Integrated Stewardship Strategy for the Stuart TSBs (A, B, C) in the Prince George TSA

Data Package

Version 1.1

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Project 419-37

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List of Abbreviations and Acronyms

AD	Anthropogenic Disturbance
AU	Analysis Unit
ATC	Access Timing Constraints
BEC	Biogeoclimatic Ecosystems
CFLB	Contributing Forest Land Base
ECA	Equivalent Clearcut Area
ESA	Environmentally Sensitive Area
FLNRORD	BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FNWL	First Nations Woodlot Licence
FSW	Fisheries Sensitive Watershed
ISS	Integrated Stewardship Strategy
LRMP	Land and Resource Management Plan
LUP	Land Use Plan
MPB	Mountain Pine Beetle
MHA	Minimum Harvestable Age
MVH	Minimum Volume per Hectare
NDU	Natural Disturbance Unit
NRL	Non-Recoverable Loss
NTHLB	Non-Timber Harvesting Land Base
OGMA	Old Growth Management Area
P2P	Plan to Perspective
PFT	Problem Forest Type
RMZ	Resource Management Zone
THLB	Timber Harvesting Land Base
TSA	Timber Supply Area
TSB	Timber Supply Block
TSR	Timber Supply Reserve
UWR	Ungulate Winter Range
VEG	Visually Effective Green-up
VQO	Visual Quality Objectives
VDYP	Variable Density Yield Prediction
VRI	Vegetation Resources Inventory
WHA	Wildlife Habitat Area

Document Revision History

Version	Date	Notes/Revisions
1.0	Sep 26, 2017	First version distributed to project team for review and comment.
1.1	Mar 31, 2018	Changed project name from 'Integrated Silviculture Strategy' to 'Integrated Stewardship Strategy'; added Document Revision History; incorporated comments from project team; corrected several spelling errors; updated Figure 1; added discussion for silviculture and combined scenarios (sections 4.3 and 4.4); revised tables in Appendix 2 and Appendix 3.

1 Introduction

The British Columbia Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) initiated an Integrated Stewardship Strategy (ISS) in the Stuart Timber Supply Blocks (TSBs). This Data Package document describes the information that was relevant to the analysis including the model used, data inputs, and assumptions.

This draft Data Package is not yet complete. Missing from this document are the assumptions specific to silviculture strategies that will be explored during this project. This preliminary version of the Data Package is primarily meant to present the data and assumptions planned for the base case. Once silviculture strategy assumptions are finalized, they will be included to this document.

1.1 STUDY AREA

The Stuart Timber Supply Blocks (TSB) are located around the Stuart and Takla Lakes watersheds in the North-Central part of BC in the Omineca Forest Region and the Prince George Timber Supply Area (TSA). The TSBs form an elongated area running in a northwest to southeast direction, bordered by the Skeena Mountains to the west and the Omineca Mountains to the east. The TSA includes the communities of Fort St. James (Nak'azdli), Tachie, Yekooche, Bear Lake, Leo Creek, and Takla Landing.

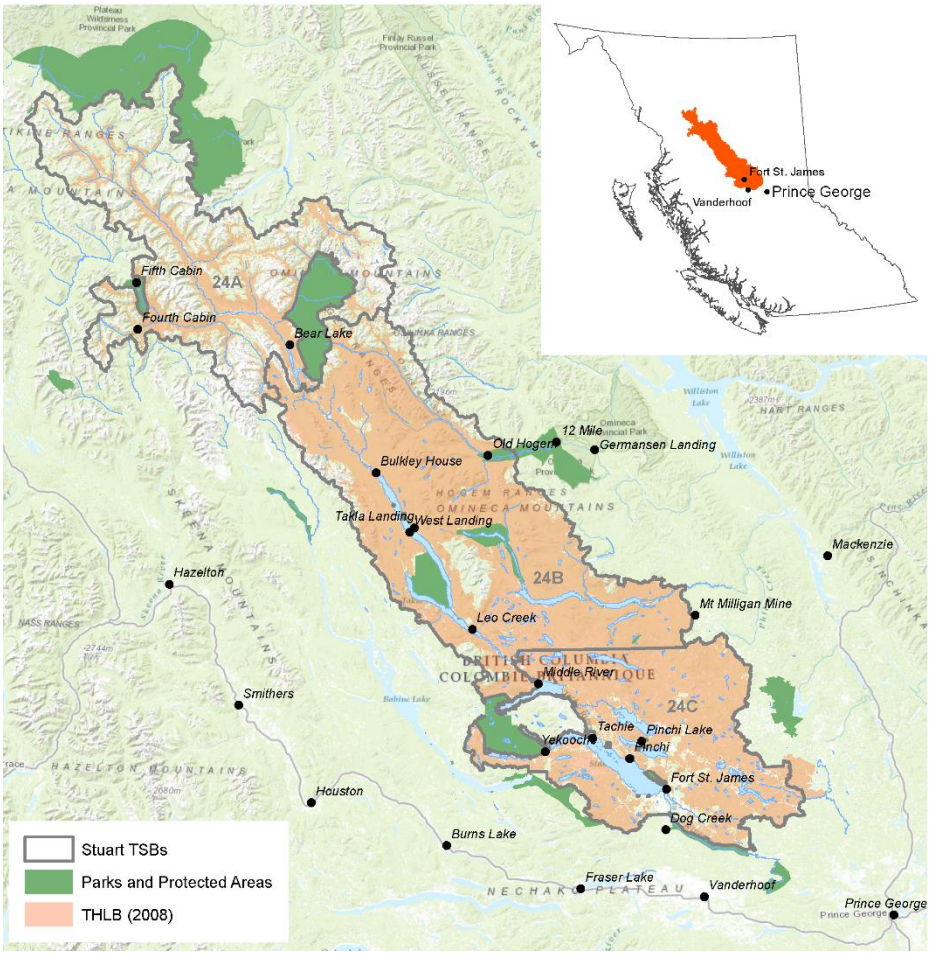


Figure 1 Stuart ISS Project Area (Timber Supply Blocks)

The study area (Stuart TSBs; Figure 1) covers approximately 3.174 million hectares and represents the former Fort St. James Forest District which is comprised of TSBs A, B, and C of the Prince George TSA. It also lies within the newly-formed Stuart Nechako Natural Resource District. Because of this recent change in district name, most documents, maps, and websites still refer to the project area as the Fort St. James Forest District.

Plans and strategies in place for the Stuart TSBs include:

- Provincial Timber Management Goals and Objectives;
- Fort St. James Land and Resource Management Plan (LRMP);
- Federal Recovery Strategy for Northern Caribou;
- Sustainable Forest Management Plan (Forest Licensees);
- Silviculture Strategies Types 1, 2, and 4;
- BC Mountain Pine Beetle Model;
- Future Forest Products and Fibre Use Strategy;
- Multiple Resource Value Assessment;
- Provincial Stewardship/ Timber Harvesting Land Base Stabilization;
- Forest Health Strategy;
- Ecosystem Restoration;
- Whitebark Pine;
- Fire and Fuel Management; and,
- Non-Spatial Biodiversity Management Objectives.

Many aspects of these plans will have an influence on the development of this Data Package and modeling strategies.

1.2 CONTEXT

This document is the third in a series of documents developed through the ISS process.

1. Situation Analysis – describes in general terms the situation for the unit.
2. Scenario Development – describes the development of a Combined Scenario to be explored through forest-level modelling and analysis. This is first developed and explored as three separate scenarios:
    a) Base Case Scenario – provides a baseline for comparison against other scenarios. It is a more flexible test that takes into account non legal 'status quo management' compared with TSR that can only consider legally-established objectives.
    b) Reserve Scenario – review and analyze existing and proposed management zonation and develop strategy options that provide for the sustainable management of non-timber values.
    c) Harvest Scenario – review and analyze current and planned timber harvesting plans, infrastructure, and capabilities in the context of the distribution of MPB-killed pine salvage opportunities and the landscape reserve scenario. This must consider the current salvage period and the transition into the mid-term timber supply.
    d) Silviculture Scenario –provides treatment options, associated targets, timeframes and benefits to minimize the impact of the MPB infestation over the mid-term timber supply.
3. **Data Package** - describes the information that is key to the analysis including the model used, data inputs and assumptions.
4. Analysis Report –provides modeling outputs and rationale for choosing a Combined Scenario.
5. Operational plan – direction for the implementation of the Combined Scenario.

6. Final Report – summary of all project work completed.
7. Monitoring Plan – direction on monitoring the implementation of the ISS; establishing a list appropriate performance indicators, developing monitoring responsibilities and timeframe and a reporting format and schedule.

1.3 MODEL

The PATCHWORKS ™ modeling software will be 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 and/or 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, coarse woody debris levels, Equivalent Clearcut Areas (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. The model's 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 analyses 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 – model size is only limited by solution times.
- Fully customizable reporting on economic, social and environmental conditions over time.

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

1.4 DATA SOURCES

Table 1 Spatial Data Sources

Spatial Data	Source	Feature Name	Effective
TSA Boundary	WHSE_ADMIN_BOUNDARIES	FADM_TSA	2010
Parks and Protected Areas	WHSE_TANTALIS	TA_PARK_ECORES_PA_SVW	2012
Candidate Goal 2 Protected Areas	WHSE_LAND_USE_PLANNING	RMP_PLAN_NON_LEGAL_POLY_SVW	2009
Indian Reserves	WHSE_ADMIN_BOUNDARIES	CLAB_INDIAN_RESERVES	2012
New Community Forest	RSI	WLCF_BOUNDARY	2012
Ownership	WHSE_FOREST_VEGETATION	F_OWN	2012
Biogeoclimatic Ecosystems (BEC)	WHSE_FOREST_VEGETATION	BEC_BIOGEOCLIMATIC_POLY	2012
Snowpack	FORSITE (BEC)	BEC_BIOGEOCLIMATIC_POLY	2012
Stand Structure Habitat Class	MOE	STND_STRC_HAB_CLS	2006
Landscape Units	WHSE_LAND_USE_PLANNING	RMP_LANDSCAPE_UNIT_SVW	2011
Old Growth Management Areas (OGMA)	WHSE_LAND_USE_PLANNING	RMP_OGMA_LEGAL_CURRENT_SVW	2011
Ungulate Winter Ranges (UWR)	WHSE_WILDLIFE_MANAGEMENT	WCP_UNGULATE_WINTER_RANGE_SP	2004
Wildlife Habitat Areas (WHA)	WHSE_WILDLIFE_MANAGEMENT	WCP_WILDLIFE_HABITAT_AREA_POLY	2011
Proposed Wildlife Habitat Areas	REG_LAND_AND_NATURAL_RESOURCE	WLD_WHA_PROPOSED_SP	2012
Watershed Reporting Units – Sub-basins	WHSE_BASEMAPPING	FWA_ASSESSMENT_WATERSHEDS_POLY	2011
Watershed Reporting Units – Basins	FORSITE (watershed sub-basins)	ALL_WATERSHEDS	2011
Community Watersheds	WHSE_WATER_MANAGEMENT	BC_COMMUNITY_WATERSHEDS	2012
Critical Fish Habitat	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Scenic Areas	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Buffered Trail Areas	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Birch Areas for First Nations	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Community Areas of Special Concern	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Lakeshore Management Classes	WHSE_LAND_USE_PLANNING	RMP_PLAN_LEGAL_POLY_SVW	2012
Wetland Management Zones (Buffers)	REG_LAND_AND_NATURAL_RESOURCE	WETLAND_MGMT_CAR_POLY	2011
Stream Management Zones (Buffers)	REG_LAND_AND_NATURAL_RESOURCE	STREAM_MANAGEMENT_CAR_POLY	2011
Riparian Buffers	TECO – Type2 Silviculture Strategy	RIPARIAN	2008
Environmentally Sensitive Areas	TECO – Type2 Silviculture Strategy	ESA	2007
Terrain Stability	WHSE_TERRESTRIAL_ECOLOGY	STE_TER_ATTRIBUTE_POLYS_SVW	2010
Slope Class	Forsite	SLOPE_CLS	2012
Haul Cycle Times	FAIB – Mid-Term Analysis (fig 2)	CYCLETIMES	2011
Forest Inventory –VRI	WHSE_FOREST_VEGETATION	VEG_COMP_LYR_R1_POLY	2011
Forest Inventory – Depletions	FAIB	CONSOLIDATED_CUTBLOCKS_2012	2012
Forest Inventory – Cut Blocks	WHSE_FOREST_TENURE	FTEN_CUT_BLOCK_POLY_SVW	2012
Forest Inventory – Results Openings	WHSE_FOREST_VEGETATION	RSLT_OPENINGS_SVW	2012
Forest Inventory – Reserves	WHSE_FOREST_VEGETATION	RSLT_FOREST_COVER_RESERVE_SVW	2012
Forest Inventory – Results Forest Cover	WHSE_FOREST_VEGETATION	RSLT_FOREST_COVER_INV_SVW	2012
Forest Inventory – Results SU	WHSE_FOREST_VEGETATION	RSLT_STANDARDS_UNIT_SVW	2012
Forest Inventory – Managed Site Index	FAIB	SITE_PROD_WILLIAMS_LAKE	2011
Spaced/Fertilized	WHSE_FOREST_VEGETATION	RSLT_ACTIVITY_TREATMENT_UNIT_SVW	2012
Wildfires – Historic (1996-2012)	WHSE_LAND_AND_NATURAL_RESOURCE	PROT_HISTORICAL_FIRE_POLYS_SP	2011
Wildfires – Current (2012)	WHSE_LAND_AND_NATURAL_RESOURCE	PROT_CURRENT_FIRE_POLYS_SP	2012

1.5 FOREST INVENTORY UPDATES

The current forest inventory of the Stuart TSBs is based on inventory projects dating back to 1971. However, most of the southern portion of the TSA (approximately 40% of the area) is based on aerial photography acquired between 2001 and 2015.

While the vegetation inventory available for the Stuart TSBs has been acquired over several decades, most projects throughout the area defined as the Timber Harvesting Land Base (THLB) have been conducted fairly recently, albeit prior to impacts from Mountain Pine Beetle (MPB), spruce, and balsam bark beetle infestations.

Disturbance

The forest inventory was updated for logging disturbance prior to 2015. Harvested areas were identified using a consolidated cutblock layer (Cutblock_2015) that includes the Vegetation Resources Inventory (VRI), forest tenure administration blocks, and Reporting Silviculture Updates and Land Status (RESULTS) tracking System data. Logged areas were identified by year of harvest completion (Disturbance_End_Date).

Mountain Pine Beetle

The 2015 update to the Provincial Forest Cover incorporates changes to account for current MPB losses:

- For inventories captured before MPB, stand density and volume estimates were adjusted/ prorated based on the BCMPB Model version 11 and a Year-of-Death data layer. For inventories captured after the peak MPB-attack period of 2008, volumes did not need to be adjusted because the MPB impact was already reflected in the typing.
- Growth and yield projections utilized the dead stand percentage available in the inventory and no additional future mortality from MPB was implemented. The dead stand percentage attributes reflect percentages for the entire stand, factored according to the pine component within the stand (Section 2.4.8).

Wildfires

Areas burned by wildfire were identified using two Ministry provided layers (FIRE_CURRENT and FIRE_HISTORIC) and based on the fire year. These stands will be treated as managed stands from their burn date (FIRE_YEAR).

Volume Adjustments

No volume adjustments were applied to the forest inventory. The VRI Phase I was completed in 2003, Phase II completed by 2009, and the Net Volume Adjustment Factor program was completed between 2005 and 2009. The inventory was audited in 2014 and these projects were deemed suitable for this analysis.

2 Base Case Scenario

This section describes the assumptions used to model the base case scenario (status quo management). This scenario provides the base from which to compare various scenarios.

2.1 LAND BASE ASSUMPTIONS

Land base assumptions are used to define the contributing forest land base (CFLB) and THLB in the TSA. The THLB is designated to support timber harvesting while the CFLB is identified as the broader productive forest that can contribute toward meeting non-timber objectives (e.g., biodiversity).

