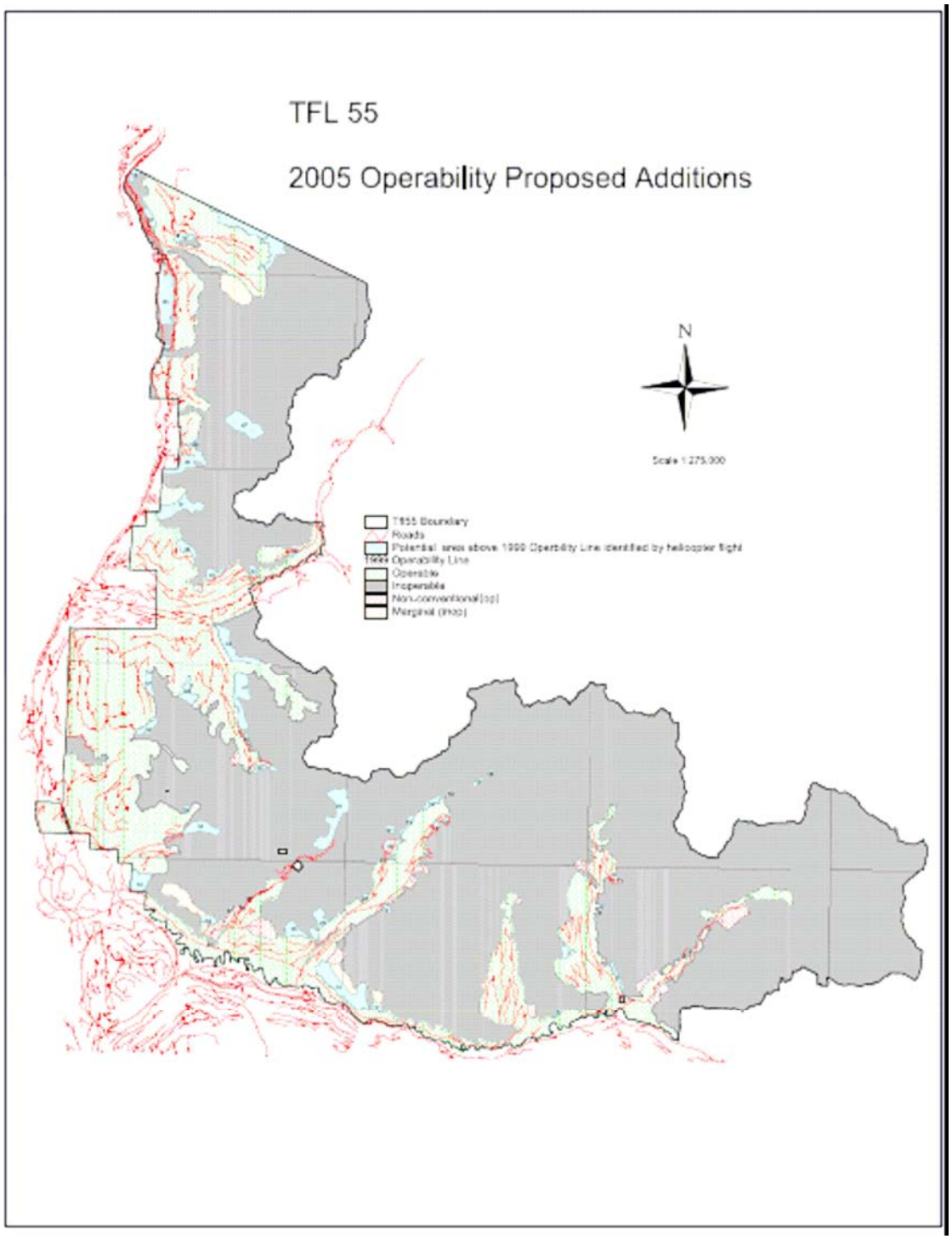
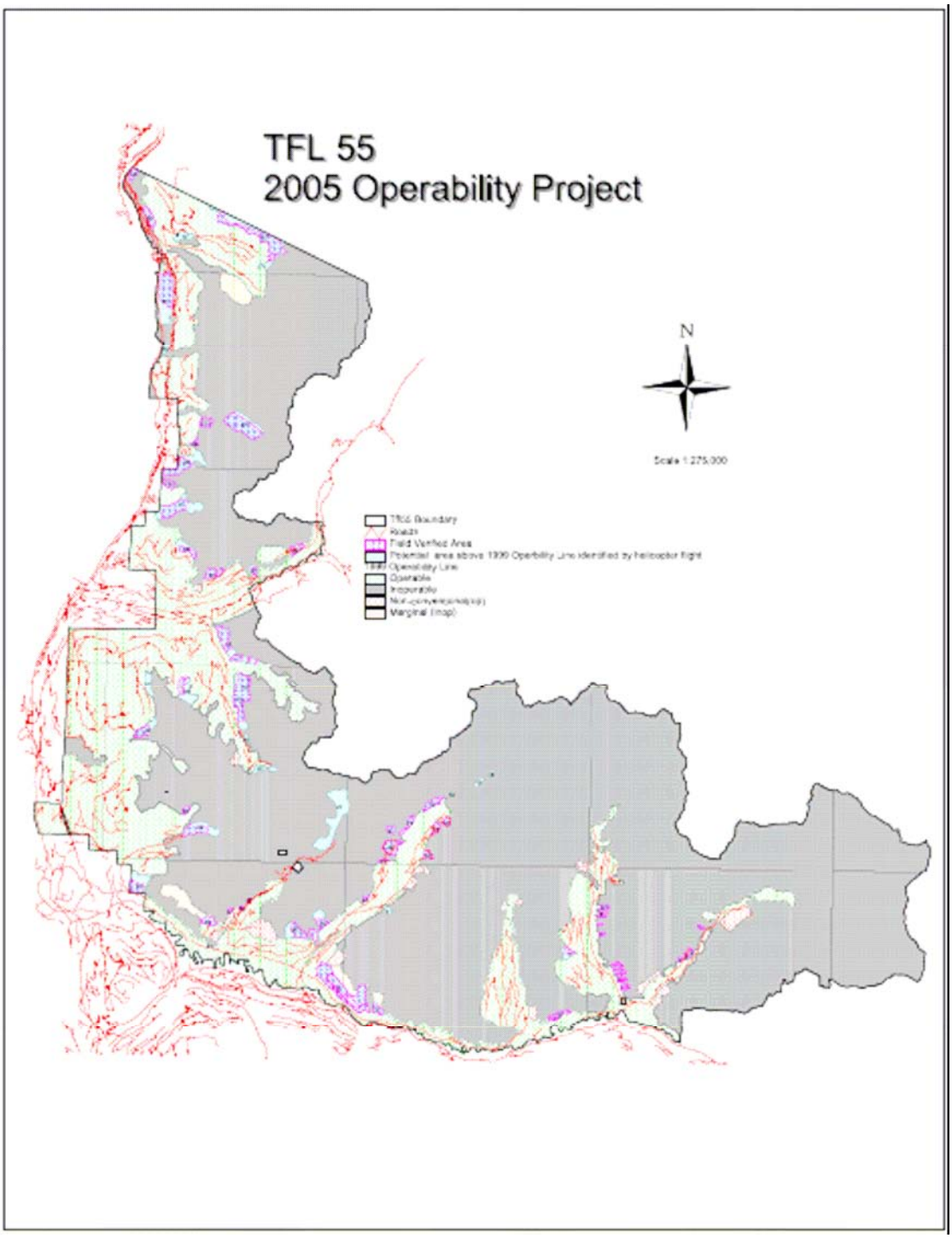


Table 4 – Age class by Area Distribution of 2005 additional Operable Hectares




TFL 55
1999 Operability Line Map
N
Scale 1:275,000
TFL55 Boundary
Roads
1999 Operability Line
Operable
Inoperable
Non-conventional(op)
Marginal (inop)


TFL 55
2005 Operability Proposed Additions
N
Scale 1:275,000
TFL Boundary
Roads
Potential area above 1000 Operability Line identified by helicopter flight
Operability Line
Operable
Inoperable
Non-conventional (op)
Marginal (inop)


TFL 55
2005 Operability Project
N
Scale 1:275,000

Appendix F

Road Buffer Report

TFL55
ROAD BUFFER WIDTHS FOR TSR

TIMBERLINE NATURAL RESOURCE GROUP

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

August 2008

Timberline
Natural Resource Group

The information contained herein is the property of Timberline Forest Natural Resource Group and is intended solely for the purpose of evaluating this proposal.

