Type 4 Silviculture Strategy

Data Package – 100 Mile House TSA

Version 2.3

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1 Introduction

1.1 Context

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

1. 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.
2. **Data Package - describes the information that is material to the analysis including the model used, data inputs and assumptions.**
3. Modeling and Analysis report –provides modeling outputs and rationale for choosing a preferred scenario.
4. Silviculture Strategy –provides treatment options, associated targets, timeframes and benefits.

1.2 Project Objectives

The Ministry of Forests, Lands and Natural Resource Operations (MFLNRO) has initiated a type 4 silviculture strategy for the 100 Mile House timber supply area (TSA). The strategy will help MFLNRO work towards the government's strategic objectives such as:

- Best return from investments and activities on the forest and range land base;
- Encourage investments to benefit forest and range resources;
- Manage the pest, disease and wildfire impacts;
- Mitigate mid-term timber supply shortage caused by the MPB;
- Maximize timber growth in the provincial forests.

The silviculture strategy will be a result of collaboration and sharing of ideas involving MFLNRO Victoria staff, MFLNRO local staff, other government and industry stake holders, and other professionals. The ultimate goal is a realistic strategy that will be owned and championed by district staff and licensees. In particular, this strategy will produce:

- A fully rationalized plan to guide the expenditure of public silviculture funds to improve the future timber supply and habitat supply in the 5 management units;
- A plan with a consistent format and content so that expanding it to regional and provincial levels is feasible and so that comparisons between management units are possible;
- A plan containing the right information in the right format so that it can be utilized by government and industry for resource management related decision making;
- Silviculture regimes and associated standards that may potentially be adopted in forest stewardship plans as required standards for basic silviculture operations.

1.3 Study Area

The 100 Mile House Timber Supply Area (TSA), about 1.23 million hectares in size, is located in south-central British Columbia. The TSA boundaries are identical to those of the 100 Mile House Resource District, which is one of four districts in the Cariboo Region. The TSA is bounded on the west by the Fraser River, on the east by the Cariboo Mountains and Wells Grey Park, on the north by the Williams Lake TSA, and on the south by the Kamloops TSA.

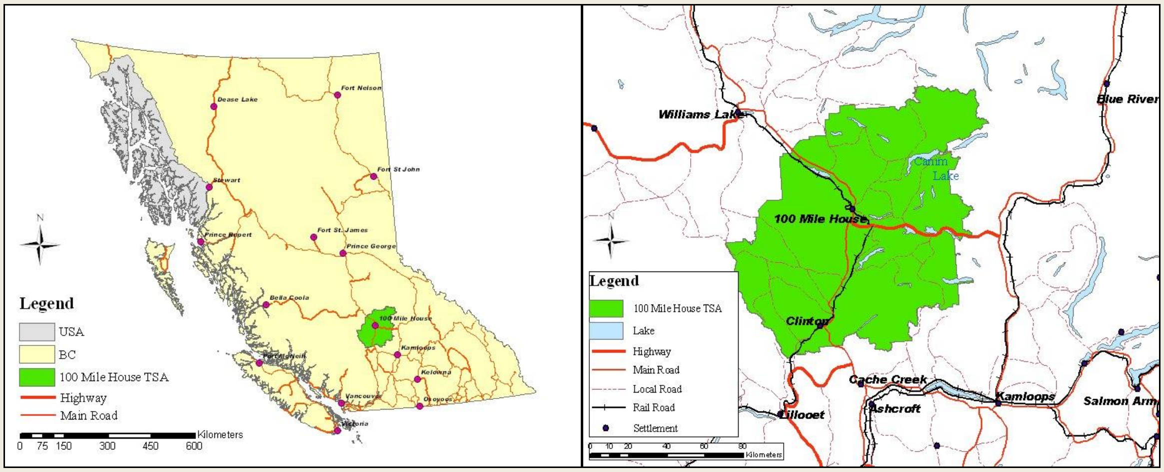

Figure 1: Location of 100 Mile House TSA

The climate in the 100 Mile House TSA is variable and affected by the diverse topography. The TSA has two mountain ranges, one in the southwest and the other in the northeast. These ranges are divided by a flat plateau. The climate in the west is hot and dry, while the eastern parts of the TSA can receive significant amounts of precipitation.

The dominant tree species are lodgepole pine and Douglas-fir with other tree species occurring such as spruce, subalpine fir (balsam), western redcedar, western hemlock and broadleaf species.

The dominant biogeoclimatic zone variants in the 100 Mile House TSA are interior Douglas fir (IDF) forest types with sub-boreal spruce (SBS) forest types. Some englemann spruce-subalpine fir (ESSF), interior cedar-hemlock (ICH) and montane spruce (MS) types also exist (Figure 2).

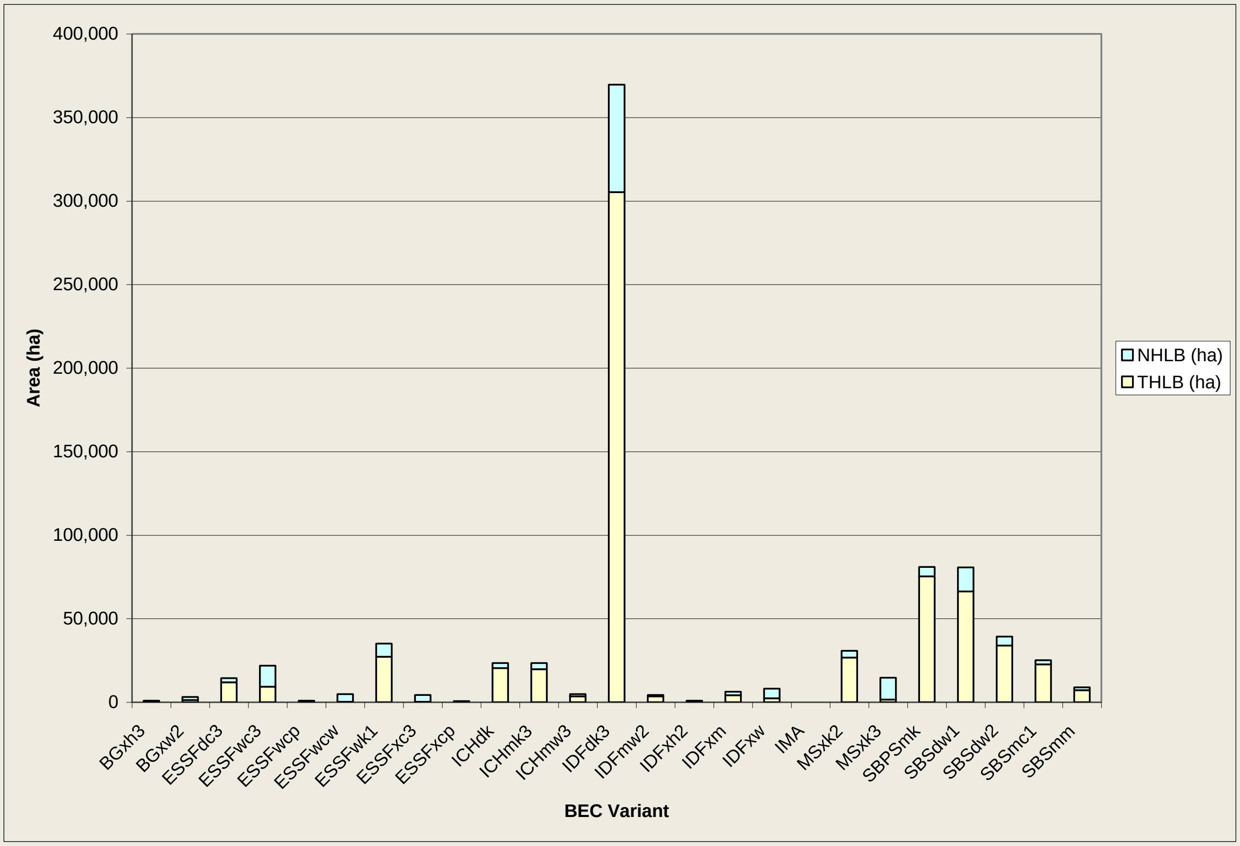

Figure 2: BEC variants in the 100 Mile House TSA

The productivity of the growing sites in the 100 TSA is average compared to other BC interior TSAs. Table 1 shows the average site indices for natural and managed stands for different species groups.

Table 1: Average site productivity in the 100 Mile House TSA

Site Index Type	Balsam	Pine	Spruce	Douglas fir	Broadleaf
VRI Site Index Average (THLB):	12.46	14.22	15.83	13.11	16.41
SIBEC average (THLB):	17.11	19.11	18.66	18.96	19.68

1.3.1 Cariboo-Chilcotin Land Use Plan (CCLUP)

Natural resource management in the 100 Mile House TSA is directed by the Cariboo-Chilcotin Land Use Plan (CCLUP) and associated Land Use Order (April 18, 2011) and guiding documents. It is a legal higher level plan established by cabinet under the Forest Practices Code in January 1996. It covers 100 Mile House, Quesnel and Williams Lake TSAs. The plan is a representation of economic, social and environmental values of the people and communities in the region. Sub-regional level planning further refined and mapped land uses and was carried out in consultation with industry, interest groups and local First Nations. The plan consists of specific land use designations, such as Old Growth Management Areas (OGMAs), that direct operations and are accounted for in timber supply reviews and subsequent annual allowable cut (AAC) determinations.

2 Current Situation

2.1 Timber Supply Issues

2.1.1 Historical and Current AAC

The current AAC in the 100 Mile House TSA is 2.0 million m^3 per year. It was increased in 2006 from 1.334 million m^3 (Table 2) in response to the MPB epidemic, to facilitate salvage of the attacked pine stands. It is expected that 90 % of the harvested volume comes from stands with at least 70 % pine component.

Table 2: Historical and current AAC (million m^3)

1996	2002	2006	Current
1.362	1.334	2.0	2.0

The harvest performance in the TSA has mostly met expectations; from 2007 to 2011 the average annual harvest level in the 100 Mile House TSA was 2.01 million cubic metres of which 78% was pine and 90% was from pine-leading stands.

2.1.2 Age Class Distribution

The current age class distribution for the 100 Mile House TSA is presented in Figure 3. The increased harvest due to the MPB salvage is reflected in the age class distribution. 21% of the THLB is between 0 and 20 years old and 39% of the THLB is younger than 41 years of age. Age class 3 and 4 are under – represented at 7.4% and 4.8% of the THLB respectively, which characterizes the timber supply problem in the TSA; these age classes are the potential sources for the mid-term timber supply.

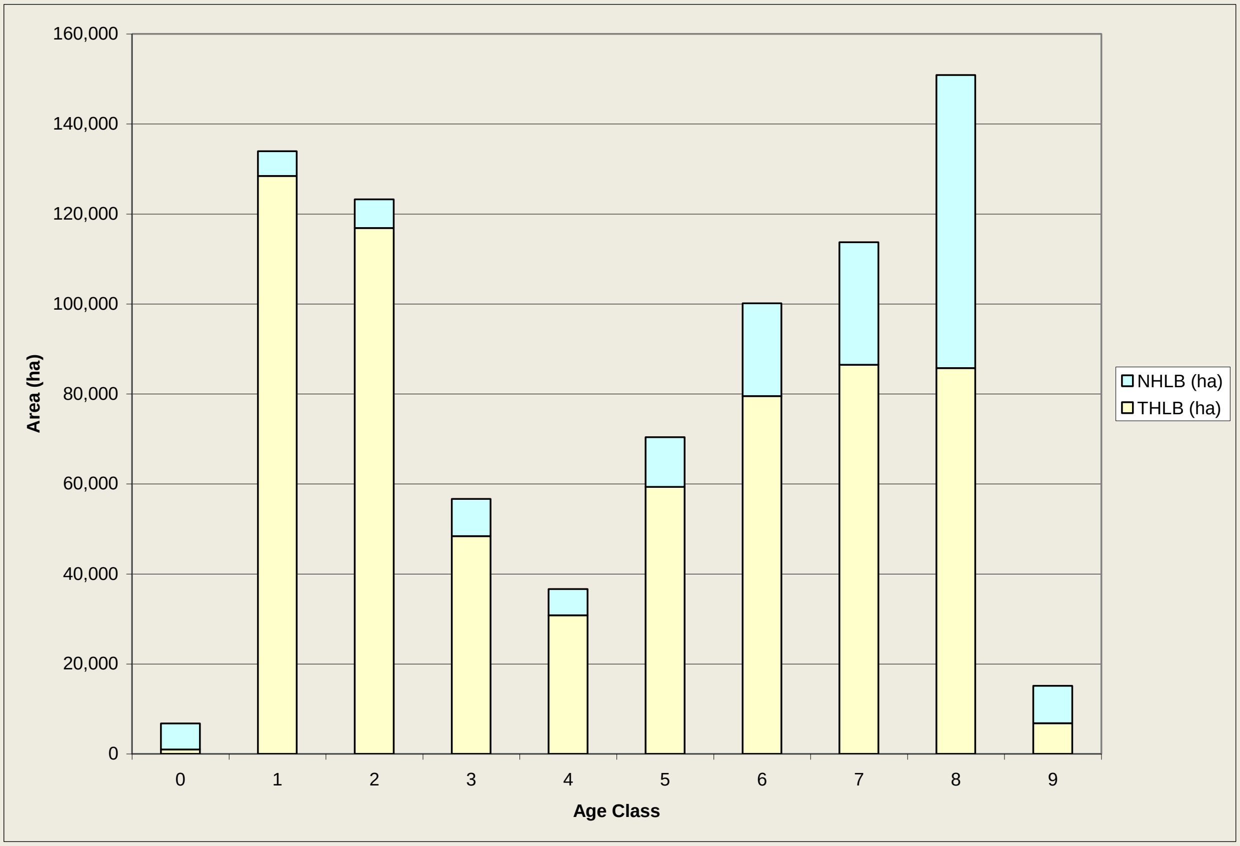

Figure 3: Current age class distribution in the 100 Mile House TSA

2.1.3 Current Timber Supply Situation

The latest version of the British Columbia Mountain Pine Beetle Model (BCMPB v9) predicts a total mature pine kill of 41.6 million cubic metres for the 100 Mile House TSA by 2021. This is approximately 73% of the mature pine that was on the timber harvesting land base in 1999.