Table 2 Stuart TSBs Land Base Area Summary

Land Base Element	Total Area (ha)	Effective Area (ha)*	% Total Area	% CFLB
Total Crown area (PA FMA)	**3,178,261**	**3,178,261**		
Less:				
Non-Forest	516,380	516,380	16.2%	
Roads, Rail, Utilities Corridors	18,837	17,039	0.5%	
Low SI	535,660	535,660	16.9%	
Fed/Private/Non-TSA	226,825	112,901	3.6%	
First Nations Wood Titles	102,685	88,235	2.8%	
John Prince Research	13,035	12,132	0.4%	
Crown Forest Land Base (CFLB)		**1,895,914**	**59.7%**	
Less:				
Agriculture Development Area	4,229	3,959	0.1%	0.2%
Misc. Lease/Protected Area	421	143	0.0%	0.0%
Settlement Reserve Area	1,979	1,835	0.1%	0.1%
Parks and Reserves	185,120	127,172	4.0%	6.7%
UWR approved	387,967	73,801	2.3%	3.9%
Grizzly	2,071	6	0.0%	0.0%
Pelican	498	441	0.0%	0.0%
FSW (No Harvest Zones)	855	699	0.0%	0.0%
Uneconomic -Low Volume Pine	52,546	35,981	1.1%	1.9%
Uneconomic - Low Volume Other	1,489,741	307,876	9.7%	16.2%
Uneconomic -Haul Distance	268,959	34,753	1.1%	1.8%
Uneconomic -Steep Slope	239,883	16,465	0.5%	0.9%
Uneconomic - Elevation	578,320	7,064	0.2%	0.4%
Uneconomic -Problem Forest Type	4,190	1,437	0.0%	0.1%
Riparian Buffers	420,619	90,272	2.8%	4.8%
Uneconomic - Isolated	1,193	1,193	0.0%	0.1%
Current Timber Harvesting Land Base (THLB)		**1,192,816**	**37.5%**	**62.9%**
Less Non spatial Netdowns:				
Stand Level MPB Conservation Uplift		88,552	2.8%	4.7%
Stand Level Retention (in-block and matrix - 4.5%)		53,677	1.7%	2.8%
Effective THLB		**1,050,588**	**33.1%**	**55.4%**
Less Future Non-Spatial Netdowns:				
Future permanent roads (1.7%)		17,860	0.6%	0.9%
Effective Future THLB		**1,032,728**	**32.5%**	**54.5%**

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

More detailed descriptions of these land base assumptions are provided within the following subsections. After applying these assumptions, the land base was summarized below according to BEC zones (Figure 2) and age classes (Figure 3). The distribution of the major BEC zones for both the THLB and Non-THLB (NTHLB), together equalling the CFLB.

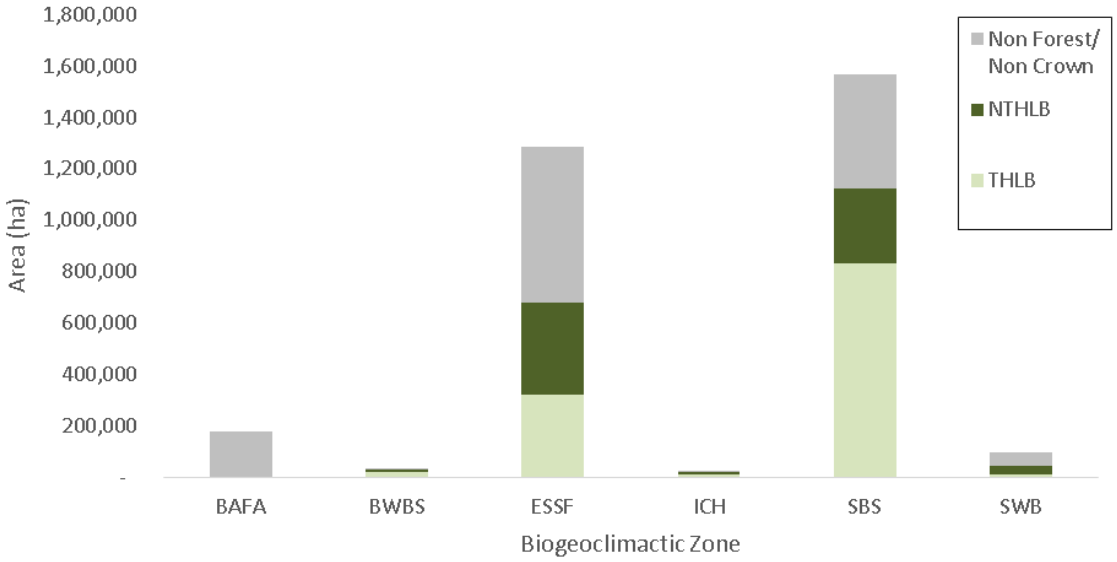
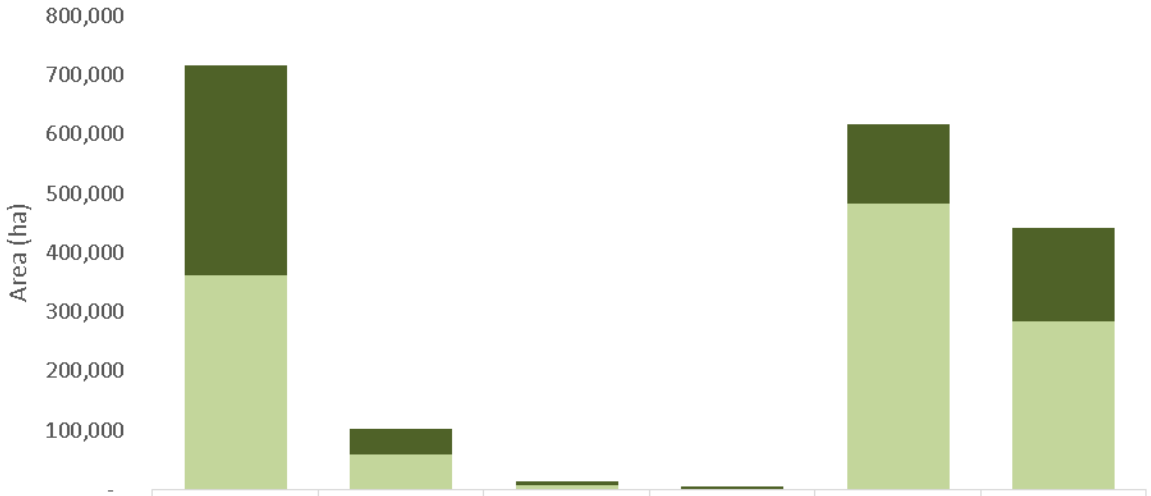


Figure 2 BEC Zone Distribution across the Forest Management Land Base

Considering the magnitude of area affected by Mountain Pine Beetle (MPB) and fire across the spectrum of age classes, it is expected there will be a large shift of future stands into a narrow age class range. Once mature, these stands within the narrow age class range will become available for harvest again in a common period. It will be necessary to find ways to break up this age class cohort to promote a somewhat even flow of timber and minimize the risk of future MPB outbreaks.

After applying assumptions to reflect changes in stand age from disturbances (i.e., fire, insects, and harvesting) the current age class distribution and species composition of both the THLB and NTHLB are shown in Figure 3 and Figure 4, respectively.

Figure 3 Age Class Distribution across the Forest Management Land Base



	Balsam	Decid	Fir	Hemlock	Pine	Spruce
NTHLB	354,177	42,707	7,502	3,972	136,077	158,552
THLB	362,168	59,615	6,366	-	481,774	282,821

Figure 4 Area distribution by Leading Species within the CFLB

2.1.1 Non-Forest and Non-Productive

The non-forest includes areas that are non-vegetated and/or non-productive (Figure 5). Areas were identified using the logic provided in Table 3.

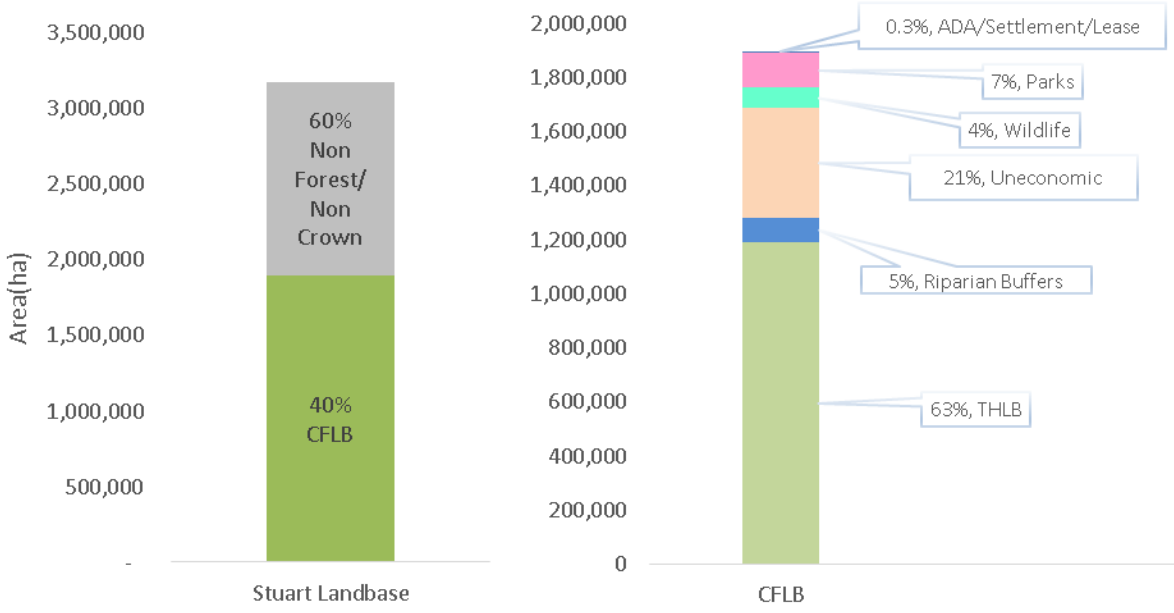


Figure 5 Breakdown of Non-Forest and Non-Productive areas compared to CFLB

Table 3 Non-Forest and Non-Productive Classification

Type	Description	Attributes
Non-treed	Non-vegetated	BCLCS_Level_1 = 'N'
	Non-managed forest with crown closure <	BCLCS_Level_2 = 'N'

	10%	
	Rock, ice, etc.	BCLCS_Level_4 = 'SI' or BCLCS_Level_4 = 'RO' or BCLCS_Level_4 = 'EL' and not previously harvested
Non-productive	Site index < 5 m	Site_index < 5
Water	Lakes/Reservoirs	BCLCS_LEVEL_5 in ('LA', 'RE')
	Wetlands	BCLCS_LEVEL_3= 'W'
	River/Stream	BCLCS_LEVEL_5 = 'RI'
Alpine	BC land classification	BCLCS_Level_3 = 'A'
	BEC zones	Zone in ('BAFA','IMA')

2.1.2 Cleared Right-of-Ways

A current road network was compiled using the Fort St. James District (DJA) roads layer. The roads in this layer were already given classes based on usage (Table 4). In addition, the utility polygon layer also included some further buffers for areas that are considered road right-of-ways (i.e., main highways and their buffers).

Table 4 Existing Roads and Non-Forested Widths

Class	Non-Forested Width (m)
1 Mainline	28
2 Operational	13
3 In-block	6

Total area affected by power transmission, rail and pipe lines were tallied for the entire Prince George TSA in the Timber Supply Review (TSR) 5 Data Package (BC Ministry of Forests, Lands, and Natural Resource Operations, 2015) and was not cut out by supply block. For application in the Stuart TSBs, the classification in Table 5 utilizes the widths used in the Mackenzie TSA TSR Data Package on the basis that the two study areas are assumed to be similar.

Table 5 Utility and Rail Line Non-Forested Widths

Class	Non-Forested Width (m)
Rail Lines	45
Main Power Line	200
Pipelines	18

2.1.3 Non-TSA Ownership, Parks and Protected Areas

For this analysis, the CFLB was spatially reduced for all areas identified as private land, Indian Reserve, parks, protected areas, tree farm licences, woodlot licences, community forest agreements, and some miscellaneous leases (Table 6).

Table 6 Non-TSA Lands, Parks and Protected Areas Classification

Code	Land Type	CFLB	THLB
40	Private – Crown Grant	Excluded	Excluded
52	Indian Reserve	Excluded	Excluded
60	Crown Ecological Reserve	Included	Excluded
61	Crown UREP (Use, Recreation and Enjoyment of the Public) Reserve	Included	Excluded
63	Provincial Park	Included	Excluded
68	Crown BMTA (Biodiversity, Mining and Tourism Area)	Included	Excluded
69	Crown Miscellaneous Reserves	Included	Excluded
72	Crown and Private Schedule "B" Lands	Included	Excluded
77	Crown and Private Woodlot Licence	Excluded	Excluded
79	Community Forest	Excluded	Excluded
99	Crown Misc. Lease (fairground, club site, cottage site)	Excluded	Excluded

The government has proposed some additional line work for First Nations Woodlot Licences (FNWL) that is currently not in the TSR. These areas are removed from the contributing land base in the model (Table 7).

Table 7 Draft FNWL implemented in ISS

FNWL	Area (ha)
Nakazdi	31,069
Yekoochie	32,336
Tanizul	33,297
Quantum Treaty	5,985

2.1.4 Crown Land Plans

There are two types of crown land plans present within the area, ADAs and SRA. Both of these designations require 100% THLB reduction (Table 8).

Table 8 Crown Land Plans Designations

Designation in CLP	THLB Reduction (%)
Agriculture Development Area (ADA)	100
Settlement Reserve Area (SRA)	100

2.1.5 Ungulate Winter Range

Various legal orders exist for Ungulate Winter Range (UWR) in the former Fort St. James District. These regulatory vehicles contain both, 100% legal exclusions from THLB (Table 9) and forest cover constraints applied to the THLB (section 2.2.4).

Table 9 Spatial THLB Reductions for Ungulate Winter Ranges (Legal)

UWR Tag	UWR Name	Habitat Units	Gross Area (ha)
7-002	Mule Deer	19	176
7-003	Mountain Caribou	T-003, T-006, T-014, T-016	38,971
7-019	Mountain Goat	All	309,672
7-026*	Northern Caribou	All	139,700

** Wasn't Legal for TSR5*

2.1.6 Wildlife Habitat Area

While there are no legally established wildlife habitat areas (WHA) in the Stuart TSBs, there are various draft and proposed orders which in ISS scenarios are assumed to be binding (Table 10). Here, 100% of the WHAs are excluded from the THLB.

Table 10 Draft Spatial Reductions for Wildlife Habitat Areas

Constraints	Units	Modelling Criteria* (total hectares)	Field Names
Draft WHA: White Pelican	7-001 Core	Core (500 ha): No harvest or roads.	MGMT_TYPE
	7-001 Management Zone	Management Area (1,319 ha): Access management; timber harvest and roads permitted.	MGMT_TYPE
Draft WHA: Grizzly Bear	**7-002** Tl'oba WHA	Core (2,065 ha): No harvest or roads	WHA_NME
	7-002 Access (Riparian Buffer)	Specified Area (4,371 ha): Access management; timber harvest and roads permitted.	WHA_NME (not modeled)
	7-002 Denning (M-Zone)	Denning Habitat (668 ha): Access management; timber harvest and roads permitted.	WHA_NME (not modelled)
Draft WHA: Chase, and Wolverine Caribou Herds	Calving	All (13,897 ha CFLB): No harvest or roads.	Handled as a Group in the model
Draft WHA: Chase, and Wolverine Caribou Herds	Post Rut	All (1,046 ha CFLB): No harvest.	Handled as a Group in the model

2.1.7 Fisheries Sensitive Watersheds

There are 20 proposed Fisheries Sensitive Watersheds (FSW) that overlap with the Stuart TSBs. Nine of the FSWs have designated no harvest zones which are 100% excluded from harvesting (Table 11).

Table 11 No Harvest Zones for Fisheries Sensitive Watersheds

Source	Watershed, Basin or Sub-basin	Total Area (ha)	No Harvest Area (ha)
Proposed FSW - f-7-006	Gluskie Creek	4,881	85
Proposed FSW - f-7-007	Forfar Creek	3,752	235
Proposed FSW - f-7-008	O'Ne-ell/Kynoch Creek	7,096	363
Proposed FSW - f-7-010	Bivouac Creek	4,181	77
Proposed FSW - f-7-011	Van Decar Creek	2,708	144
Proposed FSW - f-7-012	Sidney Creek	4,402	18
Proposed FSW - f-7-013	Paula Creek	4,578	91
Proposed FSW - f-7-014	Sandpoint Creek	6,523	332
Proposed FSW - f-7-015	Narrows Creek	6,534	25
Total		**44,655**	**1,370**

2.1.8 Physically and Economically Inoperable

Forested stands are considered physically or economically inoperable based on the limits of historical harvest activity. Five attributes are assessed to determine the upper and lower bounds for operability: slope, elevation, terrain stability, distance, and low-volume stands. The criteria used in TSR5 to identify areas deemed to be inoperable are also used in this analysis (Table 12).