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1.0 INTRODUCTION

In the TFL 55 AAC Rationale released March of 2008 the Deputy Chief Forester stated:

> I therefore make the following requests, to be completed before the next determination:
>
> - *Roads, trails, and landings*: I ask the licensee to develop a better approach for estimating losses of productive area due to construction of future roads, trails, and landings so that this factor can be more fully accounted for in the next determination;

In Response to this request Timberline Natural Resource Group Ltd. (Timberline) has carried out a road survey program to better estimate the losses of productive area due to existing and future roads. The first step was to carry out road surveys to find an appropriate road buffer width for each road class (TSR used 17m). The next step was apply the road buffer to roads within recent harvest blocks to find the average 'roaded' area, which can be applied to for the future road reduction.

2.0 BACKGROUND

TFL 55 is located in the south-eastern corner of British Columbia and is in the Revelstoke TSA. It is part of the Columbia Forest District and is administered from the LP Malakwa Division. The total area of TFL 55 is approximately 92,706 hectares, of which approximately 40% is non-productive/non-forested. Figure 2.1 provides an overview map of the Revelstoke TSA showing TFL 55(Timberline 2005).

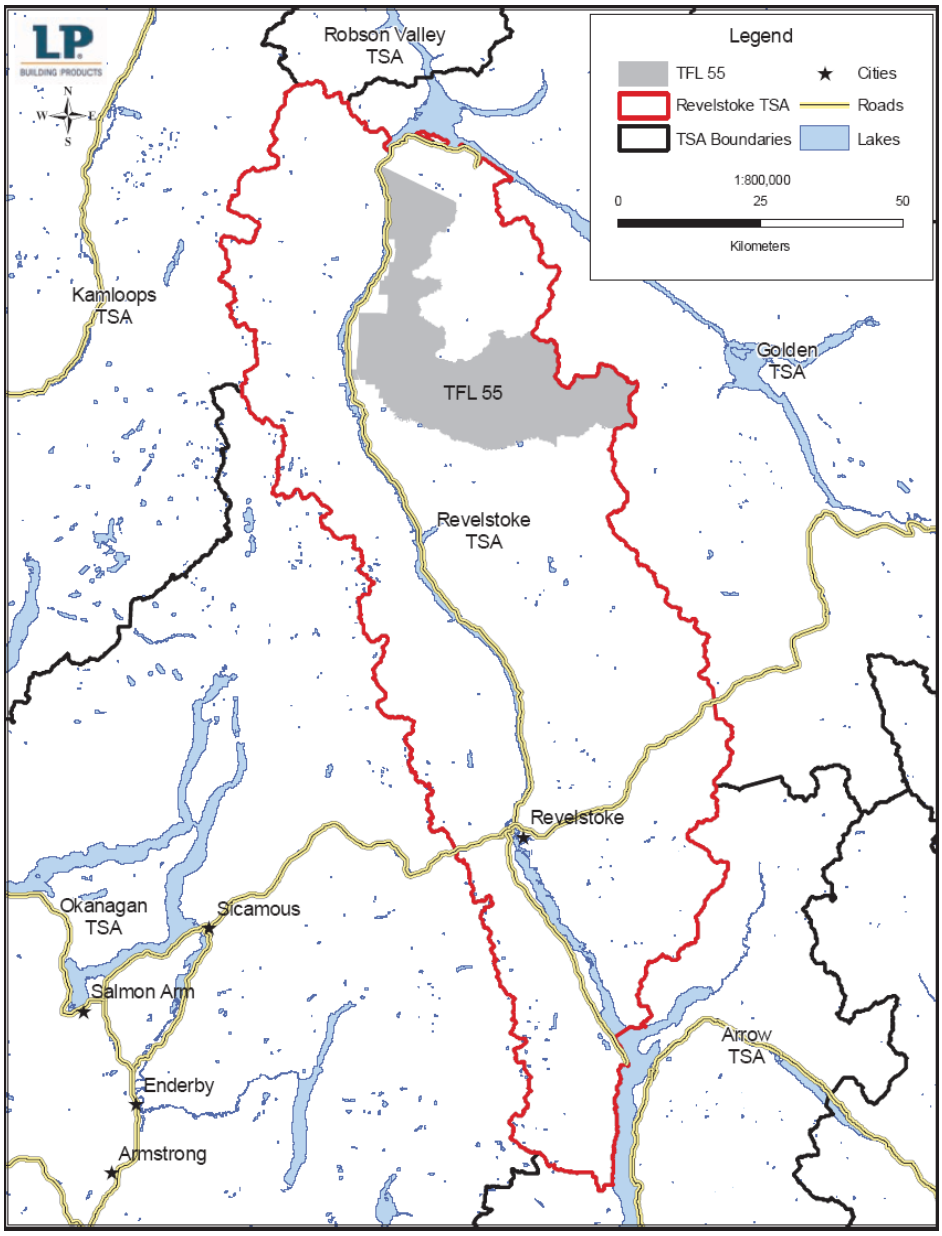


Figure 2.1 Revelstoke TSA and TFL 55

2.1 Roads, Trails and Landings in TSR

For use in TSR existing roads were identified by Louisiana Pacific and buffered 8.5 meters either side giving a total of 17 meters. This buffer distance was used to be consistent with the Revelstoke TSR. In total 802 hectares of roads were identified and removed from the productive landbase as shown in Table 2.1 (Timberline 2005).

Table 2.1 Roads, trails, and landings

Description	Gross (ha)	Productive (ha)	Area Removed (ha)
Existing Roads	910	0	802

Future roads were accounted for by applying a 6 % reduction to the THLB

3.0 METHODOLOGY

The first step of the project is to fond an appropriate road buffer width. The road buffers will be applied to all the forestry roads within TFL 55. The forestry roads have been stratified by LP staff to indicate which roads are primary and secondary forestry road (See Figure 3.1).