Douglas-fir bark beetle, spruce bark beetle and balsam bark beetle also impact the timber supply. The current management direction is to give first harvest priority to pine stands with a pine component greater than 70% and spruce stands with the White spruce/Engelmann spruce (Sw/Se) component greater than 70%. Prioritizing the harvest of spruce stands is intended to prevent the spread of spruce beetle.

The on-going timber supply review (TSR) for the 100 Mile House TSA has presented a public discussion paper (PDP) with a proposed base case (MFLNRO, 2013). In the base case, the initial harvest volume of 2.0 million m^3/year (current AAC) can be maintained for 7 years; at year 8 the harvest level must be reduced to the mid-term level of 865,000 m^3 per year where it is predicted to stay until year 60, when the long-term harvest level of 1,400,00 m^3 per year is reached.

The TSR base case predicts a significant mid-term trough for about 50 years; the mid-term timber supply at 865,000 m^3 per year is approximately 35% lower than the mid-term harvest forecast of 1.3 million m^3 per year presented in TSR 2 before the MPB infestation. The mid-term forecast is lower due to mortality and accelerated short-term harvest of mostly pine leading stands.

The base case assumed that dead pine trees would be available for harvest up to 15 years of death. The PDP presented several sensitivity analyses: the mid-term timber supply was somewhat sensitive to a shorter shelf life of the dead pine trees. Reducing the shelf life to 10 years reduced the mid-term timber supply by 6%.

Approximately 25% of the predicted harvest volume during the first 7 years in the base case is assumed to come from live stands. 300,000 m^3 per year of this harvest is predicted to be spruce while the remaining 200,000 m^3 per year is forecasted to come from green pine stands. The dead pine stands are predicted to form the majority of the short-term harvest at 1,500,000 m^3 annually.

2.2 Timber Quality Issues

Managed pine leading stands will start contributing to timber supply within the next 30 to 40 years. By the end of the mid-term, it is expected that most of the harvest will consist of managed pine leading stands. The health, quality and yield of these stands are paramount to the late mid-term timber supply and affect the viability of potential silviculture investments. Unfortunately, a significant component of these stands has also been impacted by the MPB, resulting in low residual stocking numbers of poorer quality. As such, the future available volume from these stands will likely be impacted.

Most timber supply forecasts predict a decrease in the age of harvested stands over time due to shorter rotations of second growth managed stands. The MPB induced mid-term timber supply deficit will likely accelerate this trend as young managed stands will be the primary source of harvest during the end of the mid-term. Timber quality and the average piece size may decrease as a result of the predicted shorter rotations.

Incremental silviculture can potentially mitigate the predicted negative timber quality impacts. It is relatively easy to increase the average piece size at harvest; however, this is usually accomplished at some cost to harvest volumes. It is more difficult and expensive to create desired taper and clear logs.

2.3 Other Issues

A large part of the post salvage harvest will come from Douglas-fir leading dry belt stands. It is important to gain a better understanding on the health and vigour of these stands in relation to natural disturbance and potential harvesting opportunities.

Where harvesting in UWR and WHAs is permitted, the law requires the use of selection silvicultual systems. This is challenging and costly; therefore, harvesting in these areas is avoided.

In areas where clear-cutting with reserves of Douglas-fir stands is practised, too much pine regeneration is created resulting in a greater than the desired pine regeneration component.

3 Modelling Approach

3.1 Model

For this analysis Forest Simulation Optimization System (FSOS) is used for modelling. FSOS can operate as both a simulation and a heuristic optimization model using the same database. Simulation allows for sensitivity analysis and utilizes a hard constraint-based approach. Optimization is a target-oriented approach representing a shift in modeling approach from “what can we take from the forest” to “what can we create in the forest.” Blocking and scheduling is conducted separately in simulation, and simultaneously in optimization. Scheduling in simulation progresses one period at a time, while optimization planning considers all periods at the same time. Data can be spatial and/or non-spatial. FSOS accommodates overlapping resource values and constraints and can account for multiple values such as timber, silvicultural treatments, carbon allocation, biodiversity, wildlife, and visual quality. Algorithms employed in FSOS include simulated annealing, Tabu search algorithms, and Hill Climbing.

3.2 Data Sources

This analysis is based on the current 100 Mile House TSA TSR. The TSR was initiated in 2011 and is ongoing. Gordon Nienaber of the Forest Analysis and Inventory Branch (FAIB), Ministry of Forests, Lands and Natural Resource Operations provided the required data, most of it in ESRI shapefile format.

Table 3 lists all the data layers used in the analysis. For more information, refer to the 100 Mile House Timber Supply Area Timber Supply Review Data Package (January 2012) published by the Ministry of Forests, Lands, and Natural Resource Operations; link:
http://www.for.gov.bc.ca/hts/tsa/tsa23/current_2012/23tsdp12.pdf

Table 3: Spatial Data Sources

File Name	Description/Notes	Source	Source Data Format
bcmpb_v9	Mountain Pine Beetle outbreak projection	MFLNRO	ESRI GRID
bec	BEC where no PEM, otherwise PEM BEC was used	FAIB	Shapefile
bnd	TSA Boundary	FAIB	Shapefile
canim_fnwl	Canim Lake First Nation Replaceable Forest Licence	FAIB	Shapefile
clinton_cfa	Clinton Community Forest Area	FAIB	Shapefile
cutblocks	Depletion Coverage: Shapefile contains records from 1945 - 2011, and from FTEN, LANDSAT, RESULTS and VRI	FAIB	Shapefile
cws	Community Watersheds	FAIB	Shapefile
fl	Woodlot Data	FAIB	Shapefile
goal2	Parks Data		Shapefile
hmhwshedrisk	Watershed Risk	FAIB	Shapefile
lu	Landscape Units and BEOs	FAIB	Shapefile
lup	Cariboo Chilcotin Landuse Plan (CCLUP)	FAIB	Shapefile
grassland	Grassland	extracted from CCLUP	Shapefile
lkshr_mgmt	Lakeshore Management Zones (200m)	extracted from CCLUP	Shapefile

File Name	Description/Notes	Source	Source Data Format
scenic_areas	Scenic Areas, VQO	extracted from CCLUP	Shapefile
scenic_corr	Scenic Corridors	extracted from CCLUP	Shapefile
trail_areas	Recreational Trails Buffers	extracted from CCLUP	Shapefile
mpb100	Mountain Pine Beetle kill, cycle time, wildfire data from 2002 to 2010; processed and clipped to TSA boundary by FESL	MFLNRO	GRID, Geodatabase
ogma	Old Growth Management Areas: Shapefile provided contains the combined records for permanent, rotational and transitional OGMAS	FAIB	Shapefile
operability	Operability (based on slope class)	FAIB	GRID
own	Ownership	FAIB	Shapefile
pem_hm	Predictive Ecosystem Modelling, BEC	FAIB	E00
roads_10m	Digital Road Atlas (buffered, total buffer width 10m)	LRDW	Shapefile
sibec	Province-wide Raster SIBEC site indices by species	MFLNRO	GRID, Geodatabase
snowpack	Snowpack (tied to Ungulate Winter Range)	FAIB	Shapefile
stst_5-003	Habitat Type (tied to Ungulate Winter Range	FAIB	Shapefile
uwr	Ungulate Winter Range	FAIB	Shapefile
vri	Vegetation Resource Inventory	FAIB	Shapefile
wha	Wildlife Habitat Areas	FAIB	Shapefile

3.2.1 Forest Inventory

The current forest inventory in the 100 Mile House TSA is mostly a vegetation resource inventory (VRI) converted from the old forest cover inventory (FC1). Only 17% of the VRI is new phase 1 VRI. The inventory was projected to January 1, 2011 by LRDW and projected further (Jan 1 2013) by FESL to reflect the starting date of the analysis.

Depletions were updated from the RESULTS data base with the latest update date of March 31, 2012. All the recent fires were incorporated in the data.

3.2.2 MPB

The latest MPB outbreak projection (BCMPB v.9) was used to model the MPB.

3.2.3 Site Index

Predictive ecosystem mapping covers the 100 Mile House TSA. SIBEC based site indices were used for modelling managed stands. The site indices were provided by the Forest Analysis and Inventory Branch through the provincial site index layer.

4 Base Case Scenario

4.1 Key Assumptions

The following key assumptions are employed in this analysis:

- Silviculture opportunity evaluation is not limited by factors such as the availability of funding, 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.
- Mountain pine beetle populations have moved from epidemic to endemic levels, and no additional large scale mortality will occur.

4.2 Land Base Assumptions

We have attempted to duplicate all the relevant land base assumptions of the on-going 100 Mile House Timber Supply Area Timber Supply Review. However, differences exist due to GIS platform differences; the data for the on-going TSR for the 100 Mile House TSA was prepared in a raster environment, while our analysis is based on a vector dataset.

Land base assumptions define the crown forested 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 contributes toward meeting non-timber objectives such as biodiversity.

A netdown is the process in which areas are removed from the total land base in order to determine the CFLB and the THLB. The removal process is attribute-based (netdown factors), and an area can theoretically be removed from the CFLB or THLB for more than one reason as a result of overlapping resource issues. In practise, however, once an area has been removed, it cannot be deducted again further along in the process.

A netdown is sensitive to the order in which the netdown factors are applied; a different netdown order will return different net areas removed for the various netdown factors, however, the final CFLB and THLB areas will be the same. We have duplicated the netdown order of the on-going 100 Mile House TSA TSR when possible to make netdown comparisons meaningful.

The 100 Mile House TSA land base classification is as follows:

Excluded Land Base (EXLB): this category includes non-crown owned or managed lands, as well as non-forested areas and roads. The total land base less the EXLB returns the CFLB.

Crown: in accordance with the netdown for the 2011 100 Mile House TSA TSR, we have listed the crown-owned and –managed portion of the total land base as a separate entity. This category does include non-forest and roads.

Crown Forested Land Base (CFLB): this category represents the total forested areas under crown management.

Non-Harvestable Land Base (NHLB): this category represents the portion of the CFLB where, following current forest practises, harvesting will not or cannot occur. The NHLB includes areas that are currently not harvestable due to economic considerations, meaning that the possibility exists that at least some of NHLB might become harvestable under different economic conditions.

Timber Harvesting Land Base (THLB): this category represents the productive forested land where harvesting is possible based on current legislation and current forest practices.

The results of the netdown are shown in Table 4; these reductions are described below (Table 5, Table 6, Table 7, Table 8 and Table 9) in further detail (areas listed are gross areas and not additive to Table 4).

Table 4: 100 Mile House Netdown Summary

Description	Gross Area (ha)	Net Area removed (ha)
Total Area	1,237,629	1,237,629
Non-Crown Land	161,159	161,159
Woodlots and K2W	47,880	5,026
Clinton Community Forest Agreement	65,444	65,290
Canim Lake First Nations Replaceable Forest Licence	21,444	21,416
Crown-Owned Land		**984,738**
Non-Forest - Rock	30,427	26,297
Non-Forest - Water	58,458	54,711
Non-Forest - Vegetated	120,219	61,518
Existing Roads (semi-spatial)	19,123	11,963
Crown Forested Land Base (CFLB)		**830,249**
Non-THLB Crown Lands	54,387	43,584
Non Commercial	1,563	530
OGMA (Permanent and Rotational)	109,749	80,075
Parks (Goal 2 Protected Areas)	5,714	2,340
Slope (inoperable > 70%)	11,251	2,668
Slope (cable >50% and <70%)	27,014	3,849
Low Productivity Site	14,399	5,375
Wildlife Habitat Areas	19,655	10,012
Class A Lake Buffers	6,062	999
Riparian Reserve and Management Zones	24,753	15,372
Recreation Trails	6,797	3,342
Timber Harvesting Land Base (THLB)		**662,103**
WTP reduction (for modelling only)	138,679	138,679
Timber Harvesting Land Base (THLB) for model		**523,524**

4.2.1 Non-Crown Land

Several categories of non-crown land were excluded from the CFLB. These areas were excluded based on their ownership codes and include privately owned lands, federal and Indian reserves, woodlot licences, community forests and miscellaneous leases. These areas are shown in Table 5.