Table 12 Inoperable Classification

Category	Criteria
Slope	> 62%
Elevation	> 1492 m
Terrain Stability	Terrain stability class 'V' or '5', ESA class = 'S1'
Excessive Haul Distance	Cycle time > 23 hours
Low-Volume Stands: non-MPB	MVH = 182 m^3
Low-Volume Stands: MPB	MVH = 140 m^3 and a shelf life loss adjustment factor

Slope and elevation criteria are determined based on an analysis of cutblocks over the past 50 years, slope and elevation class thresholds, equipment capability, and environmental suitability. Terrain stability criteria include Environmentally Sensitive Areas (ESA) mapping and Biophysical and Terrain Stability Mapping.

A cycle time analysis defines excessive hauling distance as 23 hours away from processing facilities near Fort St. James or Houston.

Low-volume stands were considered un-merchantable based on a minimum volume per hectare (MVH) criteria. Since volume per hectare has not been adjusted from catastrophic loss from MPB, different MVH criteria were utilized for non-MPB and MPB-attacked stands.

Problem forest types (PFT) are stands that are physically operable and/or exceed the non-productive site index threshold but are not currently utilized or have marginal merchantability and are considered uneconomic. The PFTs definition used in TSR5 analysis is also used here because harvesting was not observed in these areas since TSR5 came into effect (Table 13).

Table 13 Problem Forest Types Classification

Leading Species	THLB Reduction (%)
Hemlock	100
Black Spruce	100
Non-commercial deciduous (Alder, Willow)	100

** Leading species refer to the dominant (generally highest volume) species in the VRI polygon*

2.1.9 Riparian Zones

The TSR5 used an aspatial strategy to estimate riparian buffers as a portion of the in-block retention. In this analysis, streams, rivers, lakes, and wetlands were all buffered spatially to ensure that a spatially-explicit tactical plan can be delivered (Table 14).

Table 14 Spatial buffers of riparian features

Riparian Class	Size	Description	Buffer Width (m)
Streams	Large	Stream Order >= 6	70
	Medium	Stream Order in (3,4,5)	50
	Small	Stream Order in (1,2)	30
Lakes and Wetlands	Large	Area >= 5 ha	50
	Medium	Area >=1ha & <5ha	30
	Small	Area < 1ha	30

Note: Stream Order is not the same as Stream Classification

2.1.10 First Nations Interests, Recreation, and Cultural Heritage Resources

Cultural heritage trails are managed through timber reserves, mitigating operation designs, silvicultural systems, and operational timing. Cultural heritage sites were accounted for within designated recreation sites and reserves, existing resource management zones, protected areas, wildlife and fish habitat areas, riparian areas, scenic areas, and visual preservation zones.

2.1.11 Resource Management Zones

In the Fort St. James LRMP, resource management zones (RMZ) include Stuart River, Mt. Pope, Fleming, Mudzenchoot, Blanchet, Nation, Omineca, Upper Sustut-Thumb, Damdochax, and Small (Goal 2. The above RMZs are 100% excluded from the THLB.

The Fort St. James LRMP also recognizes a visually sensitive preservation zone around the Sustut and Bear rivers, which is addressed by the visual landscape inventory.

2.1.12 Future Roads, Trails and Landings

The TSR5 Data Package applied a 2.7% reduction from the THLB for future roads.

In this analysis, the future road reduction is determined as 2.7% of the volume harvested further than 300m from a current road, using the equation below:

$$\%\ of\ THLB\ as\ Future\ Road = \frac{(\text{Area of THLB} > 300\text{m from road}) * 0.027}{Area\ of\ THLB} * 100$$

The THLB area >300m from existing roads was estimated to be 760,064 ha. Given the estimated THLB area of 1,292,816 ha, the percentage of THLB as future roads was estimated to 1.7%. This percentage is applied in the model as a yield reduction for all future managed stands following clearcut of existing natural stands.

2.1.13 Isolated

Stands that are still considered part of the THLB after all other netdown factors were considered, but <4ha in size and greater than 150m away from any THLB neighbours > 4ha, are considered isolated and removed from the THLB.

2.2 NON-TIMBER MANAGEMENT ASSUMPTIONS

This section describes the criteria and considerations used to model non-timber resources.

2.2.1 Landscape-Level Biodiversity

Landscape-level biodiversity objectives established for the Prince George TSA (2004) include relevant guidelines for old forest retention, old interior forest, and young forest patch size distribution based on the natural range of variability as merged biogeoclimatic (BEC) units (mBEC) (Figure 6) and natural disturbance sub units (Figure 7). Requirements for landscape-level biodiversity objectives are listed in Table 15, Table 16, and Table 17.

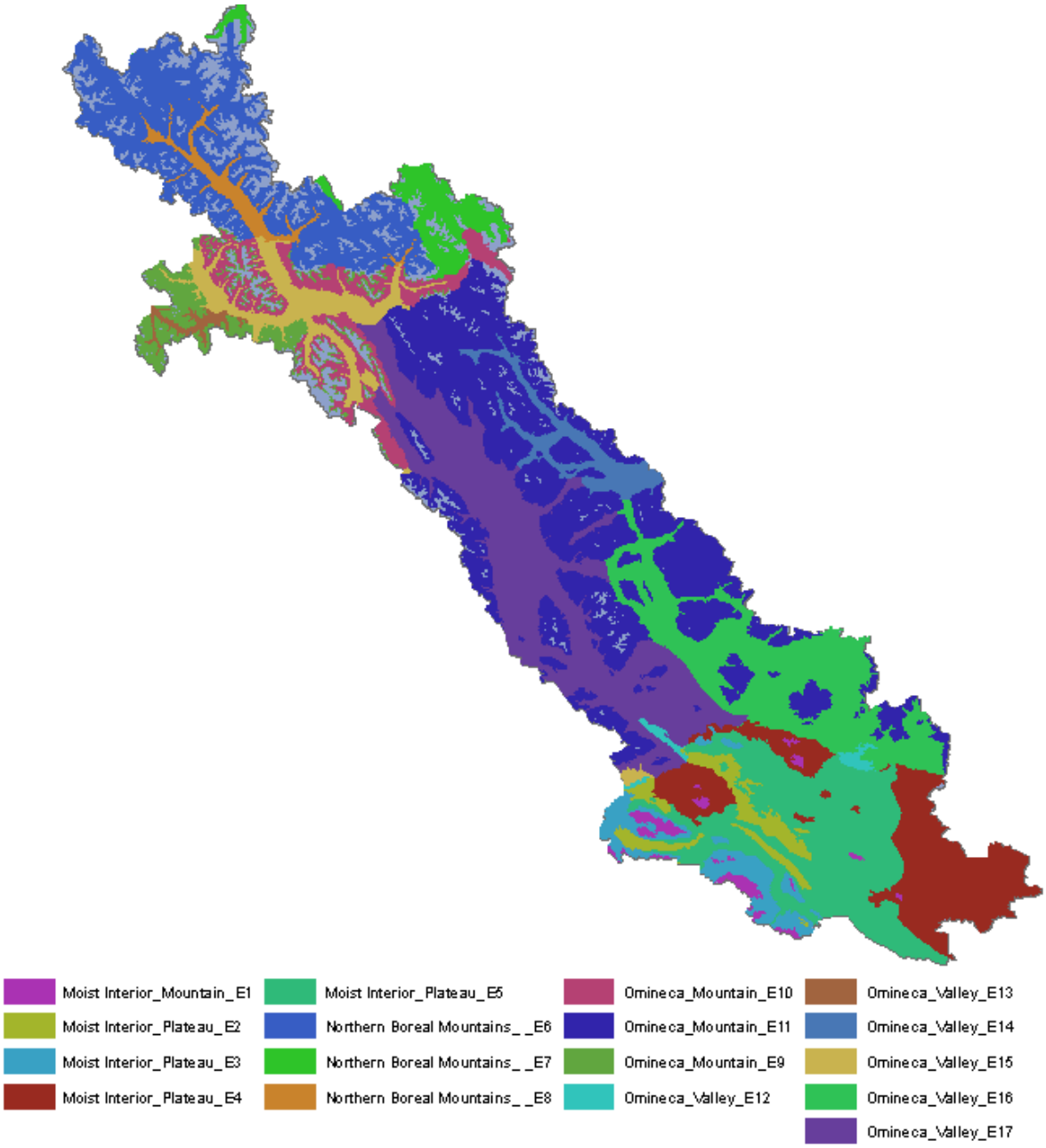


Figure 6 Merged BEC Units Used for Old forest Retention Requirements

Table 15 Old Forest Retention Requirements

Unit Label	Natural Disturbance Unit (NDU)	Merged BEC Units (mBEC)	Minimum Percent of CFLB Retained as Old Forest (%)	Minimum Percent of CFLB Retained as Old Non-Pine Leading Forest (%)	Minimum Age of Old Forest (years)
E1	Moist Interior – Mountain	ESSF mv1, ESSF mvp1, ESSF mv3	41	33	140
E2	Moist Interior – Plateau	SBS dk	17	13	120
E3	Moist Interior – Plateau	SBS mc2	17	10	120
E4	Moist Interior – Plateau	SBS mk1, SBS wk3,	12	4	120
E5	Moist Interior – Plateau	SBS dw3	12	6	120
E6	Northern Boreal Mountains	ESSF wvp, ESSF mcp, ESSF mc, ESSF wv	37	-	140

E7	Northern Boreal Mountains	SWB mks, SWB mk	37	-	140
E8	Northern Boreal Mountains	SBS mc 2	26	-	140
E9	Omineca – Mountain	ESSF wvp, ESSF wv, ESSF mcp	58	-	140
E10	Omineca – Mountain	SWB mks, SWB mk, ESSF mc	41	-	140
E11	Omineca –Mountain	ESSF mvp3, ESSF mv3	41	-	140
E12	Omineca – Valley	SBS dk, SBS dw3	16	9	120
E13	Omineca – Valley	ICH mc1	23	-	140
E14	Omineca – Valley	BWBS dk1	16	10	120
E15	Omineca – Valley	SBS mc2	16	13	120
E16	Omineca – Valley	SBS mk1	16	10	120
E17	Omineca – Valley	SBS wk3	16	12	120

Table 16 Old Interior Forest Requirements

Unit Label	NDU	Merged BEC Units (mBEC)	Minimum Percent of the Old Forest Required in Table 15 that Must be Old Interior Forest (%)
E1	Moist Interior – Mountain	ESSF mv1, ESSF mvp1, ESSF mv3	40
E2	Moist Interior – Plateau	SBS dk	10
E3	Moist Interior – Plateau	SBS mc2	10
E4	Moist Interior – Plateau	SBS mk1, SBS wk3,	25
E5	Moist Interior – Plateau	SBS dw3	25
E6	Northern Boreal Mountains	ESSF wvp, ESSF mcp, ESSF mc, ESSF wv	40
E7	Northern Boreal Mountains	SWB mks, SWB mk	40
E8	Northern Boreal Mountains	SBS mc 2	25
E9	Omineca – Mountain	ESSF wvp, ESSF wv, ESSF mcp	40
E10	Omineca – Mountain	SWB mks, SWB mk, ESSF mc	40
E11	Omineca – Mountain	ESSF mvp3, ESSF mv3	40
E12	Omineca – Valley	SBS dk, SBS dw3	25
E13	Omineca – Valley	ICH mc1	40
E14	Omineca – Valley	BWBS dk1	25
E15	Omineca – Valley	SBS mc2	25
E16	Omineca – Valley	SBS mk1	25
E17	Omineca – Valley	SBS wk3	25

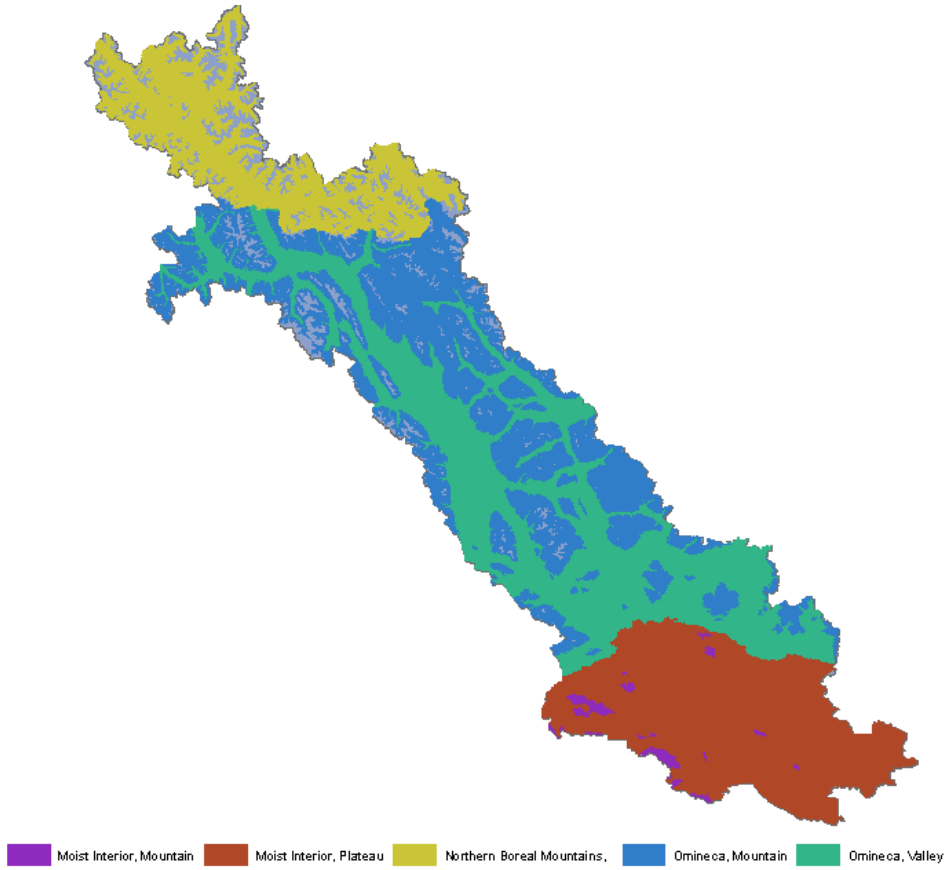


Figure 7 Natural Disturbance Sub Units

Table 17 Young Forest Patch Size Distribution Objective

Natural Disturbance Sub-unit	Percent of Young Forest by Patch Size Category (%)			
	>1000 ha	101 – 1000 ha	51 – 100 ha	<50 ha
McGregor Plateau	40	45	5	10
Moist Interior - Mountain	40	30	10	20
Moist Interior - Plateau	70	20	5	5
Northern Boreal Mountains	60	30	5	5
Omineca - Mountain	40	30	10	20
Omineca - Valley	60	30	5	5
Wet Mountain	10	60	10	20
Wet Trench - Mountain	10	60	10	20
Wet Trench - Valley	10	60	10	20

2.2.2 Stand-Level Biodiversity

The TSR5 used a value of 12.1% reduction of THLB to represent stand-level retention, including riparian and wildlife tree patch retention. In this analysis, the stand-level retention differs as the riparian areas are spatially represented. To reduce the in-block retention by the appropriate percent the following formula was used to calculate the base in-block retention:

$$TSR\ Retention - \frac{Effective\ Riparian\ Reserves\ (ha)}{Effective\ Riparian\ Reserves + THLB\ (ha)} = ISS\ base\ InBlock\ Retention\ (\%)$$

When this formula is applied, the new base reduction factor for all cut blocks outside of the MPB salvage zone is 12.1%-7.6% = 4.5%.

2.2.3 Conservation Uplift Retention Factor

To address the potential negative impacts of large openings created by MPB salvage operations, the Chief Forester developed a guide for adjusting the retention levels relative to opening size (i.e. conservation uplift). Based on this guidance, opening sizes were determined for the MPB salvage zone.