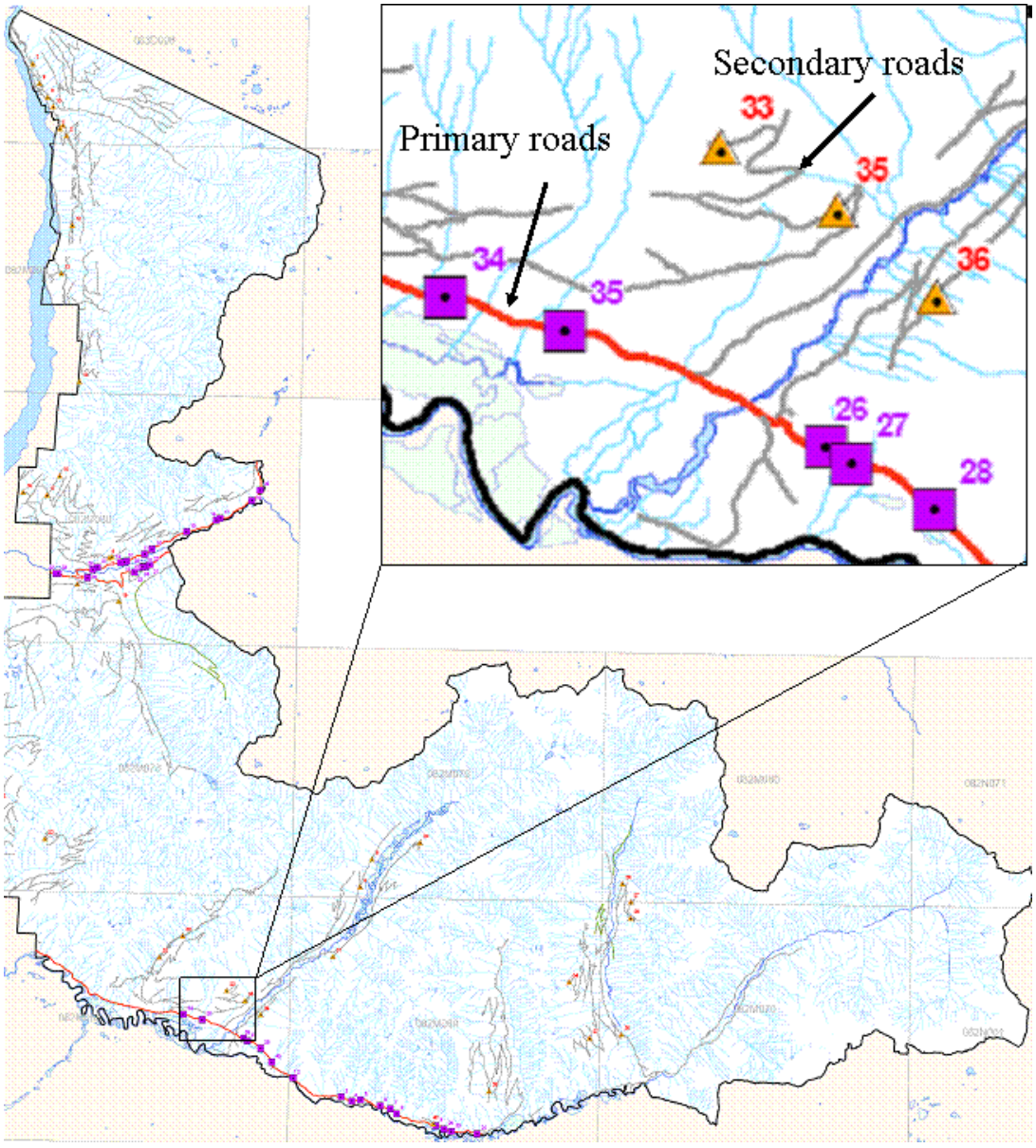


Figure 3.1 TFL 55 Roads – Primary and secondary forestry roads

3.1 Sample Selection

The plot samples were randomly selected using probability proportional to length with replacement. The process used for this was:

1. A shapefile with the latest roads was provided by the client. This shapefile was converted to a ArcInfo coverage.
2. Areas known to be inaccessible were identified and not included in the sampling. These roads were all secondary and will be buffered with the secondary buffer width, which was considered appropriate by LP personnel who are familiar with the inaccessible roads.
3. Highway 23 runs through portions of TFL55 and these sections were not used in GIS analysis and field measurements portions of this project. The highways are already removed from the landbase so are not considered in this project.
4. Primary and secondary roads used in the sampling were identified, attributed and put into a new shapefile for use in the analysis.
5. Road segments and their length were exported into excel. A cumulative sum of the road length was created. Random numbers were selected between 0 and the maximum road length to find random segments to be sampled. Forty plots were selected for both the primary and secondary roads. Table 3.1 shows the process used for randomly selecting the road segments.

Table 3.1 Random selection of road segments

LENGTH	MAJOR_ROAD	RD_STATUS	CUMULITIVE SUM	TOTAL POINTS	RANDOM_NO	RANDOM
488.22070312500	1	Major	488		1,701	
1340.28381348000	2	Major	1,829	1	3,675	yes x 1
124.00336456300	3	Major	1,953		4,826	
4325.78564453000	4	Major	6,278	4	5,089	yes x 4

6. The location of the plots were randomly selected using the '*create random points'* command is used in ArcGIS. These point files are then combined to create final shapefiles for the minor and major random sample points. The xy coordinates for UTM zone 11 are added which are used for field navigation purposes.

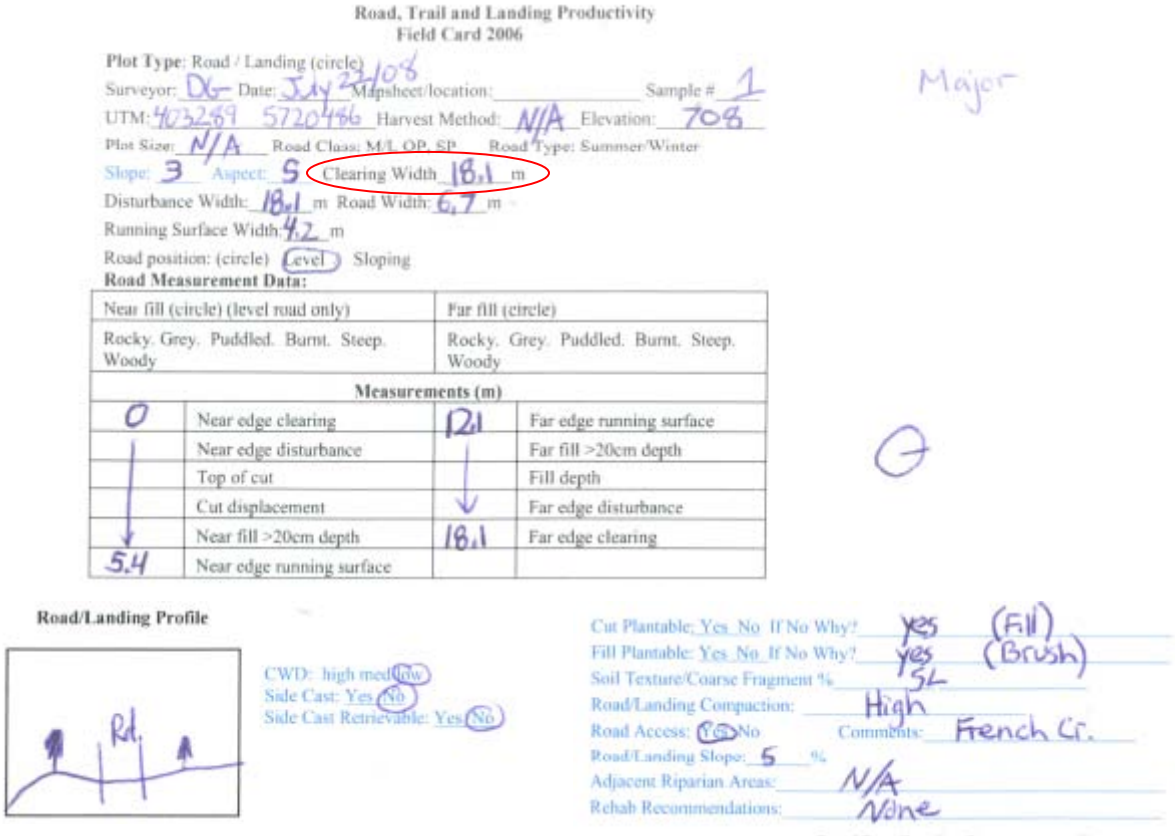
3.2 Road survey procedures

The field program was carried out in July 2008. Garmin GPS units were used to navigate and locate the specific sample site locations for the field measurements. The minor roads were mainly accessed by quad due to ease of travel, and the major roads were accessed by truck. Sample sites were marked in the field by hanging orange ribbon with the sample site#, date, and organization.

