Lakes TSA – Type IV Silvicultural Strategy

Working Data Package

Version 2.1

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Project 419-24

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1 Introduction

The BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) have initiated a Type IV Silvicultural Strategy for the Lakes Timber Supply Area (TSA). A timber supply review (TSR) was recently completed and an allowable annual cut (AAC) was determined at 2,000,000 m^3 per year effective July 12, 2011. The Morice and Lakes Innovative Forest Practices Society completed an extensive analysis of a variety of management options between 2007 and 2010, and completed a Silvicultural Type II analysis in 2009. In addition FLNRO recently completed a special timber supply analysis as part of the Mid-term Timber Supply Project. All of these documents were reviewed and summarized in the Lakes Type IV Situational Analysis document. Given the focus of this project, a new data package was created and in addition to generating new information, took advantage of existing information from the TSR4, IFPA and Type II data packages as appropriate.

1.1 Project Objectives

The objectives of this project are to produce:

- A fully rationalized tactical plan to guide the expenditure of public silviculture funds to help improve the mid-term and long-term timber supply of the Lakes TSA;
- Reports with consistent format and content so that the information can be consolidated to regional and provincial levels as well as compared between units;
- Information that can be utilized by industry and government in related decision-making processes; and,
- Silvicultural regimes and associated standards that may be adopted in forest stewardship plans as required standards for basic silviculture operations.

This data package aims to describe the information that is material to the analysis including data inputs and assumptions.

1.2 Context

This document is the second of four documents that make up a type IV Silvicultural Strategy:

- Situational Analysis – describes in general terms the situation for the unit – this could be in the form of a PowerPoint presentation with associated notes or a compendium document.
- Data Package - describes the information that is material to the analysis including the model used, data inputs and assumptions.
- Modeling and Analysis report –provides modeling outputs and rationale for choosing a preferred scenario.
- Silvicultural Strategy –provides treatment options, associated targets, timeframes and benefits.

1.3 Study Area

The Lakes TSA is located in West-central British Columbia (Figure 1), abutting Tweedsmuir Park in the south and containing some of the headwaters for the Skeena and Fraser Rivers.

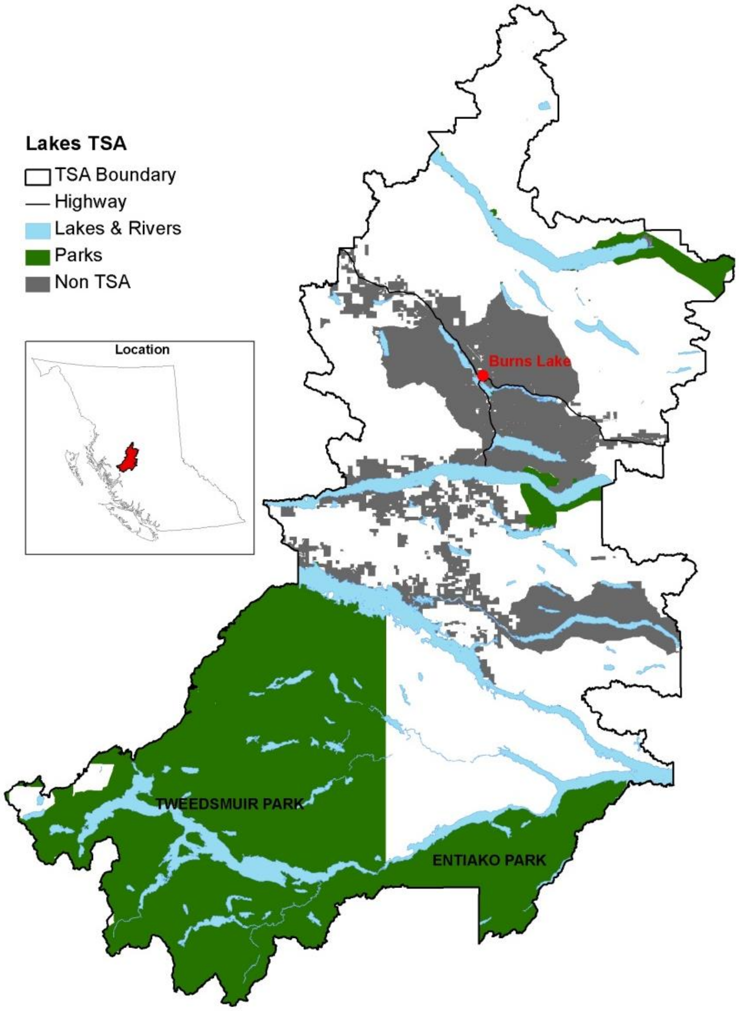

Figure 1 Lakes TSA overview map

The TSA covers approximately 1.58 million hectares (ha). Excluding Tweedsmuir Park, the TSA is reduced to 1.12 million ha where approximately 737,449 ha is considered productive forest.

Areas set aside as other parks, protected areas, Old Growth Management Areas (OGMA), riparian reserve zones, low quality and deciduous leading stands, wildlife tree retention and other areas considered unavailable for timber harvesting account for roughly 204,426 ha. The Timber Harvesting Land Base (THLB) considered for this project is approximately 533,022 ha or 47.5% of the total area in the Lakes TSA (excluding Tweedsmuir Park). More information on the land base determination can be found in Section 3.2.

The forest inventory used for this analysis shows there is approximately 40 million cubic metres (m^3) of live volume currently available for harvesting on the land base and approximately 39 million m^3 of dead volume for a total of 79 million m^3. Figure 2 illustrates the distribution of volume by species over the THLB. Pine comprises the majority of the volume on the land base but approximately 80% [1] of this volume is dead.

[1] Derived based on district staff estimates (see section 3.5.7.1)

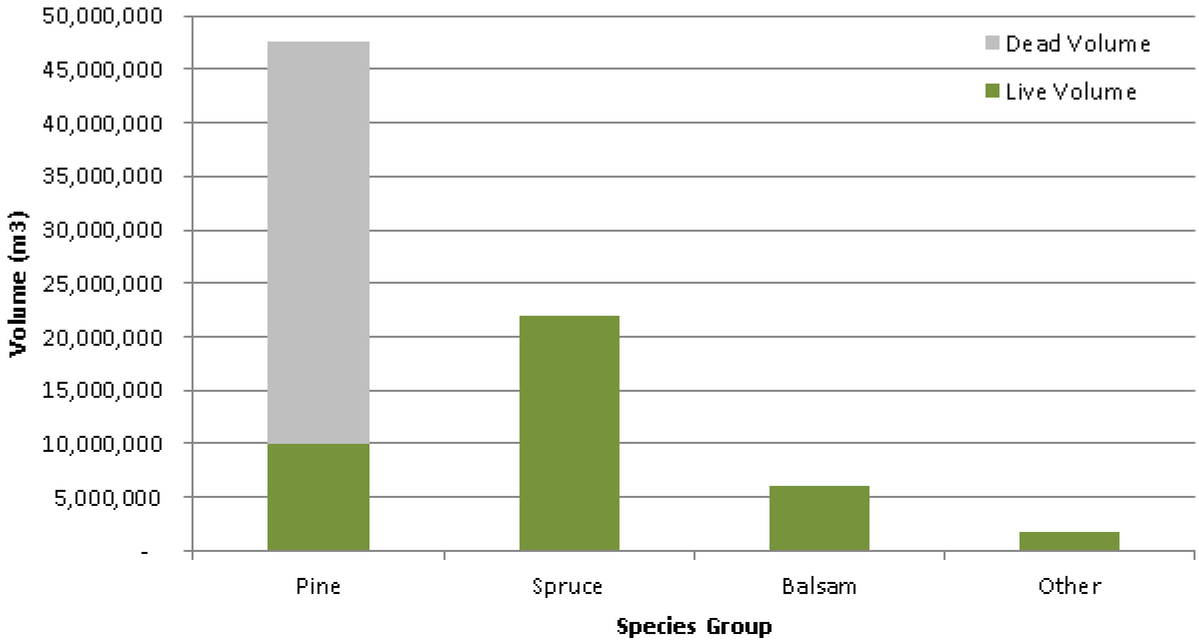

Figure 2 Total growing stock on the timber harvesting land base by species group and condition

Figure 3 illustrates the age class distribution for both the non-harvesting land base (NHLB) and THLB (before aspatial netdowns). Natural stands are mostly older than 40 years, while managed stands are under 40 years. The current age distribution shows a considerable gap in the 40 to 60 year age class – typically important for maintaining mid-term harvest levels. This age class gap likely contributes to the considerable reduction of harvest levels in mid-term, as demonstrated in previous studies.

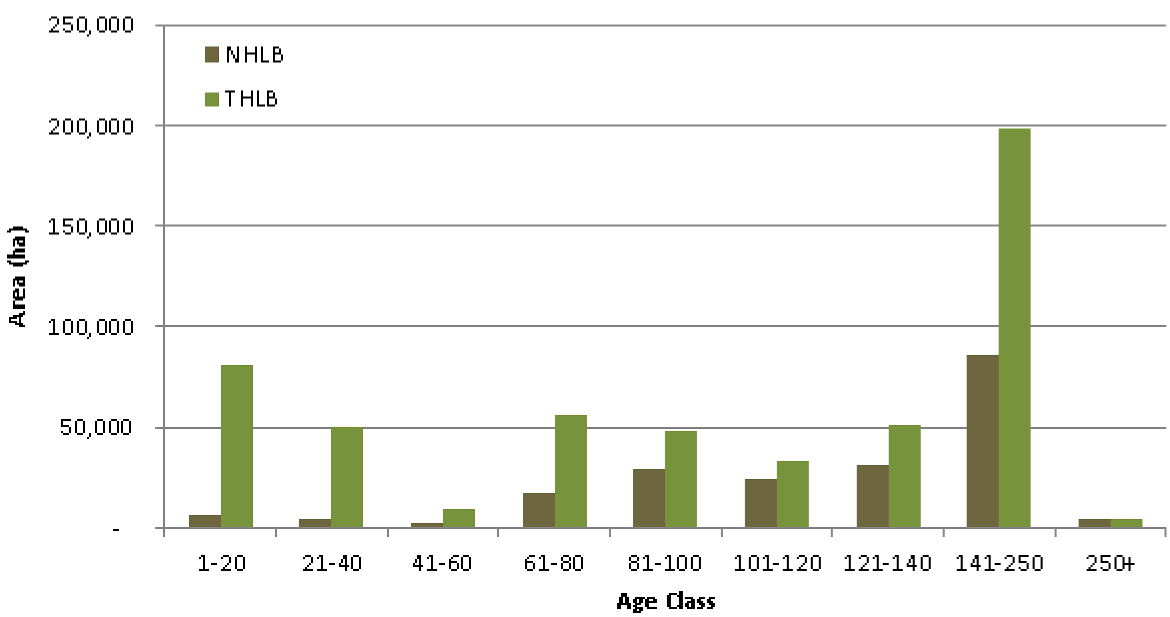

Figure 3 Age class distribution

2 Modelling Approach

2.1 Model

The PATCHWORKS ™ modeling software was used for forecasting and analysis. This suite of tools is sold and maintained by Spatial Planning Systems Inc. of Deep River, Ontario (Tom Moore - www.spatial.ca).

PATCHWORKS ™ is a fully spatial forest estate model that can incorporate real world operational considerations into a strategic planning framework. It utilizes a goal seeking approach and an optimization heuristic to schedule activities across time and space in order to find a solution that best balances the targets/goals defined by the user. Targets can be applied to any aspect of the problem formulation. For example, the solution can be influenced by issues such as mature/old forest retention levels, young seral disturbance levels, patch size distributions, conifer harvest volume, growing stock levels, snag densities, CWD levels, ECAs, specific mill volumes by species, road building/hauling costs, delivered wood costs, net present values, etc. The PATCHWORKS ™ model continually generates alternative solutions until the user decides a stable solution has been found. Solutions with attributes that fall outside of specified ranges (targets) are penalized and the goal seeking algorithm works to minimize these penalties – resulting in a solution that reflects the user objectives and priorities. Patchworks' flexible interactive approach is unique in several respects:

- PATCHWORKS' ™ interface allows for highly interactive analysis of trade-offs between competing sustainability goals;
- PATCHWORKS ™ software integrates operational-scale decision-making within a strategic-analysis environment: realistic spatial harvest allocations can be optimized over long-term planning horizons. Patchworks can simultaneously evaluate forest operations and log transportation problems using a multiple-product to multiple-destination formulation. The model can identify in precise detail how wood flows to mills over a complex set of road construction and transportation alternatives;
- Allocation decisions can be made considering one or many objectives simultaneously and objectives can be weighted for importance relative to each other (softer vs. harder constraints);
- Allocation decisions can include choices between stand treatment types (Clearcut vs. partial cut, fertilization, rehabilitation, etc.);
- Unlimited capacity to represent a problem – only solution times limit model size; and,
- Fully customizable reporting on economic, social, and environmental conditions over time.

Reports are built web-ready to share analysis results easily – even comparisons of multiple indicators across multiple scenarios.