The MPB salvage zone is defined by: i) areas harvested since 1986 (last 30 years), ii) mature stands that will become non-merchantable by the end of MPB salvage period (MPB disturbance since 2003), and iii) stands disturbed by fires in the last 30 years (all fire records from the VRI since 1986 as well as the fire history records since 1998 where fire size >50ha). To prevent opening splitting by narrow linear features (e.g., roads), openings that are within 20 m of one another are grouped together.

For each of the opening sizes within the salvage and non-salvage zones, a retention percentage was determined. The base value from above (4.5%) was subtracted from the midpoint of the Chief Forester's target to give the IBM impact for each of the Salvage sizes (Table 18). This additional reduction was then applied to each THLB polygon for the length of the planning horizon.

Table 18 WTR requirements relative to opening size

Salvage Zone	Opening Size	Target Retention [1] (% of opening size)	Modelled Retention [2] (% of opening size)	IBM impact (Modeled – In block)
Small	<50 ha	10%	10%	5.5%
Medium	50-250 ha	10-15%	12.5%	8%
Large	250-1000 ha	15-25%	20%	15.5%
Very Large	≥1000 ha	>25%	30%	25.5%
Non-Salvage Zone	n/a	N/A	4.5%	0%

[1] Taken from 2005 Chief Forester Guidance

[2] Criteria implemented in TSR and adjusted as aspatial figure (target retention less spatial riparian)

2.2.4 Ungulate Winter Ranges and Wildlife Habitat Areas

A variety of UWR and WHAs were established within the project area. All UWR objectives resulting in a 100% netdown were described in Section 2.1. General wildlife measures and appropriate modeling assumptions for spatially-defined UWR and WHAs areas are summarized in Table 19.

Table 19 General Wildlife Measures

UWR Tag	UWR Name	Habitat Units	Legal Requirements	Modeling
7-002	Mule Deer	1-5, 11, 12, 14	Minimum 40% of the winter range area in age class 8 or greater at all times with crown closure > 56% (Douglas-fir, Spruce); Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	≥ 40% ≥ 140 years Regen ≥ 50% Fd
		6-8, 13	Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	Regen ≥ 50% Fd
		9, 10, 15-18	Minimum 50% of stands in age class 8 or greater at all times with crown closure > 66% (Douglas-fir, Spruce); Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	≥ 50% ≥ 140 years Regen ≥ 50% Fd

UWR Tag	UWR Name	Habitat Units	Legal Requirements	Modeling
7-003	Caribou	T-005, T-009, T-010, T-012	Travel corridors – harvesting results in minimum 20% of forest within each unit as 100+ years of age in corridor with no more than 20% of productive forest area of unit < 3 m green-up condition	≥ 20% of forest ≥ 100 years ≤ 20% <3m (15 years)
7-015	Northern Caribou	9a-001, 9b-001, 9c-001, 10-001, 9a-002, 9a-007, 9b-002, 9c-002, 9c-003, 10-002, 10-004	Manage defined non-terrestrial Lichen habitat and terrestrial Lichen habitat through a two-pass, 140 year rotation – within each pass harvest 50% +/- 20% of total area	≤ 50% < 70 years old
Draft WHA: Finlay, Chase, and Wolverine Caribou Herds		Migration Corridors	All (35,175 ha CFLB): ≤ 35% of forest < 40 years with wildfire and <70 years for cutblocks	Handled as a Group in the model

2.2.5 Visual Quality Objectives

Visual quality objectives (VQOs) are addressed in this analysis by using Plan to Perspective (P2P) ratios and Visually Effective Green-up (VEG) heights for 5% slope class increments, to determine the maximum percent alterations. The P2P ratios and VEG heights assessed by slope class, as well as the allowable VQO percent alterations are detailed in Table 20 and Table 21, respectively. The slope is associated with the raster cell and the P2P ratio is calculated by weighted # of CFLB rasters per VQO polygon: raster cells are 20x20

Eg: P2P = $\frac{(\#\text{cells in } 0{-}5){*}4.68 + (\#\text{cells in } 5{-}10){*}4.23 + \ldots}{total\ \#\ of\ Cells}$

Table 20 P2P Ratios and VEG Heights by Slope Class

	Modified Visual Unit Slope Classes for P2P Ratios and VEG Heights														
Slope %	0-5	5.1-10	10.1-15	15.1 -20	20.1 -25	25.1 -30	30.1 -35	35.1 -40	40.1 -45	45.1 -50	50.1 -55	55.1 -60	60.1 -65	65.1 -70	70+
P2P Ratio	4.68	4.23	3.77	3.41	3.04	2.75	2.45	2.22	1.98	1.79	1.6	1.45	1.29	1.17	1.04
VEG Height (m)	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	6.5	7.0	7.5	8.0	8.5	8.5	8.5

Table 21 VQO by Percent Alterations

VQO	Permissible % Alteration in Perspective View	Proposed % Alteration in Perspective View
Preservation	0	0
Retention	0 – 1.5	0.8
Partial Retention	1.6 – 7.0	4.3
Modification	7.1 – 18.0	12.6
Maximum Modification	18.1 – 30.0	24.1

The percent denudation applied to each Visual Landscape Inventory polygon in the model is calculated as the weighted P2P ratio by slope class multiplied by the proposed percent alteration in perspective view by VQO polygon. The resulting percent denudation value is then applied as a constraint on the maximum proportion of the polygon that can be below the VEG height at any given time.

The next step is to determine age when the VEG height is achieved for each of the Visual Landscape Inventory polygons. For this purpose, the area weighted site index (i.e., top height in m at age 50) and most prevalent species within each Visual Landscape Inventory polygon are determined based on the cover of predicted future stands. It is assumed that once the existing stand is harvested and regenerated, the future stand's yield is known. Thus, it is possible to estimate the age at which the

regenerated stand reaches the previously-determined VEG height. The area-weighted average site index is determined from the provincial site productivity layer, while the prevalent species is determined as the leading species with the highest area in each Visual Landscape Inventory polygon (where the THLB of the Visual Landscape Inventory polygon is assumed to be all covered by future stands). Then, the site index and species are entered in Site Tools (v.4.1 beta) to determine the age where VEG height is reached. Note that deciduous stands are all considered to be dominated by trembling aspen and Visual Landscape Inventory polygons with no site index estimates are assumed to have the area-weighted site index average for the entire land-base (16.7m).

2.2.6 Fisheries Sensitive Watersheds

Within the Stuart TSBs, there are 20 proposed Fisheries Sensitive Watersheds (FSW) (Appendix 1). In addition to the no harvest zones (section 2.1.7), in 16 FSWs harvest is restricted via maximum disturbance thresholds defined by the equivalent clearcut area (ECA), while in the remaining 4 FSWs, harvest is not restricted, but ECA values are reported.

The ECA is an index that measures the impact stand replacing disturbances (e.g., clearcuts) have on the hydrology of an area. It is assumed that clearcut of a forested area is the maximum impact a disturbance can have on the hydrology of the affected area. Consequently, the ECA of newly clearcut area is assumed to be 100% of the affected area. As a new stand emerges, a hydrological recovery process begins and the impact a clearcut has on the hydrology of the area decreases. The emergence of the new stand is measured by the tree height. For example, when the newly established stand reaches heights over 3 m, it is considered that 25% of the area is hydrologically recovered, or, 75% of the area still has an equivalent clearcut impact on the hydrology of the affected area (i.e., ECA is 75% of the affected area). The definition of a fully hydrologically recovered stand is up for debate, but in general, stands with tree heights over 12 m are considered fully recovered. At this stage, the ECA is 0% of the affected area. Note that natural disturbances are also assumed to have an impact on the hydrological processes.

In this analysis, the ECAs were determined based on the general guidance provided for FSWs in the Omineca Region (November 2, 2016 - Sandra Sulyma) (Table 22 and Table 23). Given the separate accounts for private and permanent anthropogenic disturbances (AD), new ECA targets had to be developed (Appendix 1):

- Determine the area for private lands, AD, natural non-forest, and CFLB.
- Determine the maximum area allowed to be disturbed.
    - Max Area ECA (ha) = Watershed Area (ha) * ECA target (%).
- Determine the Area ECA generated from AD and private lands.
    - Area ECA AD+Private = Max Area ECA (ha) – (Area AD (ha) x ECA (100%) – Area Private (ha) x ECA (75%)).
- Determine the new max ECA.
    - New Max ECA (%) = (Max Area ECA (ha) – Area ECA AD+Private(ha)) /CFLB area (ha).

Table 22 ECA estimates by stand height and land use

Criteria	ECA%
Private Land	75
Anthropogenic Disturbance*	100
Stand height <3m	100
Stand height ≥3m and <5m	75
Stand height ≥5m and <7m	50
Stand height ≥7m and <9m	25
Stand height ≥9m and <12m	10
Stand height ≥12m	0
Natural Non-Forest	0
Wildfires**	100

**Anthropogenic disturbance examples: roads (Digital Road Atlas), gravel pits, mines, railway, pipelines, utility corridors.*
***Not modelled here.*

Table 23 ECA estimates for MPB-affected stands

Years Since Attack*	ECA% by Dead Percentage Class**		
	≥30 and <50%	≥50 and <70%	≥70%
0 to 5	5	5	10
6 to 10	10	15	30
11 to 15	15	20	40
16 to 20	20	30	45
21 to 25	20	30	45
26 to 30	15	20	40
31 to 35	10	15	30
36 to 40	5	10	25
41 to 45	0	5	20
46 to 50	0	0	15
51 to 55	0	0	10
56 to 60	0	0	5
>60	0	0	0

** Years since attack derived from VRI (N_LOG_DIST, N_LOG_DATE)*
*** Dead Percentage Class derived from VRI (DEAD_PCT)*

Two sets of ECA curves were then developed, one set for existing and future managed stands based on tree heights (Table 22) and one set for all stands impacted by MPB (i.e., stand percentage dead >=30%, non-logging disturbance = IBM, ” and non-logging disturbance year >=2003) (Table 23). The ECA height curves were developed during the yield generation using TIPSY and the specifications in Table 22. The ECA height curves were then used to develop a feature account in Patchworks which tracked the ECA based on height for each watershed. For the ECA-MPB curves, a feature account was developed in Patchworks to track in each watershed, all stands impacted by MPB and assigned corresponding curve from Table 23. Finally, for each watershed, the two accounts (ECA based on heights and ECA-MPB) were summed, a ratio account was developed by dividing with the total CFLB area, and the New Max ECA targets (Appendix 1) applied to the ratio accounts.

2.3 HARVESTING ASSUMPTIONS

This section describes the criteria and considerations used to model timber harvesting activities.

2.3.1 Utilization Levels

The minimum merchantable timber specifications for all species and analysis units (natural and managed) are shown in Table 24.

Table 24 Utilization Levels

Leading Species	Minimum Diameter at Breast Height (cm)	Maximum Stump Height (cm)	Minimum Top Diameter Inside Bark (cm)
Pine	12.5	30	10
Cedar older than 141 years	17.5	30	15
All other	17.5	30	10

2.3.2 Minimum Harvest Criteria

In order for a stand to be considered economic and eligible for harvest within the model it must meet the MVH and minimum harvestable age (MHA) criteria. Stands that never meet these requirements are removed from the THLB, as described in Section 2.1.8.

Stands must have at least 182 m³/ha to be harvested with the exception of MPB-impacted stands which have a MVH of 140 m³/ha. For existing and future managed stands, in addition to the MVH, the MHA has to be within 95% of the analysis unit's culmination age.

2.3.3 Harvest Priority

Harvest priorities and limits are placed in the model within certain stand types, management zones, or regions of the TSBs to reflect salvage operations and other forest management objectives.

The short-term harvest level is set to reflect the average realized harvest level over the past five years in the TSA and district-specific movement of harvest since the last TSR. The short-term harvest prioritizes salvage of pine-leading stands with MPB mortality (minimum 80% of the harvested volume in the first 10 years) until the profile is depleted, at which point the model will be released from its pine-leading preference. Salvage operations are focused in the salvage zone. The harvest queue throughout the forecast will be driven by stand preference based on MVH, a production weighted average cycle time index, and distance to nearest existing road.

A second harvest partition is placed on the deciduous leading stands to a maximum of approximately 5.6% of the total harvest volume, for the entire planning horizon. This percentage is prorated from the maximum 8% set for the entire Prince George TSA.

2.3.4 Silvicultural Systems

Clearcut with reserves is assumed to be the predominant silvicultural system used for all stand types within the Prince George TSA.

2.4 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 (height, tree diameters, presence of dead trees, etc.).

2.4.1 Stand Projection Models

Yield curves developed for the forest estate model were prepared using the following stand projection models:

- Existing natural stands: Variable Density Yield Prediction (VDYP) 7 at a polygon level were then aggregated at the Analysis Unit (AU) level.
- Existing and future managed stands: Table Interpolation Program for Stand Yields 4.3, modeled by AU.

2.4.2 Natural Yield Curves

In the TSR5, each natural polygon has its own yield curve derived directly from VDYP7. These curves then have MPB and balsam bark beetle loss equations applied to them.

For this analysis, the natural polygons are aggregated into analysis units (AU), initially based on BEC Zone, and leading species. Next, if the leading species is balsam, then the AU's are split between supply blocks A&B or C. Finally, for pine leading stands, AU's are split between age of attack, and percent dead (Table 25; see sections below for detailed decline rates).

2.4.3 Analysis Unit Characteristics

Stands are grouped into AUs to reduce the complexity and volume of information in the model and to assign potential treatments and transitions to yield curves following harvest. The AUs are based on BEC zone and leading species group, as shown in Table 25.

For existing natural stands, a VDYP yield curve is generated for each forest polygon, then area-weighted averages of these curves are calculated according to the assigned AUs. For MPB-impacted stands, yield curves are also adjusted to reflect the future trajectories for both live and dead portions of the stand using the average dead/live ratio from the forest inventory for the stands in the AU (max 20% span in any AU) and the shelf life function outlined in Section 2.4.8.

Table 25 Criteria Used to Group Stands into Analysis Units

Existing Stand Type	Future Stand Type (Transition)
Existing Natural Stands ○ BEC/Leading species ○ Site Index (<10,10-18,>18) ○ For pine ○ Perc Dead; and, ○ 5 year age classes (60-300). ○ Balsam Decline(supply Block A & B)	Future Managed Stands Developed by TSR ○ BEC (BAFA,BWBS,ESSF,ICH,MS,SBPS,SWB) Leading species groups (B,C, Decid, F,H,P,S) Site productivity SI<10,10-18, >18 ○ Planted vs. Natural Regeneration
Existing Managed Stands Developed by TSR Split by ERA (pre 2003 &post 2003) ○ BEC (BAFA,BWBS,ESSF,ICH,MS,SBPS,SWB) ○ Leading species groups (B,C, Decid, F,H,P,S) ○ Site productivity (PHR SI for Pine @ SI <19, ≥19&<25, ≥25; PHR SI for Non-pine @ SI <15, ≥15&<24, ≥24) ○ Age class for MPB attacked stands (5 year increments) ○ Planted vs. Natural Regeneration ○ MPB Impacted	

2.4.4 Decay, Waste, and Breakage

For natural stands, default reductions to stand volume for decay, waste and breakage factors are the provincial stand loss factors. These factors are applied in the development of the VDYP7 yield curves. For managed stands, Operational Adjustment Factors were applied by TSR.

2.4.5 Managed and Natural Stand Definitions

To project stand growth and yield, stands are classified as natural or managed stands based on their year of establishment. Natural stands are considered to be stands established prior to 1987. Natural stand yields are generated using VDYP 7. Managed stands are considered to be stands established post-1987. Existing managed stands are divided into two eras, 1987-2002 and 2002+. The managed stand yields applied in ISS were provided by FLNROD, since they were very recently developed for the Prince George TSR and described in the accompanying Data Package.

Stands recently disturbed through harvesting were assumed to regenerate as managed stands, whereas stands that are disturbed by a natural agent (and not salvaged) regenerated as natural stands.

2.4.6 Site Index Assignments

Site index reflects the potential productive capacity of a stand. Site index estimated in the forest inventory was used as the site productivity input to develop yield tables for existing natural stands (Section 2.4.5). Managed stand yields were derived using site index calculated from the Provincial Site Productivity Layer.

2.4.7 Regeneration

If the planting year for a stand is known, the regeneration delay is calculated as the difference between the harvest end year and the planting year (harvest end year – planting year). If the planting year is not known, the regeneration delay is defined as: (reference year – harvest end year) – stand age.