Road measurements were taken with a loggers tape and slope corrected using a Suunto clinometer. Measurements were taken from the near edge clearing to the far edge clearing.

Figure 3.2 shows a sample of the field card and data collected at each plot. The field card contains many of the key and important pieces of information needed to complete this project. Additional

notes were recorded on information such as cut plantable, compaction, slope, and rehab recommendations. This information may be used in the future if required. For the purpose of this project the key component is the clearing width.



Road, Trail and Landing Productivity
Field Card 2006

Plot Type: Road / Landing (circle)
Surveyor: DG Date: July 23/08 Mapsheet/location: _____ Sample # 1
UTM: 403259 5720486 Harvest Method: N/A Elevation: 708
Plot Size: N/A Road Class: M/L OP SP Road Type: Summer/Winter
Slope: 3 Aspect: S Clearing Width 18.1 m
Disturbance Width: 18.1 m Road Width: 6.7 m
Running Surface Width: 4.2 m
Road position: (circle) Level Sloping
Road Measurement Data:

Near fill (circle) (level road only)		Far fill (circle)	
Rocky. Grey. Puddled. Burnt. Steep. Woody		Rocky. Grey. Puddled. Burnt. Steep. Woody	
Measurements (m)			
0	Near edge clearing	12.1	Far edge running surface
	Near edge disturbance		Far fill >20cm depth
	Top of cut		Fill depth
	Cut displacement		Far edge disturbance
	Near fill >20cm depth	18.1	Far edge clearing
5.4	Near edge running surface		

Road/Landing Profile

CWD: high med low
Side Cast: Yes No
Side Cast Retrievable: Yes No

Cut Plantable: Yes No If No Why? yes (Fill)
Fill Plantable: Yes No If No Why? yes (Brush)
Soil Texture/Coarse Fragment %: SL
Road/Landing Compaction: High
Road Access: Yes No Comments: French Cr.
Road/Landing Slope: 5 %
Adjacent Riparian Areas: N/A
Rehab Recommendations: None

Major

Figure 3.2 Sample field card

Figure 3.3 shows photos of a primary and secondary road sample.

Figure 3.3 Picture of sample plots (left – sample # 4 secondary; right sample #34 primary)

Many secondary plots were dropped for the following reasons:

- Located on an proposed road
- Inaccessible Road
- Located within a power line right of way
- Budget and time constraints

4.0 RESULTS

4.1 Field Results

The road buffer widths were placed into an excel table and averaged to compare the result to the previous buffer widths. The average for secondary roads is 17.0m and is based on 18 field sample sites. The other 22 sites were dropped. The average for primary roads is 20.1m and is based on 40 field sample sites.

Table 4.1 Average road width for primary and secondary roads

Secondary Roads	Width	Primary Roads	Width
1	19.9	1	18.1
2	14.1	2	17.2
3	20.6	3	20.7
4	17.5	4	23.1
5	----------	5	20.1
6	----------	6	18.8
7	----------	7	23.2
8	----------	8	25.7
9	----------	9	27.0
10	----------	10	19.2
11	----------	11	14.5
12	----------	12	12.4
13	20.3	13	14.7
14	----------	14	17.2
15	18.6	15	15.2
16	----------	16	27.3
17	20.5	17	24.6
18	11.7	18	16.5
19	----------	19	31.7
20	16.2	20	21.3
21	18.6	21	14.8
22	----------	22	27.2
23	----------	23	14.4
24	18.6	24	12.5
25	----------	25	18.4
26	15.3	26	24.3
27	----------	27	23.5
28	----------	28	25.8
29	----------	29	17.9
30	12.6	30	12.6
31	13.5	31	11.0
32	18.4	32	14.5
33	----------	33	16.7
34	----------	34	21.0
35	15.2	35	26.8
36	15.4	36	22.1
37	----------	37	18.5
38	----------	38	35.0
39	19.0	39	13.6
40	----------	40	24.3
Average Width	**17.0**	**Average Width**	**20.1**

4.2 Future Roads

In TSR a 6% road reduction has been applied to stands on their first rotation. This future road reduction is in addition to the area that is net out of the THLB through applying the road buffers. Table 4.2 shows the road reduction in sample cutblocks, which are also shown in the image Figure 4.1. The reduction percentages needed for future road reductions only include the area not already roaded, which is considerably lower then the % removed shown in Table 4.2.

Table 4.2 Road Area in sample Cutblocks – Picture 1

Picture	FID	CP Block	Area (ha)	Road Area (ha)	Percent Removed
1	130	784-2A	50	7.1	14.2%
1	134	784-9	30	3.9	13.0%
1	132	784-3A	35	3.9	11.1%

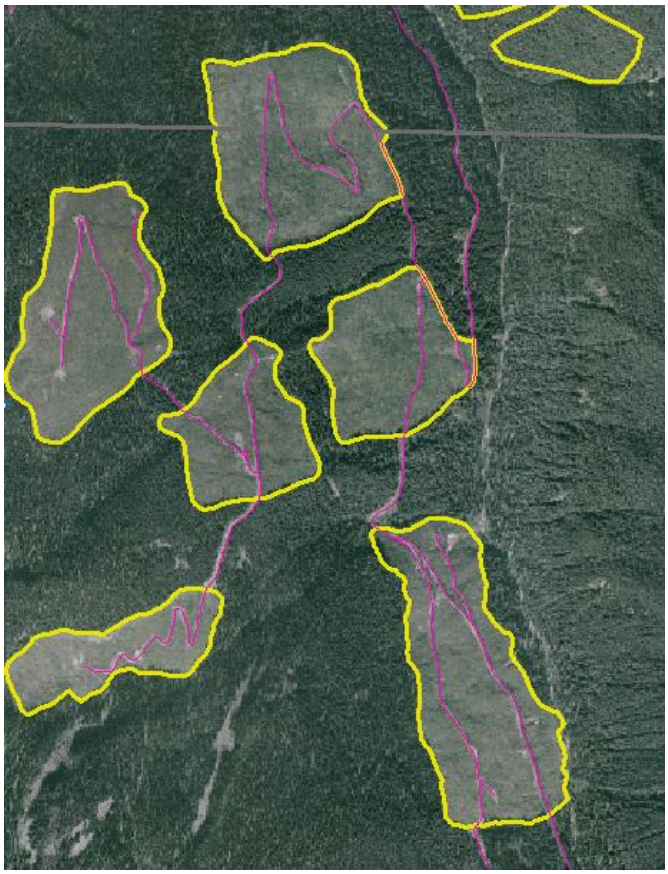


Figure 4.1 Picture of roads in sample cutblocks shown in Table 4.1

Table 4.3 shows more sample cutblocks, which are also shown in the pictures in Figure 4.2.