2.2 Data Sources

Much of the data used was also used in the preparation of the most recent TSR. Table 1 describes the data and sources used for this analysis, and contains notes for specific data sources.

Table 1 Spatial data sources

Spatial Data	Source	Feature Name
TSA Boundary	LRDW: FADM_TSA.shp	TSA_bdy_Lakes
Parks and Protected Areas	LRDW:TA_PEP_SVW_polygon.shp	TA_PEP_SVW1
Ownership: Private land	DND: DND_PrivateLand.shp	DND_PRIVATE_LAND_Dis
Ownership: Forest tenure managed licence (woodlots/community forests)	LRDW: FTN_MG_L_P.shp	FTN_MG_L_P_Dis1
Ownership: Indian reservations	LRDW: CLAB_INRES.shp	CLAB_INRES
Lakes Sustainable Management Plan (SLRP)- RMP_LG_PL	LRDW: RMP_LG_PL.shp	LRP_Union
Landscape Units (LU)	LRDW: RMP_LU_SVW.shp	LU
Mineral/Wildlife – resource management zone	LRDW: RMP_NLG_PL.shp	MWM_RMZ
Old Growth Management Areas (OGMA)	LRDW: OGMA_LEG_C.shp	OGMA_LEG_C
Scenic Areas	LRDW: REC_VMS_EV.shp	REC_VMS_EV_clean
Goat habitat	DND: LakesTSA_Goats.shp	LakesTSA_Goat
Mule Deer	DND: lakesTSA_deer.shp	lakesTSA_deer
Moose	DND: lakesTSA_moose.shp	lakesTSA_moose
Takla Caribou	DND: Lakes_Takla_Caribou.shp	Lakes_Takla_Caribou
Grizzly Bear	DND: LakesTSA_Grizzly.shp	LakesTSA_Grizzly
Lakes	LRDW: CWB_LAKES.shp	CWB_LAKES
Rivers	LRDW: CWB_RIVERS.shp	CWB_RIVERS
Wetlands	LRDW: CWB_WETLND.shp	CWB_WETLND
Stream classification (input for buffers and FSW's)	DND: Lakes_Stream_Class.shp	STR_CLASS
Riparian Buffers	DND: IFPA_RMZ_DLA.shp and IFPA_RMZ_DLA	Buf_width
Watersheds	LRDW: FWA_ASS_WS.shp	WSF_ATLAS_ASSEMT2
Fishery sensitive watersheds	DND: Lakes_DraftFSW_2012.shp	Lks_DraftFSW_2012
Clipped stream buffers	Internal:Lakes_Stream_Class.shp	FSW13_5m_BUF_S456D_MpSClip
Licensee interest areas (operating areas)	DND: Nadina_Operating_Areas_2011-10-05.shp	Operating_Areas_Final
Road network	DND: Gov\RoadWidths.shp	RoadWidths
Licensee Cycle Times	DND: BioEnergy_CycleTimes_Contours.shp	CycleTimes
Biogeoclimatic Ecosystems (BEC)	LRDW: BEC_POLY.shp	BEC_POLY
Environmentally Sensitive Areas	FES Consulting: tsa14_res	ESA_W_res
Forest Inventory –VRI	LRDW: Vegetation Resources Inventory (VRI)	VEG_R1_PLY
Forest Inventory – Depletions	FAIB: Consolidated_Cutblocks_2012.gdb	CutBLocks
Forest Inventory – Cut Blocks	LRDW: FTN_C_B_PL.shp	RSLT_FC_IN
Forest Inventory – Results Openings	LRDW: RSLT_FC_IN.shp	FTN_C_B_PL
Final Depletions - With Reserves	Internal processed layer	
RESULTS_FC: Reserve	LRDW: RSLT_FCRES.shp	FCRES_GROW_D
RSLT_FC_IN: Reserve (MAT & NAT)	LRDW: RSLT_FC_IN.shp	FCRES_GROWyMATNAT_D
Forest Inventory – Reserves	Internal processed layer	
Forest Inventory – Depletions no reserves	Internal processed layer	
Wildfires – Historic (2004-2010)	LRDW: H_FIRE_PLY.shp	H_FIRE_PLY
Spaced/Fertilized Treatments	LRDW: RSLT_FC_IN.shp; FTN_C_B_PL.shp	Spacing; Fertilization

Table 2 Notes for specific spatial data sources

Spatial Data	Comments
Road network	Both line and polygon data were received, however only the buffer data was used in the net down process. Significant additional time would be needed to create a proper road network that could then be buffered.
Fishery sensitive watersheds	Was edited to remove slivers along TSA boundary
Clipped stream buffers	To account for the basal area retention within the riparian management zones, another buffer was created for S4, S5, S6 (90%x15m=13.5 effective buffer)
Recreational Scenic Areas	Some very small polygons were merged
Final Depletions – With Reserves	Topology clean-up and union/update of forest inventory – depletions, forest inventory – cut blocks and forest inventory – results openings
Forest Inventory	No Phase 2 or other volume adjustments were applied to the spatial data.
Forest Inventory – Reserves	Union of RESULTS_FC: Reserve and RSLT_FC_IN: Reserve (MAT & NAT)
Forest Inventory – Depletions no reserves	Removed Forest Inventory – Reserves from Final Depletions – With Reserves

3 Base Case Scenario

A TSR4-like base case was created, and is intended to provide a benchmark with which to compare other model runs. The assumptions largely reflect those used in the TSR analysis, however, updates have been made for developments since the TSR and recent harvest and depletion information has been incorporated to reflect disturbances since the development of the TSR data package.

3.1 Key Assumptions

The following key assumptions are employed in this analysis:

- Silviculture opportunity evaluation is limited by the availability of funding (maximum $5,000,000/yr) but not funding source, or the ability to deliver a program. However, the final preferred strategy will be plausible;
- “Normal” market conditions will prevail in terms of demand and prices for timber and fibre;
- All portions of the THLB within the TSA are assumed to be economically viable, regardless of the quality of the fibre, or length of time the pine has been dead; and,
- Mountain pine beetle populations have moved from epidemic to endemic levels, and no additional large scale mortality will occur.

3.2 Land Base Assumptions

Landbase assumptions define the crown forest land base (CFLB) and timber harvesting land base (THLB). The THLB is designated to support timber harvesting while the CFLB is identified as the broader land base that can contribute toward meeting non-timber objectives (i.e., biodiversity).

The land base assumptions used in this project are primarily based on those used in TSR4. Updates have been made for new information such as changes in ownership. Deviations from TSR4 are noted. Further details regarding the landbase netdowns are provided in the TSR data package and technical report. Table 3 summarizes the landbase netdown, criteria and assumptions used for the Base Case run.

Table 3 Landbase assumptions

<table>
<tr><th>Netdown Criteria</th><th>Assumption</th></tr>
<tr><td>Tweedsmuir Park</td><td>Excluded all areas identified as Tweedsmuir Park, including all area in the Lindquist and Chikamin Mineral/Wildlife Management Zone.</td></tr>
<tr><td>Non-TSA Ownership</td><td>Excluded all areas defined as private land, indian reserves, and community forests or woodlots.</td></tr>
<tr><td>Non-Forest and Non-Productive</td><td>Excluded all areas that have not been logged and the CFLB identified in the VRI is "N" (where BCLCS is NP and SI <5m).</td></tr>
<tr><td>Existing Roads, Trails and Landings</td><td>Excluded all areas buffered on road segments accordingly:
<table>
<tr><th>Road Type</th><th>Width (observed [2])</th><th>Width (modelled)</th></tr>
<tr><td>Highways (16 & 35)</td><td></td><td>30m</td></tr>
<tr><td>Secondary Highways (gravel)</td><td></td><td>15m</td></tr>
<tr><td>Mainlines</td><td>13.7m</td><td>15m</td></tr>
<tr><td>Operational/Branch</td><td>9.5m</td><td>9m</td></tr>
<tr><td>In-Block</td><td>4.2m</td><td>5m</td></tr>
</table>
Note: widths are one-sided
Observed buffer widths (13.7m for mainlines, 9.5m for operational and 4.2m for in-block) were suggested after the resultant dataset was prepared. Since the overall impact to the THLB was estimated to be only 0.02%, no changes to RTLs were made.</td></tr>
<tr><td>Parks and Protected Areas</td><td>Excluded all areas designated as parks and protected areas in TA_PEP_SVW_polygon.shp (keep as CFLB).</td></tr>
<tr><td>Wildlife Areas (ESAs)</td><td>Excluded all areas designated as wildlife Environmentally Sensitive Areas.</td></tr>
<tr><td>OGMA</td><td>Excluded all areas designated in OGMA_LEG_C.shp</td></tr>
<tr><td>Physically Inoperable</td><td>No areas were excluded as physically inoperable due to terrain.</td></tr>
<tr><td>Scenic Areas</td><td>No areas were excluded for visual sensitivity (Established Visual Quality Class code of preservation). Scenic areas were managed as forest cover constraints (see below).</td></tr>
<tr><td>Stands with low potential for growing coniferous timber</td><td>Excluded all stands never harvested in the past that are unlikely to reach the minimum operable volume of 140 m^3/ha by the age described in the table[3] below.
<table>
<tr><th>BEC</th><th>Leading species</th><th>Age</th><th>Site index</th></tr>
<tr><td rowspan="4">ESSF</td><td>Douglas-fir</td><td>250</td><td><8.9</td></tr>
<tr><td>Balsam</td><td>250</td><td><5</td></tr>
<tr><td>Spruce</td><td>250</td><td><5</td></tr>
<tr><td>Pine</td><td>250</td><td>≥6.2</td></tr>
<tr><td rowspan="4">SBS</td><td>ougls-fir</td><td>140</td><td><11</td></tr>
<tr><td>Balsam</td><td>140</td><td><7</td></tr>
<tr><td>Spruce</td><td>140</td><td><7.1</td></tr>
<tr><td>Pine</td><td>140</td><td><8.7</td></tr>
</table></td></tr>
<tr><td>Non-Merchantable Species - Deciduous</td><td>Excluded all volume and area from deciduous-leading stands (AC, ACT, EP, AT). Yield tables also removed all deciduous volume from conifer leading stands.</td></tr>
<tr><td>Problem forest type – Old Balsam-leading stands</td><td>Excluded all balsam-leading stands with ages ≥250 years.</td></tr>
<tr><td>Riparian Reserve Zones</td><td>Excluded all areas buffered on stream segments, lake and wetland polygons accordingly:
<table>
<tr><th>Riparian Class</th><th>Description</th><th>Buffer Width (one side)</th></tr>
<tr><td>L1, L1 Large</td><td>Lake between 5 – 1000 ha</td><td>10.0m</td></tr>
<tr><td>S1 Large</td><td>Fish stream, width ≥100m</td><td>7.5m</td></tr>
</table></td></tr>
</table>

[2] Coombes, T, Bernard, A. and Nigh, G. 2010. Extension Note – Forest access road widths in the Lakes Timber Supply Area. BC Journal of Ecosystems and Management, Volume 11, Numbers 1 & 2, pg 84-90.

[3] Lakes Timber Supply Area, Timber Supply Review. Updated data package following completion of the timber supply analysis, June 2010, pg. 10.

Netdown Criteria	Assumption
	S1 Fish stream, width ≥20m 52.5m S2 Fish stream, width ≥5m 32.0m S3 Fish stream, width ≥1.5m 22.4m W1/W5 Wetland ≥5 ha/Complex 13.0m These buffer widths correspond to retention levels applied to combined widths for riparian reserve and riparian management zones.
Future Roads, Trails, and Landings	Future roads are shown in the netdown (Table 4) as a 2.2% aspatial reduction to the THLB but are applied as reductions to future yield tables.
Wildlife Tree Retention	The management practice for the Lakes North SRMP area is to retain a minimum of 5% of the gross cutblock area for WTR and a minimum of 10% of the total area of cutblocks harvested annually (including other stand-level retention). WTR targets for the Lakes South SRMP area range from minimums of 9% to 16% depending on BEC zone and LU. For this analysis, it was assumed that 54% of the WTR areas overlap with other spatial netdowns[4]. Accordingly, 5.1% of the net CFLB was retained as aspatial reductions. These areas were managed in the model where 5.1% of each polygon is retained and tracked separately.

Table 4 provides a summary of the land base area by netdown category. Excluding Tweedsmuir Park, the total area with the Lakes TSA is approximately 1.12 million ha. Of this area, approximately 65.7% is within the CFLB and 44.1% is considered the effective THLB.