Table 5: Lands not managed by the BC Forest Service (based on ownership codes)

Ownership Class	Ownership Code	Total Area (ha)
Private Land	40N	116,673
Federal Reserve	50N	902
Indian Reserve	52N	5,312
Woodlot Licence	77B	19,826
Community Forest	79B	18,305
Miscellaneous Leases	99N	142
Total		161,160

4.2.2 Additional Woodlots and other Non-Crown Owned or Crown Managed Lands

An additional dataset containing woodlot licences was provided. This dataset included additional woodlots (Schedule A and Schedule B) not yet incorporated into the most recent ownership coverage, as well as a Schedule B area identified as K2W. Other areas removed as non-crown owned or crown managed were the areas covered by the Clinton Community Forest Agreement, and the Canim Lake First Nations Replaceable Forest Licence. The areas removed are shown in Table 6.

Table 6: Additional Lands not owned or managed by the BC Forest Service

Additional Lands not owned or managed by the Crown	Total Area (ha)
Woodlots (Schedule A)	2,975
Woodlots (Schedule B)	26,339
K2W	18,566
Clinton Community Forest Agreement	65,444
Canim Lake First Nations Replaceable Forest Licence	21,444
Total	134,768

4.2.3 Non-Forest

Three categories of Non-Forest lands were identified based on the British Columbia Land Classification System (BCLCS), which is part of the Vegetation Resource Inventory (VRI): rock, water and vegetated but non-treed. To ensure that areas previously harvested were not removed as vegetated non-treed areas, areas identified as having been harvested were considered forested. For this purpose, FAIB provided a depletion coverage (cutblocks), which includes harvesting data up to May 05, 2011. Non-Forest areas are shown in Table 7.

Table 7: Non-Forest Lands (based on BCLCS and RESULTS)

Non-Forest Lands	Total Area (ha)
Non-Forest Water	58,457
Non-Forest Rock (not vegetated)	30,427
Non-Forest Vegetated Non-Treed without harvesting history	120,219
Total	209,103

Table 8 shows the areas that BCLCS classifies as Non-Forest Vegetated Non-Treed, but have been considered forested and are contributing to the CFLB.

Table 8: Areas classified by BCLCS as Non-Forest Vegetated Non-Treed but with a history of harvesting

Decade	Source of Harvesting Data (Areas in ha)				Total Area (ha)
	FTEN	LANDSAT	RESULTS	VRI	
Unknown	0	0	2	4,057	4,059
1950-1959	0	0	0	707	707
1960-1969	0	0	240	3,319	3,559
1970-1979	0	0	16,170	1,724	17,894
1980-1989	0	0	39,646	2,412	42,058
1990-1999	7	0	44,270	1,417	45,694
2000-2009	197	151	37,777	829	38,954
2010-2011	7	3	314	0	323
All	**210**	**154**	**138,419**	**14,466**	**153,249**

4.2.4 Existing Roads

A digital road buffer dataset in raster format was provided by FAIB; however, as we compiled our analysis dataset as a vector dataset, the raster-based road buffer data proved unworkable and a vector based road buffer dataset was built from the original Digital Road Atlas (DRA) files. A constant road buffer with of 10m (total width, 5m to each side of the road centreline) was applied.

The road buffer data was added to the resultant dataset "semi-spatially"; the percentage of the resultant polygon that is road was calculated. This methodology conserves the exact total road area without adding additional and usually small polygons to the resultant dataset. This percent reduction was applied in the netdown and the road area removed from the CFLB. Table 9 shows properties of the various road classes (by surface type, buffer width applied, total length and total area).

Table 9: Road Classes, Lengths and Areas

Road Classes (by Road Surface)	Buffer Width (m)	Total Length (km)	Total Area (ha)*
Loose	10	4,059	4,059
Overgrown	10	457	457
Paved	10	704	704
Rough	10	14,003	14,003
Total	10	19,223	19,223

* The total area as mathematically calculated; the actual total GIS area is 19,123ha due to overlap between the various classes at intersections.

4.2.5 Non-THLB Crown Lands

While all provincially owned lands are considered to contribute to non-timber objectives, only forests on land classified as 62C or 69C contribute to the THLB. Hence, all other provincially owned lands were removed from the THLB. Table 10 shows the provincially owned lands not contributing to the THLB.

Table 10: Provincial Lands not contributing to the THLB

Ownership Class	Ownership Code	Total Area (ha)
Crown Ecological Reserve	60N	239
Crown UREP (Use, Recreation and Enjoyment of the Public) Reserves	61C	404
Crown UREP (Use, Recreation and Enjoyment of the Public) Reserves	61N	1,703
Crown Provincial Park Class A	63N	48,040
Crown Miscellaneous Reserves	69N	4,001
Total		54,387

4.2.6 Non-Commercial Forests

Cottonwood, juniper and whitebark pine leading stands have been identified as non-commercial species in the 100 Mile House TSA. While contributing to the CFLB, they were removed from the THLB. Table 11 shows the areas of non-commercial leading stands.

Table 11: Non-Commercial Forest

Species Group	Leading Species	Total Area (ha)
NonComm	AC or ACT	694
NonComm	JR	457
NonComm	PA	411
Total		1,563

4.2.7 Old Growth Management Areas

OGMAs contribute to biodiversity objectives and will be managed as per the CCLUP.

Conditional harvesting is allowed in OGMAs as described in the CCLUP and Section 7 of the 100 Mile House SRMP. Salvage of the dead trees in pine and mixed-pine stands is allowed by approval from the Regional Biodiversity Conservation Committee as a one-time draw down allowing seral stage levels temporarily below desired CCLUP targets. The *Strategy for Management of Mature Seral Forest and Salvage of Mountain Pine Beetle Killed Timber* is provided in the Biodiversity Conservation Strategy Update Note #8. The strategy acknowledges that in some cases, MPB mortality may result in deficits of mature and old seral stages. The update specifies harvest and establishes mature and old recruitment strategies as well. Rotational and permanent OGMAs will only be excluded from the THLB by 90% to reflect the one-time draw down.

Transitional OGMAs will remain until replaced by older forest in a LU-BEC unit or until the year 2030 at which time they will be available for harvest. In the analysis, transitional OGMAs were included in the timber harvesting land base. The area of transitional OGMAs and any additional areas required to meet seral stage objectives will be modelled by reserving mature and old areas in the timber supply model. Table 12 lists OGMA area in the 100 Mile House TSA.

Table 12: Old Growth Management Areas

Type of OGMA	% Removed from the THLB	Total Area (ha)
Permanent	90%	106,504
Rotational	90%	3,245
Transitional	0%	45,847
Total		155,596

4.2.8 Goal 2 Protected Areas

Goal 2 Protected Areas identify candidate areas proposed for establishment as per the Protected Area Strategy of British Columbia (1993, http://www.env.gov.bc.ca/bcparks/aboutBCParks/prk_desig.html); these areas are intended to protect special features within the region. 29 areas ranging in size from 0.1 ha to 2,241.2 ha have been identified and have been removed from the THLB. The total area removed is 5,714 ha.

4.2.9 Inoperable Areas

Inoperable areas are based on slope class as calculated by GIS. FAIB provided a raster-based dataset, which was converted to vector. Slopes steeper than 70% are deemed inoperable, and were removed from the THLB, while many stands on slopes between 50% and 70% can be accessed and harvested with cable-based systems. Accordingly only 50% of the area in this slope class was removed from the THLB. Table 13 lists the operability classes and areas.

Table 13: Inoperable Areas

Slope/Operability Class	Description	Reduction (%)	Harvest System	Total Area (ha)
0 - Operable	Slope <= 50%	0	Ground Skidding	1,199,364
1 - Partially Operable	Slope > 50% and <= 70%	50	Cable Yarding	27,014
2 - Not Operable	Slope > 70%	100	None	11,251
Total				1,237,629

4.2.10 Low Timber Growing Potential

Stands growing on sites with low productivity were removed from the THLB. These sites were identified based on the Python script obtained from Gordon Nienaber, **not** on the lookup table in the 2011 100 Mile House TSA TSR data package (*Table 7: Description of sites with low timber growing potential*). The script identified low productivity sites based on site index. The site index used as the cut-off was the higher of either the VRI site index or SIBEC. Table 14 lists the areas removed due to low site productivity.

Table 14: Low Site Productivity Stands

Leading Species	MaxSi	Reduction (%)	Total Area (ha)
PY	all	50	5,576
PL, PLI	<7	100	97
AT, E, EP	<8	100	28
B, BA, BL, CW, H, HW, FD, FDI, S, SB, SE, SW, SX	<9	100	8,698
Total			14,399

4.2.11 Wildlife Habitat Areas

General wildlife measures (GWM) as established under the Government Actions Regulations (GAR) guide harvest practices in Wildlife Habitat Areas (WHA). Several approved wildlife habitat areas (WHA) exist within the 100 Mile TSA boundaries; five of these are of special concern and are excluded from the THLB. Table 15 lists the WHAs that are excluded from the THLB.

Table 15: Wildlife Habitat Areas – Excluded Areas

WHA Identifier	Reduction (%)	Species/Habitat under Consideration	Total Area (ha)
5-073	100	Data sensitive (not available to the public)	79
5-115	100	Mountain Caribou	1,771
5-117	100	Mountain Caribou	17,644
5-875	100	Badger	65
5-895	100	Great Basin Spadefoot	96
Total			19,655

4.2.12 Class "A" Lake Buffers

The netdown for appropriate riparian reserves from previous timber supply reviews was used for this analysis as well. This netdown included 7,442 hectares of lakeshore buffers based on a 200-metre management zone with 50% allowance for harvesting. The CCLUP datasets provided by FAIB included a lakeshore management dataset. This dataset was identified in the Python netdown script received and employed for the netdown. Due to data processing the gross area of the class "A" lake buffers in this analysis dataset is 6,047 hectares, 19% less than reported in TSR 2.

4.2.13 Riparian Reserve and Management Areas

Riparian Reserve and Riparian Management Zones were accounted for as non-spatial reductions applied to each resultant polygon. As per TSR 2, the reduction for riparian reserve areas was 1.3% and the reduction for riparian management areas was 0.7%, for a total of 2.0%, which amounts to 24,752.6ha, as shown in Table 16.

Table 16: Riparian Reserve and Management Zones

Riparian Reserve Areas		Riparian Management Areas		Total Area
%	ha	%	ha	ha
1.3	16,089	0.7	8,663	24,753

4.2.14 Recreation Trail Buffers

Important recreational trails were established as part of the CCLUP Recreation Corridor Management Strategy. They were buffered by 100 m. 50% of the recreation trail buffer area is excluded from the THLB, as listed in Table 17.

Table 17: Recreation Trail Management Zones

Feature	Buffer (m)	Reduction (%)	Total Area (ha)
Recreation Trails (CCLUP)	100	50	13,594

4.3 Management Assumptions

Management assumptions define how non-timber values are reflected or addressed in the model and how forest management occurs.

4.3.1 Age 2012 Calculation Assumptions

The VRI dataset was provided by FAIB in shape file format, and only contained key attributes. The last reference year listed was 2010. After working with the VRI dataset for some time, it became obvious that the ages provided in the VRI data were often incorrect as it was not possible to match area summaries reports with the on-going TSR. Information from the FAIB regarding their procedure to update ages in the inventory file directed us to do the same. The ages were updated as follows based on the BCLCS classification and a cutblock layer containing depletions from 1945 to 2011:

- If BCLCS indicated that the polygon was not vegetated or not forested, the updated age was set to 0
- If BCLCS indicated that the polygon was forested but that there was no history of previous logging, then the updated age was calculated as [age + 1] (to project from 2011 to 2012)
- If BCLCS indicated that the polygon was forested and there was a history of previous logging, then the updated age was calculated as [2012 – harvest year] + 1
- Likewise, if the cutblock layer indicated that an area had been previously logged even if BCLCS indicated that the area was non-forested, the age was calculated as [2012 – harvest year] + 1
- Updates for wildfires are based on the wildfire data that was supplied together with the Mountain Pine Beetle cycle time data [*mpb100*], which contained wildfire data for 2002 to 2010. The expected age for burned stands was calculated as [2012 – fire year – 10], with the –10 accounting for regeneration delay.
- Areas harvested only recently were identified in Results. These were not part of the cutblock dataset. An assumption was made that stands that were tagged as NSR, in Results but were older than 80 in the inventory had been logged recently. Consequently, the ages for these areas were set to 0 and they were considered current NSR.
- The results of the age update algorithm used were compared to the updated ages as provided by FAIB. For about 80% of the TSA (in terms of either total area or THLB area) the adjusted ages were identical; this figure increased to about 90% if ages within 5 years of each other were considered the same.