Table 4.3 Road Area in Sample cutblocks – Picture 2

Picture	FID	CP Block	Area (ha)	Road Area (ha)	Percent Removed
2	142	779-26	29	3.4	11.7%
2	140	779-30	27	1.6	5.9%

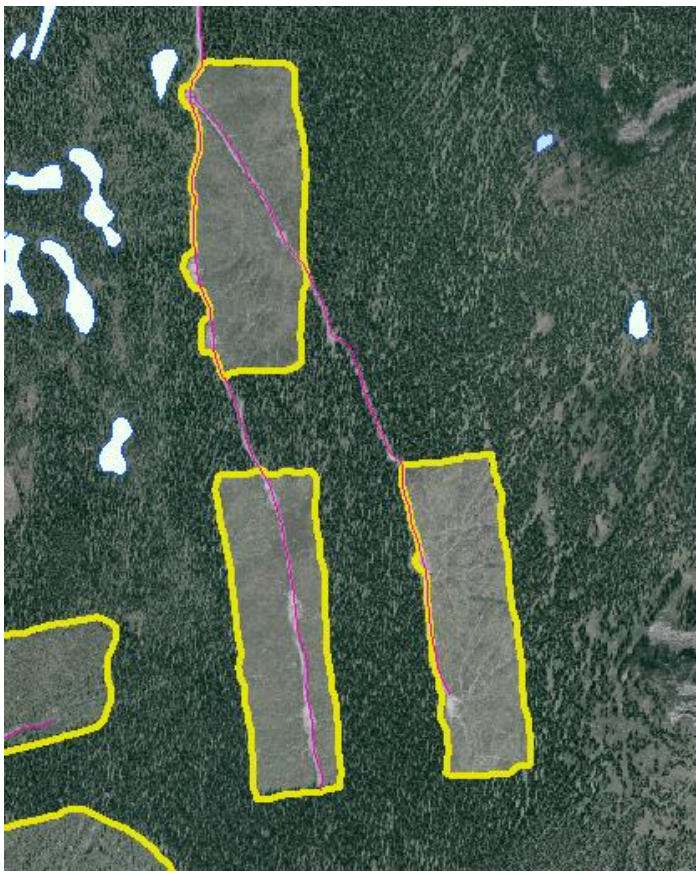


Figure 4.2 Picture of roads in sample cutblocks shown in Table 4.3

Table 4.4 Roaded are in sample cutblocks – Picture 3

Picture	FID	CP Block	Area (ha)	Road Area (ha)	Percent Removed
3	12	816-14A	54	5.8	10.7%

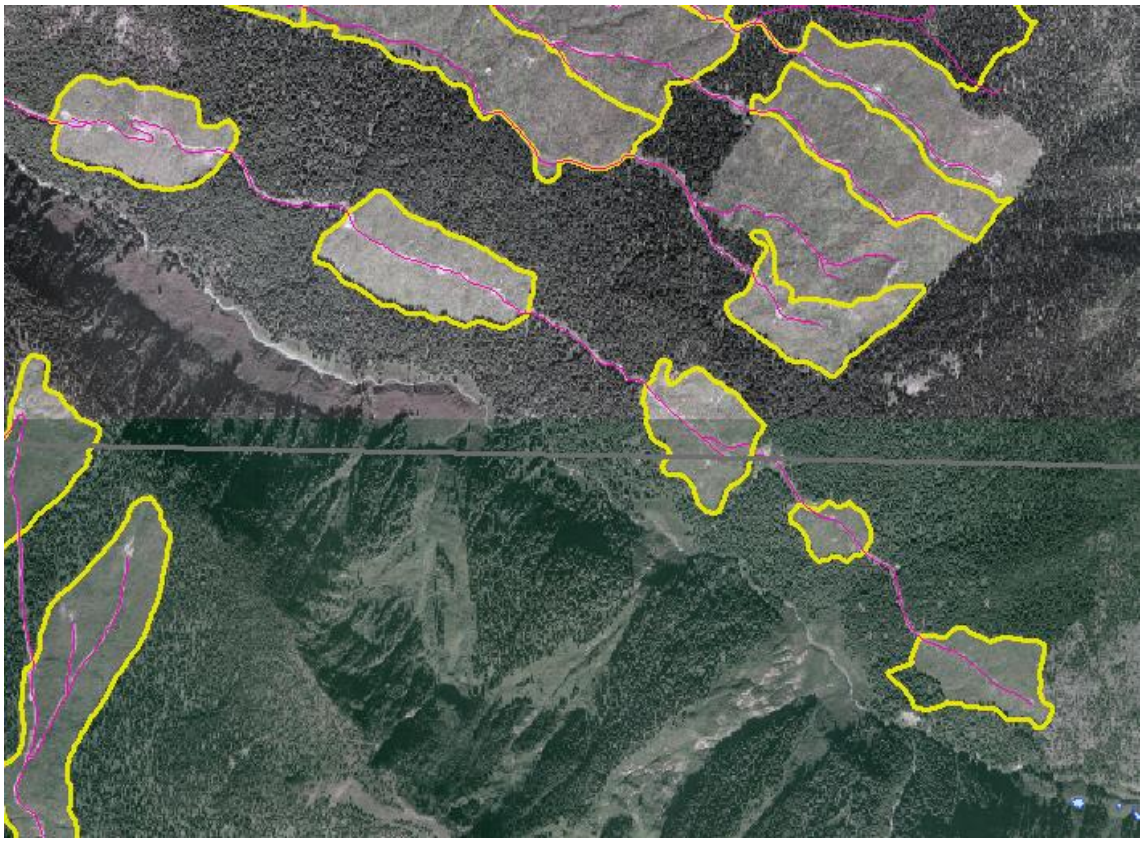


Figure 4.3 Picture of roads in sample cutblocks -

The average area weighted reduction is 11%. This reduction should only be applied in areas where there are currently no roads. In areas where the roads already exist the reduction should be minimal. For example the areas between the cutblocks shown in Figure 4.3, would require no further netdown in addition to the road reduction already applied through the netdown of the existing road coverage.

In future TSR it is recommended that a future road reduction of 11% is removed from THLB area that is currently not roaded. This is an increase in reduction percent however it would be applied to considerably less area.

4.3 Review TFL55 Roads

It is recommended that all of the roads in TFL55 be reviewed and reclassified, with a focus on the secondary roads. During the field measurements portion many secondary roads were found to not built, inaccessible, not driveable, or overgrown. The reclassification of the roads would be important for future projects, such as determining the correct timber harvest land base for future GIS analysis. The checks could be done by air photo interpretation, site visits, or aerial reconnaissance.

Additionally there are some landings found that could be rehabilitated and put back to productive land base. Also there are roadside areas that would benefit from planting. There are notes on the field cards indicating if planting could take place.

Appendix C

Approved Public Review Strategy
and
Consultation Summary documents

TFL 55 Management Plan #5

Proposed Referral and Public Review Strategy

Louisiana-Pacific Canada Ltd. (LP) is required to complete a new Management Plan (MP#5) and timber supply analysis (TSA) which includes an updated Information Package (IP) on Tree Farm Licence (TFL) 55 for the Forest Analysis and Inventory Branch (FAIB) of the Ministry of Forests, Lands, and Natural Resources Operations (MFLNRO). The last timber supply review (TSR) was completed in 2006 and the AAC determination made in 2007. The current Management Plan (MP4) was submitted in 2005 and expires on March 8, 2017. The TFL Management Plan Regulation, section 6 outlines the requirements for public review and comment and requires that a strategy be submitted one year before the date of the MP is submitted to the chief forester.

General Notes and Timelines

All documents and maps will be available for download from the LP Building Products website. Printed documents and maps will also be made available by mail or pick up at the LP office in Malakwa, BC or by email as preferred or requested.

Following approval of the Public Review Strategy, a draft timber supply analysis information package (IP) will be made available for review and comment. Appropriate changes will be made if required before the final IP submitted to FAIB for acceptance. Then a draft MP which includes the TSA and accepted IP will be made available for review and comment. Appropriate changes will be made if required and the final MP will be submitted to the Chief Forester for acceptance.

Table 1 presents the chronological order of steps in the proposed Referral and Public Review Strategy.