Table 4 Lakes TSA land base area summary

	Total Area (Ha)	Effective Area (Ha)	Percent of Total Area	Percent of CFLB
Total Area (less Tweedsmuir Park)	1,121,638	1,121,638	100%	
less:				
Non-TSA (Private, Reserves, Community Forests and Woodlots)	240,710	233,285	20.8%	
Non-Forest / Non-Productive	408,263	150,905	13.5%	
Crown Forest Land Base		737,449	65.7%	100%
less:				
Existing Roads, Trails, and Landings	13,384	9,263	0.8%	1.3%
Parks and Protected Areas	96,960	86,687	7.7%	11.8%
Wildlife Areas	857	205	0.0%	0.0%
OGMA	90,108	63,990	5.7%	8.7%
Low Productivity	97,801	6,064	0.5%	0.8%
Deciduous-Leading	74,351	28,066	2.5%	3.8%
Problem Forest Types (Old Balsam-Leading Stands)	69,365	1,801	0.2%	0.2%
Riparian Reserve Zones	29,302	8,349	0.7%	1.1%
Timber Harvesting Land Base		533,022	47.5%	72.2%
Less aspatial netdowns:				
Future Roads, Trails, and Landings (@2.2%)		* *11,726*	1.0%	1.6%
Wildlife Tree Retention (@5.1%)		* *26,586*	2.4%	3.6%
Effective Timber Harvesting Land Base		494,710	44.1%	67.1%

** Aspatial netdowns are applied in the model but are not reflected in the GIS dataset areas.*

By comparison, this effective THLB is 17,857 ha less than what was reported in TSR4 THLB (512,567 ha). Major differences in areas between TSR4 and this analysis appear to involve the netdown order and designation of lands not managed by the BC Forest Service (i.e., expanded area for Burns Lake Community Forest and Cheslatta Community Forest).

[4] Personal comm. A. Bernard, February 13, 2013 – From a Forest and Range Evaluation Program study .

Beyond the netdown process, the NHLB and THLB were reduced by another 9,264 ha and 0.5 ha, respectively, to account for polygons where natural yields were unavailable.

3.3 Non-Timber Management Assumptions

This section describes how non-timber values were reflected or addressed in the model and how forest management occurs.

The management assumptions used in this project are very similar those used in the TSR. Updates have been made and in some cases, due to inherent differences in model architecture between Woodstock ™ and PATCHWORKS ™. Further details regarding the TSR management assumptions are provided in the TSR data package[5] and technical report. Table 5 summarizes the management criteria and assumptions used for the Base Case run.

Table 5 Non-Timber management assumptions –base case

<table>
<tr><th>Criteria</th><th>Assumption</th></tr>
<tr><td>Seral stage distribution</td><td>Seral stage distribution targets for the CFLB were specified outside the entire Chelaslie landscape unit and portions of the Intata and Ootsa landscape units within the caribou migration zones, where distributions were specified for combinations of BEC, landscape unit and biodiversity emphasis option.
The criteria used to model seral stage distributions are shown in the table below. These criteria were applied to CFLB areas within identified LU polygons.
<table>
<tr><th rowspan="2">Seral stage</th><th rowspan="2">Criteria/LU</th><th colspan="2">Intermediate BEO
Babine East, Bulkley, Cheslatta, Fleming, Francois West, Intata, Ootsa</th><th colspan="2">Low BEO
Babine West, Burns Lake East, Burns Lake West, Francois East, Taltapin</th></tr>
<tr><th>SBS</th><th>ESSF</th><th>SBS</th><th>ESSF</th></tr>
<tr><td rowspan="2">Early</td><td>Maximum disturbance</td><td>54%</td><td>36%</td><td>NA</td><td>NA</td></tr>
<tr><td>Age for retention</td><td><40</td><td><40</td><td><40</td><td><40</td></tr>
<tr><td rowspan="2">Mature plus old</td><td>Minimum retention</td><td>23%</td><td>28%</td><td>11%</td><td>14%</td></tr>
<tr><td>Age for retention</td><td>≥100</td><td>≥120</td><td>≥100</td><td>≥120</td></tr>
<tr><td rowspan="2">Old</td><td>Minimum retention</td><td>11%</td><td>9%</td><td>11%</td><td>9%</td></tr>
<tr><td>Age for retention</td><td>≥140</td><td>≥250</td><td>≥140</td><td>≥250</td></tr>
</table></td></tr>
<tr><td>Lakes South SRMP landscape corridors</td><td>Specific forest cover requirements were identified for the Lakes South SRMP landscape corridors. At least one of these requirements must be met in each landscape corridor. The criteria specified in TSR4 also applied crown closure targets, but these were not included in this analysis.
The criteria used to model landscape corridors within the South SRMP are shown in the table below. These criteria were applied to CFLB areas within all landscape corridor polygons.
<table>
<tr><th>BEC zone</th><th>Analysis units</th><th>Minimum area retained</th><th>Retention age</th></tr>
<tr><td>SBS</td><td>Conifer leading</td><td>70%</td><td>≥70</td></tr>
<tr><td>ESSF</td><td>Conifer leading</td><td>70%</td><td>≥100</td></tr>
<tr><td>SBS</td><td>All</td><td>70%</td><td>≥100</td></tr>
<tr><td>ESSF</td><td>All</td><td>70%</td><td>≥120</td></tr>
<tr><td>All</td><td>Deciduous leading</td><td>70%</td><td>≥40</td></tr>
</table></td></tr>
</table>

[5] Lakes Timber Supply Area, Timber Supply Review. Updated data package following completion of the timber supply analysis, June 2010, pages 21-26.

Criteria	Assumption

Lakes North SRMP landscape corridors

The Lakes North SRMP specified forest cover requirements to be managed within specific landscape corridors. Spatially, these were applied as provided in the SRMP data in the biodiversity value field.

The criteria used to model landscape corridors within the North SRMP are shown in the table below. These criteria were applied to CFLB areas within all landscape connectivity polygons.

Analysis Unit	Minimum area retained	Retention age	Retention period
Ba and Sx leading ≥140 yrs ("vegbio")	100%	n/a	Until 2015
	70%	≥140 yrs	From 2016 on
Hydro-riparian ecosystems ("hydro")	100%	n/a	Until 2015
	70%	≥140 yrs	From 2016 on
Rare ecosystems ("cdc")	100%	n/a	All times

Visuals

In a similar manner to TSR4, this analysis used visually effective green-up (VEG) heights and a plan-to-perspective (P2P) approach to model the maintenance of visual values. The detailed calculations to determine % planimetric alterations and VEG heights are described in the TSR4 data package.

The criteria used to model visual quality objectives are shown in the table below. These criteria were applied to CFLB areas within identified LU polygons.

VQO	% planimetric alteration	VEG height
Modification	43.6	4.2
Partial retention	14.9	4.2
Retention	2.5	4.5

Modeled age to achieve the minimum VEG height requirement were derived for each LU using SiteTools Batch v3.3.

Wildlife habitat

Four species were explicitly considered in this analysis. Deer, Moose and Grizzly Bear utilize the same criteria to manage their habitat, while Caribou utilizes seral stage criteria discussed above.

The criteria used to model wildlife habitat values for Deer/Moose and Grizzly Bear are shown in the table below. These criteria were applied to both CFLB and THLB areas within identified LU polygons.

Criteria	Deer/Moose	Grizzly Bear
Maximum allowable disturbance	33 % of THLB	33% of THLB
Minimum green-up height	3m	5m
Minimum area retained	50% of CFLB for deer 30% of CFLB for moose	50% of CFLB
Minimum age for retention	101	NA
Maximum age for retention	NA	121

Modeled age to achieve the minimum green-up height requirements were derived for each LU using SiteTools Batch v3.3.

Caribou is managed through seral stage distribution targets on the CFLB, within three specified migration zones, for the entire Chelaslie landscape unit and portions of the Intata and Ootsa landscape units within the migration zones.

The criteria used to model wildlife habitat values for caribou are shown in the table below. These criteria were applied to CFLB areas within identified LU polygons

Migration Zone	<40 years	≥80 years	≥140 years
High Use	<25%	≥60%	≥40%
Moderate Use	<32%	≥45%	≥30%
Low Use	<54%	≥30%	≥20%

3.4 Timber Management Assumptions

This section describes the criteria and considerations used to model timber harvesting activities. Table 6 summarizes the key harvest assumptions applied.

Table 6 Timber management assumptions –base case

Criteria	Assumption
Utilization Levels	Applied sawlog specifications for pine (12.5 dbh) and others (17.5 dbh)
Green-up	Applied a green-up constraint similar to TSR4 (max 25% <3m height) except that in the model, this constraint was applied to THLB within identified LU polygons; the TSR4 data package indicated that this constraint was applied across the entire THLB as one unit. Modelled ages to achieve the minimum height requirement were derived for each LU using SiteTools Batch v3.3.
Silvicultural Systems	The most common silvicultural system implemented within the Lakes TSA is clearcut with reserves. Accordingly, this was the only silvicultural system modelled.
Initial Harvest Rate	The initial harvest rate was set at the current AAC for the Lakes TSA of 2.0 million m^3/yr
Harvest Rule	Harvest Rules are only relevant in simulation models. The model used for this analysis (Patchworks) uses a goal seeking optimization heuristic approach to find a solution that best meets user defined objectives for timber and non-timber values.
Harvest Flow Objectives	Short-term (1-20yrs): Concentrated harvest from salvageable MPB-impacted pine stands as much as possible for the first decade of the planning horizon. Placed controls on the contribution of harvest from non-pine volume similar to that used in the AAC decision maximum of 350,000 m^3/yr. Mid-term: Minimized the depth and duration of the mid-term timber supply short-fall resulting from the MPB-pine mortality. Long-term: Adjusted the long-term harvest flow until a harvest level was found that reflected managed stand yields in order to produce growing stock that neither declined nor increased in the long-term.

3.5 Growth and Yield Assumptions

Growth and yield assumptions describe how net volumes for natural and managed stands are developed and incorporated in the model. They also describe changes in other tree and stand attributes over time (e.g., height, tree diameters, presence of dead trees, etc.).

While the growth and yield assumptions used in this project are different than those used in TSR4, the primary tools used to create the yields (TIPSY v.4.3, VDYP v.7) and the base assumptions for developing the yields (i.e., utilization, decay, waste, breakage, OAFs) are the same. Table 7 summarizes the details for key criteria, and where needed a more detailed explanation follows below.

Table 7 Growth and yield assumptions – base case

Criteria	Assumptions
Analysis Units	All stands were stratified for the purpose of assigning yields, reflecting MPB impacts and assigning treatments and transitions (yield curve post-harvest). See Sections 3.5.7 and 3.5.8 for further details on how this was done.
Stand Projection Models	VDYP7 was used for natural stands and TIPSY 4.3 for existing and future managed yield
Managed Stand Definition	Stands established after 1970 were considered managed (excluding fire origin stands)
Decay, Waste, and Breakage	Applied VDYP7 default reductions to stand volume for DWB according to BEC Zone; Lakes TSA includes forest inventory zones (FIZ) H and I.
Minimum Harvest Criteria	In order to be considered merchantable, a stand had to have at least 140 m^3/ha. The age at which this was achieved was used as the minimum harvest age.

Criteria	Assumptions
TIPSY Operational Adjustment Factors (OAF)	Work by Woods[6,7] and others indicates higher levels of hard pine rusts than expected within the Lakes TSA. To reflect this, OAFs were applied to existing and future managed stands as follows: OAF1 of 20% on pure (≥80%) pine stands and OAF1 of 15% on all other stands. OAF2 of 5% was applied to all stands.
Existing Inventory	Provincially maintained forest cover was utilized.
Volume Reductions	No volume exclusions were made for mixed stands as in TSR4. This allowed tracking and reporting of wood type (e.g., deciduous vs. coniferous). Controls were placed on the amount of coniferous and deciduous contributing to the harvest profile. Harvest forecast for each type was controlled and managed for separately.
Regeneration Methods	Both natural and artificial regeneration methods were/are employed to both existing and future managed stands. However, input assumptions were applied in TIPSY as natural regeneration (only) for existing managed stands and planting (only) for future managed stands. This approach provided more appropriate yield projections for planned silviculture strategies that rely on specific stand density ranges or use of select seed.
Genetic Gains	Genetic worth assumptions were applied to future managed stands: Pl 7.8%, Sx 22.4% (see section 3.5.6). Gains for existing managed stands were not applied as these stands were configured in TIPSY with natural regeneration methods (see above).
Not satisfactorily restocked (NSR)	Like TSR4, any current and backlog NSR areas were considered operational ground that will be restocked under various initiatives. These areas were modeled as stocked stands with a starting age of 0.
Unsalvaged Losses	An unsalvaged loss rate 23,568 m^3/yr representing endemic levels of fire, insect, and wind was assumed (same as TSR4) and removed from the total harvest. This was applied as a fixed volume reduction to the final harvest flow across the entire planning horizon.
Wildfire Impacts to stand yields	Any cutblocks harvested after a fire disturbance are managed under some legal obligation and assumed to be a managed stand. These stands were assigned to the BEC-median managed stand yield curve. The standing volume, height and age for all other stands disturbed by fire since (including) 2004 were set to zero. These stands were assumed to be regenerated using natural VDYP7 curves based on pre-existing stand attributes.

Four categories of yield tables were developed for this analysis; Natural Stands, Managed Stands, Future Managed Stands, and Secondary Structure.