4.3.2 Not Satisfactorily Restocked Areas (NSR)

The 2012 100 Mile House TSA TSR data package listed a total of 52,328 ha of NSR, most of it current (50,596 ha). Due to differences in GIS methodology and data processing the NSR numbers differ slightly as shown in Table 18. According to the district, the backlog NSR (pre-1987) is being surveyed and the expectation is that 50% of it is free growing while the rest will be treated and declared free growing by 2015.

Table 18: Not satisfactorily restocked (NSR) areas

	THLB Area (ha) as per:	
Description	**Jan 2012 Data Package**	**This Data Package**
Backlog NSR (pre-1987)	1,132	582
Current NSR	50,596	50,082

4.3.3 Base Case Management Assumptions

The assumptions used in the base case model are listed in Table 19, and described in further detail below.

Table 19: Management Assumptions –Base Case

Criteria	Assumption
Green-up	Max 33% <3 m height within the THLB applied by Landscape Unit. Apply only in non-scenic areas where visual quality objectives are not designated.
Visuals	P-0.5%; R-2.5%; PR-7.7%, M-20% with green-up height of 3 m.
Ungulates	Caribou and mule deer managed with a variety of harvest systems: clearcut with reserves, group and single tree harvesting. All modelling in this analysis used clearcut with reserves approach.
Seral Stage Targets	OGMAs with some salvage allowed = 90% netdown. Targets for mature and old by LU and BEC variant.
Initial Harvest Rate	The initial harvest rate was set at the current AAC for the100 Mile TSA (2.0 million m^3/yr)
Harvest Rule	Relative oldest first, queue by age/minimum harvest age..
Utilization	Pine 12.5, all other species 17.5
Harvest Flow Objectives	Needs to be discussed with stakeholders at the next workshop. Likely objectives to minimize depth and duration of mid term timber supply shortage, sustainable long-term harvest.
Volume Exclusions	Only 50% of Ponderosa pine volume was accounted for.
Harvest Priority	Priority on MPB-attacked stands and spruce leading stands to avoid spruce bark beetle damage
Minimum Harvest Criteria	60 m^3 per ha for pine and 100 m^3 per ha for other species. Also minimum harvest age 60 years for pine and 80 years for other species.
Harvest Quality Objectives	Needs to be discussed at the next workshop. At minimum analysis will provide estimates of future piece sizes.
Silviculture Systems	Clearcut with reserves, group selection, single tree selection

4.3.3.1 Green-up

As a surrogate for cutblock adjacency, a green-up target was applied to the THLB. No more than 33% of the THLB can be less than 3 m in height at any time. This limit is applied by landscape unit in all areas that are not within visual polygons.

4.3.3.2 Visuals

CCLUP directs forest management in scenic areas. The percent disturbance mid-point for each VQO from Table 3 of "Procedures for Factoring Visual Resources into Timber Supply Analysis", (1998, http://www.for.gov.bc.ca/hfp/values/visual/Publications/timber_supply/TSR10.pdf) is used in the timber supply model as described in Table 20.

Table 20: Visual classes and maximum allowable disturbance

Visual Class	Maximum Allowable Disturbance	Modeled Maximum Disturbance	Green-up Height (m)	Total CFLB Area (ha)
Preservation (P)	0 to 1%	0.5%	3	33
Retention (R)	1.1 to 5%	2.5%	3	19,340
Partial Retention (PR)	5.1 to 15 %	7.7%	3	49,041
Modification (M)	15.1 to 25%	20%	3	32,224

4.3.3.3 Seral Stage Targets

This analysis will apply seral stage distribution requirements as per the CCLUP Biodiversity Conservation Strategy (1996) and updates. The targets are set for each landscape unit and BEC zone and applied to the CFLB, i.e. both the NHLB and THLB contribute towards mature and old biodiversity objectives. The timber supply model applies natural disturbance in the NHLB as described under section 4.5.

Table 21 presents the targets for mature and old seral stage in the analysis.

Table 21: Targets for mature and old seral stages

NDT	BEC Zone	Mature Age	Target Mature and Old Seral Stage (%)		
			Low Biodiversity Emphasis	Intermediate Biodiversity Emphasis	High Biodiversity Emphasis
1	ESSF	121	19	36	54
1	ICH	101	17	21	32
2	ESSF	121	14	28	42
2	ICH	101	15	31	46
2	SBS	101	15	31	46
3	ESSF	121	14	23	34
3	MS	101	14	26	39
3	SBPS	101	8	17	25
3	SBS	101	11	23	34
3	ICH	101	14	23	34
4	IDF Fd	101	22	43	33
4	IDF Pl	101	11	23	34

4.3.3.4 Stand Level Biodiversity

This analysis used the same approach as the on-going TSR to model stand level biodiversity. Rather than applying the CCLUP limits for wildlife tree retention that are set by landscape unit, BEC variant and species group, the THLB was aspatially reduced to account for stand level retention.

Current practice within the TSA is dispersed retention together with defined WTRA (patches) for a full rotation. This analysis used a seven percent area reduction to account for WTRA in non-salvage areas and a total of 20% retention in pine salvage areas. The 20% was maintained for 60 years only then reverted to 7%. An additional 1%-12% reduction for dispersed retention was also included as per the CCLUP. The percent used was based on landscape unit and BEC as described in the CCLUP. Note that both the 7% and the 20% WTRA and the dispersed retention were in addition to other reductions. The stand level retention levels are shown in Table 22.

Table 22: Stand level retention

Category	Stand Level Retention	Duration
Pine salvage	20%	60 years
All other harvest	7%	Planning horizon
Dispersed retention	1% to 12%	Planning horizon

4.3.3.5 Ungulate Winter Range

Several ungulate winter ranges (UWRs) exist within the TSA. These are summarized in Table 23. The management of the UWRs is designated to take place through a variety of harvest systems including clearcut with reserves, group selection and single tree selection. In this analysis all UWRs were modelled using the clearcut with reserves approach combined with cover constraints to control the numbers of entries and harvest areas. All the Fd managed stand yield curves were reduced to account for retention effects on future stands.

Table 23: Ungulate winter ranges in the 100 Mile TSA

UWR Class	Sub Class	System	Retention	Re-entry (Years)
UWR shallow moderate snowpack >40% Fd	Low structure habitat	Single Tree Selection	65%	30
	Moderate structure habitat		75%	30
	High structure habitat		85%	30
UWR transition and deep snowpack > 40% Fd	Low structure habitat	Group Selection	67%	40
	Moderate structure habitat		75%	40
	High structure habitat		80%	40
UWR transition and deep snowpack <= 40% Fd	n/a	Clearcut with reserves	All Fd retained	
Caribou WHA	n/a	Group Selection	33% volume removal	80

4.3.3.6 Wildlife habitat restoration

There are areas in the 100 Mile House TSA where non-timber management objectives are a priority. These are Benchmark Grassland Area, American Badger WHA and Great Basin Spadefoot WHA. In these areas some harvesting is allowed for habitat restoration purposes. In the timber supply model, these areas were removed from the forested land base after the first harvest.

4.3.3.7 Harvest Rule

The relative oldest harvest rule will be used in the simulation mode of the analysis. This harvest rule queues the stands for harvest based on the stands age relative to its minimum harvest age. In heuristics there is no set harvest rule. Rather, the model attempts to harvest each stand at an age beneficial to the over all solution of the model.

4.3.3.8 Utilization Levels

The utilization levels used in this analysis are shown in Table 24

Table 24: Utilization levels used in the analysis

Leading Species	Minimum Diameter at Breast Height	Maximum Stump Height	Minimum Top Diameter Inside Bark
Pine	12.5 cm	30 cm	10 cm
Non-Pine	17.5 cm	30cm	10 cm

4.3.3.9 Volume Exclusions

Fifty percent of the Ponderosa pine volumes were excluded from the timber supply in this analysis.

4.3.3.10 Harvest Priority

The current management in the TSA prioritizes the harvest of pine stands with a pine component greater than 70% and spruce stands with the White spruce/Engelmann spruce (Sw/Se) component greater than 70%. Prioritizing the harvest of spruce stands is intended to prevent the spread of spruce beetle.

Table 25: Harvest priority in the forest estate model

Priority	Stand Type	Management Objective
1	> 70% Pine	MPB salvage
1	> 70% Spruce	Beetle salvage in moderate to high risk infestation
2	50-70% Pine	MPB salvage in mixed-pine stands
3	All others	Preserve growing stock

4.3.3.11 Minimum Harvest Criteria

Minimum harvest criteria are used to determine the age when stands become available for harvesting. While harvesting may periodically take place at the minimum age or volume per ha to meet the harvest target, most stands will not be harvested until past the minimum ages due to management objectives for other resource values.

For this analysis, the minimum harvest criteria were set as depicted in Table 26. Using both age and volume as criteria provides a realistic analysis assumption for salvaging poorer MPB infested stands that tend to be older but may have low volumes per ha. Using the age in conjunction with the volume criterion ensures that managed stands will be harvested at reasonable volumes in the future.

Table 26: Minimum harvest criteria

Analysis Unit	Minimum Harvest Volume	Minimum Harvest Age
All Pine	65	60
Non-pine	100	80

4.3.3.12 Harvest Profile

No specific harvest profile will be targeted or limited in the base case.

4.3.4 Silvicultural Systems

Clearcut with reserves is the predominant silvicultural system in all non-Douglas-fir leading stands in the 100 Mile House TSA. In Douglas fir leading stands variable retention is used with the average retention level of 25%. The variable retention in Douglas fir stands was modeled as a 25% area reduction.

Clear cut with reserves and selection systems – both single tree and group - are used in UWR (mule deer) and WHA (Caribou). In UWR, Douglas fir-leading stands may be harvested using different silvicultural systems depending on the snowpack zone and stand structure habitat class. The Northern Caribou WHAs may be harvested using a clearcut with reserves approach.

The modelling approach to different silvicultural systems is discussed under section 4.3.3.5.

4.3.5 Related Strategies

This silviculture strategy will consider other related strategies and if feasible incorporate components of them in modelling and strategy development.

4.3.5.1 Wildfire Management

This section describes the criteria and considerations used to incorporate elements from other related strategies into the model.

Wildfire Management Strategy

Wildfire management strategies aim to encourage healthier ecosystems, reduce the risk of loss to communities, address climate change and enable a more cost-effective fire response.

Wildfire Management Branch is currently updating the Provincial Strategic Threat Analysis (PSTA) https://ground.hpr.for.gov.bc.ca/provincialstrategicthreatanalysis.htm . As part of this process, burn probability modeling (using a process called Burn P3) is being completed for the interior TSAs over the next few years. If Burn P3 results for the 100 Mile House TSA are available in time, they will be incorporated into the development of integrated silviculture strategies and used to prioritize areas for treatment.

Fuel Management Strategy

Under the Strategic Wildfire Prevention Initiative, the Cariboo Regional District completed a Community Wildfire Protection Plan (CWPP) in 2006 which included the 100 Mile House TSA. Subsequently, the District of 100 Mile House developed a CWPP in 2007 and has implemented treatments and strategies to mitigate forest fuels in the interface areas. Other communities in the 100 Mile House TSA have or are exploring development of localized CWPP's.

While it is not feasible to include detailed plans and strategies from the CWPP's in the forest level analysis supporting this silviculture strategy, fire planning and management and fuel management around communities will be integrated into the development of this strategy.

4.3.5.2 Forest Health Strategy

Forest health strategies aim to recommend actions to address forest health issues. Table 27 summarizes the priority forest health agents from the 2012 Cariboo Region Forest Health Strategy (http://www.for.gov.bc.ca/ftp/DCC/external/!publish/Forest%20Health/Forest%20Health%20Strategy/Cariboo%20Forest%20Health%20Strategy%20Final.pdf).

Table 27: Priority forest health factors for the Cariboo by ranking

High	Mod-High	Moderate	Low-moderate
Western spruce budworm	Spruce Beetle	Western Balsam Bark beetle	2 year cycle budworm
Gypsy Moth	Douglas-fir beetle	Laminated root disease	Hemlock Looper
Fire		Armillaria root disease	Spruce Weevil
		Tomentosus root disease	Lodgepole pine dwarf mistletoe
		Western gall rust	Elytroderma needle cast
		Commandra blister rust	Mammal damag
			Snow press

The current district strategy for the priority forest health agents will follow the specific strategies and tactics outlined in the Forest Practices Code Guidebooks, Provincial Bark Beetle Strategy, Regional Bark Beetle Plans, and focus on areas identified by the 100 Mile House Resource District Detailed Aerial Survey Maps.

One of the key forest health strategies is to protect stands contributing to the mid-term timber supply. Based on feedback from forest district staff and stakeholders, there is a need for a risk rating and an integrated plan for dealing with an ongoing spruce bark beetle outbreak and to quantifying the impacts of serious forest health damage in young pine leading stands.

4.3.5.3 Enhanced Retention Strategy

In 2007 the 100 Mile House Resource District Enhanced Retention Strategy Committee released an Enhanced Retention Strategy for the district. The intent of the strategy is to enhance the Chief Forester's current direction based on the analysis of each watershed in the district. The strategy does not specify retention or patch size distribution targets; rather it relies on professional judgment in implementation.