Table 1 Timelines

Step	Action	Approximate Date(s)
1	LP submits the review strategy to Regional Executive Director (RED) for approval	Early September 2015
2	RED approves strategy	September 2015
3	LP submits, refers and advertises for review a draft Information Package (IP)	Early November 2015
4	Review period (60 days) takes place	Nov 2015-Jan 2016
5	LP considers any comments received and submits a final IP	Early February 2016
6	IP accepted by FAIB	Late February 2016
7	LP submits, refers and advertises for review a draft Management Plan (MP) including the timber supply analysis	Early March 2016
8	Review period (60 days) takes place	March –May 2016
9	LP considers any comments received and submits a final Management Plan	Early September 2016
10	Chief Forester approves the Management Plan and determines the AAC	March 2017

Newspaper Ad

Advertisements will be placed in the Revelstoke Review, Sicamous Eagle Valley News and the Salmon Arm Observer newspapers for a period of 2 consecutive weeks in early November 2015 for the draft IP. The ads will indicate that the draft IP will be available for a period of 60 days for review and comment and will note the public viewing locations as well as other provisions to access copies of the information. The advertisement is shown below:

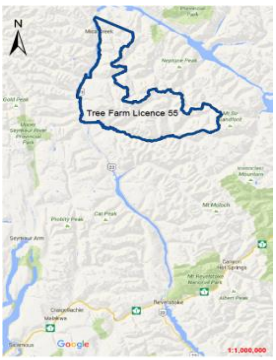
Ad for Draft IP

TREE FARM LICENCE 55

Draft Information Package

Management Plan #5

Notice is hereby given under section 6 (1) of the *Tree Farm Licence Management Plan Regulation*, that Louisiana-Pacific Canada Ltd. (LP) is seeking public review and comment on the draft Information Package (IP) relating to Management Plan #5 (MP5) for Tree Farm Licence 55 (TFL55).



TFL 55, held by LP, and covers roughly 92,000 hectares of crown forest land, and is located approximately between Revelstoke and Mica Creek on the east side of the Revelstoke reservoir in the Selkirk Mountains

The IP describes the information used to support the timber supply analysis (TSA). The TSA provides information to assist the Chief Forester of BC in determining the Allowable Annual Cut on TFL 55.

All interested parties are invited to view and comment on the draft Information Package for MP#5 from month/day/year through to month/day/year. All documents and maps will be available for download by visiting the LP Building Products website http://lpcorp.com/sustainability/sustainable-forestry/XXX. Printed documents and maps will also be made available by mail or pick up at the LP office in Malakwa, BC or by email as preferred or requested. Viewing appointments can be arranged by calling the LP office at 250-836-3100 Comments will be accepted in writing until 4:00 pm month/day/year

For further information please contact:

Brenda Dyck, RFT
250-836-5203
brenda.dyck@LPCorp.com
Louisiana-Pacific Canada Ltd, 4872 Lybarger Rd, Malakwa, B.C. V0E 2J0

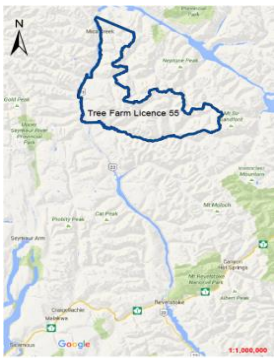
Advertisements will again be placed in the Revelstoke Review, Sicamous Eagle Valley News and the Salmon Arm Observer newspapers for a period of 2 consecutive weeks in early March 2016 for the draft MP. The ads will indicate that the draft MP will be available for a period of 60 days for review and comment and will note the public viewing locations as well as other provisions to access copies of the information. The advertisement is shown as below:

Ad for Draft MP#5

TREE FARM LICENCE 55

Draft Management Plan #5

Notice is hereby given under section 6 (1) of the *Tree Farm Licence Management Plan Regulation*, that Louisiana-Pacific Canada Ltd. (LP) is seeking public review and comment on the draft Management Plan #5 (MP5) for Tree Farm Licence 55 (TFL55).



TFL 55, held by LP, covers roughly 92,000 hectares of crown forest land, and is located approximately between Revelstoke and Mica Creek on the east side of the Revelstoke reservoir in the Selkirk Mountains.

The Management Plan provides a general description and a brief history of the TFL along with a list of publicly available planning documents that guide LP's operations on the TFL and an accepted timber supply analysis (TSA) of the TFL. The results of the timber supply analysis (TSA) provides information to assist the Chief Forester of BC in determining the Allowable Annual Cut on TFL 55.

All interested parties are invited to view and comment on the draft MP#5 from month/day/year through to month/day/year. All documents and maps will be available for download by visiting the LP Building Products website http://lpcorp.com/sustainability/sustainable-forestry/XXX. Printed documents and maps will also be made available by mail or pick up at the LP office in Malakwa, BC or by email as preferred or requested. Viewing appointments can be arranged by calling the LP office at 250-836-3100 Comments will be accepted in writing until 4:00 pm month/day/year

For further information please contact:
Brenda Dyck, RFT
250-836-5203
brenda.dyck@LPCorp.com
Louisiana-Pacific Canada Ltd, 4872 Lybarger Rd, Malakwa, B.C. V0E 2J0

First Nations Referrals

Notification email letters will be sent to all First Nations listed in Table 1 for both the draft Information Package and for the draft Management Plan #5. The emails and/or letters will indicate that the draft IP/MP#5 will be available for a period of 60 days for review and comment and will note the public viewing locations as well as other provisions to access copies of the draft IP/draft MP#5. The First Nations will be invited to meet and review the draft IP/MP#5 if desired. An email reminder will be sent approximately 3 weeks prior to the end of each 60 day period if no response has been received.

Table 1

Stakeholder Name	Stakeholder Group	Contact
Adams Lake Indian Band	First Nations	Steve Murphy
Akisqnuk First Nation	First Nations	Adrian Bergles
Ktunaxa First Nation	First Nations	Jessie Nicholas
Little Shuswap Indian Band	First Nations	Stewart Adamson
Lower Similkameen Indian Band	First Nations	Wendy Hawks
Neskonlith Indian Band	First Nations	Naomi August
Okanagan Indian Band	First Nations	Collen Marchand
Okanagan Nation Alliance	First Nations	tbd
Penticton Indian Band	First Nations	James Pepper
Shuswap Indian Band	First Nations	tbd
Simpcw First Nation	First Nations	Carli Pierrot
Splatsin First Nation	First Nations	Jack Andrews
Upper Nicola Indian Band	First Nations	Christine Saddleman

Other Stakeholders

Notification emails/letters will be sent to all stakeholders listed in Table 2 for both the draft Information Package and for the draft Management Plan #5. The emails and/or letters will indicate that the draft IP/MP#5 will be available for a period of 60 days for review and comment and will note the public viewing locations as well as other provisions to access copies of the draft management plan.

Table 2

Stakeholder Name	Stakeholder Group	Contact
Columbia Shuswap Regional District	Regional Government	
Environment Canada	Federal Government	
Ministry of Transportation	Provincial Government	
Ministry of Agriculture and Lands-Integrated Land Management Bureau	Provincial Government	
City of Revelstoke	Local Government	
Revelstoke Snowmobile Club	Community Group	
Revelstoke Rod and Gun Club	Community Group	
Canadian Mountain Holidays	Tenure Holder	
Monashee Outfitters	Guide-Outfitter	
Ministry of Environment	Provincial Government	
Beaumont Timber Company Ltd.	Private Landholder	
BC Timber Sales	Licencee	
Bethlehem Resources Inc.	Mining Company	
Graham Edwards	Trap Licence #TR0439T005	
Wade Rota	Trap Licence #TR0438T005	
Bob Bennison	Trap Licence #TR0438T006	
Philip Brown	Trap Licence #TR0438T007	
BC Hydro	Crown Corporation	
North Columbia Environmental Society	Non Profit Society	
Revelstoke Caribou Rearing in the Wild Society	Non Profit Society	

A copy of the First Nations and other Stakeholder Notification letter for the draft IP is shown below:

Louisiana-Pacific Canada Ltd.
4872 Lybarger Road
Malakwa, B.C. V0E 2J0

November XX, 2015

Stakeholder
Address

Attention: contact

Re: Draft Information Package for Management Plan #5 for TFL 55 Available for Review and Comment

Dear XXX;

Louisiana-Pacific Canada Ltd has made the Draft Information Package (IP) for Management Plan #5 (MP#5) for TFL 55 Available for review and comment. The IP describes the information used to support the timber supply analysis (TSA). The TSA provides information to assist the Chief Forester of BC in determining the Allowable Annual Cut on TFL 55.