3.5.1 Analysis Unit Characteristics

Stands were grouped into analysis units (AU) to reduce the complexity and volume of information in the model and for assigning potential treatments and transitions to yield curves following harvest. The AUs are complex because of the desire to reflect MPB impacts, secondary structure, past silvicultural investments, and potential future silviculture investments. Criteria used to group stands are provided in Table 8.

[6] Are free-growing stands meeting timber productivity expectations in the Lakes timber supply area? FREP report #13, May 2008

[7] Monitoring post free-growing stand conditions in five timber supply areas throughout British Columbia: What are we seeing so far? FREP Extension note #18, June 2011

Table 8 Criteria used to group stands into analysis units

Existing Stand Type	Future Stand Type (Transition)
Existing Natural Stands (1000 series) ➢ BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2) ➢ Species Groups: Pure Pine (Pl, Pa ≥ 80%); Pine Leading (Pl, Pa ≥ 40% & <80%); Spruce Leading (Sb, Se, Sw, Sx ≥40%); Balsam Leading (Ba, Bl ≥40%); Other Leading (Fd, Cw, Hw, Lw ≥40%); Deciduous Leading (At, Ac, Dr, Ep ≥40%) ➢ Site Classes (PHR[1] Site Index): Good (≥19m); Medium (≥15m & <19m); Poor (<15m) ➢ Age class for MPB attacked stands (5 yr increments) ➢ Year of Death (VRI Disturbance date) ➢ % Stand Dead (<20, ≥20&<40, ≥40&<60, ≥60&<80, ≥80) ➢ Secondary Structure Density Class (None, L, M, H)	**Future Managed Stands (3000 series)** ➢ BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2) ➢ Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLL=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); DEL=Deciduous Leading (At, Ac, Dr, Ep ≥40%) ➢ Site Classes (PHR[1] Site Index): Good (≥19m); Medium (≥15m & <19m); Poor (<15m) ➢ Planted vs. Natural Regeneration
Existing Managed Stands (2000 series) ➢ BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2) ➢ Species Groups: Pure Pine (Pl, Pa ≥ 80%); Pine Leading (Pl, Pa ≥ 40% & <80%); Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); Deciduous Leading (At, Ac, Dr, Ep ≥40%) ➢ Site Classes (PHR[1] Site Index): Good (≥19m); Medium (≥15m & <19m); Poor (<15m) ➢ Stocking Classes (Total Stems): Open (0 to <1000 sph), Closed (1,000 to <2,500 sph), Dense (2,500 to <4,500 sph), Thick (4,500 to <25,000 sph), Repressed (≥25,000 sph) ➢ Planted vs. Natural Regeneration ➢ Age class for MPB attacked stands (5 yr increments) ➢ MPB Impact classes	**Future Managed Stands (3000 series)** ➢ (Same criteria as above)

1 – Post-Harvest Regenerated

A detailed list of AUs and TIPSY inputs for existing natural, existing managed and future managed stands is provided in Appendix 1.

3.5.2 Existing Natural Stands

This group of AUs is comprised of all stands within the CFLB except those that have originated from openings harvested since 1970. Standard inventory attributes were used with VDYPv.7 to develop natural yield curves for each forest polygon. Area-weighted averages of these curves were then calculated according for each of the assigned AUs. Yields were also adjusted for MPB-impacted stands to reflect the growth and decay of both live and dead portions of the stand using mortality assumptions described below in sections 3.5.7 and 3.5.8.

3.5.3 Existing Managed Stands

Managed stands are those harvested since 1970. TIPSYv.4.3 was used to develop yield curves and data from the RESULTS[8] data base was used as inputs. A RESULTS download was analyzed and preliminary results for species composition, site index and density were distributed to workshop attendees for review, and comment.

AUs were developed to include first and second species, site index breaks based on Provincial guidance for fertilization while density classes reflecting a combination of espacement thresholds, MAI

[8] Results summaries were compiled by Mie-Ching Tsoi (through FLNR) on September 3, 2012

production and Provincial spacing/fertilization guidance. These groups supported various silvicultural strategies considered in this project.

3.5.4 Future Managed Stands

Future managed stands have not yet been harvested so the yields for this group reflect current regeneration assumptions that are expected to be implemented in the future. The existing natural and managed stands harvested in the forest estate model transitioned into appropriate future managed AUs.

Future managed stand curves were developed for the same BEC, species and site index groups as the existing natural and managed stands. Summaries of more recent RESULTS data were used to develop regeneration assumptions that considered espacement densities with natural ingress, regeneration delay, species composition and genetic gain.

3.5.5 Site Index assignments

Managed stand site index reflects the potential productive capacity of a stand. The inventory site index was used as the site productivity input to develop yield curves for existing natural stands while the managed site index was used for existing managed and future managed stands.

For this analysis, site index for managed stands was calculated as area-weighted averages from provincial site productivity estimates[9]. These estimates were based on SIBEC estimates and site series identified in the predictive ecosystem mapping for Lake TSA. The distribution of natural and managed stand site indices across the THLB is shown in Figure 4. The area-weighted average site index of the THLB for natural stands is 14.5 m. After the THLB is converted into managed stands the average site index increases to 17.8 m.

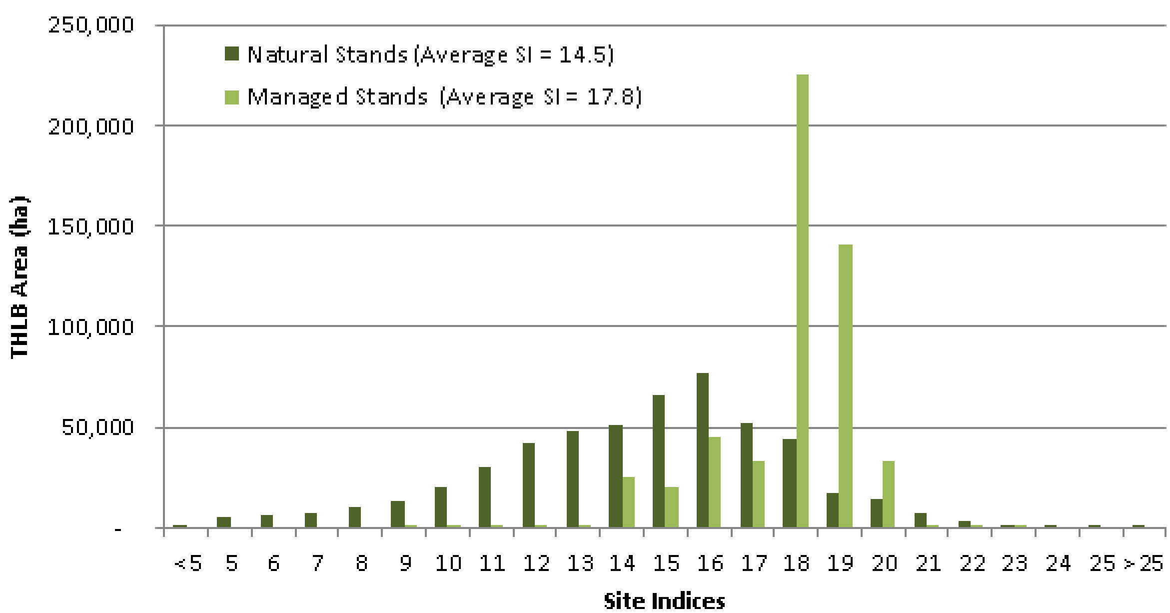

Figure 4 Distribution of natural and managed stand site indices over the THLB

[9] FLNR Provincial Site Productivity Layer, TEM/PEM-SIBEC and Biophysical Analysis, V3.3, July 30, 2012. Clover Point Consulting

3.5.6 Select Seed Use / Genetic Gains

Genetic gains were only applied to future managed stands. Gains for existing managed stands were not applied as these stands were configured with natural regeneration methods in TIPSY to provide more appropriate yield projections for planned silviculture strategies that rely on specific stand density ranges.

Genetic gain assumptions for future managed stands were derived from a review of both current (recent seed use and genetic gain practices estimated over the past 5 years) and future (near to short term) estimates of seed use and genetic gain projected over the next 10 years. Forecasted seed production and genetic gain estimates were identified for all seed planning units (SPU) falling within the TSA (see Table 9).

Table 9 Seed planning unit area of use

Seed Planning Unit (SPU)	Seed Planning Zone (SPZs)	MIN ELEV (m)	MAX ELEV (m)
PLI.BV.LOW	BV, BVC, BVP	700	1400
PLI.BVC.LOW	BVP (overlap zone)	700	1300
PLI.CP.LOW	CP, BVC, CPP	700	1300
Oie Lake – Class B+	BLK, CHL, CT, MGR, MRB, NCH, QL	+200	-500
Udy Creek – Class B+	BLK, CHL, CT, MRB, NCH, QL	+200	-500
SX.PG.LOW	PG, BVP,PGN	600	1400
SX.BVP.LOW	BVP (overlap zone)	600	1400
SX.BV.LOW	BV, BVP	500	1400
SX.BVP.HIGH	BVP (overlap zone)	1200	1550
SX.PG.HIGH	PG, BVP, PGN	1200	1550
FDI.PG.LOW	PG, BVP, PGN	700	1200
LW1	Climate Change – Limited Assisted Migration LW1 zone	500	1800

Source: Forest Genetics Council of BC 2012/13 species plans
Note: In November, 2008 upward elevation transfer limits were increased by 200m for both orchard (including Sx, Pli, Fdi, Lw) and natural stand (including Pli) interior seed sources – see Amendments to the Chief Forester Standards, November 2008 http://www.for.gov.bc.ca/code/cfstandards/amendmentNov08.htm

The production forecast of class A seed projected over the next 10 years was used to weight the estimated gains achievable (based on orchard capacity and current seed use behaviour) for each SPU years relative to demand (based on total SPU seed use –all seed users). To provide average species gains for the TSA, the production-weighted gains were area-weighted by the proportion of the SPU within the THLB where each species is planted. The seedling need assigned for each SPU is assumed to account for the needs in the Lakes TSA. Table 10 summarizes the information used to calculate the anticipated genetic gains for future managed stands.

Table 10 Genetic gain for future managed stands

Seed Planning Unit	SPU Need (million)	SPU Production Forecast (million)	SPU Weighted Gain (2012-2021)	SPU Production Weighted Gain (1)	TSA/SPU Area Weighting (2)	TSA Applied Weighted Gain
17 PLI.BV.LOW	21.4	12.9	12.9%	7.9%	97.4%	Pli 7.8%
Overlap: PLI.BVC.LOW	15.9	11.5	15.4%	11.3%	1.2%	
18 PLI.CP.LOW	10.4	10.1	17.9%	17.0%	0.0%	
Class B+	1.9	1.9	3.0%	3.0%	1.5%	
14 SX.PG.LOW	28.0	28.0	26.2%	26.2%	0.2%	Sx 22.4%
Overlap: SX.BVP.LOW	18.7	19.8	25.1%	25.1%	70.3%	
35 SX.BV.LOW	9.3	11.6	23.9%	23.9%	19.9%	
Overlap: SX.BVP.HIGH	5.9	7.7	19.5%	19.5%	0.1%	
42 SX.PG.HIGH	2.4	3.5	15.1%	15.1%	0.0%	
41 FDI.PG.LOW	1.7	1.8	27.6%	25.6%	2.8%	Fdi 0.7%
Assisted Migration LW1	1.9	3.4	25.0%	25.0%	2.0%	Lw 0.5%

(1) Estimated gain weighted by the proportion of the annual SPU seedling need to the annual production forecast over 10 years
(2) Proportion of the SPU within the THLB where each species is planted
(3) Assumption that all seed users operating within the SPU will have an equal opportunity to select available seed.

Gains for some seed planning units were dropped because they were located outside of the THLB (e.g., PLI BV HIGH). The eastern portion of the TSA is classified as a zone of overlap (i.e., BVP). Zones of overlap or 'transition areas' allow for seed selection choices from either of the 'mother' seed zones (e.g., PG or BV orchards). At the time of seed selection, seed users have the option to select seed produced from either orchard, where available. For example, in SX BVP LOW, seed can be selected from either the SX PG LOW or SX BV LOW orchards.

Between 2005 and 2013, only 6% of the interior Lodgepole pine sown used Class B+ (natural stand superior provenance) stock while current seed inventories indicate a surplus of this seed exists. For this analysis, the deficit in Class A seed production was assumed to be partially filled through the use of Class B+ pine using the Oie Lake and Udy Creek superior provenance seed sources in areas associated with the natural stand seed planning zones of Bulkley Valley. While estimated gains for this material may be higher on certain sites, the current Genetic Worth is 3%, based on the provenance testing and analysis to date for zonal sites across the 'tested' seed planning zones. As the production weighted gain was assumed to reflect 6% of the total need (a net down based on a 9-year average 6% B+ seed use) over the deficit area, the B+ class seed contributed an additional 0.05% to the applied genetic gain for pine.