2.4.8 Mountain Pine Beetle

Mountain pine beetle (MPB) peaked in the Prince George TSA between 2005 and 2008 and has since leveled off leaving approximately 190 million cubic metres of dead pine. The extent and severity of the MPB infestation was forecasted using the BCMPBv11, which calculated existing and future mortality of pine in stands greater than 60 years of age. Unsalvaged losses due to MPB are dependent on the shelf life and amount of merchantable volume attributed to the affected land base.

On average, pine-leading stands are approximately 28% of the species composition by volume of all stands in the CFLB. The estimate of pine mortality in the TSA for mature stands is 92%, which equates to a median stand-level mortality of 46%. In the TSA, the weighted average year since death in MPB-impacted stands is 7.5 years. Merchantable pine volume within an attacked stand decreases over time as the portion of the stand killed during the infestation degrades. The dead portion of the stand is tracked through its shelf life, decreasing merchantable volume based on a shelf life curve until the dead portion has 100% loss.

Stands over 60 years:

Mature pine stands (over 60 years) that have been affected by MPB are identified if they are pine species (1-6) with “IBM” or “I” codes in the “non-logging disturbance Type”. These stands have AUs based on percent mortality and age of attack. The yield curves were modified by determining dead pine volume (at 12.5 cm dbh[1] utilization) and calculating the total Dead (PliVol from Yield curve * % dead). The yield reduction curve (Figure 8) was developed by comparing the age of attack to the percent of dead pine, calculated in 5 year increments. Assumptions are listed in Table 26. The final yield curve is depicted by a black line in Figure 8.

The shelf life curve increases exponentially as shown in Figure 9. This curve assumes 100% merchantability for one year after death, after which merchantability declines immediately to 80% in year two and continues to decline to 40% after year 15, and 0% in year 22.

[1] dbh = diameter at breast height

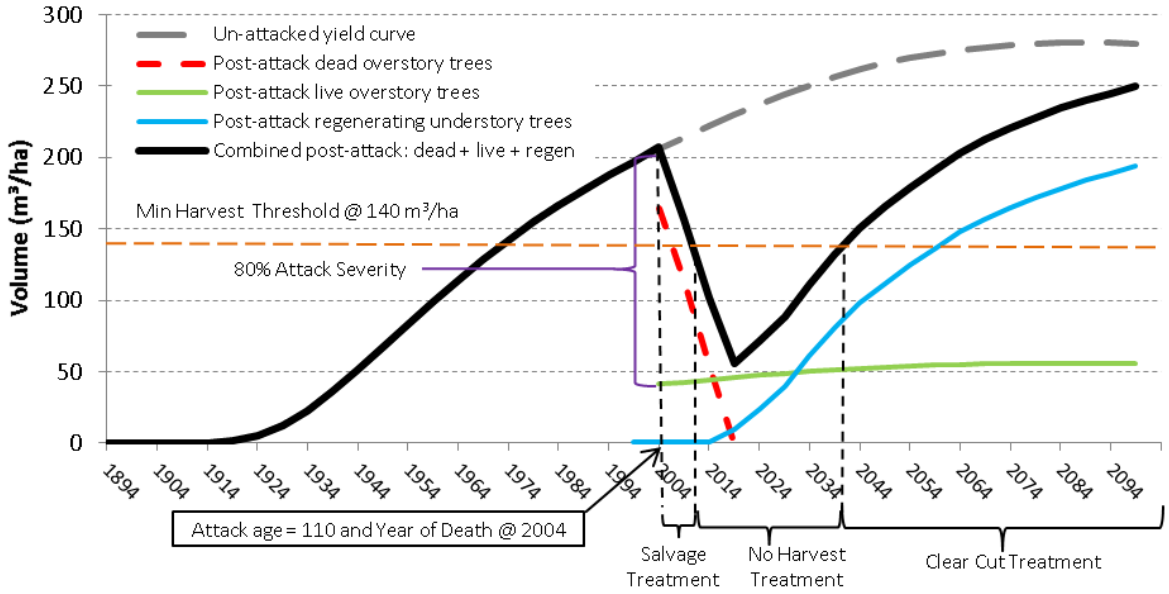


Figure 8 Yield reduction example.

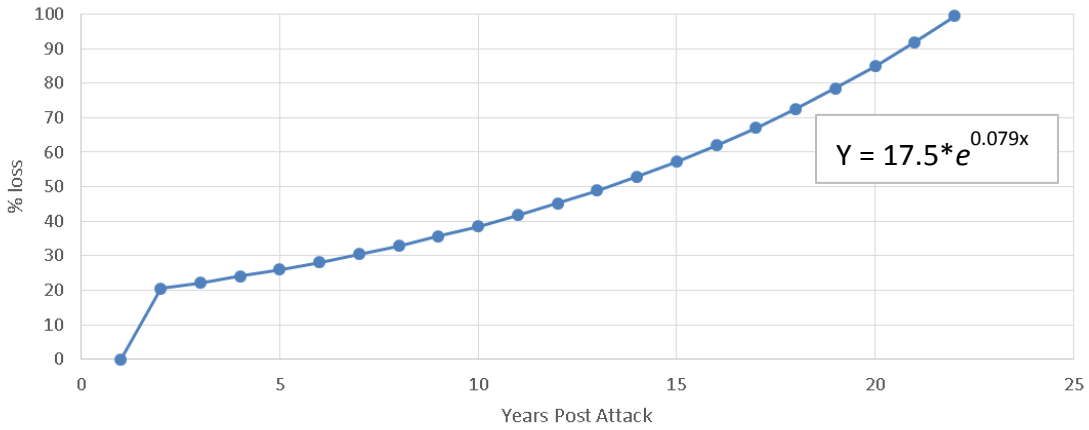


Figure 9 Loss curve for percentage of a stands affected by mountain pine beetle

Table 26 Yield Curve Assumptions

Factor	Assumption
Shelf life curve	Y=17.5*EXP(0.079*X) where Y is the loss percentage and X is the post-MPB attack year (values 1 to 22). Starting in year 23 post MPB attack, the dead pine component is removed from the stand.
Live overstorey trees	Same natural yield curve as the original stand; yield reduced according to attack severity (i.e. area-weighted stand percentage dead for each AU).

Factor	Assumption
Understorey regeneration	The understorey regeneration yields were developed for each AU without the stratification of the MPB factors. Only the leading species, site index, and BEC were used to stratify the regeneration yields for the MPB impacted stands. Ten years of advanced regeneration was considered (i.e., regeneration layer yield from age 10 on the yield curve, begins in the MPB attack year). Rationale: The regeneration yield is not identical to the original yield impacted by MPB. Given the many stratification factors used to determine each AU (especially the age class), VDYP sample size cannot cover the entire age range in a typical yield curve (e.g., years 0-350). For example, the backward projection of old stands (e.g. older than 200 years) is not accurate. It was observed that in many cases there were no yield values for a good portion of the start of the yield curve (i.e., age 0 to 50). Similarly, the VDYP projection forward of the young stands is believed to be less accurate.
Mature pine mortality (>=65 years)	• Age 2016 split into 35 sets of 5-year age classes (65-69, 70-74… 230-234, >234). • 8 attack year (2003-2008, 2010-2011). • Attack age on the yield curve was determined by subtracting the difference between current year (2016) and attack year from the mid-point of the age class. ○ Example: Age 2016 is 65-69, mid-point is 67, attack age is 67-(2016-2003) = 54 years. ○ Age >234, area-weighted average is determined for the age class mid-point. • 9 stand percentage dead classes (10-19%, 20-29…80-89, ≥ 90%). ○ Area weighted averages were calculated for each AU. ○ Percentage dead applied to entire original yield at attack age. • Shelf life curve is applied for the next 22 years following MPB attack. It takes 22 years for the killed volume to become zero. ○ After the 22 years, any killed volume left is removed from the yield. • Add understorey regeneration (match attack age on the original yield with age 10 on the understorey regeneration yield). ○ Understory regeneration yield reduced according to stand percentage dead removed by MPB.

Young Pine Mortality

The provincial MPB model only considers stands greater than 60 years old and does not address mortality in younger stands. To account for younger stands, the approach used in TSR5 is also applied in this analysis: pine-leading stands between 15 and 60 years of age are selected. The applicable inventory data is summarized by landscape unit in MPB affected stands to derive mortality estimates as described in Table 27. Yields belonging to existing polygons that meet the criteria (landscape unit/age class) are factored down by the percentage total attack.

Table 27 Young Pine Mortality

Landscape Unit	Age Class	Total Area (ha)	Total % Attack
Pinchi	1	12,125	5
Pinchi	2	8,801	14
Pinchi	3	2,295	2
Salmon	1	13,390	8
Salmon	2	7,777	14
Salmon	3	2,072	27
Stuart	1	6,166	42
Stuart	2	2,369	4
Tezzeron	2	7,440	1
Tezzeron	3	2,445	24
Whitefish	1	11,192	0.5
Whitefish	2	7,727	6
Whitefish	3	1,018	0.3
Total		84,817	11.4

2.4.9 Balsam Bark Beetle

Heavy balsam bark beetle infestations have been noted in the northern two supply blocks. As a result, stands with balsam as the leading species are placed on a decline curve, which is effective for Supply blocks 24A and 24B (Figure 10).

Figure 10 Supply blocks showing decline due to Balsam Bark Beetle

Mortality in balsam-leading stands is modeled through the application of a mortality regression model. Mortality was due to outbreaks of western balsam bark beetle and two-cycle spruce budworm, as well as various heart rot diseases common to over-mature balsam-leading stands.

$$Final\ volume = initial\ volume * (1 - (-4.55E^{-2} + (3.21E^{-4} * initial\ volume) + (1.02E^{-3} * age)))$$

This regression model is used to adjust stand volumes in the inventory within balsam-leading stands in supply blocks A and B.

2.4.10 Spruce Beetle

Recent forest health surveys have captured a significant increase in spruce beetle activity. The TSR treated spruce beetle as a generic non-recoverable loss (NRL) value which will be included in the ISS base case scenario.

2.5 Natural Disturbance Assumptions

Natural disturbance assumptions define the extent and frequency of natural disturbances across the land base. Assumptions used to model disturbance within the THLB and NHLB are explained below.

2.5.1 Natural Disturbance within the THLB

Throughout the planning horizon, natural disturbances within the THLB are addressed as non-recoverable losses (NRL). These are estimates of annual volume losses resulting from catastrophic events such as insect epidemics, fires, wind damage, or other agents.

Table 28 shows the NRL figures adopted from TSR5 based on salvaged loss on the THLB. In these summaries, forest cover information was used to derive impacted merchantable volume within areas mapped in annual overview flights. The NRL will be used to adjust the harvest flow forecasts.

Table 28 Non-Recoverable Losses

Variable	Volume (m^3/year)
NRL through midterm(95 years)	147,722
Long term NRL	159,120

2.5.2 Natural Disturbance within Non-THLB

For this analysis, a constant area is disturbed annually within each natural disturbance unit. The area of disturbance varies based on the biogeoclimatic variants present, their associated natural disturbance intervals, and old seral definitions, as outlined in the Biodiversity Guidebook (B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks, 1995). Table 29 shows the process used to determine the annual disturbance limits applied to the forested NTHLB.

Table 29 Annual Natural Disturbance Parameters applied to NHLB by NDU

Natural Disturbance Unit	Disturbance Interval (years)	Old Forest Definition (years)	% Area Old	Effective Rotation Age (years)*	NTHLB Area	Annual Area Disturbed (area/rot age)
Moist Interior – Mountain	200	140	50%	278	12,811	46
Moist Interior – Plateau	100	120	30%	172	75,248	438
Northern Boreal Mountains	180	140	46%	259	117,414	453
Omineca – Mountain	300	140	63%	375	117,414	313
Omineca – Valley	120	120	37%	190	124,383	655
Total					447,270	1,905

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

2.6 CARIBOU ASSESSMENT

The Caribou assessments are conducted as post-processing GIS exercises and the results combined for both Mackenzie and Stuart TSAs. The GIS exercises are carried out in 7 periods along the planning horizon (P0 – initial, P1 – 5 years, P2 – 10 years, P4 – 20 years, P10 – 50 years, P20 – 100 years, and P40 – 200 years). Disturbances are assessed as anthropogenic and natural disturbances. The anthropogenic disturbances (AD) included disturbed blocks <40 yrs old and permanent AD (e.g., camps, mines, and linear features - existing and future roads). In accordance with the recovery strategy, disturbance was extended with AD (i.e., 500 m buffer), while the areas with natural disturbance were not. After initial assessment, the harvest area is controlled in caribou habitats of each herd in order to keep the disturbance levels under the maximum disturbance target level of 35%. Harvest level in federal and provincial recovery strategies is controlled so that the disturbance levels remain under 35% in all 7 periods.

In each of the 7 periods, 3 Caribou assessments are completed:

1) Examine potential <u>impacts on timber harvest</u> from implementing the federal recovery strategy.

a) Buffer all linear features (roads, seismic, hydro lines, pipelines, etc.) and polygonal features <40 years old (cut-blocks, well pads, etc.) by 500m.
b) Merge into an “anthropogenic disturbance” layer (AD).
c) Determine the natural disturbances.
   i) In P0, fire history since 1976
   ii) In P1-P4, the last 40-year of fire history corresponding to each analyzed period, the THLB blocks harvested by the model, and the non-THLB disturbed areas (section 2.5) loaded into the model
   iii) In P10-P40, relative to the period in question, the THLB blocks harvested by the model in the last 40 years, and the non-THLB disturbed areas (section 2.5) in the last 40 years
   iv) The NRLs were determined to be 1% of the maximum target disturbance of 35%
d) Assess disturbance levels for each herd and the impact on harvest rate when the maximum 35% disturbance level is achieved.

2) **Examine potential impacts on timber harvest from implementing provincially regulated areas.** Same assumptions as for federal recovery strategy, except areas are different (Figure 11).

3) **Examine potential impacts on Caribou population from the predicted disturbance.**

   a) Calculate population growth rate based on natural and anthropogenic disturbance levels

   b) Calculate the amount of not-buffered "natural disturbance" (ND) and calculate % of herd area in ND.

   c) Calculate population growth rate as lambda = 1.192 - 0.00315*%AD - 0.00292*%ND (Sorensen, et al., 2008)

   d) From there, calculate annual or period-specific population size as: N(i) = lambda(i) * N(i-1), where (i) is the time step and N(0) would be 350 for the Wolverine herd and 500 for the Chase herd.

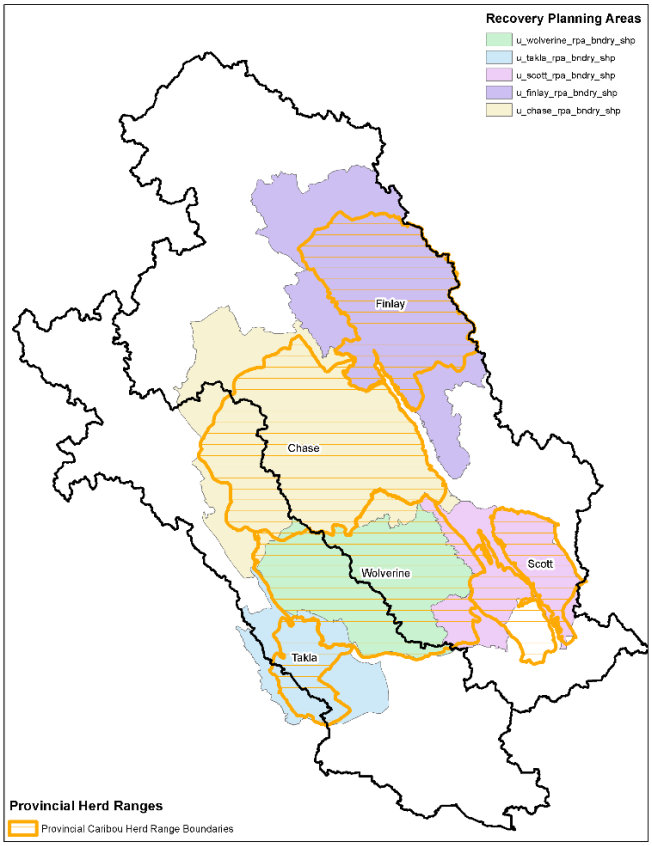


Figure 11 Federal and Provincial Recovery Strategies for Mackenzie TSA (up) and Stuart TSA (down)

2.7 MODELING ASSUMPTIONS

General assumptions were incorporated into the model to improve its efficiency and to produce results that were more spatially realistic. Table 30 summarizes the modeling assumptions employed in this analysis.