TFL 55, held by LP, covers roughly 92,000 hectares of crown forest land, and is located approximately between Revelstoke and Mica Creek on the east side of the Revelstoke reservoir in the Selkirk Mountains.

You are invited to view and comment on the draft IP for MP#5 from month/day/year through to month/day/year. All documents and maps will be available for download by visiting the LP Building Products website http://lpcorp.com/sustainability/sustainable-forestry/XXX. Printed documents and maps will also be made available by mail, email, or pick up at the LP office in Malakwa, BC as preferred or requested. Meetings can be arranged by calling the LP office at 250-836-3100

All comments must be received in writing by the above noted date in order to be considered in the draft IP. Please address your comments to Brenda Dyck, RFT, at the address noted above, by fax 1-250-836-3215 or via email, Brenda.Dyck@LPCorp.com

Sincerely,

Brenda Dyck, RFT
250-836-5203

A copy of the First Nations and other Stakeholder Notification letter for the draft MP#5 is shown below:

Louisiana-Pacific Canada Ltd.
4872 Lybarger Road
Malakwa, B.C. V0E 2J0

March XX, 2016

Stakeholder
Address

Attention: contact

Re: Draft Management Plan #5 for TFL 55 Available for Review and Comment

Dear XXX;

Louisiana-Pacific Canada Ltd has made the Management Plan #5 for TFL 55 Available for review and comment. The Management Plan provides a general description and a brief history of the TFL along with a list of publically available planning documents that guide LP's operations on the TFL and an accepted timber supply analysis (TSA) of the TFL. The results of the TSA provides information to assist the Chief Forester of BC in determining the Allowable Annual Cut on TFL 55.

TFL 55, held by LP, covers roughly 92,000 hectares of crown forest land, and is located approximately between Revelstoke and Mica Creek on the east side of the Revelstoke reservoir in the Selkirk Mountains.

You are invited to view and comment on the draft MP#5 from month/day/year through to month/day/year. All documents and maps will be available for download by visiting the LP Building Products website http://lpcorp.com/sustainability/sustainable-forestry/XXX. Printed documents and maps will also be made available by mail, email, or pick up at the LP office in Malakwa, BC as preferred or requested. Meetings can be arranged by calling the LP office at 250-836-3100

All comments must be received in writing by the above noted date in order to be considered in the draft MP#5. Please address your comments to Brenda Dyck, RFT, at the address noted above, by fax 1-250-836-3215 or via email, Brenda.Dyck@LPCorp.com

Sincerely,

Brenda Dyck, RFT
250-836-5203

Agencies

Email notices will be sent to the agency contacts listed below in Table 3 requesting their preferred method of receiving the both the draft IP and draft MP#5 and other pertinent documents.

Table 3

Agency		Contact
FAIB - Victoria	Sr. Analyst TFLs	Bud Koch
FAIB - Kamloops	Timber Supply Forester	Jeff Stone
FLNR-Region	Regional Tenures Forester	Peter Lewis
FLNR-District	Advisor, First Nations	Ian Wiles

Public Review Summary and Communications

LP will reply in writing to each party who provided written comment on MP#5.

The final MP submission to FAIB will include a copy of the approved Referral and Public Review Strategy and a Public Review Summary which details the comments received, the name and organization, date and type of communication, follow up and actions taken to accommodate, and any outstanding concerns.

Following step 4 and step 8 in Table 1, the Public Review Summary and copies of all correspondence sent or received by LP in review of MP#5 including all First Nations letters will be provided to the appropriate agencies in Table 3.

BRITISH COLUMBIA

File: 19710-30/TFL55

October 2, 2015

Fernando Cocciolo, RPF
Manager
Louisiana-Pacific Canada Ltd.
4872 Lybarger Road
Malakwa, British Columbia
V0E 2J0

Dear Fernando Cocciolo:

Thank you for your submission on September 14, 2015 and update on of a Public Review Strategy for Management Plan No. 5 of Tree Farm Licence 55.

As required by Section 6(2) of the *Tree Farm Licence Management Plan Regulation*, I hereby approve your Public Review Strategy for Management Plan No. 5 of Tree Farm Licence 55.

Please be advised that the public review process, including information sharing with First Nations, is subject to the terms and conditions outlined in Part 3 of the *Personal Information Protection Act*.

Yours truly,

Paul Rasmussen
Regional Executive Director
Kootenay Boundary Region

pc: Garth Wiggill, District Manager, Selkirk Natural Resource District
Bud Koch, Senior Timber Supply Analyst – TFLs, Forest Analysis and Inventory Branch

Ministry of Forests, Lands and Natural Resource Operations **Kootenay Boundary Region**
Mailing Address:
1902 Theatre Rd
Cranbrook, BC V1C 7G1
Tel: (250) 426-1766
Fax: (250) 426-1767
Website: www.gov.bc.ca/for/

Consultation Summary
TFL 55 Draft Management Plan #5

August 24 2016 to October 24, 2016

Stakeholder Name	Stakeholder Group	LP Consultation Date	Consultation Type	Stakeholder reply date	Stakeholder response	LP follow up date	LP Follow up comments
Revelstoke Rod and Gun Club	Community Group	August 22, 2016	letter				
Revelstoke Snowmobile Club	Community Group	August 22, 2016	letter				
North Columbia Environmental Society	Community Group	August 22, 2016	email letter				
Revelstoke Caribou Rearing in the Wild Society	Community Group	August 22, 2016	letter				
Adams Lake Indian Band	First Nations	August 22, 2016	email letter				
Ktunaxa First Nation	First Nations	August 22, 2016	email letter				
Little Shuswap Indian Band	First Nations	August 22, 2016	email letter				
Lower Similkameen Indian Band	First Nations	August 22, 2016	email letter				
Neskonlith Indian Band	First Nations	August 22, 2016	email letter				
Okanagan Indian Band	First Nations	August 22, 2016	email letter				
Okanagan Nation Alliance	First Nations	August 22, 2016	email letter				
Penticton Indian Band	First Nations	August 22, 2016	email letter				
Shuswap Indian Band	First Nations	August 22, 2016	email letter	August 29,2016	Reviewed briefly, but do not have the capacity to provide technical review or comments		
Simpcw First Nation	First Nations	September 21, 2016	email letter	September 22,2016	Will review and respond by October 24th.		
Splatsin First Nation	First Nations	August 22, 2016	email letter				
Upper Nicola Indian Band	First Nations	August 22, 2016	email letter				
City of Revelstoke	Government -local	August 22, 2016	letter				
Fisheries and Oceans Canada	Government-federal	August 22, 2016	letter				
Ministry of Environment	Government-provincial	August 22, 2016	letter				
Ministry of Transportation	Government-provincial	August 22, 2016	letter				
Minister of Energy & Mines	Government-provincial	August 22, 2016	email letter	October 28, 2016	no concerns but be aware of mining activitives in the area	October 31, 2016	LP acknowledges working with govt and various mining companies
Columbia Shuswap Regional District	Government-regional	August 22, 2016	email letter				
Monashee Outfitters	Guide-Outfitter	August 22, 2016	letter				
Canadian Mountain Holidays	Licence holder	August 22, 2016	email letter				
BC Timber Sales	Licence holder	August 22, 2016	email letter	October 24, 2016	email stating they have no concerns		
Downie Timber	Licence holder-nearby	August 22, 2016	letter				
Revelstoke Community Forest Corporation	Licence holder-nearby	August 22, 2016	email letter				
Bethlehem Resources Inc.-Moe Markstrom	Mining company	August 29, 2016	email letter				
Environment Canada	Parks	August 22, 2016	letter				
Beaumont Timber Company Ltd.	Private Landholder	August 22, 2016	email letter				
BC Hydro	Provincial Corporation	August 19, 2016					
Wade Rota	Trap Licence #TR0438T005	August 22, 2016	letter				
Bob Bennison	Trap Licence #TR0438T006	August 22, 2016	letter				
Philip Brown	Trap Licence #TR0438T007	August 22, 2016	letter				
Graham Edwards	Trap Licence #TR0439T005	August 22, 2016	letter				
Worksafe BC	WCB	August 22, 2016	letter				