Opportunities to address forest health concerns through the selection of Class A (orchard) seed exist for interior spruce and, over the next 10+ years, for Lodgepole pine. Currently, orchard #211 produces weevil-resistant interior spruce seed for the SX PG (and BVP) seed planning zone. In addition, disease tolerant/resistant seed sources may become available for Interior Lodgepole pine as anew breeding program that tests resistance and tolerance to Comandra blister rust and Dothistroma needle cast has been recently established based on early results from progeny tests. There is also a young PG LOW gall rust resistance seed orchard that will serve the Pli PG and BVP transition (overlap) zones.

Gains associated with limited assisted migration of Lw were also considered for this analysis assuming that this material can only be applied as directed in the Climate-Based Seed Transfer Interim Policy Measures (June 2010). However, opportunities were limited due to minimal SPU (LW1) coverage within the TSA [10].

[10] MPB Seed Planning Impact interactive PDF map plots are available under 'Interactive Map Plots' at: http://www.for.gov.bc.ca/hts/rs/mpb_impact/mpb_impact2009.html

3.5.7 Mountain Pine Beetle Impacts on Stands ≥60 yrs Old

Using current forest inventory attributes, VDYP was used to generate volume yield curves for each natural stand. These curves were then adjusted to develop volume curves that reflect MPB impacts on pine mortality, shelf-life and understory regeneration.

3.5.7.1 MPB Mortality

The recent mountain pine beetle epidemic that peaked in 2004 has had a significant impact on natural stands. For this analysis, estimates of stand mortality and year of death were taken from the forest inventory data. These estimates were derived from the provincial MPB model (year 8) and the 2010 aerial overview surveys. Overall, the forest inventory shows the average pine mortality of 83% for stands over 60 years of age within the THLB. This ranges between 68% and 94% by BEC unit.

3.5.7.2 Stands with dead percentage ≥ 60%

Natural stands with 60% or more stand mortality were assigned three yield curves; combined to reflect growth and yield over time. The three stand components (live volume + dead, merchantable volume + naturally regenerating understory volume) are described in Table 11 and illustrated in Figure 5.

Table 11 Approach to reflect post-attack MPB impacts to yields for natural stands

Stand Component	Timing [1]	Yield Adjustments [2]
Dead overstory trees	➢ Model age adjusted to 0 from year of death	➢ VDYP used to project yields for each polygon Yield and density reduced according to attack severity (Dead% x Yield) ➢ Yield static for 5 years, then drops incrementally to 0 m³/ha over 15 years (see shelf life assumptions below).
Live overstory trees	➢ Model age adjusted to 0 from year of death	➢ VDYP used to project yields for each polygon ➢ Yield and density reduced according to attack severity ((100%-Dead%) x Yield) ➢ Yield calculated as the incremental growth from the original unattacked projection: LV = UV x (1-AS), where LV is live volume, UV is unattacked volume and AS is percent attack severity.
Regenerating understory trees [3]	➢ Assigned advanced regeneration period (model age minus 10 yrs)	➢ TASS used to project average yields for BEC Zone and density class (see Table 12), applying the following assumptions: o Fix species composition including a high clumpiness factor o Reduce potential site index by 2 metres o Adjust OAF1 to 25% and OAF2 to 15% o 10 year advanced regeneration (i.e., +-10 from year of death) ➢ Density classes are randomly assigned to stands with ≥60% attack according to the proportions for BEC zones (see Table 12).

1. Year of death was determined as the year when MPB attack exceeds 50% and assigned as either 2004 or 2007.
2. Stand dead % applies to the stand – the pine component within each stand is factored into this estimate.
3. Yields for regenerating understory trees were prepared by Jim Thrower and Ken Polsson.

In the example shown in Figure 5 (110 yr old stand, 80% stand mortality), the stand's dead merchantable volume (red dashed line) declines over the 15 years following attack (in 2004), while the remaining live portion of the stand (solid green line) continues to grow along with the understory regeneration (blue solid line - 10 years old at time of attack). The sum of the three curves (black solid line) provides the total merchantable volume at any time. In this example, the stand never recovers to post attack volumes primarily because of the reduced growth associated with the naturally regenerating portion of the stand. This is an illustration only.

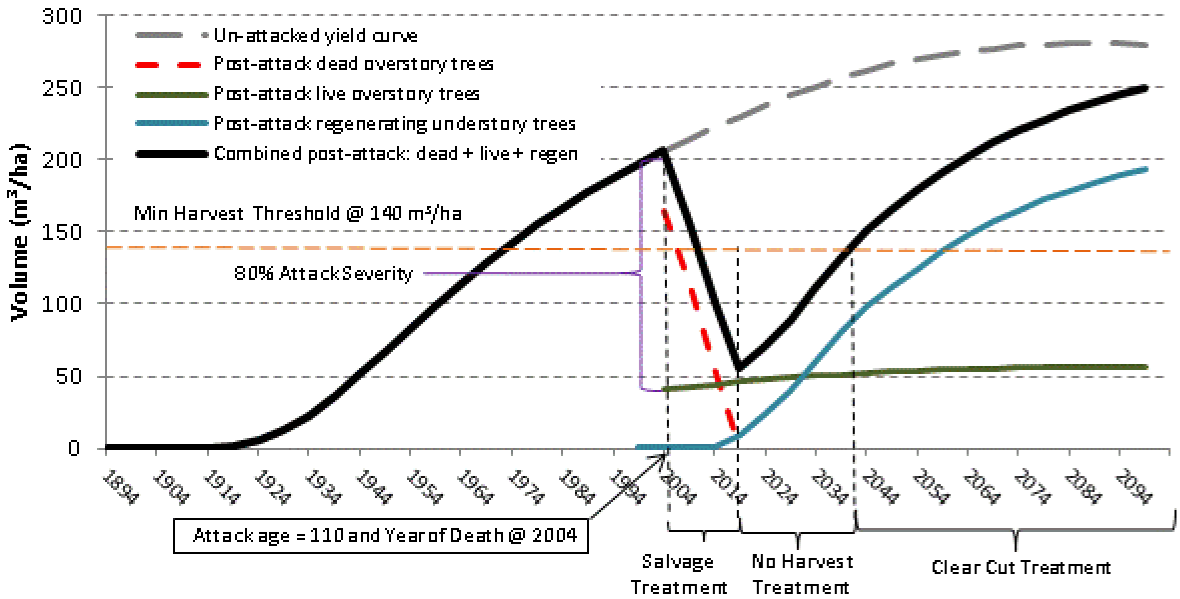

Figure 5 Illustration of natural yields impacted by MPB

These stands are considered ineligible for harvesting when the total merchantable volume for the stand (dead + live + regeneration) falls below the minimum volume threshold (140 m^3/ha).

For modelling purposes, the age of stands with ≥ 60% dead, was initially reduced to 7 or 4 years old, depending on whether the year of death was classified as 2004 or 2007, as the initial year for modelling was 2011. The live and dead merchantable volumes, however, remained available for harvest but were adjusted as described above. This approach assumes that stands in both the THLB and NHLB, with less than 60% live volume, do not contribute towards meeting some non-timber management assumptions for old seral stages (see section 3.3). To reduce the number of analysis units, stands with less than 60% live volume were adjusted to their respective age class mid-points. Finally, managed stands and any unattacked stands maintained their original age as of 2011.

3.5.7.3 Shelf Life Assumptions

Shelf life is the time a tree/stand remains economically viable to harvest. Typically, this begins from the year that the stand dead percentage from MPB exceeds 50% (year of death).

The shelf life of dead pine volume within MPB-attacked stands was assigned according to Figure 6. If a stand was not harvested within 15 years from its year of death (attack peaked in 2004), its dead volume portion was completely removed. The existing natural yield curves were adjusted to reflect the remaining dead salvageable volume.

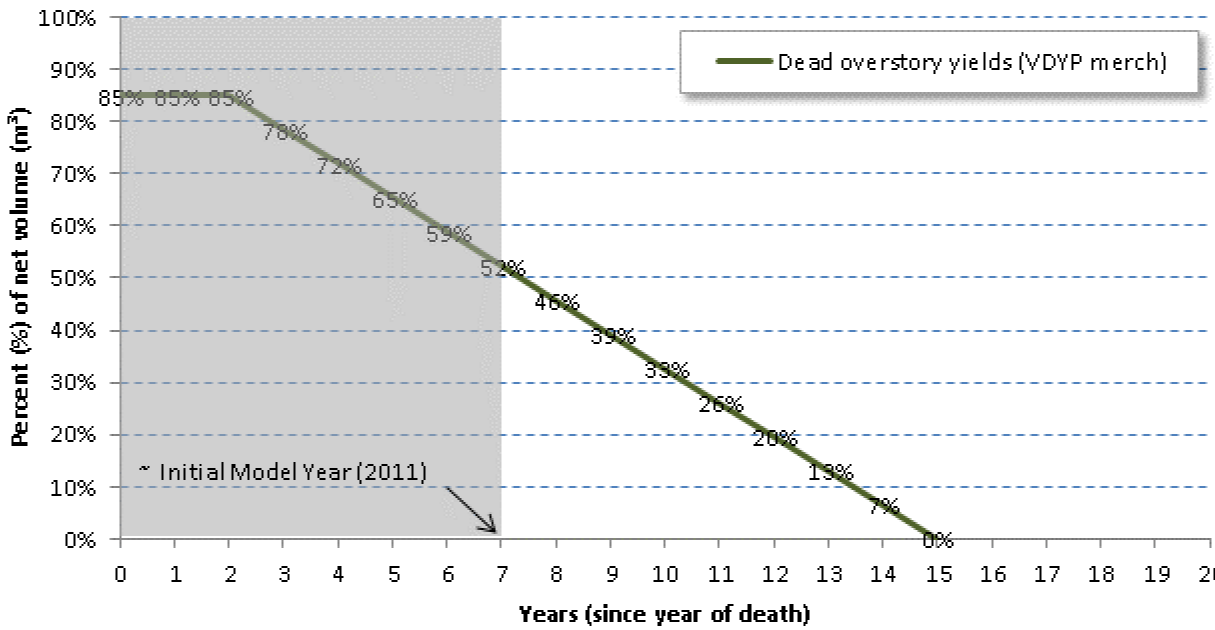

Figure 6 Shelf-life of dead overstory trees within MPB-attacked stands

3.5.7.4 Understory regeneration

Unsalvaged, MPB-attacked stands were augmented with yield curves for understory regeneration, or secondary structure. Based on work done by Coates and Sachs[11] et al, and Thrower[12], these yields incorporated specific assumptions regarding species composition, site index, stand density class, spatial and age distribution of trees, operational adjustment factors, and regeneration delay (see Table 11).

Since this understory regeneration cannot be identified in the current forest inventory, density classes were randomly assigned to stands with ≥60% remaining live volume and according to the proportions for BEC zones given in Table 12.

Table 12 Density class and species compositions modelled for regenerating understory component

BEC Zone	Species Composition	SI (m)	Low Density (200/ha)	Med Density (800/ha)	High Density (1600/ha)
SBSmc2	Sx 100	17	20%	20%	60%
SBSdk (dw3/wk3)	Sx 65 Pl 35	16.5/17.1	40%	30%	30%
ESSFmc (mv1/3/p/mcp/BAFAun)	Sx 100	13	5%	10%	85%

From Thrower [12]

3.5.7.5 Stands with dead percentage < 60%

For natural stands (unsalvaged) with up to 60% MPB attack, only the two overstory curves were applied (live volume + dead merchantable volume). Naturally-regenerating understory volumes were not included because any secondary structure will not likely perform as well with a denser overstory.

[11] Coates, K D, and D L Sachs. "Current state of knowledge regarding secondary structure in mountain pine beetle impacted landscapes. MPB impacted stands assessment project. Second draft. Jan. 2012." 2012, 14p.

[12] Thrower, J S. "Understory Yield Tables for MPB-Impacted Stands in the Lakes TSA: Application to the Type IV Silvicultural Analysis." File Report, 2012, 12p.

3.5.8 Mountain Pine Beetle Impacts on Stands <60 yrs Old

Young regenerating stands form a key component of the future harvest – particularly during the late mid-term period. Within the TSA, most stands under the age of 60 were impacted to some degree (approximately 38% of the THLB). Moreover, damage to these young stands is often exacerbated by attack from secondary bark beetles and diseases.

The pattern of this damage was most often patchy, creating numerous holes in the regenerating canopy, particularly on larger diameter trees. Trees with higher productivity situated at lower elevations were most likely to be attacked. Similarly, stands that had been juvenile spaced exhibited higher levels of attack.

District staff surveyed young stand mortality and summarized the data according to the figures provided in Table 13 [13].

Table 13 Summary of 2006-2008 survey in pine-leading plantations in the Lakes TSA

Age	Area Surveyed (1)	Area with MPB	MPB Attack (2)	NSR % (3)
0-20	6,140 ha	270 ha	4%	0%
21-40	10,874 ha	3,144 ha	29%	1%
41-60	1,699 ha	819 ha	48%	24%

(1) Area surveyed at 1 plot/ha
(2) Percentage of area that has a population of MPB
(3) Percentage of area fallen below minimum stocking levels

To account for MPB impacts in young stands, reductions were applied to both natural and existing managed stand yields of Pl-leading AUs according to the age range and NSR percent shown in Table 13. These were applied regardless of the pine component or attack levels described in the forest inventory. Yields from non-pine-leading AUs were not adjusted.