Table 30 Modeling assumptions

Criteria	Assumption
Minimum Polygon Size	Resultant polygons less than 0.01 ha in size were merged into neighbouring polygons through a geoprocessing exercise to eliminate small polygons.
Blocking	To improve modeling performance, resultant polygons were blocked (or grouped) where possible by maintaining the same AUs and 10-year age classes. The model was configured for a target harvest opening size of 25 ha and a maximum opening size of 50 ha.
Planning Horizon	A 300 year planning horizon was applied reported in 5-year increments (i.e. 60 periods).
Harvest Flow Objectives	○ Short-term: Concentrate harvest on salvageable MPB-impacted pine stands as much as possible but less than 80% of harvest profile for the first decade of the planning horizon. ○ Mid-term: Will not go below the volume achieved using an even flow constraint. ○ Long-term: Adjust the long-term harvest flow until the harvest level reflects managed stand yields while producing growing stock that neither declined nor increased.

3 Sensitivity Analyses

Sensitivity analyses explore the implications of changing management assumptions or data quality on the forecasted timber supply.

3.1 Access Timing Constraints Scenario

In the Access Timing Constraints (ATC) Scenario, 13 areas of interest are selected for a periodic entry allowance (Figure 12). The entry allowance cycle is five years of harvest, followed by 30 years of no harvest.

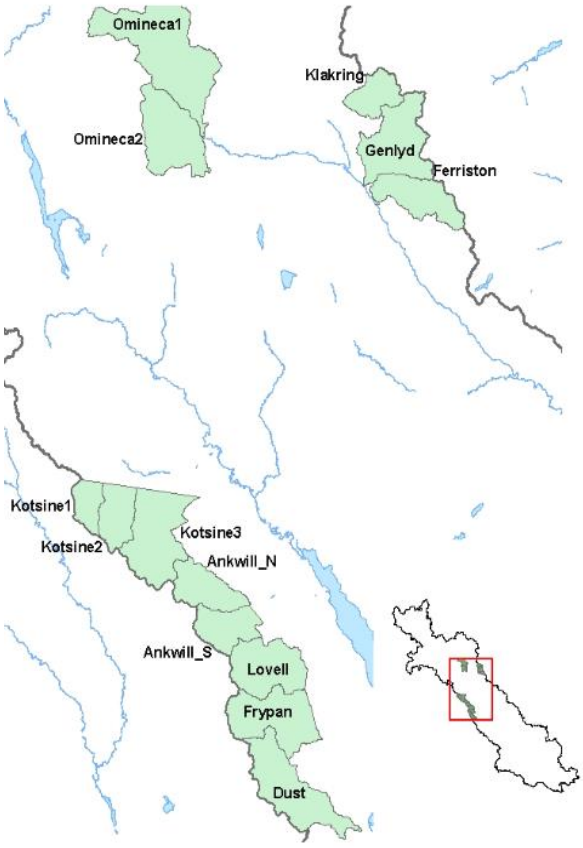


Figure 12 ATC areas

3.1.1 Methodology

The base case scenario is used to create the timing of the cycle. The period in the base case in which the cumulative harvest reaches 30% of the ATC THLB area is considered to be the first period of the cycle.

In the ATC scenario up to 30% of the of the THLB area is allowed to be harvested in that period, followed by 30 years (Six, five year periods) of 0% harvest levels (Table 31). This cycle repeats for the remainder of the planning horizon.

Table 31 ATC areas and disturbance allowances.

Location	THLB (ha)	Maximum One-Period Disturbance Every 35 years	
		%	Area (ha)
Ankwill_N	1,257	30%	377
Ankwill_S	1,029	30%	309
Dust	1,291	30%	387
Ferriston	1,141	30%	342
Frypan	395	30%	119
Genlyd	2,475	30%	743
Klakring	1,121	30%	336
Kotsine1	1,788	30%	536
Kotsine2	2,650	30%	795
Kotsine3	2,505	30%	752
Lovell	571	30%	171
Omineca1	3,434	30%	1,030
Omineca2	1,264	30%	379
Total	**20,921**		**6,276**

3.2 TL'AZT'EN ECA TARGETS

The Tl'azt'en First Nation has developed a Land Use Plan (LUP) which includes ECA targets using the same FSW boundaries as proposed above. The LUP includes more constraining targets for nine watersheds (Table 32). Similar ECA targets development procedure is followed as in section 2.2.6.

Table 32 Tl'azt'en ECA targets

Watershed, Basin or Sub-basin	Tl'azt'en ECA (%)	Area (ha)
Gluskie Creek	5	4,881
Forfar Creek	3	3,752
O'Ne-ell/Kynoch Creek	7	7,096
Bivouac Creek	7	4,181
Van Decar Creek	3	2,708
Sidney Creek	5	4,402
Paula Creek	6	4,578
Sandpoint Creek	10	6,523
Narrows Creek	6	6,534

4 Scenarios

4.1 RESERVES SCENARIO

The Reserves scenario is designed to answer the question, "Where and how should we reserve forested stands to address landscape-level biodiversity and non-timber values while, wherever possible, minimizing impacts to the working forest?" It emphasizes various requirements to maintain non-timber values, as well as, practical issues to identify areas that are less or more attractive for timber harvesting. The reserve scenario examines additions or changes to assumptions associated with non-timber values that were built into the ISS Base Case Scenario. The underlying purpose of this scenario is to explore tactics aimed to maintain the harvest area while providing a wide range of values on the land base (i.e., co-location). This could be done by maximizing relative scores assigned across the land base for:

- old forests;
- rare sites/ecosystems;
- identified cultural interests; and
- habitat and identified connectivity for identified wildlife species.

In accordance with the Chief Forester's guidance (FLRNO 2005), this scenario will also increase stand-level retention within forests attacked by mountain pine beetle.

The candidate reserves selected, guided by thresholds described in various stand- and landscape-level objectives, will meet multiple criteria and thresholds and can provide a preliminary spatial result to work from. However, it must be emphasized that these polygons **must first be confirmed and reconfigured by planners, and, where possible, field checked before they can be considered spatial OGMAs**. Finally, the implementation in the Combined Scenario is to 'lock' these areas from harvesting for some period over the short term (e.g., 20 years). In this case, edge polygons identified to maintain forest interior thresholds will also be included with the candidate reserves.

4.1.1 Approach

Two options were considered for approaching this scenario:

1. Spatial exercise - static assessment at time 0 (current); then incorporate spatial results into the Combined Scenario; "pre-process" GIS assessment possibly including internal buffers for interior forest; because there was not enough time to undertake detailed assessments for each LU, a systematic approach was developed to score stands based on : a) existing anchors/constraints, and b) stand attributes (Figure 13).
2. Temporal exercise - incorporate scoring into the forest estate modelling exercise; possibly allow reserves to move across the land base through time.

For this first iteration of the ISS, the team elected to approach this scenario as a spatial exercise (i.e., no forest estate modelling) as a preliminary step towards possible future work, for example: a) spatially refine the polygons into temporary non-legal reserves (teams to review candidate reserves on a LU-by-LU basis); and apply scoring methodology into a forest estate model (temporal exercise) that will select reserves appropriately over the landscape and into the future (i.e., shifting locations but maintaining requirements).

A stand's total score, determined by the spatial exercise, is the sum of the anchor scores (number of overlapping anchors), constraint scores, and stand features. Stands are then sorted by their total scores – those with the highest values are the most desirable candidate reserves. Candidate reserves are selected through a forest modelling exercise that assesses the combined score for each stand relative to established one or more landscape-level thresholds. In this case, candidate reserves must address

multiple thresholds. In addition, to maintain an appropriate spatial pattern for reserves, stands with higher scores are also grouped to accommodate patch size distribution criteria. This prevents the 'shot-gun' pattern that otherwise results if only the highest scoring stands are selected.

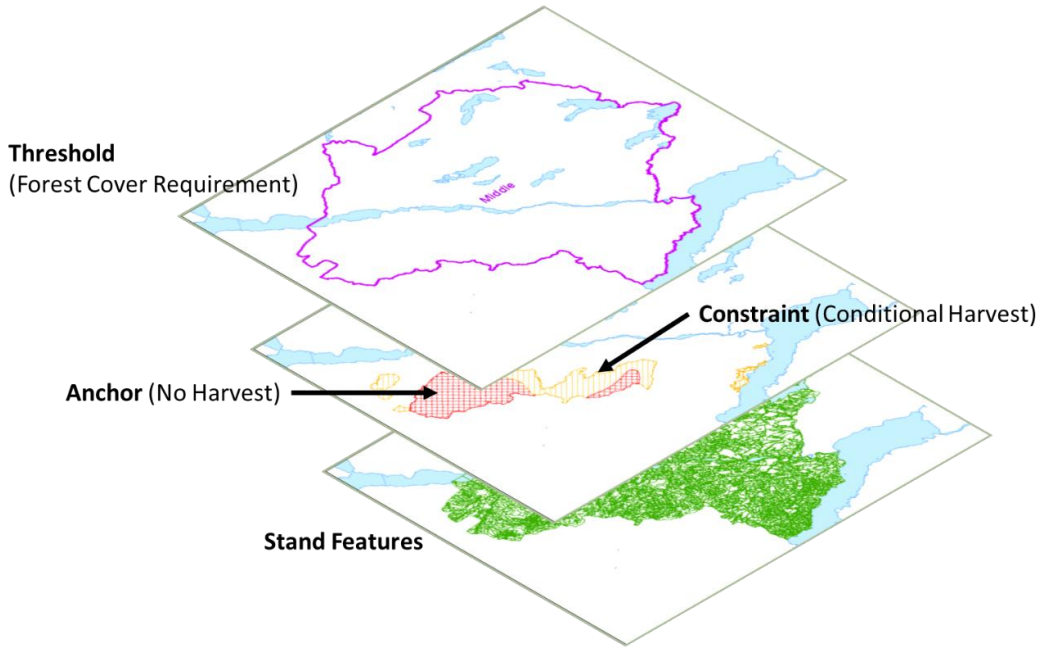


Figure 13 Cumulative Scoring of Reserve Criteria

4.1.2 Stand Features

The objective of stand features is to rank and score stands independently based on their ability to meet landscape biodiversity values (Table 33). The indicators are defined as the structural or functional ability of the stands to contribute to old growth attributes and any critical elements identified for retention. Once defined, the indicators are scored from -2 to 10 and summed up for each stand, independently from anchors and constraints. Negative values were used to account for undesirable characteristics. For example, a stand in the old seral stage (9 points), that's non-pine leading (0 points), 26 m tall (3 points), with 25% deadwood (2 points) and a vertical complexity of 4 (2 points) has a total score of 16 points. Stand scoring may also consider/incorporate other criteria associated with forest resilience (e.g., site productivity; aspect; slope; fire risk).

Table 33 Stand Feature Scoring Matrix

Indicator	Rationale	Category	Score
Forest Management	Differentiate between anthropogenic and natural disturbances	Primary/Natural	5
		Managed/Harvested	0
Seral Stage	Overarching intent is to designate reserves in old seral stand types because they typically do not occur when forests are managed using economic rotation ages. Retaining old stands on the land base ensures habitat / biodiversity niches continue to exist. Seral stage is assigned to VRI polygons using age and BEC zone.	Young	1
		Mid	2
		Mature	5
		Old	9
		Very Old (Old+50 yrs)	10
Species Composition	Non-pine leading or deciduous leading stands are higher contributors to biodiversity and old growth habitats. A higher diversity of species mix lends to a higher potential for biodiversity, however species mix will be to a certain extent captured in the rare ecosystem classification.	Deciduous-leading	3
		Mixed with cottonwood	6
		Mixed conifer (multiple/<50% leading species)	5
		Other conifer	1
		Douglas-fir leading	7
		Pine-leading (≥ 70%)	-1

Indicator	Rationale	Category	Score
Deadwood Abundance	Desirable stands consist of old, large, living and dead trees with coarse woody debris. Snags are an important contributor to biodiversity.	5 to 30% dead stems	2
		> 70% dead stems	-2
Vertical Complexity	Higher levels of vertical structure / complexity are linked with old growth stands.	4 – Non-Uniform	2
		5 – Very Non-Uniform	3
Tree Height	Connection between height, age and site productivity – taller trees for a given age can provide valuable habitat and recruitment for future snags.	≥ 20 < 25 m	2
		≥ 25 < 30 m	3
		≥ 30 m	4
Rare Ecosystems	Rare, old forested ecosystems are priority for contribution to old seral stage targets, old growth management areas, connectivity, and wildlife tree patches.		5
Old / Mature Interior Forest	The quality of old growth habitat is affected by edge conditions versus old interior forest. Areas large enough to provide interior condition are preferred.		3

4.1.3 Anchors

Anchors are areas where timber harvesting is not permitted. The objective of anchors is to score existing resource management areas based on their overall suitability as a candidate reserve. Scoring based on an anchor's potential impact on timber availability, independently of the scoring matrices developed for stand features and constraints (Table 34). Each anchor is given a score of 10 (i.e., all anchors are considered equal as they represent no-harvest stands), then stands are scored based on the number of overlapping anchors (i.e., the more anchors occurring in a stand, the higher the total score). Note that additional anchors were identified, yet the data were not available for this analysis. The additional anchors with incomplete data were included here for consideration in a future iteration. Detailed criteria for scoring anchors are included in Appendix 2.

Table 34 Anchors Scoring Matrix

No.	Anchors Included	Stuart	Score
1	Parks and Protected Areas	All	10
2	Ecological Reserves	(see Parks and Protected Areas)	10
3	Riparian Management Areas	All	10
4	Wildlife Tree Retention	All	10
5	UWR Mule Deer	u-7-002 (19)	10
6	UWR Mountain Goat	u-7-019, u-7-025	10
7	UWR Northern Caribou	u-7-003 (T-003, T-006, T-014, T-016), u-7-026	10
8	Draft WHA Northern Caribou (Chase-Wolverine)	Post-Rut	10
9	Draft WHA Northern Caribou (Chase-Wolverine)	Calving	10
10	Draft WHA White Pelican	7-001 Core	10
11	Draft WHA Grizzly Bear	7-002 Tl'oba WHA	10
12	Proposed FSW	f-7-006 to 015 (no harvest)	10
	Anchors NOT Included at this time		
	Identified First Nations Interests		
	Recreation Sites and Trails (buffers)		
	Research Sites		
	Conservation Lands (Sec 16/17 Reserves)		
	Karst		
	Mineral Licks (Wildlife Habitat Feature)		
	Rare ecosystems		
	Water Intakes (50m buffer)		

4.1.4 Constraints

Constraints are areas where timber harvesting is restricted (i.e., conditional harvesting). The objective of constraints is to score existing resource management areas based on their overall suitability as a candidate reserve. Scoring is based on constraints' potential impact on timber availability, on a scale from 1 to 10, independently of the scoring matrices developed for stand features and anchors (Table 35). A stand's total score is the sum of all applicable constraint scores occurring over that stand (can have multiple overlapping constraints). Note that additional constraints were identified with the potential to be included in future iterations. Detailed criteria for scoring constraints are included in Appendix 3.

Table 35 Constraints Scoring Matrix

No.	Constraints	Stuart	Score
1	Non-Harvestable Land Base	Yes	10
2	UWR: Caribou Low Elevation	u-7-015 (All)	4
3	UWR: Caribou High Elevation	u-7-003 (Where Harvest Permitted), u-7-026 (SA)	3
4	UWR: Elk		4
5	UWR: Mule Deer	u-7-002 (1-5, 9-12, 14-18)	3
6	Approved WHA: White Pelican	7-001 Management Zone	3
7	Proposed WHA: Grizzly Bear	7-002 Access (Riparian Buffer) 7-002 Denning (M-Zone)	6
8	Draft WHA: Caribou - Migration Corridors	26 units (7-244 to 7-316)	4
9	Community Watersheds	Where Harvest Permitted	5
10	Draft Fisheries Sensitive Watersheds	Where Harvest Permitted	2
11	VQO: Preservation	Preservation	10
12	VQO: Retention	Retention	8
13	VQO: Partial Retention	Partial Retention	4
14	MPB Salvage Zones	Small, Medium, Large, Very Large	6
15	High value Fisher habitat	SBS and Boreal	3
16	Crown Reserve Notations	Fish & Wildlife Only	7
	Constraints NOT included at this time		
17	FSJ RMZ: Multi-Value		
18	FSJ RMZ: Protected		
19	FSJ RMZ: Resource Development		
20	FSJ RMZ: Settlement/Agriculture		
21	FSJ RMZ: Special Management		

4.1.5 Assessment Units and Thresholds

Assessment units and thresholds are used to establish when enough candidate reserves are selected. The assessment unit defines the spatial extent where specific thresholds apply. For consistency reasons, the mBEC units grouping defined for landscape-level biodiversity objectives (section 2.2.1) were adopted in this scenario. Additional options that could be used in future iterations include landscape unit, natural disturbance type, or watersheds.