Review and monitoring of the strategy is not formal. Occasional meetings are held to review accomplished retention levels.

It is assumed that the enhanced retention strategy is incorporated in stand and landscape level retention as described in sections 4.2.7 and 4.3.3.4.

4.3.5.4 Climate Change

There is no climate change strategy for the 100 Mile TSA yet. While this analysis will not incorporate climate change into modelling directly, climate change will be considered when designing and recommending future silviculture treatments.

4.4 Growth and Yield Assumptions

Growth and yield assumptions define the net volumes that are realized when natural and managed stands are harvested. They also describe various tree and stand attributes over time (i.e., height, diameter, presence of dead trees, etc.).

4.4.1 Analysis Units

Forest stands in the 100 Mile TSA older than 50 years (51yrs +) were assigned to natural analysis units, stands younger than 51 years of age but older than 10 years (11-50yrs (i.e. disturbed or harvested before 1963) were assigned to existing managed analysis units and stands younger than 11 years (0-10yrs) were assigned to future managed analysis units. Table 28 list the areas of the 100 Mile House TSA by Analysis Unit Group.

Table 28: Stratification of the 100 Mile House THLB into Analysis Units Group

Analysis Unit Group	Age	THLB (ha)	THLB (%)
Future Managed	0-10	95,736	14
Existing Managed	11-50	185,567	28
Existing Natural	>50	380,800	58
		662,103	**100**

Yield curves and corresponding analysis units were provided by FAIB in two formats: as a lookup table that allowed linking existing natural stands non-spatially (on VRI Feature_ID), and as spatial files in raster format for existing and future managed stands.

FAIB had assigned a unique identifier to each natural stand, resulting in over 40,000 natural stands, and growth and yield curves. The number of yield curves was reduced in this analysis by grouping natural stands with similar attributes into analysis units.

This process of grouping was different for the THLB and the NHLB. For stands in the THLB, natural stands were grouped based on leading species (species groups), site index class and VDYP volume at age 140. In some cases, this information was missing from the VRI, and data was generated for the missing records as follows:

- Species – based on queries that returned the most common species by BEC variant;
- Site Index – based on area-weighted average site indices by species group where site index was available;
- VDYP Volume at age 140 – the volume was derived using regression analysis from site index – volume where this information existed.

Table 29 lists the natural stand analysis units and associated site index and volume ranges.

Table 29: Natural Analysis Units in the 100 Mile House TSA

Analysis Unit	Species Group	Leading Species	Site Index Range (m)	Volume Range (m3/ha)	THLB Area (ha)
ba1-1	Balsam	B, BA, BL, CW, H, HW	<10	<110	1,065.6
ba1-2	Balsam	B, BA, BL, CW, H, HW	<10	110-170	2,241.4
ba1-3	Balsam	B, BA, BL, CW, H, HW	<10	>170	1,020.7
ba2-1	Balsam	B, BA, BL, CW, H, HW	10 - 14.9	<150	224.0
ba2-2	Balsam	B, BA, BL, CW, H, HW	10 - 14.9	150-210	205.7
ba2-3	Balsam	B, BA, BL, CW, H, HW	10 - 14.9	210-270	518.4
ba2-4	Balsam	B, BA, BL, CW, H, HW	10 - 14.9	270-330	616.8
ba2-5	Balsam	B, BA, BL, CW, H, HW	10 - 14.9	>330	226.0
ba3-1	Balsam	B, BA, BL, CW, H, HW	15 - 19.9	<350	287.9
ba3-2	Balsam	B, BA, BL, CW, H, HW	15 - 19.9	350-410	1,421.3
ba3-3	Balsam	B, BA, BL, CW, H, HW	15 - 19.9	>410	342.0
ba4-1	Balsam	B, BA, BL, CW, H, HW	>=20	all	26.1
de1-1	Deciduous	AT, E, EP	<10	<30	441.9
de1-2	Deciduous	AT, E, EP	<10	>30	111.2
de2-1	Deciduous	AT, E, EP	10 - 14.9	<70	391.7
de2-2	Deciduous	AT, E, EP	10 - 14.9	70-130	4,936.4
de2-3	Deciduous	AT, E, EP	10 - 14.9	130-210	6,670.9
de2-4	Deciduous	AT, E, EP	10 - 14.9	>210	515.0
de3-1	Deciduous	AT, E, EP	15 - 19.9	<110	31.6
de3-2	Deciduous	AT, E, EP	15 - 19.9	110-190	353.2
de3-3	Deciduous	AT, E, EP	15 - 19.9	190-250	1,402.7
de3-4	Deciduous	AT, E, EP	15 - 19.9	250-290	2,110.7
de3-5	Deciduous	AT, E, EP	15 - 19.9	290-350	1,098.5
de3-6	Deciduous	AT, E, EP	15 - 19.9	>350	42.7
de4-1	Deciduous	AT, E, EP	>20	<230	264.6
de4-2	Deciduous	AT, E, EP	>20	230-290	2,017.5
de4-3	Deciduous	AT, E, EP	>20	290-330	2,358.5
de4-4	Deciduous	AT, E, EP	>20	330-430	1,157.2
de4-5	Deciduous	AT, E, EP	>20	>430	843.9
df1-1	Douglas Fir	FD, FDI	<10	<10	775.3
df1-2	Douglas Fir	FD, FDI	<10	10-50	3,199.1
df1-3	Douglas Fir	FD, FDI	<10	50-130	3,509.1
df1-4	Douglas Fir	FD, FDI	<10	>130	202.0
df2-1	Douglas Fir	FD, FDI	10 - 14.9	<30	1,064.8
df2-2	Douglas Fir	FD, FDI	10 - 14.9	30-90	13,910.8
df2-3	Douglas Fir	FD, FDI	10 - 14.9	90-170	32,527.0
df2-4	Douglas Fir	FD, FDI	10 - 14.9	170-230	14,258.8
df2-5	Douglas Fir	FD, FDI	10 - 14.9	230-330	6,200.1
df2-6	Douglas Fir	FD, FDI	10 - 14.9	>330	286.3
df3-1	Douglas Fir	FD, FDI	15 - 19.9	<130	857.3
df3-2	Douglas Fir	FD, FDI	15 - 19.9	130-190	1,089.8
df3-3	Douglas Fir	FD, FDI	15 - 19.9	190-270	6,129.0
df3-4	Douglas Fir	FD, FDI	15 - 19.9	270-330	9,690.9
df3-5	Douglas Fir	FD, FDI	15 - 19.9	330-410	5,635.2
df3-6	Douglas Fir	FD, FDI	15 - 19.9	410-490	2,782.2
df3-7	Douglas Fir	FD, FDI	15 - 19.9	>490	1,099.4

Analysis Unit	Species Group	Leading Species	Site Index Range (m)	Volume Range (m3/ha)	THLB Area (ha)
df4-1	Douglas Fir	FD, FDI	>=20	<430	133.7
df4-2	Douglas Fir	FD, FDI	>=20	430-470	413.3
df4-3	Douglas Fir	FD, FDI	>=20	470-530	1,046.5
df4-4	Douglas Fir	FD, FDI	>=20	530-570	387.0
df4-5	Douglas Fir	FD, FDI	>=20	570-650	1,218.8
df4-6	Douglas Fir	FD, FDI	>=20	>650	744.1
pi1-1	Pine	PL, PLI, PY	<10	<30	2,015.7
pi1-2	Pine	PL, PLI, PY	<10	30-90	9,707.4
pi1-3	Pine	PL, PLI, PY	<10	>90	1,830.6
pi2-1	Pine	PL, PLI, PY	10 - 14.9	<50	642.8
pi2-2	Pine	PL, PLI, PY	10 - 14.9	50-90	2,396.4
pi2-3	Pine	PL, PLI, PY	10 - 14.9	90-150	25,253.5
pi2-4	Pine	PL, PLI, PY	10 - 14.9	150-210	33,965.4
pi2-5	Pine	PL, PLI, PY	10 - 14.9	210-310	32,262.0
pi2-6	Pine	PL, PLI, PY	10 - 14.9	>310	713.0
pi3-1	Pine	PL, PLI, PY	15 - 19.9	<170	1,397.4
pi3-2	Pine	PL, PLI, PY	15 - 19.9	170-250	15,690.9
pi3-3	Pine	PL, PLI, PY	15 - 19.9	250-350	39,693.8
pi3-4	Pine	PL, PLI, PY	15 - 19.9	350-430	18,222.0
pi3-5	Pine	PL, PLI, PY	15 - 19.9	>430	1,873.8
pi4-1	Pine	PL, PLI, PY	>=20	<250	36.3
pi4-2	Pine	PL, PLI, PY	>=20	250-310	757.9
pi4-3	Pine	PL, PLI, PY	>=20	310-370	2,276.8
pi4-4	Pine	PL, PLI, PY	>=20	370-430	3,442.9
pi4-5	Pine	PL, PLI, PY	>=20	430-490	5,101.4
pi4-6	Pine	PL, PLI, PY	>=20	490-550	2,631.5
pi4-7	Pine	PL, PLI, PY	>=20	>550	481.4
sp1-1	Spruce	S, SB, SE, SW, SX	<10	<90	652.2
sp1-2	Spruce	S, SB, SE, SW, SX	<10	90-170	1,018.0
sp1-3	Spruce	S, SB, SE, SW, SX	<10	170-230	2,623.8
sp1-4	Spruce	S, SB, SE, SW, SX	<10	>230	222.8
sp2-1	Spruce	S, SB, SE, SW, SX	10 - 14.9	<130	822.4
sp2-2	Spruce	S, SB, SE, SW, SX	10 - 14.9	130-230	2,883.1
sp2-3	Spruce	S, SB, SE, SW, SX	10 - 14.9	230-290	4,345.9
sp2-4	Spruce	S, SB, SE, SW, SX	10 - 14.9	290-330	2,582.1
sp2-5	Spruce	S, SB, SE, SW, SX	10 - 14.9	330-410	1,429.7
sp2-6	Spruce	S, SB, SE, SW, SX	10 - 14.9	>410	104.4
sp3-1	Spruce	S, SB, SE, SW, SX	15 - 19.9	<250	369.9
sp3-2	Spruce	S, SB, SE, SW, SX	15 - 19.9	250-350	4,140.3
sp3-3	Spruce	S, SB, SE, SW, SX	15 - 19.9	350-450	8,184.9
sp3-4	Spruce	S, SB, SE, SW, SX	15 - 19.9	450-530	3,573.8
sp3-5	Spruce	S, SB, SE, SW, SX	15 - 19.9	>530	232.0
sp4-1	Spruce	S, SB, SE, SW, SX	>=20	<430	311.7
sp4-2	Spruce	S, SB, SE, SW, SX	>=20	430-450	1,428.0
sp4-3	Spruce	S, SB, SE, SW, SX	>=20	450-550	2,606.4
sp4-4	Spruce	S, SB, SE, SW, SX	>=20	>550	2,771.0

For the MPB attacked stands, the analysis units in Table 29 were further subdivided based on the age at death and severity of mountain pine beetle attack. This was done for all stands, not only for stands in the Pine-based analysis unit group. Data from the BCMPB v9 analysis was used for this process. The BCMPB model assumes that only pine stands older than 60 yrs are susceptible. The results of this analysis are shown in Table 30. The column "Pine Dead or Alive" only refers to the pine component of the stand. The "Already dead" row denotes that in 264,000 ha of stands, pine trees area assumed dead.

Table 30: Mountain Pine Beetle Attack Results for the 100 Mile House TSA

Analysis Unit Group	MPB Model Applies	Pine Dead Or Alive	THLB (ha)	%
Existing Natural	No (No Pine in Stand)	n/a	67,384.9	17.70
Existing Natural	No (Pine Present < 60yrs)	n/a	24,418.6	6.41
Existing Natural	Yes	Not Attacked	13,592.0	3.57
Existing Natural	Yes	Dead in 1 Year	643.0	0.17
Existing Natural	Yes	Dead in 2 Years	12.7	0.00
Existing Natural	Yes	Dead in 3 Years	270.1	0.07
Existing Natural	Yes	Dead in 4 Years	1,169.1	0.31
Existing Natural	Yes	Dead in 5 Years	858.4	0.23
Existing Natural	Yes	Dead in 6 Years	1,361.2	0.36
Existing Natural	Yes	Dead in 7 Years	165.0	0.04
Existing Natural	Yes	Dead in 8 Years	342.1	0.09
Existing Natural	Yes	Dead in 9 Years	2,409.4	0.63
Existing Natural	Yes	Dead in 10 Years	1,442.6	0.38
Existing Natural	Yes	Dead in 11 Years	1,848.1	0.49
Existing Natural	Yes	Dead in 12 Years	298.5	0.08
Existing Natural	Yes	Dead in 13 Years	166.4	0.04
Existing Natural	Yes	Dead in 14 Years	739.2	0.19
Existing Natural	Yes	Already Dead	263,678.6	69.24
			380,800.0	100.00

For attacked stands, the age at death (age at which at least 50% of pine is dead) was divided into 5-year increments, starting at age 60. The attack severity was defined based on the maximum percent of the stand that was dead. The five severity classes were defined as follows:

- Class 1: >0-<=25% dead
- Class 2: >25-<=50% dead
- Class 3: >50-<=70% dead
- Class 4: >70-<=90% dead
- Class 5: >90% dead

This process significantly increased the number of natural stand analysis units. An example analysis unit name for a MPB-attacked stand is sp2-6_mpb_100_5, meaning the stand is spruce-leading, with site index class of 2 (10-14.9) and volume class of 6 (volume at age 140 exceeding 410 m3/ha). The MPB attack age at death is 100, and the severity of attack is class 5.