3.6 Natural Disturbance Assumptions

Natural disturbance assumptions define the extent and frequency of natural disturbances across the land base. The natural disturbance assumptions used in this project are different than those used in TSR4. For this analysis, a constant area was disturbed annually in each LU/NDT combination. The amount of disturbance in each LU/NDT combination was based on the BGC variants present and their associated natural disturbance intervals and old seral definitions as outlined in the Biodiversity Guidebook[14] and Table 14 below.

Table 14 Annual natural disturbance limits in the forested non-THLB by BGC Zone/NDT

BEC Group	NDT	Disturbance Interval (yrs)	"OLD" Defn (yrs)	% Area ≥ OLD*	Effective Rotation Age (yrs)*	Contributing Non-THLB Area (ha)	Annual Area Disturbed (ha)(area/rot age)
ESSF	2	200	≥250	29%	350	19,362	55
SBPS	3	125	≥140	33%	208	48,137	232
SBS	3	125	≥140	33%	208	127,664	614
Grand Total						195,163	901

** % area old = exp (-[old age / disturbance interval]), Effective rotation age = old age / (1 – % area old)*

To reduce the number of modeled zones required, modeling disturbance was simplified BGC/NDT combinations for applying annual disturbances. Stands were randomly selected to account for these natural disturbance areas. Ages were then adjusted in each period according to the effective rotation

[13] Lakes Timber Supply Area timber Supply Review – Updated Data Package following completion of the timber supply analysis, June 2010
[14] BC Ministry of Forests and BC Ministry of Environment, Lands and Parks 1995

age so that all stands within each unit were turned over once throughout the effective rotation. This process continued throughout the planning horizon and avoided seral requirements because disturbance was selected randomly; independent of modeled harvest priority.

Across the NHLB, approximately 901 ha (0.46%) is disturbed each year, resulting in an average disturbance turn-over of the non-THLB approximately every 217 years (range is 208 to 350 years).

3.7 Harvest Profile Targets

Harvest profile targets were configured in the model to ensure reasonable harvest profiles were being achieved for each time period.

3.7.1 Product Profiles

Modelling products distributions delivered to the mill is a complex and often criticized exercise. The considerations required for this are not trivial: stand-level variations for predicting products on the stump, harvesting practices, preferred log specifications specific to each manufacturing facility. This is further complicated by the damage from insects – particularly shelf-life, and other disturbances (e.g., piece size, decay, checking, blue-stain).

Rather than categorizing harvested products as a model input, this analysis tracked and reported leading species harvested by age class. Through a post-processing exercise, product distributions were then combined with the harvest summaries (as a model output). Table 15 shows the preliminary product distributions applied. With this approach, one can easily adjust the product distribution with specific assumptions to generate new product profiles.

Table 15 Preliminary product distributions by age class and species group

	Dead Pine			Live Pine			Spruce/Balsam			Douglas-fir/Larch		
Age Class	**Peeler**	**Sawlog**	**Pulp**	**Peeler**	**Sawlog**	**Pulp**	**Peeler**	**Sawlog**	**Pulp**	**Peeler**	**Sawlog**	**Pulp**
0 to <40			100%			100%			100%			100%
≥40 to <60			100%		85%	15%		40%	60%		65%	35%
≥60 to <80			100%		92%	8%		60%	40%		85%	15%
≥80 to <120			100%		95%	5%	4%	71%	25%	5%	90%	5%
≥120 to <200			100%	1%	96%	3%	8%	76%	16%	10%	85%	5%
≥200			100%	2%	96%	2%	10%	80%	10%	25%	70%	5%

Note: these figures are preliminary estimates that can easily be modified and incorporated into a post-modelling process

As this approach applies product distributions through a post-modelling process, the model was not configured regulate the harvest flow for any specific product, or combination of species and age class.

3.7.2 Patch Size Distribution

The model was configured to create, where possible, patches that are consistent with very young seral (<20yr) patch size distributions as defined in the Lakes North/South SRMPs. This is meant to control the spatial distribution of harvest on the landbase while avoiding strict 40 hectare green-up rules and or unrealistically sized harvest openings. This objective was not active during the first 20 years of the planning period.

Patches were defined as contiguous areas less than 20 years of age. Stands within 50 metres of each other were considered to be contiguous so patches could be made up of a single cutblock or an aggregation of cutblocks close together.

The criteria used to model patch size distribution for each SRMP area (North/South) are shown in Table 16. These criteria were applied to THLB areas within identified NDT (BEC/LU) polygons.

Table 16 Patch size targets by Lakes North and South SRMP areas

		Patch Sizes (ha)			Target Forested Area (%)		
NDT	**BEC Unit**	**Small**	**Medium**	**Large**	**Small**	**Medium**	**Large**
2	ESSF	<40	≥40 & <80	≥80	30-40	30-40	20-40
3b	SBS	<40	≥40 & <250	≥250	10-30	10-30	40-80

Note: Only early seral stands (Age <20 years) were modelled; target sizes/% adopted from the North/South SRMPs.

3.8 Modeling Assumptions

General assumptions were incorporated into the model to improve its efficiency or to produce results that are spatially more realistic. Table 17 summarizes the modelling assumptions employed in this analysis.

Table 17 Modeling assumptions

Criteria	Assumption
Minimum Polygon Size	Resultant polygons less than 0.25 ha in size were minimized by conducting a GIS eliminate process.
Blocking	To improve modelling performance, resultant polygons were blocked (or grouped) where possible by maintaining the same AUs and 10-year age classes and the model was configured for a target harvest opening size of 25 ha and a maximum opening size of 40 ha.
Planning Horizon	A 300 year planning horizon was applied reported in 5-year increments for the first twenty years and 10-year increments thereafter (i.e., 32 periods). 2011 was used as the initial modeling year.
Harvest Flow Objectives	o Short-term: Attempt to harvest the current AAC of 2 million m^3/yr, concentrating harvest on salvageable MPB-impacted pine stands with no more than 350,000 m^3/yr of the harvest profile with non-pine species for the first 5-year period of the planning horizon. o Mid-term: Minimized the depth and duration of the mid-term timber supply short-fall resulting from the MPB-pine mortality. o Long-term: Adjusted the long-term harvest flow until the harvest level reflected managed stand yields while producing growing stock that neither declined nor increased.

4 Sensitivity Analyses

4.1 Cycle Times

To explore the impact physical limitations associated with log hauling may have on harvest flows, a sensitivity analysis was undertaken to apply limit the harvest from two haul zones.

Based on a cycle time map provided by district staff, stands were designated with either within a 9 hour cycle time (two return trips per day - one long and one short) or outside a 9 hour cycle time (one return trip per day).

The criteria used to model the cycle time sensitivity are shown in Table 18. These criteria were applied to THLB areas within each cycle time zone.

Table 18 Harvest limits for cycle time sensitivity

Maximum Haul	Cycle Time Zone	Maximum Harvest
Two trips per day	< 9 hours	100%
One trip per day	≥ 9 hours	0%

4.2 Hydrologically Equivalent Disturbed Area

To explore the impact of constraining harvests within fisheries sensitive watersheds (FSW), a sensitivity analysis was undertaken to include Hydrologically Equivalent Disturbed Area (HEDA) thresholds currently proposed through draft orders establishing FSWs.

The additional criterion was used to limit the natural or anthropogenic disturbance within designated FSWs with consideration given to the silvicultural system, regeneration growth and location within the watershed. This revised approach was expected to shift some harvesting onto non-FSW units during critical periods.

Throughout the planning period, the model tracked area-weighted average HEDA values for each FSW. The criteria shown in Table 19 were applied to disturbed stands and those susceptible to attack by the MPB. For modelling purposes, height parameters were translated to ages for each AU using Site Tools. The pine distribution criteria, however, were applied according to the available AU characteristics (section 3.5.1).

Table 19 HEDA factors calculated for draft fisheries sensitive watersheds

Stand Type	HEDA Factor
Vegetated areas with height <3m	1.00
Disturbed areas with height ≥ 3m and <5m	0.75
Disturbed areas with height ≥ 5m and <7m	0.50
Disturbed areas with height ≥ 7m and <9m	0.25
Mature pine-leading stands (Pl ≥ 80%)	0.50
Mature pine-mixed stands (Pl ≥ 31% and <80%)	0.20

Modelled ages required to achieve the target heights were derived for each FSW using SiteTools Batch v3.3.

Another criterion for these draft FSWs requires that at least 90% of the riparian areas is retained within 15 metres of S4, S5 and S6 streams. To simplify this, an effective buffer of 13.5m (15m x 90%) was spatially defined.

The criteria used to model HEDA are shown in Table 20. These criteria were applied to CFLB areas within identified draft FSW polygons.

Table 20 Maximum HEDA thresholds applied to draft fisheries sensitive watersheds

Draft FSW	Maximum HEDA
Foxy	15%
Gullwing	n/a
Henkel	19%
Pierre	19%
Tildesley	TBA

5 Silvicultural Strategies

This section describes several silvicultural strategies that might be considered for the analysis. Given budget constraints for this analysis, it is unlikely that all strategies will be pursued so details pertaining to the strategy will be refined or developed after once they have been reviewed by the project steering group.

Several silviculture treatments and one composite scenario were examined in this analysis. Each was constrained to an annual budget of $5,000,000. The key silvicultural strategies included:

1. Single Fertilization;
2. Multiple Fertilization;
3. Pre-commercial Thinning / Cleaning Dense Pine;
4. Rehabilitating MPB Impacted Stands;
5. Enhanced Basic Reforestation
6. Harvest Sequencing; and
7. Composite Mix of Treatments.

5.1 Single Fertilization

This silvicultural strategy examined the impact to harvest flows from applying a single fertilization treatment applied any time between 30 and 80 yrs of age. Responses to fertilizer were assumed to decline beyond age 80. This strategy also assumed that harvesting of treated stands could not occur for 10 years after fertilizer application. As we are only looking to develop a strategy for the next 10 years, this treatment will be limited to stands already in the ground today (existing natural and existing managed stands).

Eligible stands for this strategy were identified using the criteria provided in Table 21. Approximately 51,000 ha of existing stand types were identified as eligible for this treatment under the single fertilization strategy.

Table 21 Criteria for the single fertilization strategy

BEC Groups	Species Groups	SI Range	Existing Density Range (sph)
SBSdk, SBSmc	Pl leading	≥19 & <25	≥1,000 & <4,500
SBSdk, SBSmc	Sx leading	≥15 & <24	≥1,000 & <4,500

Responses to a single fertilization application are shown by species in Table 22.

Table 22 Fertilization criteria for single fertilization

	Lodgepole pine	Spruce	Douglas-fir
Site index range	≥19 & <25	≥15 & <24	≥15 & <24
Age (treatment window)	30-60 yrs	30-80 yrs	30-80 yrs
Response (for 10 yrs)	12 m^3/ha	15 m^3/ha	15 m^3/ha
Efficiency Assumed (TIPSY)	100%	100%	100%

Minimum harvest ages will be adjusted as necessary to reflect earlier achievement of minimum harvest volumes.

Ten years following the fertilization treatment, stand yields were increased to these responses. Due to the methodology for developing analysis units (section 3.5.1), some ineligible stands were treated (i.e., Sx leading AU includes the leading species: B, Ba, Bl, S, Sb, Se, Ss, Sw, and Sx).

The following modelling assumptions were also incorporated into the single fertilization strategy:

- Stands are assumed to be fully stocked and healthy.
- Fertilization response is assumed to be independent of the age of the stand when fertilization occurs so the same response will be applied for stands between the ages of 30 and 80;
- Minimum harvest ages for fertilized analysis units were reduced by 3 years;
- Harvest eligibility was delayed for 10 years following the final fertilizer application; and
- Application costs were assumed to be $450 per hectare.

5.2 Multiple Fertilization

This silvicultural strategy examined the impact to harvest flows from applying an intensive fertilization program to Sx (every 5 years) and successive fertilizations to Pl stands (every 10 yrs). Windows for these multiple fertilization treatments were between age 25 and 60 years. Fertilization beyond these ages is most likely to fall into the single fertilization.

This strategy also assumed that harvesting of treated stands could not occur for 10 year after fertilizer application (5 yrs for Sx). As we are only looking to develop a strategy for the next 10 year, this treatment will be limited to stands already in the ground today (existing natural and existing managed stands).

This strategy should provide additional volume in the mid-term periods by increasing stand volumes or allowing harvest to occur sooner.

Eligible stands for this strategy were identified using the criteria provided in Table 23. Approximately 51,000 ha of existing stand types were identified as eligible for this treatment under the multiple fertilization strategy.

Table 23 Criteria for the multiple fertilization strategy

BEC Zones	Species Groups	SI Range	Existing Density Range (sph)
SBSdk, SBSmc	Pl leading	≥19 <25	≥1,000 <4,500
SBSdk, SBSmc	Sx leading	≥15 <24	≥1,000 <4,500

Cumulative responses to multiple fertilization treatments are shown in Table 24 and Table 25. The response from multi-fertilization of Sx is based on initial research findings and ongoing monitoring of repeat applications would be needed to ensure the full response is being achieved (per com. Rob Brockley). Sx response is based on a SI 18 stand (SI 20 and 22 had even higher gains) where N, S and B are applied every 5 years at a cost of $600/ha.