The thresholds define the indicators and targets (i.e., objectives) to be maintained or enhanced through the scenario analysis. In modelling terms, these are typically forest cover requirements configured as target levels that the model seeks to achieve as (1) minimum or maximum levels, (2) units in percent or area, (3) over a given unit (i.e., Assessment Unit), and (4) across specified periods (not applicable for this reserve scenario). Thus, the landscape-level biodiversity objectives were adopted in this scenario as the assessment unit and thresholds (Table 36). The current condition (Figure 14) provides an indication of where recruitment from the THLB or from Mature NHLB is possible to fill the requirements.

Table 36 Targets for old, old interior, and old non-pine leading

mBEC Unit	Old Target	Interior Target	Non Pine Target	CFLB Area	Target Old Area	Target Interior Area	Target Non Pine Leading Area
E1	41%	40%	33%	18,585	7,620	3,048	6,133
E2	17%	10%	13%	26,667	4,533	453	3,467
E3	17%	10%	10%	58,002	9,860	986	5,800
E4	12%	25%	4%	158,540	19,025	4,756	6,342
E5	12%	25%	6%	187,663	22,520	5,630	11,260
E6	37%	40%	0%	110,083	40,731	16,292	0
E7	37%	40%	0%	30,750	11,378	4,551	0
E8	26%	25%	0%	34,276	8,912	2,228	0
E9	58%	40%	0%	23,342	13,538	5,415	0
E10	41%	40%	0%	69,322	28,422	11,369	0
E11	41%	40%	0%	390,866	160,255	64,102	0
E12	16%	25%	0%	9,828	1,572	393	0
E13	23%	40%	0%	11,966	2,752	1,101	0
E14	16%	25%	0%	64,050	10,248	2,562	0
E15	16%	25%	0%	98,315	15,730	3,933	0
E16	16%	25%	0%	239,488	38,318	9,580	0
E17	16%	25%	0%	346,997	55,519	13,880	0

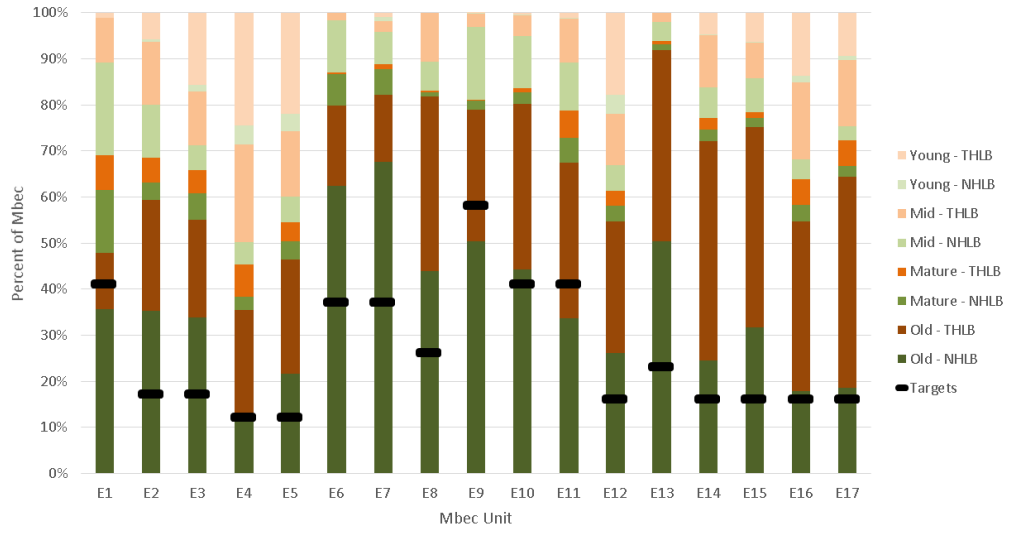


Figure 14 Current Forested Area Distribution by mBEC Unit and Seral Stage

4.1.6 Analysis Steps

This scenario needed to assess reserves relative to multiple thresholds and group reserves into larger areas. This scenario was approached via a GIS exercise combined with spatially-explicit modelling via Patchworks™. The GIS exercise prepared the data needed for the modelling approach (seral stage, old forest, old interior, and scores) while the modelling approach aimed to maximize the cumulative score towards a target patch size distribution.

The following steps were employed for the GIS exercise:

- A copy of the 'resultant' spatial overlays from the ISS Base Case provided an initial dataset to work with.
- Additional spatial data, not required for the ISS Base Case, were added to the resultant:
  - Fisher habitat capability, and
  - Fish and wildlife reserve notations.

- Assessment criteria were then calculated as separate fields in the database:
  - assign seral stage; specifically to determine old seral forest, and
  - create interior old forest patches defined as the area of 'old forest' or 'natural forest area' buffered from younger age classes or disturbances (i.e., 200 m from adjacent stands >80 years/age class 5). The 200m buffer area of interior forest stands were maintained as edge buffer areas.
- Scores for stand features, anchors, and constraints were assigned to separate fields, then combined into additional fields. These were assigned as a script that accesses Excel spreadsheets recorded with the indicators and scores transferred from Table 33, Table 34, and Table 35.

The following steps were employed for the spatially-explicit modelling via Patchworks™:

- Product area accounts for the thresholds defined in section 4.1.5 (i.e., mBEC units) were created to account for Old and Interior forest:
  - OLD,
  - OLD + Mature,
  - OLD + Mature + Mid, and
  - OLD + Mature + Mid + Young.
- The minimum targets in Table 36 were set with decreasing weights from OLD. Here, preference is given to OLD area first, then recruiting from Mature, Mid, and finally from Young stands.
- To give priority first to the non-THLB stands, the non-THLB stands with anchor score >=10 were hard-coded so they will always be selected as candidate reserves. In addition, a product area for non-THLB was created and an unreachable minimum target area was set (e.g., 4 million ha) with a soft weight. Here, priority to NHLB stands was given over THLB stands within same seral stage (e.g., if the model had to choose between an OLD THLB stand and an OLD non-THLB stand, the candidate reserve will be selected first from a non-THLB stand).
- To enable grouping of candidate reserve stands, patch sizes and targets were set for the total product area account as follows:

Area (ha)	Min %	Max %	Attractor
1-10	---	0	---
10-100	---	10	---
100-500	---	---	---
500-1000	40	---	---
1000-1500	30	---	---
1500+	---	---	Yes

- A basic “maximize score” target was applied across the entire land base so that scores would accumulate as the model selected candidate reserves.

Unfortunately, Patchworks does not track interior forest dynamically as candidate reserves are selected. As described above, initially there were identified interior and edges, then influenced the model to maintain the interior forest thresholds. However, if polygons within edges that define the interior forest are not selected, then the interior forest is no longer ‘interior’. So, an additional assessment of the candidate reserves must be undertaken to confirm that the old forest interior thresholds are, in fact, maintained and identify where they are not.

4.2 HARVEST SCENARIO

The Harvest scenario is designed to answer the question “Which stands should be prioritized for harvest/salvage in the short term (and what are the mid/long term consequences of not following this

strategy)?" The underlying purpose of this scenario is to explore tactics aimed to improve timber harvesting opportunities by adding and changing harvest-related assumptions to the ISS Base Case scenario. Besides salvage, the harvest scenario has the potential to alleviate economic challenges related to harvest distribution shortcomings (e.g., species profile, haul distance). In this ISS iteration, the Project Team identified 3 tactics to be explored: 1) minimum harvest criteria, 2) wildfire management, and 3) harvest priorities. Therefore, two scenarios are modelled: one scenario that looks at tactic (1) called Harvest-MHC scenario and another that looks at tactics (2) and (3) combined, called Harvest-WHP.

The Project Team also considered investigating the most logical and cost-effective timber harvest opportunities by incorporating key operational considerations (e.g., access or distance limitations), prioritize or limit stand types/locations according to expected returns (e.g., site index, haul distance, and terrain/harvest constraints), and assign targets for stands/analysis units to prioritize specific product profile distributions. While this tactic was not implemented in this ISS iteration, it could be explored in the future.

4.2.1 Minimum Harvest Criteria

The minimum harvest criteria (MHC) set for the ISS Base Case scenario limits harvesting by slope (maximum 62%) and by volume (minimum 140 m^3/ha in pine leading stands and minimum 182 m^3/ha in non-pine-leading stands). In addition, in the Harvest-MHC scenario, a MPB salvage treatment opportunity is explored: for MPB stands the MHC criteria is changed to minimum 100 m^3/ha on maximum 35% slope and the haul cycle time is set to maximum 3 hours. No other changes compared to the ISS Base Case scenario occurred in the Harvest-MHC scenario set-up.

4.2.2 Wildfire and Harvest Priority

The Harvest-WHP scenario (short from Wildfire and Harvest Priority) aims to explore wildfire management and harvest priority tactics.

The wildfire management tactic aims to incorporate stand- and landscape-level wildfire management strategies to address the potential impact or risk of fire. Harvest is prioritized for those stands that are rated as extreme by the 2015 Provincial Strategic Threat Analysis (PSTA) – wildfire threat component dataset for Stuart TSB. The extreme fire threat rated stands cover approximately 88,000 ha THLB. In addition, the fire loss mitigation through identified fuel breaks landscape-level strategy is addressed by prioritizing harvesting in coniferous-leading stands covering the identified fuel breaks. The coniferous-leading stands within identified fuel breaks cover approximately 101,000 ha THLB. Note that there is an overlap of approximately 11,000 ha THLB between the extreme fire threat and identified fuel breaks. The Project Team also considered implementing fire stocking standards within Wildland Urban Interface (WUI) designated areas. While this tactic was not implemented in this ISS iteration, it could be explored in the future.

The harvest priority tactic aims to influence the model to prioritize or limit harvesting in certain areas, for certain stands/species, or for certain land base conditions. For the Harvest-WHP scenario, the harvest flow objectives set for the Base Case scenario (section 2.7, Table 30) are turned off. In addition, harvest opening sizes are controlled in each 5-year period without harvest flow penalties (Table 37).

Table 37 Harvest-WHP Scenario – Opening Size Targets

Area (ha)	Min %	Max %	Weight	Attractor
<20	---	0	10	---
20-<50	---	0	1	---
50-<100	---	---	---	---
>=100	---	---	---	Yes

4.3 SILVICULTURE SCENARIO

The Silviculture Scenario examines tactics that can enhance timber quantity and quality over the mid- and long-term, as well as, improve biodiversity, wildlife habitat, and cultural interests. This scenario integrates three key silviculture tactics: 1) fertilization, 2) enhanced basic silviculture, and 3) rehabilitating MPB impacted stands. The Silviculture Scenario reflects the best combination of these treatments applied to stands within the Stuart TSBs, while assuming a steady funding level of $3 million per year over the first 20 years of the planning horizon. Specific tactics and approaches are briefly summarized in Table 38.

Table 38 Tactics applied in the Silviculture Scenario

<table>
<tr><th>Tactic</th><th>Element</th><th>Description</th><th>Criteria</th></tr>
<tr><td rowspan="6">Rehabilitation of MPB/IBS impacted stands</td><td>Eligible Stands</td><td>Unlogged existing natural stands by the end of the salvage period</td><td>○ Conifer Leading
○ Slope <=35%
○ >=40% stand percentage dead
○ <=140m³/ha live volume at the end of salvage period, or live + dead volume during the salvage period
○ Stand Age >=40 yrs at time of MPB attack
○ BEC: SBS, ESSF
○ Inventory SI >=11</td></tr>
<tr><td>Timing</td><td>Period within the planning horizon</td><td>○ First 40 years</td></tr>
<tr><td>Treatment Response</td><td>Transition stands onto future managed stands as if harvested</td><td>○ Regular future AUs, or enhanced future AU (where stand eligibility overlaps)</td></tr>
<tr><td rowspan="3">Costs</td><td>Marginally Economic (>= 50m³/ha) - Harvest/Knockdown/Site Prep/Plant</td><td>○ $1,500/ha</td></tr>
<tr><td>Uneconomic (<50m³/ha) - Knockdown/Site Prep/Plant</td><td>○ $2,000/ha</td></tr>
<tr><td>Distance cost beyond 2 hrs (one way)</td><td>○ $50/ha each 2 hrs (one way)</td></tr>
<tr><td>Anticipated Issues</td><td>Access limitations (new road construction prohibitive)</td><td>○ N/A</td></tr>
<tr><td rowspan="8">Fertilization</td><td rowspan="2">Eligible Stands</td><td>Existing natural stands not impacted by MPB</td><td>○ Sx + Pl >=80%
○ BEC: SBS, ESSF
○ Inventory SI >=14
○ Slope <= 35%</td></tr>
<tr><td>Existing managed stands not impacted by MPB</td><td>○ Sx + Pl >=80%
○ SBS, ESSF
○ Managed SI >=14
○ Slope <= 35%</td></tr>
<tr><td>Timing</td><td>Minimum and Maximum age defining opportunity window, for up to 4 applications, every 10 years</td><td><table><tr><th>Applications (every 10 yrs)</th><th>Age Window (yrs)</th></tr><tr><td>1</td><td>25 - 75</td></tr><tr><td>2</td><td>25 - 65</td></tr><tr><td>3</td><td>25 - 55</td></tr><tr><td>4</td><td>25 - 55</td></tr></table></td></tr>
<tr><td rowspan="3">Treatment Response</td><td>Growth increase 10 years after application (entire stand) – existing natural stands</td><td>10m³/ha for each application.</td></tr>
<tr><td>Growth increase 10 years after application (entire stand) – existing managed stands</td><td><table><tr><th>Applications (every 10 yrs)</th><th>Sx-Leading (m³/ha)</th><th>Pl-Leading (m³/ha)</th></tr><tr><td>1</td><td>17</td><td>17</td></tr><tr><td>2</td><td>36</td><td>34</td></tr><tr><td>3</td><td>57</td><td>49</td></tr><tr><td>4</td><td>76</td><td>64</td></tr></table></td></tr>
<tr><td>Transitions to future stands</td><td>○ Locked from harvesting, 10 years after last application.</td></tr>
<tr><td rowspan="2">Costs</td><td>Fertilization costs for all stands</td><td>○ $450/ha for each application.</td></tr>
<tr><td>Distance Costs</td><td>○ $25/hectare each 2hours (1 way)</td></tr>
</table>

Tactic	Element	Description	Criteria
	Anticipated Issues	First Nations' concerns	
Enhanced Silviculture	Eligible Stands	Existing natural and managed stands.	○ BEC: SBS, BWBS ○ SI (managed) >=14
	Timing	Period within the planning horizon	○ First 40 years
	Treatment Response	Transition to future enhanced managed stands	
		Regeneration method	○ 100% planted
		Density	○ Increase to 1,700 stems/ha
		Genetic gains	○ No changes from current
		Regeneration delay	○ From 2yrs to 1yr
		OAF1	○ From 85% to 89%
	Costs	Incremental planting of trees sown with select seed	○ $285/ha
	Anticipated Issues	Currently lacks funding source; possibly operational cost allowance	

Stands eligible for treatments were classified based solely on their yield in 2016: stands <50 m³/ha were eligible as 'uneconomic rehabilitation', stands between 50 and 140 m³/ha were eligible as 'economic rehabilitation', and stands >140m³/ha were eligible as clearcut (salvage) treatments. Over the planning horizon, if stand yields declined below or increased above these thresholds, the model simply took them offline until they eventually became available for clearcut (>140 m³/ha). That is, once they were initially classified, stand eligibility could not shift from clearcut to economic rehabilitation, from economic to uneconomic rehabilitation, or from uneconomic to economic rehabilitation.