After analysis units had been assigned and the corresponding curves generated, these curves were split into two to allow tracking the live and dead components, respectively. This process is described in section 4.4.3.

For the NHLB, all stands were classified into analysis units using the species and site index classes as above (volume was not considered). MPB-attacked NHLB stands were further split based on attack severity. Stands with an attack severity of >50% dead (class 3, 4, 5) were grouped together, as were those with a severity <=50% dead (class 1, 2). Growing stock losses due to MPB were not tracked in the NHLB yield curves.

4.4.2 Existing Managed and Future Managed Stands

Stands up to 50 years of age were considered managed stands in the analysis. No distinction was made between existing managed and future managed stands when designing analysis units. The same analysis units were used; however, some of the inputs into the growth and yield model were different. Managed stands between ages 11 and 50 were divided in to 4 age groups; each age group was modeled with its own density and species distribution assumptions. These are detailed in section 4.6.2.

The managed stands were classified into analysis units as follows:

Table 31: Analysis units for managed stands

Analysis Unit	Leading species	Site index Range	THLB Area (ha)
Decid poor	Aspen, Birch	< 10	0
Decid medium	Aspen, Birch	10 - 14.9	1,093
Decid good	Aspen, Birch	15 – 19.9	34,871
Decid very good	Aspen, Birch	>=20	4,310
Douglas-fir poor	Douglas-fir (pine in FM)	< 10	251
Douglas-fir medium	Douglas-fir (pine in FM)	10 - 14.9	1,203
Douglas-fir good	Douglas-fir (pine in FM)	15 – 19.9	130,532
Douglas-fir very good	Douglas-fir (pine in FM)	>=20	27,355
Balsam poor	Balsam	< 10	0
Balsam medium	Balsam	10 - 14.9	1,844
Balsam good	Balsam	15 – 19.9	8,136
Balsam very good	Balsam	>=20	3,725
Pine poor	Pine	< 10	29
Pine medium	Pine	10 - 14.9	385
Pine good	Pine	15 – 19.9	292,896
Pine very good	Pine	>=20	98,424
Spruce poor	Spruce	< 10	1
Spruce medium	Spruce	10 - 14.9	105
Spruce good	Spruce	15 – 19.9	34,661
Spruce very good	Spruce	>=20	22,280

SIBEC site indices were used to model managed stands. The site indices were provided by the Forest Analysis and Inventory Branch through the provincial site index layer. The BEC default species was used where leading species information was unavailable. If the SIBEC site index was missing, it was calculated using TIPSY conversion equations from the SIBEC value of another species. If there was no site index value for any species, the VRI site index was used (only 948 ha).

4.4.3 Modelling of MPB Impacted Stands 60 Years and Older

Each THLB attacked stand greater than 60 years old at the time of the MPB attack is modelled as shown in Table 32. The year of death is defined as the year when the cumulative kill reaches 50%. If the cumulative kill does not reach 50% by the end of the BCMPB projection (2026), the year of death is the weighted average year of attack for the stand. The percent dead is the pine component of the stand multiplied by the maximum cumulative percent killed from the BCMPB v9 data. The percent live equals 100% - percent dead.

Table 32: MPB attack modelling in the THLB

Severity of Attack	Stand Component	Timing	Yield/Volume Projection
>50% dead	Dead overstory	Adjusted at year of death	VDYP, shelf life of 16 years. Volume remains at 100% for 2 years then drops to 0 in 14 years.
	Live overstory	Adjusted at year of death	Total yield times percent live.
	Regeneration	Advanced regen, positive regen delay of 10 years.	TASS projections with high clumpiness factor Potential site index less 2 metres Adjust OAF1 to 25% and OAF2 to 15% 10 year advanced regeneration Randomly assign density class for modeling stand densities based on BEC variants from Coates data
<=50% dead	Dead overstory	Adjusted at year of death	VDYP, shelf life of 16 years. Volume remains at 100% for 2 years then drops to 0 in 14 years.
	Live overstory	Adjusted at year of death	Total yield times percent live.
	Regeneration	Assume no regeneration	Stand will continue to grow on the live overstory yield curve.

Each stand may have up to three yield curves associated with it:

- ***Yield** curve for dead timber (percent dead * VDYP volume) that remains static for 2 years after which the volume drops to 80 % and then to 0 m³/ha over the next 14 years. This volume is lost if it is not harvested before the total volume per ha falls below the minimum harvest volume. The volume is also lost 16 years from the year of death;*
- ***Post-attack live curve** ((total volume – percent dead)*VDYP volume);*
- ***Advanced regeneration curve**); this curve starts at age 10 from the time of death of the overstory (positive regeneration delay of 10 years).*

These three curves were added together to make the composite curve for each stand, then the curves for all stands within each analysis unit were averaged to make the final curves used in the model. Stands with >50% dead had their ages "reset" after the dead pine component drops to 0 to the age of the regenerating component. Stands <=50% dead have no regeneration and keep the age of the live component.

Figure 4 provides an example of how a post-attack dead volume yield curve, post-attack live yield curve and a regenerating yield curve were derived from an original VDYP yield curve then combined.

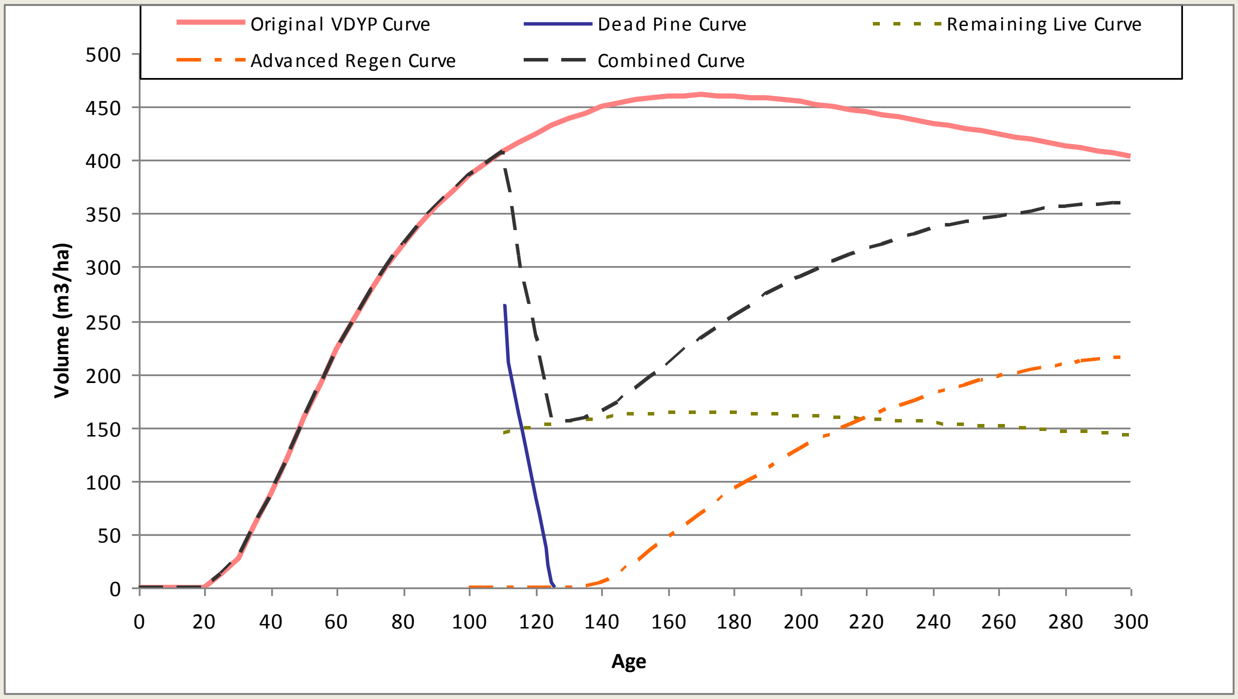

Figure 4: Example of a MPB stand yield curve; pine-leading, 64% dead at age 110, advanced regeneration

For the NHLB attacked by MPB, stands >50% dead were assigned to break up 20 years after year of death and regenerate on the same natural curve. Stands <=50% dead were not set to break up; rather they were assumed to continue growing. Growing stock losses due to MPB were not tracked in the NHLB.

4.4.3.1 Shelf Life

The merchantability of beetle-killed wood remains an important uncertainty in timber supply analyses. In this analysis shelf life is defined as the time a stand remains economically viable for sawlog harvesting. The shelf life starts at the year of death (as defined above). The status quo shelf life assumptions in most timber supply analyses to date have assumed 100% retention of merchantability for 15 years, after which the volume is no longer usable. This analysis assumes that a time period of 16 years from the average time of death is required until the stand becomes entirely un-merchantable. The merchantability is assumed to decline after the first two years to 0 at year 16 as shown in Figure 5. The shelf life for other product types may be longer; however, it is not modeled in this analysis.

The TSR shelf life approach assumes that the trees are viable, from a FIBRE perspective, as long as they are standing. Once they fall over, they are assumed to be inoperable. This is represented in the TSR by the change from being operable in year 15, and inoperable in year 16.

For the Type 4 silviculture strategies, the shelf life assumptions are driven by the sawlog component of the stand. The sawlog component decreases over time until the volume drops below the operability limit for the stand. This general approach is consistent with other on-going type 4 silviculture strategies with differences in the length of shelf life and slope of the volume reduction.

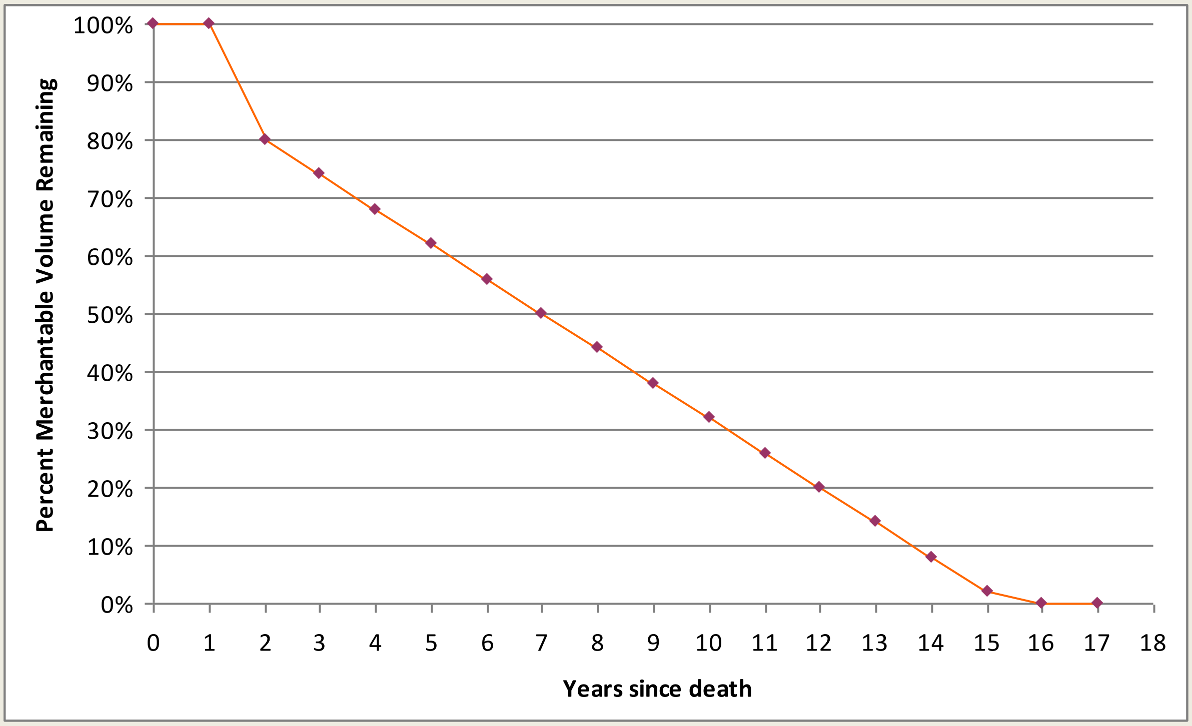

Figure 5: Shelf life for dead pine sawlogs

4.4.3.2 Minimum harvest volume of MPB Impacted stands

The minimum harvest criteria in this analysis is 60 m^3 per ha for pine and 100 m^3 per ha for all the other species. The same criteria apply to the MPB impacted stands; unless the sum of live and dead volume is greater than or equal to the minimum harvest volume the stand will not get harvested. Note that the shelf life assumptions in the analysis will reduce the merchantable dead volume to zero in 17 years after death. As a result, some stands may be eligible for harvest at the very beginning of the planning horizon but not in 10 years. On the other hand, the secondary structure and the remaining live trees may reach the minimum harvest criteria over time, and the stand may again become eligible for harvesting.