Table 24 Cumulative incremental responses from multiple fertilization treatments (Sx)

Fertilization Application	Stand Age at Treatment	Spruce Response (m^3/ha; 5 yrs after treat)	Efficiency
1	25	7	100%
2	30	49	100%
3	35	89	100%
4	40	132	100%
5	45	155	100%
6	50	176	100%

Sx response derived from information provided by the MFLNRO in the document "Intensive fertilization graphs.xlsx" (Rob Brockley email June 14,, 2012, Mel Scott/Ralph Winter email June15, July 28, 2012).

Table 25 Cumulative incremental responses from multiple fertilization treatments (Pl)

Fertilization Application	Stand Age at Treatment	Pine Response (m^3/ha; 10 yrs after treat)	Efficiency
1	25	12	100%
2	35	24	100%
3	45	36	100%
4	55	48	100%

Pl responses are simply multiples of the single treatment response.

Ten years following the corresponding fertilization treatments, stand yields were increased according to these responses (5 yrs for Sx). Again, due to the methodology for developing analysis units (section 3.5.1), some ineligible stands will be treated (i.e., Sx leading AUs includes the leading species: B, Ba, Bl, S, Sb, Se, Ss, Sw, and Sx).

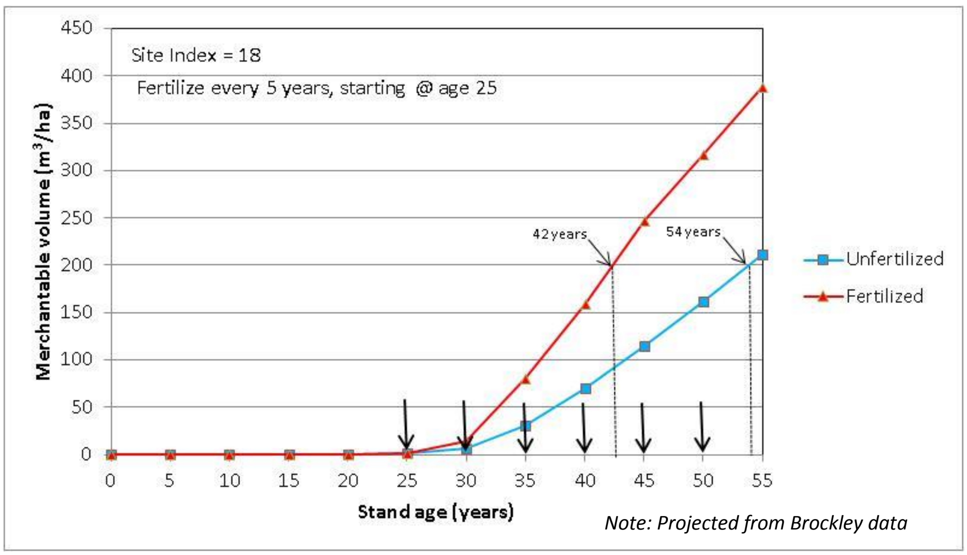

Figure 7 Intensive Sx fertilization response starting treatment at 25 yrs old

The following modelling assumptions were incorporated for the multiple fertilization strategy:

- Stands are assumed to be fully stocked and healthy.
- Responses were assumed to follow the same progression regardless of the stand age when the first fertilization was applied;
- Minimum harvest ages for applicable analysis units were reduced by 2 years per application;
- Harvest eligibility was delayed for 10 years following the final fertilizer application; and
- Application costs for Sx treatment were increased to $600 per hectare as different fertilizer blends are required to ensure an appropriate mix of micro-nutrients. Pl remains at $450/ha.

5.3 Pre-commercial Thinning / Cleaning Dense Pine

This silvicultural strategy examined the impact of pre-commercial thinning (PCT) dense Pl stands (typically 5,000 sph) between the ages of 10-20 years old down to a target density of 3,500 sph. The purpose of the treatment is to advance early operability in these stands and improve stand quality/health/resilience through leave tree selection.

Eligible stands for this strategy were identified using the criteria provided in Table 26.

Table 26 Criteria for the pre-commercial thinning of dense pine strategy

BEC Zones	Species Groups	SI Range	Existing Density Range (sph)
SBSdk, SBSmc	Pl leading	≥19	≥4,500

Approximately 20,700 ha of existing stand types were identified as eligible for this treatment under the cleaning of dense pine strategy.

The following assumptions were used in modeling this strategy:

- Minimum harvest ages for applicable analysis units were reduced by 3 years after treatment. Merchantable volumes were seen to only improve slightly as a result of the PCT but the average diameter of the prime 250 trees was seen to increase and is expected allow more economic harvesting and higher lumber recovery /ha.
- Treatment costs were applied at $800 per hectare, given that fewer trees are cut for this cleaning treatment compared to the density control standard required with PCT ($1100 per hectare from FFT Cost Benchmarks 2012).

5.4 Rehabilitating MPB Impacted Stands

This silvicultural strategy examines the impact to harvest flows from rehabilitating MPB impacted stands with little or no salvage opportunity. By ensuring unsalvaged stands are ameliorated and managed, this strategy is expected to increase late mid-term harvest levels.

Recovery of any merchantable (green) volume from these stands will support mid-term harvest levels while long-term harvest levels are improved because of the regeneration volumes are significantly improved. Rehabilitating damaged stands should also help to ensure issues such as watershed recovery were minimized – potentially improving mid-term harvest levels.

Following the salvage period of MPB-killed stands, conditions exist where stands will not recover to pre-attack conditions or minimum merchantability criteria (140 m^3/ha) within the planning horizon. Effectively, these stands cease to contribute to the working forest. Within this profile, a continuum of stands exists ranging from marginally economic to uneconomic:

- Marginally economic stands: some green volume and larger piece sizes to produce lumber, pulp chips and potentially bio-fuel feed stocks (similar for stands treated under the ITSL program).
- Uneconomic stands: younger, small-diameter trees, higher percent dead and long haul distances.

The challenge with this strategy involves identifying stands that would not otherwise regenerate to become operable on their own; thus maximizing the ROI. Moreover, the analysis data does not include some spatially-explicit, stand-level criteria required to distinguish the viability of some treatments. With no direct stand-level data to draw from, assumptions for this strategy were designed from opinions of local forest professionals.

Among other opportunities, the treatable areas project [15] identified MPB-impacted stands eligible for rehabilitation as: within the THLB, pine composition ≥50%, severe to very severe cumulative MPB impact (≥30% trees attacked), unlogged, unburned, site index ≥18m, slopes <30% and cycle time within 4 hours. For this analysis, however, eligible stands included all unlogged MPB-impacted stands

[15] Powelson, A. 2012. Treatable Area Project Methods. "FFT Potentially Treatable Areas – Nadina Forest District – 2012". BC Ministry of Forest, Range and Natural Resource Operations. http://lbis.forestpracticesbranch.com/LBIS/node/1045

(identified from the Base Case scenario) with at least 40% dead and greater than 40 yrs old at time of attack. It was assumed that younger stands offer little opportunity for rehabilitation treatments.

Treatments and costs associated with the rehabilitation strategy can vary considerably according to specific site characteristics. Again, with no quantitative information available for this strategy, local forest professionals provided opinions on a set of basic treatments off-set according to potential economic recovery from these stands. Treatments and costs were applied according to the amount of recoverable sawlog volume in the stand and distance cost criteria were added based on haul cycle times (see Table 27).

Table 27 Treatments and costs for rehabilitating damaged stands

Treatment	Marginal Economic (75-120 m³/ha)	Little Economic (50-75 m³/ha)	No Economic (<50m³/ha)
Knockdown and site prep	0	500	1000
Planting and brushing	1000	1000	1000
Total Cost (1)	**$1000/ha**	**$1500/ha**	**$2000/ha**

(1) Add distance costs: <5 hrs @ $0/ha, ≥5 & <7 hrs @ $50/ha, ≥7 hrs @ $250/ha

Responses for these treatments were modelled by transitioning stands onto future managed stands from the treatment date. Accordingly, these responses take advantage of improved OAFs, lower regeneration delay and select seed to produce higher yields that achieve minimum harvest volumes much sooner. These stand regeneration improvements will contribute to the long-term and potentially the final mid-term periods of the harvest flow.

5.5 Enhanced Basic Reforestation

Free growing guidelines set minimum standards for establishing stands with appropriate species selection, stocking, and specified requirements. This silvicultural strategy examined the impact to harvest flows from enhancing basic reforestation practices where current performance is not optimal (achieving minimum well-spaced trees/ha versus target well-spaced trees/ha). The objective of this approach is to increase timber volume and quality when these stands are harvested rather than exceeding minimum standards at free growing.

This strategy is unlikely to increase the mid-term harvest level as it will only influence stands regenerated in the future that will not be harvested for at least 45-50yrs from now. There may be some benefit to the back end of the mid-term trough but this strategy is expected to increase long-term harvest levels by improving well-spaced densities, reducing stocking gaps (OAF1) and achieving the benefits of Class A seed. This is expected to reduce minimum harvest ages, improve product quality, and help to address climate change concerns through species selection.

This strategy will increase initial well-spaced stand densities and reduce stocking gaps through a combination of site preparation, planting to higher densities, and/or fill planting as soon as ingress is complete. Planting would utilize Class A seed with volume gains associated with it. It will be implemented by increasing the planting density in TIPSY for planted stands, plus lowering OAF 1 to 10%, and incorporating planting to 800 sph plus ingress on naturally regenerating stands (Class A seed gains and shorter regeneration delay).

Eligible stands for this aggressive regeneration strategy are limited to the better sites within the TSA as described in Table 28.

Table 28 Criteria for enhanced basic reforestation

Objective	BEC Zones	Species	SI Range
intensive management	SBSdk, SBSmc	Pine leading	≥19
intermediate investment	SBSdk, SBSmc	Spruce leading	≥15
Fibre	All	All	≥15

Optimizing regeneration regimes for harvest volumes and values involved revisions to future yield assumptions. The most significant changes involved increasing initial establishment densities. The cost to achieve this strategy will be modeled as incremental planting costs of $0.57/tree x number of additional trees planted.

5.6 Harvest Sequencing

This silvicultural strategy examined the impact to harvest flows from adjusting the pattern and duration of the short-term uplift in order to maximize the mid-term harvest level. An uplift policy that targets harvesting of dead pine eventually leads to incidental harvesting of green trees from mixed stands of both live and dead trees. Accordingly, the longer this uplift is in place the more harvesting occurs of green trees that could otherwise be harvested within the mid-term. An appropriate transition from the current uplift to the mid-term is an important consideration for this TSA.

The harvest sequencing strategy adjusted the short-term uplift levels and duration to strike a balance between salvaging dead Pl and avoiding the harvest of green trees required to support higher mid-term harvest levels. Two approaches were explored:

- Immediate drop to a maximum mid-term harvest level
- Immediate step-down to a maximum mid-term harvest level

5.7 Composite Mix of Treatments

For this scenario, the model was configured to include assumptions from all of the previous strategies so that the model can select the timing and range of treatments that will produce the most appropriate outcome subject to an annual budget constraint of $5,000,000.