Appendix D

Employment Estimates

As of November 2016

Category	Permanent	Contractor/Consultants
Construction, Log hauling	1	30
Forest Management	2	4
Silviculture	1	10
Golden LVL plant	50	
(324 hourly +salaried employees)		
Total	54	44

Comments:

Estimate of TFL 55 employment attributed to Golden LVL plant is based on the AAC's of 3 LP licences (TFL 55. FL A19669, FL A17645) that supply the facility

Appendix E

Map of non-crown lands within TFL 55 boundary

TREE FARM LICENCE 55

92,572 Ha.+/-

Inset 1
Scale: 1:10,000

follow height of land of unnamed creek to watershed boundary of Louis Lee Creek

N 5748492
E 399719

to height of land at UTM coordinate

unnamed creek at outlet of unnamed lake

N 5748285
E 399835

follow south shore of unnamed lake to UTM coordinate

follow unnamed creek to unnamed lake

Inset 2
Scale: 1:10,000

Mica Creek

DL 16412

DL 16406

DL 16391

Rk A

DL 16405

follow cadastre to natural boundary of Revelstoke Lake

N 5768136 m+/-
E 391145 m+/-

DL 3961

follow natural boundary of Revelstoke Lake to 2nd most northerly boundary of Lot 16405

previous TFL deletion for reflector site

DL 16405

Inset 2

to UTM coordinate at natural boundary of Revelstoke Lake

N 5761607 m+/-
E 404432 m+/-

follow natural boundary of Revelstoke Lake to UTM coordinate

due east to the easterly limit of Highway 23 right of way

follow easterly limit of Highway 23 right of way to UTM coordinate

N 5758191 m

due west to the natural boundary of Revelstoke Lake

N 5756664 m
E 392317 m

follow natural boundary of Revelstoke Lake to UTM coordinate

N 5755010 m

N 5754983 m
E 393725 m

to north boundary Sec.7, TP 6 at UTM coordinate

N 5753375 m
E 393698 m

follow height of land for Mica Creek watershed boundary to UTM coordinate

follow height of land for Louis Lee Creek watershed boundary to Mica Creek watershed boundary

Inset 1

follow unnamed creek to unnamed lake

N 5748015 m
E 401903 m

follow watershed boundary of unnamed creek to height of land for Louis Lee Creek watershed boundary

follow righbank Louis Lee Creek to confluence of unnamed creek at UTM coordinate

cross Bigmouth Creek perpendicular to channel, then follow right bank to confluence with Louis Lee Creek

follow unnamed creek to confluence with leftbank of Bigmouth Creek

to origin of unnamed creek

N 5742655 m
E 398467 m
height of land

follow height of land - unnamed creek watershed to UTM coordinate

follow cadastral boundaries to Point of Commencement

follow height of land - Argonaut Creek watershed to watershed boundary of unnamed creek

follow height of land - Bigmouth Creek watershed to Argonaut Creek watershed boundary

follow height of land - Goldstream River watershed to Bigmouth Creek watershed boundary

follow height of land - Stitt Creek watershed to Goldstream River watershed boundary

follow height of land - Stitt Creek watershed

previous TFL deletion for radio site

previous TFL deletion for transmission right of way

previous TFL deletion DL 2662 mineral claim

previous TFL deletion DL 2669 mineral claim

POINT OF COMMENCEMENT
NE corner Sec.24, Tp.2, Kootenay LD

follow east boundary of Sec.24, Tp.2 to UTM coordinate on right bank of Goldstream River

N 5725847 m+/-

follow right bank of Goldstream River to confluence of unnamed creek at offset survey

previous TFL deletion DL 16941

N 5720311 m +/-
E 422580 m +/-
height of land - referenced from DL 16941 as per original TFL description

N 5720200 m+/-
E 422361 m+/-

to UTM coordinate at height of land

follow unnamed creek to offset survey

follow GPS traverse of A65972 1 - offset 5m from unnamed creek, by Azimuth Forestry and Mapping, Nov. 2008. Mutual agreement between TFL 55 & TFL 56 licencees on file with Forest Tenures Branch, Victoria.

confluence of right bank Goldstream River and GPS traverse of A65972 1 - offset 5m from unnamed creek.

DL 16941

DL 16941

TREE FARM LICENCE

TIMBER SUPPLY AREA

POINT OF COMMENCEMENT:

The Northeast corneof Section 24, Township 2, Kootenay Land District; then counterclockwise

Boundary locations described on this map are based on TFL 56 metes & bounds descriptions and subsequent adjustments and updates.

Boundary linework is tied to the best available digital base information (TRIM or fresh water atlas) and the best available survey information (Tantalis or Integrated Cadastral Fabric) from the BC Geographic Warehouse or from independent surveys.

If there are any discrepancies between the map and the original ground location of these boundaries, the ground location shall take precedence.

Excluding all foreshore and land covered by water, surveyed right of ways, private lands, parks and protected areas within the described area.

LOCATION MAP

Revelstoke TSA

Golden TSA

CUMMINS RIVER PROTECTED AREA

CUMMINS LAKES PARK

GOOSEGRASS CREEK ECOLOGICAL RESERVE

KEY MAP

Scale = 1:2,000,000

Alberta

Prince George District

Thompson Rivers District

Selkirk District

Okanagan Shuswap District

TFL 18

TFL 55

TFL 56

TFL 14

TFL 33

TFL 23

TFL 49

KAMLOOPS

NDERBY

RNSTRONG

VERNON

REVELSTOKE

Golden

Salmon Arm

Sicamous

Enderby

Armstrong

Vernon

Lake Country

Coldstream

Revelstoke

Malakwa

Sicamous

Nakusp

Slocan

Meadow Creek

New Denver

Kaslo

Nelson

Castlegar

Trail

Grand Forks

Christina Lake

Greenwood

Midway

Osoyoos

Oliver

Penticton

Summerland

Peachland

Kelowna

Lake Country

Vernon

Ministry of Forests, Lands and Natural Resource Operations

BRITISH COLUMBIA

Selkirk Tree Farm Licence - 55

Licence Replacement Map

Kilometres

Scale 1 : 55,000 Ratio scale is correct at 34"X 44" (E Size)

FOREST REGION : KOOTENAY / BOUNDARY	FOREST DISTRICT : SELKIRK	LAND DISTRICT : KOOTENAY	LICENSEE : Louisiana-Pacific Canada Limited
BCGS MAPSHEETS : 82N071,081, 83D008 82M098, 088, 078-080, 068-070	AREA : 92,972 HECTARES +/-	UTM ZONE : 11 NAD : 83	DRAWN BY : GeoBC Decision Support Section, MS DATE : May, 2016

N 5713102 m | N 5713003 m

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