4.4.3.3 Modelling the advanced regeneration component

If greater than 50% of the stand is dead, advanced regeneration is assumed to occur as per Coates and Sachs (2012). The density classes shown in Table 33 were randomly distributed in > 50% pine stands with over 50% mortality.

Table 33: Advanced regeneration density classes

BEC Zone	Low Density Class (200/ha)	Med Density Class (800/ha)	High Density Class (1600/ha)	Species Composition
SBPS	30%	20%	50%	Pl 100
IDF	30%	20%	50%	Fd 70 Pl 30
MS	50%	20%	30%	Pl 100
ESSF	25%	10%	65%	Sx 100
ICH	40%	15%	45%	Sx 60 Cw 40
SBS	45%	20%	35%	Sx 80 Fd 20

The methodology for modelling growth and yield for advanced regeneration was originally developed by Jim Thrower for Forsite Consultants Ltd (Thrower, 2013). TASS projections with high clumpiness factor were used. The modelling used potential site indices reduced by 2 metres and adjusted OAF1 to 25% and OAF2 to 15%. The regeneration lag was set to positive 10 years, i.e. the initiation of the regenerating stand was set 10 years before the death of the stand.

FESL used the TASS outputs (yield curves) from the Williams Lake Type 4 Analysis provided by Forsite Consultants in this analysis to model advanced regeneration.

4.4.4 MPB impact in young pine stands (<60 years old)

The modelling of the MPB impact in young stands followed the approach taken in the on-going TSR. The current TSR observed the results from a 2008 Forest Health Aerial Overview Assessments and permanent sample plot information, and consulted district and licensee staff to model the growth and yield of pure and mixed pine stands. In modelling, the volume of pure pine stands between the ages of 20 and 60 was reduced an additional 20%. The total OAF1 1 for these stands was then set to 65% (100%-15%-20%=65%). No reductions were incorporated in modelling the growth and yield of young mixed pine stands.

4.4.5 Stand Projection Models

The variable density yield prediction (Batch VDYP 7.7a.33) model developed by the MFLNRO was used for estimating the timber volumes of natural stands.

The table interpolation program for stand yields (BatchTIPSY, 4.2), developed by the MFLNRO were used to estimate timber volumes for existing and future managed stands. All stands older than 50 years were considered natural stands while stands 50 years old or younger and future stands were considered to be managed stands.

4.4.5.1 Decay, Waste, and Breakage

Default reductions to stand volume for decay, waste and breakage were applied to the VDYP7 model Zone.

4.4.5.2 Operational Adjustment Factors in Managed Stand Yields

Operational adjustment factors (OAF) are used to adjust timber yield estimates. They represent yield reductions that on average occur in managed stands that are growing in operational conditions. OAF 1 is a linear reduction of yield designed to account for small unproductive areas within stands, uneven distribution of stems, endemic losses and other random risk factors. OAF 2 reduces yields for decay, waste and breakage. It is non-linear in nature, lowering the predicted volume at a rate that will achieve the specified factor in 100 years and continue to increase thereafter based on the number of years since stand initiation.

In most analyses, the default OAF1 and OAF2 values of 15% and 5%, respectively, are used. This analysis used default values as well, except for the modelling of young pine stands as described above.

4.5 Natural Disturbance Assumptions

4.5.1 Non-Harvestable Land Base

A disturbance function was used in the analysis to prevent the non-timber harvesting land base from continually aging and providing a disproportionate and often improbable amount of old forest cover conditions to satisfy landscape biodiversity requirements,. The document “Modeling Options for Disturbance Outside the THLB – Working Paper” (Forest Analysis Branch, 2003) provides direction for disturbing areas of the landscape outside of the THLB. There are a variety of possible approaches to applying a disturbance in the non-timber harvesting land base. While each approach has its strengths and weaknesses there remains a significant amount of uncertainty as to what the most appropriate methodology is. The age reset by variant for the non-timber harvesting land base methodology was applied. The methodology is as follows:

1. List the estimated return interval for disturbance in each variant and NDT in the TSA (Landscape Unit Planning Guide Appendix 2).
2. Establish the estimated minimum target % of old seral that would be expected (Landscape Unit Planning Guide Appendix 2). The target was established using the intermediate biodiversity option.
3. Calculate a rotation age based on the age distribution described in step 2 (old age / (1- target %).
4. Divide the contributing non-THLB area in the variant by the calculated rotation age to determine the annual minimum disturbance target for each variant.

Table 34 identifies the minimum target area to be disturbed annually within each BEC variant for the 100 Mile House TSA.

Table 34: Minimum target area to be disturbed annually in each BEC variant

BEC	NDT	Mean Event Interval	Old Age	Old Seral Target % BEO = I	Rotation Age	NHLB Area (ha)	Annual Disturbance Area (ha)	Annual Disturbance %
BGxh3	4	250	250	13.0%	287	852	3.0	0.3%
BGxw2	4	250	250	13.0%	287	1,916	6.7	0.3%
ESSFdc3	3	150	140	14.0%	163	2,486	15.3	0.6%
ESSFwc3	1	350	250	19.0%	309	12,532	40.6	0.3%
ESSFwcw	2	200	250	9.0%	275	4,606	16.8	0.4%
ESSFwk1	1	350	250	19.0%	309	7,948	25.8	0.3%
ESSFxc3	3	150	140	14.0%	163	4,086	25.1	0.6%
ICHdk	3	150	140	14.0%	163	3,004	18.5	0.6%
ICHmk3	2	200	250	9.0%	275	3,608	13.1	0.4%
ICHmw3	2	200	250	9.0%	275	1,266	4.6	0.4%
IDFdk3	4	250	250	13.0%	287	66,560	231.6	0.3%
IDFmw2	4	250	250	13.0%	287	827	2.9	0.3%
IDFxh2	4	250	250	13.0%	287	826	2.9	0.3%
IDFxm	4	250	250	13.0%	287	1,998	7.0	0.3%
IDFxw	4	250	250	13.0%	287	7,245	25.2	0.3%
MSxk2	3	150	140	14.0%	163	4,152	25.5	0.6%
MSxk3	3	150	140	14.0%	163	13,378	82.2	0.6%
SBPSmk	3	100	140	7.0%	151	5,544	36.8	0.7%
SBSdw1	3	125	140	11.0%	157	14,315	91.0	0.6%
SBSdw2	3	125	140	11.0%	157	5,419	34.4	0.6%
SBSmc1	3	125	140	11.0%	157	2,361	15.0	0.6%
SBSmm	3	125	140	11.0%	157	1,652	10.5	0.6%
BGxh3	4	250	250	13.0%	287	852	3.0	0.3%
BGxw2	4	250	250	13.0%	287	1,916	6.7	0.3%

4.5.2 Timber Harvesting Land Base, Non-Recoverable Losses

Non-recoverable losses (NRL) estimate of the lost or killed average annual volume in the THLB that not is salvaged. The impacts from Mountain Pine Beetle mortality are discussed separately. Endemic pest losses are considered natural processes within stands and are accounted for within the growth and yield models. Table 35 shows the NRL from the on-going 100 Mile House TSA TSR.

Table 35: Non-Recoverable Losses

Loss Agent	Annual Non-Recoverable Losses (m^3/yr)
Fire	53,892
Wind	4,540
Douglas fir bark beetle	14,474
Spruce budworm	14,770
Spruce bark beetle	10,537
Assumed salvage	(15,000)
Total	83,213

4.5.2.1 Fire

Annual losses due fire are estimated at 53,892 m^3/year. The estimate is based on all recorded fires for the last 15 years minus any salvage volumes.

4.5.2.2 Wind

The estimates for windthrow come from aerial survey data between years 2006-2010.

4.5.2.3 Insects

Douglas fir bark beetle

According to the FLNRO the Douglas-fir beetle population in the TSA has decreased in size in recent years. The attack levels in Douglas-fir stands were determined through aerial surveys.

Spruce bark beetle

Spruce beetle infestations are cyclical with volume losses arising only during the infestation. This analysis assumed duration of 5-10 years for each infestation with a reoccurrence after every 30 years. The annual losses were calculated as the losses detected in the current infestation averaged out over a period of 30 years.

Spruce budworm

B.t.k. spray programs in the TSA have reduced western spruce budworm populations significantly. Estimated volume loss from spruce budworm is 14,770 m^3 annually.

4.5.2.4 Assumed Salvage

The TSA Small Scale Salvage program is estimated to recover approximately 15 000 m^3 of the damaged volume per year.

4.6 Silviculture

4.6.1 Genetic Gain

Current practice in the TSA is to utilize genetically improved seedlings. The FLNRO summarized the RESULTS regeneration survey data for the on-going TSR from 22 860 hectares recorded since 1999. The genetic gain by species was weighted by the share of the area reforested with improved stock. This accounted for the areas that were regenerated naturally or with planting stock with no genetic gain. It was assumed that the genetic gain shown in Table 36 remains constant throughout the planning horizon. The genetic gain shown in Table 36 was applied to future managed stands only. No genetic gain was applied to the modelling of existing managed stands.

Table 36: Genetic gain modeled in the analysis

Analysis Unit	Genetic Weight		
	Douglas fir	**Spruce**	**Pine**
Decid poor		2.0	0.2
Decid medium		2.0	0.2
Decid good		1.1	0.6
Decid very good		1.8	1.4
Douglas-fir poor		0.5	0.1
Douglas-fir medium		0.5	0.1
Douglas-fir good	0.1	0.3	0.1
Douglas-fir very good	0.9	1.6	0.1
Balsam poor		0.8	
Balsam medium		0.8	
Balsam good	0.1	0.3	
Balsam very good	4.1	2.1	0.5
Pine poor	0.1	0.6	0.1
Pine medium	0.1	0.6	0.1
Pine good	0.2	0.6	0.1
Pine very good	0.7	1.8	0.5
Spruce poor		0.2	
Spruce medium		1.0	0.1
Spruce good	0.3	1.7	0.2
Spruce very good	0.2	2.8	0.4

4.6.2 Regeneration Assumptions

The inputs for creating the managed stand yield curves (MSYT) for existing managed stands and future managed stands are shown in Table 38 and Table 38. The inputs were based on free-growing survey data of 22 860 hectares recorded since 1999. Aside from genetic gain, the analysis did not consider the method of establishment (planting versus natural) in the modelling of MSYT, rather the stand condition at free growing was the driver in the model. All the inputs were used in the latest TSR and received from the FLNRO.

Table 37: Regeneration assumptions for existing managed stands

Analysis Unit	Site Index	Regeneration Delay	Species Composition	Regeneration Method	Initial Density
Stands Currently 11 to 20 Years Old					
decid medium	11	0	At100	N	7,059
decid good	17	0	At100	N	6,487
decid very good	21	0	At100	N	4,343
fir poor	8	0	Fd87Pl13	P	1,220
fir medium	12	0	Fd85Pl15	P	795
fir good	16	0	Fd81Pl19	P	1,521
fir very good	21	0	Fd74Pl26	P	1,336
balsam poor	10	0	Bl76Cw24	P	711
balsam medium	11	0	Bl69Cw31	P	4,365
balsam good	16	0	Bl68Cw32	P	4,444
balsam very good	22	0	Bl60Pl40	P	2,310
pine poor	7	0	Pl75Se25	P	899
pine medium	11	0	Pl88Se12	P	2,930
pine good	18	0	Pl86Se14	P	3,681
pine very good	21	0	Pl82Se18	P	4,219
spruce poor	5	0	Se67Pl33	P	1,024
spruce medium	12	0	Se72Pl28	P	1,348
spruce good	16	0	Se73Pl27	P	1,839
spruce very good	21	0	Se74Pl26	P	1,824
Stands Currently 21 to 30 Years Old					
decid poor	10	0	At100	N	1,823
decid medium	11	0	At100	N	8,412
decid good	16	0	At100	N	1,425
decid very good	20	0	At100	N	1,970
fir poor	6	0	Fd87Pl13	P	2,893
fir medium	12	0	Fd85Pl15	P	1,052
fir good	17	0	Fd81Pl19	P	2,607
fir very good	21	0	Fd74Pl26	P	1,690
balsam poor	5	0	Bl76Cw24	P	3,573
balsam medium	12	0	Bl69Cw31	P	2,001
balsam good	16	0	Bl68Cw32	P	4,240
balsam very good	20	0	Bl60Pl40	P	2,417
pine poor	5	0	Pl75Se25	P	1,769
pine medium	11	0	Pl88Se12	P	2,392
pine good	18	0	Pl86Se14	P	3,545
pine very good	20	0	Pl82Se18	P	2,882
spruce poor	5	0	Se67Pl33	P	4,444
spruce medium	10	0	Se72Pl28	P	3,308
spruce good	16	0	Se73Pl27	P	4,237
spruce very good	21	0	Se74Pl26	P	2,865
Stands Currently 31 to 40 Years Old					
decid poor	10	0	At100	N	3,573
decid medium	12	0	At100	N	3,576
decid good	15	0	At100	N	1,183
decid very good	20	0	At100	N	1,983