Appendix 1. Analysis Unit Details

Existing Natural Stand Analysis Units

ANALYSIS UNIT DESCRIPTION							
EN AU	FM AU	BEC	Species Group	Site Class	THLB Area	Burnt Area	THLB Pct
1001	3005	ESSFmc	BLL	M	5,460		1.6%
1002	3006		BLL	P	13,046		3.7%
1003	3002		DEL	A	0		0.0%
1004	3001		PLL	G	1,012	259	0.4%
1005	3002		PLL	M	18,306	21	5.2%
1006	3003		PLL	P	59		0.0%
1007	3001		PLP	G	646	34	0.2%
1008	3002		PLP	M	25,314	244	7.3%
1009	3003		PLP	P	99		0.0%
1010	3004		SXL	G	10,777	94	3.1%
1011	3005		SXL	M	4,712	16	1.3%
1012	3006		SXL	P	1,174		0.3%
1013	3010	SBSdk	BLL	M	574		0.2%
1014	3010		DEL	A	61		0.0%
1015	3009		OTL	G	134		0.0%
1016	3007		PLL	G	27,117	582	7.9%
1017	3008		PLL	M	2,551	76	0.7%
1018	3007		PLP	G	44,204	1,832	13.1%
1019	3008		PLP	M	3,543	425	1.1%
1020	3009		SXL	G	3,008	118	0.9%
1021	3010		SXL	M	23,021	249	6.6%
1022	3015	SBSmc	BLL	M	6,090		1.7%
1023	3015		DEL	A	19		0.0%
1024	3014		OTL	G	116		0.0%
1025	3011		PLL	G	3,183	153	1.0%
1026	3012		PLL	M	34,665	519	10.0%
1027	3013		PLL	P	54		0.0%
1028	3011		PLP	G	2,762	207	0.8%
1029	3012		PLP	M	70,088	2,354	20.6%
1030	3014		SXL	G	19,956	186	5.7%
1031	3015		SXL	M	21,353	47	6.1%
1032	3016		SXL	P	364		0.1%

Notes:

- *BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2)*
- *Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLP=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (S, Sb, Se, Sw, Sx); BLL=Balsam Leading (B, Ba, Bl ≥40%); OTL=Other Leading (Fd, Cw, Hw, Lw); DEL=Deciduous Leading (AT, AC, DR, EP≥40%)*
- *Site Classes (PHR Site Index): A=All; G=Good (≥19m); M=Medium (≥15m & <19m); P=Poor (<15m)*
- *To simplify the table, these analysis units do not include criteria that divide units further (e.g., Age class for MPB attacked stands, MPB impact classes, wildfire impacts)*

Existing Managed Stand Analysis Units and TIPSY Inputs

ANALYSIS UNIT DESCRIPTION									TIPSY INPUTS											
EM AU	FM AU	BEC	Species Group	Site Class	Stocking	THLB Area	BURN Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	OAF1	OAF2
2001	3001	ESSFmc	PLL	G	A	119		0.1%	PL	19.1	Natural	100	2	3500	Pl	50	Sx	50	0.85	0.95
2002	3002		PLL	M	A	6,546	63	3.6%	PL	16.7	Natural	100	2	2500	Pl	60	Sx	40	0.85	0.95
2003	3003		PLL	P	A	106		0.1%	PL	13.2	Natural	100	2	4500	Pl	50	Sx	50	0.85	0.95
2004	3002		PLP	M	A	5,266	227	3.0%	PL	16.8	Natural	100	2	2500	Pl	100			0.80	0.95
2005	3003		PLP	P	A	2,289		1.3%	PL	13.1	Natural	100	2	2500	Pl	100			0.80	0.95
2006	3004		SXL	G	A	1,234		0.7%	SE	16.9	Natural	100	2	2500	Sx	80	Pl	20	0.85	0.95
2007	3005		SXL	M	A	1,022		0.6%	SE	15.9	Natural	100	2	4500	Sx	80	Pl	20	0.85	0.95
2008	3006		SXL	P	A	846		0.5%	SE	14.6	Natural	100	2	3500	Sx	80	Pl	20	0.85	0.95
2009	3010	SBSdk	DEL	A	A	250		0.1%	PL	17.0	Natural	100	2	4500	Sx	60	Pl	40	0.85	0.95
2010	3007		PLL	G	C	11,491	159	6.4%	PL	19.8	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2011	3007		PLL	G	D	9,554	92	5.3%	PL	19.8	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2012	3007		PLL	G	O	852		0.5%	PL	19.9	Natural	100	2	800	Pl	60	Sx	40	0.85	0.95
2013	3007		PLL	G	T	3,218	47	1.8%	PL	19.8	Natural	100	2	5500	Pl	60	Sx	40	0.85	0.95
2014	3008		PLL	M	C	1,699	15	0.9%	PL	18.7	Natural	100	2	2500	Pl	60	Sx	40	0.85	0.95
2015	3008		PLL	M	T	139		0.1%	PL	18.5	Natural	100	2	6500	Pl	70	Sx	30	0.85	0.95
2016	3007		PLP	G	C	6,245	255	3.6%	PL	19.7	Natural	100	2	1500	Pl	90	Sx	10	0.80	0.95
2017	3007		PLP	G	D	5,190	129	2.9%	PL	19.8	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2018	3007		PLP	G	O	1,850	0	1.0%	PL	19.8	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2019	3007		PLP	G	T	5,929	19	3.3%	PL	19.8	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2020	3008		PLP	M	C	17,447	3,045	11.3%	PL	18.6	Natural	100	2	2500	Pl	100			0.80	0.95
2021	3008		PLP	M	D	201	1	0.1%	PL	18.6	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2022	3008		PLP	M	O	152	1	0.1%	PL	18.6	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2023	3008		PLP	M	T	382		0.2%	PL	18.7	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2024	3010		SXL	M	C	2,242		1.2%	SX	18.5	Natural	100	2	1500	Sx	70	Pl	30	0.85	0.95
2025	3010		SXL	M	D	1,633		0.9%	SX	18.5	Natural	100	2	3500	Sx	70	Pl	30	0.85	0.95
2026	3010		SXL	M	O	176		0.1%	SX	18.6	Natural	100	2	800	Sx	90	Pl	10	0.85	0.95
2027	3010		SXL	M	T	585		0.3%	SX	18.3	Natural	100	2	5500	Sx	70	Pl	30	0.85	0.95

ANALYSIS UNIT DESCRIPTION									TIPSY INPUTS											
EM AU	FM AU	BEC	Species Group	Site Class	Stocking	THLB Area	BURN Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	OAF1	OAF2
2028	3015	SBSmc	DEL	A	A	68		0.0%	BL	17.0	Natural	100	2	7500	Sx	70	Pl	30	0.85	0.95
2029	3011		PLL	G	C	744	9	0.4%	PL	19.3	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2030	3011		PLL	G	D	764		0.4%	PL	19.3	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2031	3011		PLL	G	T	146	3	0.1%	PL	19.3	Natural	100	2	6500	Pl	60	Sx	40	0.85	0.95
2032	3012		PLL	M	C	17,227	258	9.6%	PL	18.2	Natural	100	2	1500	Pl	60	Sx	40	0.85	0.95
2033	3012		PLL	M	D	12,781	36	7.0%	PL	18.3	Natural	100	2	3500	Pl	60	Sx	40	0.85	0.95
2034	3012		PLL	M	O	1,000	19	0.6%	PL	18.3	Natural	100	2	800	Pl	60	Sx	40	0.85	0.95
2035	3012		PLL	M	T	4,930		2.7%	PL	18.2	Natural	100	2	6500	Pl	60	Sx	40	0.85	0.95
2036	3013		PLL	P	A	172		0.1%	PL	13.7	Natural	100	2	2500	Pl	90	Sx	10	0.85	0.95
2037	3011		PLP	G	C	1,213	35	0.7%	PL	19.1	Natural	100	2	1500	Pl	90	Sx	10	0.80	0.95
2038	3011		PLP	G	D	434	2	0.2%	PL	19.2	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2039	3011		PLP	G	O	309		0.2%	PL	19.3	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2040	3011		PLP	G	T	137		0.1%	PL	19.3	Natural	100	2	7500	Pl	90	Sx	10	0.80	0.95
2041	3012		PLP	M	C	21,010	430	11.8%	PL	18.2	Natural	100	2	1500	Pl	100			0.80	0.95
2042	3012		PLP	M	D	10,701	50	5.9%	PL	18.2	Natural	100	2	3500	Pl	90	Sx	10	0.80	0.95
2043	3012		PLP	M	O	3,501	72	2.0%	PL	18.3	Natural	100	2	800	Pl	90	Sx	10	0.80	0.95
2044	3012		PLP	M	T	5,713	40	3.2%	PL	18.2	Natural	100	2	6500	Pl	90	Sx	10	0.80	0.95
2045	3014		SXL	G	C	2,743		1.5%	SX	19.3	Natural	100	2	1500	Sx	70	Pl	30	0.85	0.95
2046	3014		SXL	G	D	1,005		0.6%	SX	19.3	Natural	100	2	2500	Sx	70	Pl	30	0.85	0.95
2047	3014		SXL	G	O	104		0.1%	SX	19.2	Natural	100	2	800	Sx	80	Pl	20	0.85	0.95
2048	3014		SXL	G	T	154		0.1%	SX	19.2	Natural	100	2	6500	Sx	80	Pl	20	0.85	0.95
2049	3015		SXL	M	C	1,953		1.1%	SX	18.9	Natural	100	2	1500	Sx	80	Pl	20	0.85	0.95
2050	3015		SXL	M	D	2,046		1.1%	SX	18.9	Natural	100	2	3500	Sx	80	Pl	20	0.85	0.95
2051	3015		SXL	M	O	392		0.2%	SX	18.8	Natural	100	2	800	Sx	80	Pl	20	0.85	0.95
2052	3015		SXL	M	T	1,221		0.7%	SX	18.8	Natural	100	2	6500	Sx	70	Pl	30	0.85	0.95

Notes:

- *BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2)*
- *Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLP=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); DEL=Deciduous Leading (At, Ac, Dr, Ep ≥40%)*
- *Stocking Classes (Total Stems): A=All; O=Open (0 to <1000 sph), C=Closed (1,000 to <2,500 sph), D=Dense (2,500 to <4,500 sph), T=Thick (4,500 to <25,000 sph), R=Repressed (≥25,000 sph)*
- *Site Classes (PHR Site Index): A=All; G=Good (≥19m); M=Medium (≥15m & <19m); P=Poor (<15m)*
- *Natural regeneration methods were applied to reflect the spatial pattern of trees at establishment. Stands were actually regenerated using both artificial and natural methods.*
- *As existing managed stands were configured in TIPSY with only natural regeneration methods, genetic gains were not applied.*
- *The analysis units described here do not include criteria that divide units further (e.g., Age class for MPB attacked stands, MPB impact classes, Wildfire impacts)*

Future Managed Stand Analysis Units and TIPSY Inputs

ANALYSIS UNIT DESCRIPTION						TIPSY INPUTS														
FM AU	BEC	Species Group	Site Class	THLB Area	THLB Pct	PHR Spc	PHR SI	Regen Method	Pct	Delay (yrs)	Establish Density	Spc1	Pct1	Spc2	Pct2	Spc3	Pct3	OAF1	OAF2
3001	ESSFmc	PLL	G	2,069	0.4%	PL	19	Plant	100	2	1500	Pl	60	Bl	20	Sx	20	0.85	0.95
3002		PLL	M	55,986	10.5%	PL	17	Plant	100	2	1500	Pl	50	Bl	30	Sx	20	0.85	0.95
3003		PLL	P	2,554	0.5%	PL	14	Plant	100	2	1500	Pl	40	Bl	40	Sx	20	0.85	0.95
3004		SXL	G	12,109	2.3%	SX	19	Plant	100	2	1500	Sx	40	Bl	40	Pl	20	0.85	0.95
3005		SXL	M	11,207	2.1%	SE	17	Plant	100	2	1500	Sx	40	Bl	40	Pl	20	0.85	0.95
3006		SXL	P	15,065	2.8%	SE	14	Plant	100	2	1500	Bl	60	Sx	20	Pl	20	0.85	0.95
3007	SBSdk	PLL	G	119,117	22.3%	PL	20	Plant	100	2	1500	Pl	70	Sx	30			0.85	0.95
3008		PLL	M	29,771	5.6%	PL	19	Plant	100	2	1500	Pl	60	Sx	40			0.85	0.95
3009		SXL	G	3,472	0.7%	SX	19	Plant	100	2	1500	Sx	70	Pl	30			0.85	0.95
3010		SXL	M	28,134	5.3%	SX	18	Plant	100	2	1500	Sx	70	Pl	30			0.85	0.95
3011	SBSmc	PLL	G	10,316	1.9%	PL	19	Plant	100	2	1500	Pl	70	Sx	30			0.85	0.95
3012		PLL	M	185,385	34.8%	PL	18	Plant	100	2	1500	Pl	60	Sx	40			0.85	0.95
3013		PLL	P	226	0.0%	PL	14	Plant	100	2	1500	Pl	50	Sx	50			0.85	0.95
3014		SXL	G	24,148	4.5%	SX	19	Plant	100	2	1500	Sx	60	Pl	40			0.85	0.95
3015		SXL	M	33,056	6.2%	BL	16	Plant	100	2	1500	Sx	70	Pl	30			0.85	0.95
3016		SXL	P	408	0.1%	SX	14	Plant	100	2	1500	Sx	80	Pl	20			0.85	0.95

Notes:

- *BEC Groups: ESSFmc (ESSFmc/mv1/mv3/mvp/mcp/BAFAun); SBSdk (SBSdk/dw3/wk3); SBSmc (SBSmc2)*
- *Species Groups: PLP=Pure Pine (Pl, Pa ≥ 80%); PLP=Pine Leading (Pl, Pa ≥ 40% & <80%); SXL=Spruce Leading (Sb, Se, Sw, Sx, Ba, Bl ≥40%); DEL=Deciduous Leading (At, Ac, Dr, Ep ≥40%)*
- *Site Classes (PHR Site Index): A=All; G=Good (≥19m); M=Medium (≥15m & <19m); P=Poor (<15m)*
- *Planting regeneration methods were applied to reflect the spatial pattern of trees at establishment. Stands were actually regenerated using both artificial and natural methods.*
- *Genetic Gains were applied accordingly: 7.7% to Pine (all BEC Groups) and 13.2% to Spruce (Only SBSdk & SBSmc BEC Groups)*
- *The analysis units described here do not include criteria that divide units further (e.g., Age class for MPB attacked stands, MPB impact classes, Wildfire impacts)*