Analysis Unit	Site Index	Regeneration Delay	Species Composition	Regeneration Method	Initial Density
fir poor	7	0	Fd87Pl13	P	4,361
fir medium	12	0	Fd85Pl15	P	884
fir good	17	0	Fd81Pl19	P	2,223
fir very good	21	0	Fd74Pl26	P	1,461
balsam poor	5	0	Bl76Cw24	P	4,444
balsam medium	11	0	Bl69Cw31	P	4,295
balsam good	17	0	Bl68Cw32	P	3,690
balsam very good	20	0	Bl60Pl40	P	3,181
pine poor	7	0	Pl75Se25	P	693
pine medium	11	0	Pl88Se12	P	4,315
pine good	18	0	Pl86Se14	P	2,113
pine very good	20	0	Pl82Se18	P	1,476
spruce poor	5	0	Se67Pl33	P	2,089
spruce medium	11	0	Se72Pl28	P	2,591
spruce good	16	0	Se73Pl27	P	4,297
spruce very good	21	0	Se74Pl26	P	3,257
Stands Currently 41 to 50 Years Old					
decid poor	10	0	At100	N	1,192
decid medium	11	0	At100	N	1,207
decid good	16	0	At100	N	1,312
decid very good	20	0	At100	N	3,796
fir poor	6	0	Fd87Pl13	P	4,235
fir medium	11	0	Fd85Pl15	P	884
fir good	17	0	Fd81Pl19	P	1,566
fir very good	20	0	Fd74Pl26	P	1,126
balsam poor	5	0	Bl76Cw24	P	1,213
balsam medium	11	0	Bl69Cw31	P	4,443
balsam good	17	0	Bl68Cw32	P	2,088
balsam very good	20	0	Bl60Pl40	P	2,310
pine poor	5	0	Pl75Se25	P	1,734
pine medium	11	0	Pl88Se12	P	1,010
pine good	18	0	Pl86Se14	P	1,397
pine very good	20	0	Pl82Se18	P	1,339
spruce poor	10	0	Se67Pl33	P	3,371
spruce medium	15	0	Se72Pl28	P	4,443
spruce good	15	0	Se72Pl28	P	4,443
spruce very good	21	0	Se74Pl26	P	1,118

Table 38: Regeneration assumptions for future managed stands

Analysis Unit	Site Index	Regeneration Delay	Species Composition	Initial Density
Decid medium	14	2	At 50% Pli 37% Fdi 7% Sx 5%	1,244
Decid good	17	2	At 60% Pli 22% Sx 10% Fdi 7% Bl 2%	1,097
Decid very good	21	2	At 52% Pli 26% Sx 13% Fdi 6% Bl 2%	1,216
Douglas-fir poor	9	1	Pli 63% Fdi 24% At 9% Sx 4% Bl 1%	1,029
Douglas-fir medium	13	1	Pli 63% Fdi 24% At 9% Sx 4% Bl 1%	1,029
Douglas-fir good	19	3	Pli 57% Fdi 25% At 14% Sx 2% Bl 1%	1,066
Douglas-fir very good	22	1	Pli 27% Fdi 25% Sx 24% At 15% Bl 9%	982
Balsam medium	15	2	Bl 56% Pli 26% Sx 11% Fdi 3% At 4%	1,065
Balsam good	18	3	Pli 55% Fdi 29% At 13% Sx 2% Bl 1%	1,040
Balsam very good	22	2	Pli 45% At 26% Fdi 10% Sx 9% Bl 9%	1,159
Pine poor	7	2	Pli 75% Fdi 8% At 8% Sx 6% Bl 2%	1,076
Pine medium	13	2	Pli 75% Fdi 8% At 8% Sx 6% Bl 2%	1,076
Pine good	19	2	Pli 75% At 9% Fdi 9% Sx 6% Bl 2%	1,072
Pine very good	21	2	Pli 55% At 16% Sx 13% Fdi 10% Bl 5%	1,064
Spruce poor	10	1	Sx 52% Pli 37% Bl 8% At 2%	1,314
Spruce medium	14	1	Pli 71% Sx 20% At 4% Bl 3% Fdi 1%	1,668
Spruce good	19	2	Pli 58% Sx 20% At 14% Bl 5% Fdi 3%	1,101
Spruce very good	22	1	Pli 40% Sx 29% At 13% Fdi 10% Bl 7%	1,067

As discussed in chapter 4.4.5.2, standard OAF values of OAF1 - 15% and OAF2 - 5% except in MPB impacted young pine stands where a 35% OAF1 was used. The base case assumed no thinning or fertilization.

5 Silviculture Strategies for Exploration

The strategies that could be employed to improve the timber supply in the 100 Mile House TSA were discussed at the second workshop with the district licensees and staff. The following strategies will be explored in this analysis:

- Assessment of quality and health of managed stands which will be relied on to support the midterm
- Fertilization, single and multiple
- Spacing of over dense understories in partial harvested Dry-Belt Douglas-fir Stands
- Overstory removal and spacing of partial harvested Dry-Belt Douglas-fir Stands
- Rehabilitating MPB-Attacked Stands
- Repression spacing of over-dense pine
- Enhanced basic reforestation
- Spacing low density, diseased and damaged pine stands in the IDF to favor existing layer 3 and 4 Douglas fir
- Spacing/cleaning of diseased, damaged poor quality pine leading stands in the SBS and ICH to favour existing Fd and Sx stocking
- Underplanting of low density, poor quality young pine stands in the IDF
- Converting non-forested area into THLB
- Harvest scheduling
- Combination of treatments

5.1 Fertilization

Single fertilization treatments can be applied in existing stands. Often best returns are achieved if the fertilized stands are harvested approximately 10 years after treatment. The population of candidate stands is limited by their location, structure, health and site index.

Multiple fertilization treatments can be applied to existing and future stands to improve their growth rates. These treatments, if recommended, will likely focus on existing managed stands, as the focus of this analysis and strategy is to provide direction for silviculture investments within the next 10 years.

5.1.1 Scenario 1

This scenario investigated the impact of multiple fertilization of existing managed stands. These stands had been fertilized previously in 2006 or 2012 and were Douglas fir or Spruce leading stands (Table 39). Depending on the age of the stand, these stands were set to be fertilized once at age 55 or twice at ages 40 and 50. The total candidate area in this scenario was 3,340 ha. Fertilization cost was assumed to be $600.00 per ha and the fertilization response was assumed to be standard TIPSY response (Table 40).

Table 39: Candidate analysis units for fertilization; Scenario 1

Analysis Unit	SI	BEC	Species group
Douglas fir good and very good	17 to 21	ICH, SBS, ESSF, SBPS	Douglas fir leading
Spruce very good	21	ICH, SBS, ESSF, SBPS	Spruce leading

Table 40: Standard Tipsy fertilization response

Application Age	Pine Response (gross m^3 per ha)	Spruce Response	Douglas fir Response
25	17	17	14
35	17	19	15
45	15	21	15
55	15	19	15

5.1.2 Scenario 2

Fertilization Scenario 2 added approximately 2,000 ha of pine leading stands currently between 21 and 30 years old to the scenario 1 population. The total candidate population in this scenario was 5,340 ha. These stands were assumed to be fertilized at ages 25, 35, 45 and 55.

Table 41: Stands added to make Scenario 2 fertilization population

Analysis Unit	SI	BEC	Species group
Pine very good	20	SBS	Pine leading

5.1.3 Scenario 3

This scenario investigated the potential impact of an aggressive fertilization program. It included all the treatments from the 2 previous scenarios and added approximately 25,000 ha of candidate stands currently between 1 and 30 years old with the total candidate population of 30,000 ha. The added stands were fertilized at ages 25, 35, 45 and 55; note that stands older than 25 were fertilized only 3 times. Table 43 shows the area weighted average cumulative responses to fertilization in this analysis.

Table 42: Stands added to make Scenario 3 fertilization population

Analysis Unit	SI	BEC	Species group
Pine good and very good	18 to 21	Mostly SBS with some ICH, ESSF, SBPS	Pine leading

Table 43: Area weighted average cumulative fertilization response

Stand Age at Treatment	Cumulative Fertilization Response (5 years after treatment) m^3/ha		
	Pine leading stands	Douglas fir leading stands	Spruce leading stands
25	10.5	3.7	1.9
35	23.6	13.7	8.3
45	35.7	29.2	22.9
50	46.4	39.4	32.7

5.2 Partial Harvesting in Dry-Belt Douglas-fir Stands

These stands are repressed due to past diameter limit cutting and exist as layered stands. They are currently harvested using the clearcut with reserves approach which often results in higher than desired pine component in the regenerated stands. Using modified partial harvesting regimes in these stands may be beneficial to wood supply, habitat supply and fuel management. A potential regime would consist of a shelterwood system with a preparation cut that would remove 30 to 50% of the basal area followed by planting with Fdi stock. The removal of the understory would occur approximately 10 years after planting.

The existing managed stands in this category outside of UWR cover approximately 36,000 ha. In the resultant dataset these stands are recorded as being 11 to 50 years old based on the latest recorded harvest. The growth and yield input that is currently used to model these stands considers them even-aged stands with an area reduction to mimic retention harvesting. A small reduction in future growth is also incorporated to account for reduced growth due to retention.

In reality these stands are multilayered stands as discussed above. Treatments on these stands were not modeled at the forest level as it would not be possible to represent treatments effects in the model adequately. However, we believe that partial harvesting of these stands is a viable treatment. This treatment option and its potential impact will be discussed in the Modeling and Analysis Report.

5.3 Rehabilitating MPB-Attacked Stands

It is likely that many MPB attacked stands have lost so much of their merchantable volume that they are not economical to harvest and will remain in the landscape. These stands are a potential fire hazard and drag to the timber supply. Rehabilitating these stands will likely have a positive impact on the timber supply. The positive impacts will extend to fire hazard abatement and watershed recovery as well.

The challenge in the analysis is to define the candidate stand population, as it is difficult to determine which stands may not be salvaged by the TSA licensees. Stands that remained unharvested in the timber supply model due lost dead pine volume were used as a starting point. This population was further reduced by removing stands within the UWR. Also, stands that in the timber supply model were assumed to contain dense advance regeneration were removed from the rehabilitation population. This left approximately 23,000 ha of good and very good pine stands that were set to be rehabilitated in the model. All rehabilitation was set to take place within the first 5 years of the planning horizon at the cost of $2,000 per ha.

5.4 Repression spacing of over-dense pine stands

According to the 100 Mile House Resource District there are small areas of over-dense repressed pine stands that may benefit from spacing. There is no data on these stands in the inventory file and as such this treatment will not be modeled in the analysis, however, it will remain as an option for the silviculture strategy.

5.5 Enhanced reforestation

This analysis used the regeneration assumptions from the latest TSR for modeling future timber supply. These assumptions were based on the data obtained from the RESULTS data base. This data indicated that in most analysis units the establishment densities were relatively low – between 1,000 and 1,100 stems per ha. This silviculture strategy investigated the impact of enhancing reforestation practices by increasing establishment densities. Increasing the establishment densities is not expected to impact the medium term, however it is generally supported by stakeholders due to the its expected result of higher timber volume, improved quality of timber and increased resilience against pests and diseases.

Two scenarios were constructed:

5.5.1 Scenario 1

All the coniferous good and very good analysis unit establishment densities were set at 1,600 stems per hectare. All the trees were assumed to be planted and where class A seed is available genetic worth was used. Genetic worth was estimated at 13% for spruce, 15% for Douglas fir outside of IDF and 1% for pine.

5.5.2 Scenario 2

Scenario 2 assumed that 75% of all the enhanced stands, except for balsam stands were fertilized at ages 30, 40 and 50 with tipsy default responses.

5.6 Spacing low productivity pine stands to favor Douglas fir

According to the 100 Mile Resource District staff there are low productivity pine leading stands with significant Douglas fir component in the district where the stands may benefit from spacing to favour Douglas fir. As with the spacing of over-dense pine stands, the inventory file does not provide adequate detail for these stands to facilitate modeling. However, this treatment will remain as an option for the silviculture strategy.

5.7 Converting non-productive areas into THLB

Converting non-productive areas is always a viable option to increase timber production. Generally the timber supply impact occurs in the long term. The district does not have readily available candidate areas for this conversion; however, this treatment remains as an option in the silviculture strategy.

5.8 Harvest scheduling

This analysis tested the mid-term timber supply impact of reducing the current harvest level immediately.

5.9 Combination of treatments

The final or preferred silviculture strategy will be a combination of various treatments and strategies. It will be developed together with the 100 Mile House stakeholder group.

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