4.4 COMBINED SCENARIO

The Combined Scenario aims to guide the development and implementation monitoring of tactical plans over the first 20 years of the planning horizon. Key elements from all four scenarios – Base Case, Reserves, Harvest, and Silviculture – are included to provide an integrated strategy to this first iteration of the ISS process. Specific tactics and approaches are briefly summarized in Table 39.

Table 39 Tactics applied in the Combined Scenario

	Modelling Run	Approach
Base Case	New Tenures	○ Spatial delineation of revised CF, FNWLs, and AOI and adjust landbase description (section 2.1.3)
Base Case	Wildlife Habitat	○ Spatial delineation of approved, proposed, and draft habitat areas added to the resultant; adjusts landbase description (section 2.1.6).
Base Case	Riparian Reserves	○ Spatial delineation of riparian reserves and adjust landbase description (section 2.1.9).
Base Case	Watershed ECA	○ Monitor and/or implement a forest cover requirement within identified watersheds and apply Tl'azt'en ECA targets to proposed FSWs (section 2.2.6 and 3.2).
Base Case	Pine Beetle	○ Implement a number of assumptions for adjusting yields to reflect stand dynamics associated with MPB-impacted stands (section 2.4.8). ○ Adjust wildlife tree retention based on opening size by implementing patch groups adjusted relative to the current distribution (section 2.2.3).
Reserve	Candidate Reserves	○ Include candidate reserves and implement access timing constraints that prevent these areas from being harvested over the first 40 years (section 4).
Harvest	Wildfire Management	○ Prioritize harvest on stands identified with wildfire risk as extreme plus coniferous-leading stands within landscape-level fuel breaks (section 4.2.2). ○ Apply even higher weights and shorter period (i.e., 10 years) while accepting some impact to harvest flow.

	Modelling Run	Approach
Harvest	Harvest Priority	○ Drop pine harvest partition (section 2.3.3) and add one that maintains a minimum of 1.5 million m³/yr harvest level from TSBs A and B.
Silviculture	Combined Treatments	○ Maximize harvest flow with annual budget of $3 million on a combination rehabilitation, fertilization, and enhanced basic treatments (section 4.3). ○ Harvest flow target excludes volume recovered through rehabilitation but reports include this volume plus harvest by age class and state.
Harvest	Harvest Priority	○ Implement more stringent targets to develop more appropriate harvest opening sizes (section 4.2.2): 0% below 1 ha and up to 5% between 1 and 5 ha in size. Accept up to 5% impact to short-term harvest level.

5 References

B.C. Ministry of Forests and B.C. Ministry of Environment, Lands and Parks. (1995). *Biodiversity Guidebook.* Victoria: Forest Practices Code.

BC Ministry of Forests, Lands, and Natural Resource Operations. (2015). *Prince George Timber Supply Area: Timber Supply Review.* Victoria BC: FLNRO.

Sorensen, T., McLoughlin, P. D., Hervieux, D., Dzus, E., Nolan, J., Wynes, B., & Boutin, S. (2008). Determining Sustainable Levels of Cumulative Effects for Boreal Caribou. *Journal of Wildlife Management, 72*(4), 900-905. doi:http://dx.doi.org/10.2193/2007-079

Appendix 1 ***Watersheds***

Source	Watershed, Basin or Sub-basin	Total Area (ha)	CFLB (ha)	Non-Forest (ha)	Private (ha)	AD (ha)	Max ECA (%)	Max ECA (ha)	New Max ECA (%)	Tl'azt'en Max ECA (%)	Tl'azt'en Max ECA (ha)	New Tl'azt'en Max ECA (%)
Proposed FSW - f-7-006	Gluskie Creek	4,709	3,719	983	8	0	25	1,177	31	5	235	6
Proposed FSW - f-7-007	Forfar Creek	3,515	2,413	1,098	3	0	25	879	36	3	105	4
Proposed FSW - f-7-008	O'Ne-ell/Kynoch Creek	6,772	5,061	1,705	6	0	25	1,693	33	7	474	9
Proposed FSW - f-7-010	Bivouac Creek	4,041	3,941	86	14	0	30	1,212	30	7	283	7
Proposed FSW - f-7-011	Van Decar Creek	2,543	1,799	740	4	0	19	483	27	3	76	4
Proposed FSW - f-7-012	Sidney Creek	4,262	3,329	715	198	15	17	724	15	5	213	0
Proposed FSW - f-7-013	Paula Creek	4,401	3,679	484	197	30	17	748	14	6	264	1
Proposed FSW - f-7-014	Sandpoint Creek	5,838	5,290	545	1	1	21	1,226	23	10	584	11
Proposed FSW - f-7-015	Narrows Creek	6,230	5,149	1,065	8	6	20	1,246	24	6	374	7
Proposed FSW - f-7-016	Frypan Creek	11,149	8,096	3,053	0	0	19	2,118	26			
Proposed FSW - f-7-017	Lovell Creek	8,585	6,073	2,508	5	0	19	1,631	27			
Proposed FSW - f-7-018	Ankwill Creek	11,010	6,514	4,483	14	0	20	2,202	34			
Draft FSW – f-7-034	Upper Omineca Watershed	92,724	45,694	47,030	0	0	20 (default)	18,545	41			
Draft FSW – f-7-035	Klawli River Watershed	41,610	35,847	5,762	2	0	Report only	N/A	N/A			
	Lower Klawli sub-basin above H60 @ 1250m	1,070	534	536	0	0	25	267	50			
Draft FSW – f-7-036	Rottacker Creek Watershed	8,931	8,068	850	13	0	Report only	N/A	N/A			
	South Rottacker Basin above H60 @ 1180m	2,276	1,946	331	0	0	25	569	29			
Draft FSW – f-7-037	Ahdatay Creek Watershed	9,802	8,251	1,543	7	0	Report only	N/A	N/A			
Fort St. James LRMP	Upper Jake Creek	16,180	4,807	11,374	0	0	Report only	N/A	N/A			
Fort St. James LRMP	Sowchea Creek	6,224	4,612	365	55	894	Report only	N/A	N/A			

Appendix 2 ***Criteria for Scoring Anchors***

Anchors	Units	Criteria (Based on Timber Impact)	Modelling
Riparian Management Areas		Stream classifications are not available/complete for the area so criteria were developed and applied to classify and buffer streams, lakes and wetlands.	No harvest
Recreation			No harvest
Parks and Protected Areas			No harvest
Inoperable – Terrain Slope Class 5			No harvest
Research Sites (i.e. PSP)			No harvest
Water Intakes			No harvest
Wildlife Tree Patches & Reserves			No harvest
Proposed Fisheries Sensitive Watersheds	No Harvest Area		No Harvest
Cultural Heritage Resources & First Nations Interests	Arch. sites, heritage features, traditional use sites, etc.	Protected and/or conserved areas under the *Heritage Conservation Act* or through consultation with First Nations.	No harvest
Draft WHA: Northern Caribou	Post Rut		No Harvest
	Calving		No Harvest
Proposed WHA: Grizzly Bear			No Harvest
Draft Amended UWR: Kennedy Siding - Low Elevation (Northern Caribou)	*U-7-001*	Revised shape and GWM.	No Harvest.
Approved UWR: Mountain Goat	*U-7-004*	No harvest within winter ranges.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_004.pdf			
Approved UWR: Stone's Sheep	*U-7-006*	No harvest within winter ranges. Plan major/secondary roads to avoid winter ranges, and de-activate any future built roads/trails (in UWR).	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_006.pdf			
Approved UWR: Northern Caribou	*U-7-009 (*PP-001, PP-002, PP-004)	Revised shape and GWM.	No harvest

Anchors	Units	Criteria (Based on Timber Impact)	Modelling
	*U-7-009 (*PP-001, PP-002, PP-004)	Retain all forest cover, with exception if purpose is to enhance quality of winter range. No roads constructed within winter ranges.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_009.pdf			
Approved UWR: Moose, Elk and Mountain Goat	*U-7-017* (AP3, AP4, AP5, AP6)	No harvesting within mountain goat UWR.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-017_order.pdf			
Approved UWR: Mountain Goat	*U-7-019*	No harvesting within mountain goat winter range.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-019_Order.pdf			
Approved UWR: Caribou and Mountain Goat	*U-7-025*	No removal of forest cover within northern caribou high elevation habitat (defined in Table 1 of Order). Forest activities in northern caribou high elevation specified area units (SA1 to SA35) and within areas of early seral moose WR potential must limit, up to free growing date, production of preferred moose browse to not more than 8% cover (unless to provide permanent access structure/ road defined in FPPR).	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-025_order.pdf			
Approved UWR: Northern Caribou	*U-7-026*	No removal of forest cover within northern caribou high elevation habitat (defined in Table 1 of Order). Forest activities in northern caribou high elevation specified area units (SA1 to SA6) and within areas of early seral moose WR potential must limit, up to free growing date, production of preferred moose browse to not more than 8% cover (unless to provide permanent access structure/ road defined in FPPR).	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-026_order.pdf			
Approved UWR: Stone's Sheep	*U-7-028*	No removal of forest cover within Stone Sheep's winter ranges. All heli-logging within 2,000 m line-of-sight to core UWR must take place July 15 – Oct 31. Within 500 m of core UWR harvesting must take place July 15 – Oct 31 (unless sheep not present). All roads constructed within 500m must be decommissioned within 3 years following harvest.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-028_order.pdf			
Approved UWR: Mountain Goat	*U-7-029*	No removal of forest cover within mountain goat winter range. All heli-logging within 2,000 m line-of-sight to UWR must take place July 15 – Oct 31. Within 500 m of core UWR harvesting must take place July 15 – Oct 31 (unless goat not present). All roads constructed within 500m must be decommissioned within 3 years following harvest.	No harvest

Anchors	Units	Criteria (Based on Timber Impact)	Modelling
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-029_order.pdf			
Approved UWR: N. Caribou, Mountain Goat, and Bighorn Sheep	*U-9-002*	Primary forest activities will result in the retention of all forest cover within the ungulate winter ranges.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/u-9-002_Order.pdf			
Approved UWR: N. Caribou and Stone's Sheep	*U-9-004 (*GR-011, GR-021, GR-022)	Activities will not result in removal of forest cover, construction or roads/trails, use of domestic sheep or goats, use of pesticides, or development of recreation sites or trails.	No harvest
http://www.env.gov.bc.ca/wld/documents/uwr/U-9-004_ord.pdf			
Approved WHA: Mountain Goat	9-001	Do not harvest or salvage within WHA.	No harvest
http://www.env.gov.bc.ca/wld/documents/wha/ORAM-9-001_ord.pdf			
Approved WHA: Northern Caribou	9-035 to 9-040 9-102, 9-103	Activities will not result in removal of forest cover, construction or roads/trails, use of domestic sheep or goats, use of pesticides, or development of recreation sites or trails.	No harvest
http://www.env.gov.bc.ca/wld/documents/wha/RATA_9-035_040,102,103_ord.pdf			
Draft WHA: White Pelican	Core		No Harvest
Draft WHA: Fisher			No Harvest
Stuart / FSJ LRMP – Resource Management Zones	Multi-Value	Integration of a wide range of resource values – access relatively unrestricted, exception of specific areas recommended for special mgmt. consideration	Not modelled
	PPA (Protected Areas)	Minimum intervention	Not modelled
	Resource Development	Intensive resource development – managed with consideration for other resource values and within guidelines of specific zone objectives and strategies – emphasis on mineral extraction, harvesting, while minimizing impacts on other resource values through IRM strategies – access relatively unrestricted	Not modelled
	Settlement / Agriculture (S&E)	Farming, proposed settlements	Not modelled
	Special Management	Managed for wide array of resources but in general indicate need for sensitive resource mgmt. – resource development may proceed as long as impacts to other resource are minimized and values are maintained	Not modelled
https://www.for.gov.bc.ca/tasb/slrp/pdf/lrmp/Fort%20St%20James_LRMP.pdf			

Appendix 3 ***Criteria for Scoring Constraints***

Constraints	Units	Criteria (Based on Timber Impact)	Modelling
Approved UWR: Caribou (Northern Pop)	*U-7-001*	Harvest max. 50% of entire area at a time on 100-yr rotation so 45-55% is 0-50 years old and 45-55% is 50-100 years old. Harvest patches 250 to 1,400 ha. Maintain visual screen between roads and adjacent cutblocks (so caribou within that cutblock are not visible from road). No silv activity to increase site productivity for trees (i.e. no fertilization). Avoid harvesting between Oct 1 – Feb 28, and ensure adequate snow cover when winter harvesting. Do not increase current road density, and future roads built to lowest class practicable.	Harvest max. 50% of area at one time (100-yr rotation) so that 45-55% is 0-50 years and 45-55% is 50-100 years. Harvest patches 250 to 1,400 ha.
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_001.pdf			
GAR Order U-7-002 Approved UWR: Mule Deer	*U-7-002 (*1-5, 11, 12, 14)	Minimum 40% winter range area in age class 8 or greater at all times with crown closure > 56% (Douglas-fir, Spruce); Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	≥ 40% ≥ 140 years Regen ≥ 50% Fd
	*U-7-002 (*6-8, 13)	Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	Regen ≥ 50% Fd
	*U-7-002 (*9, 10, 15-18)	Minimum 50% of stand in age class 8 or greater at all times with crown closure > 66% (Douglas-fir, Spruce); Minimum 50% species composition of Douglas-fir leading; Timber harvesting openings irregular shape and smaller than 1 ha in size and less than 250 m wide	≥ 50% ≥ 140 years Regen ≥ 50% Fd
	*U-7-002 (*T-001, 2, 4, 7, 8, 11, 13, 15, 17, 18, 19)	Medium habitat – harvest < 30% volume removal on cutblock every 80 years, opening sizes do not exceed 1 ha with mean opening size < 0.5 ha	≥ 30% ≥ 160 years old ≤ 30% < 80 years
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_002.pdf			
Approved UWR: Southern Caribou	*U-7-003 (*T-005, 009, 010, 012)	Travel corridors – harvesting results in minimum 20% of forest within each unit as 100+ years of age in corridor with no more than 20% of productive forest area of unit < 3 m green-up condition	≥ 20% of forest ≥ 100 years ≤ 20% < 3 m
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-003_order_09Dec09.pdf			
Approved UWR: Elk	*U-7-005*	Maintain min. 40% of stands in winter range in age class 6 + (> 100 years) with crown closure > 40%.Plan major/secondary roads to avoid winter ranges, and de-activate any future built roads/trails (in UWR).	≥ 40% of forest > 100 years and CC > 40%
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_005.pdf			
Approved UWR: Northern Caribou	*U-7-007*	Within terrestrial lichen habitat (TLH) no new mainline road construction. Each TLH aggregate (TLHA) (Table 1 of Order) managed with 2-pass harvest system over 140-year rotation. Each pass results in large openings on one side of TLHA, forested leave area within TLHA equivalent to size of harvested area ± 10%. No increase in site productivity through use of fertilizer. Re-established forested stand consistent with pre-harvest species composition.	2-pass harvest system over 140-yr rotation. Leave areas equiv. size of harvested area ± 10%.
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_007.pdf			
Approved UWR: Elk	*U-7-008*	Maintain min. 40% of forest stands in winter range in age class 6+ (> 100 years) with crown closure > 40%. Plan major/secondary roads to avoid winter ranges, and de-activate any future	Min 40% of forest > 100 years and CC > 40%

Constraints	Units	Criteria (Based on Timber Impact)	Modelling
		built roads/trails (in UWR).	
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_008.pdf			
Draft Amended UWR: Pine Pass Northern Caribou	*U-7-009 (*PP-003)	Slightly changed to accommodate U-7-001.	Min 20% > 100 years Max 20% of area < 3 m (green-up)
Approved UWR: Northern Caribou	*U-7-009 (*PP-003)	Maintain min. 20% forested stands with 100+ years in contiguous, windfirm corridor with max. 20% of unit < 3 m green-up condition.	Min 20% > 100 years Max 20% of area < 3 m (green-up)
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_009.pdf			
Approved UWR: Northern Caribou	*U-7-015* *(*9a-001, 2, 7 9b-001, 2 9c-001, 2, 3 10-001, 2, 4)	Manage defined non-terrestrial Lichen habitat and terrestrial Lichen habitat through a two-pass, 140 year rotation – within each pass harvest 50% +/- 20% of total area	Max 50% < 70 years old
http://www.env.gov.bc.ca/wld/documents/uwr/uwr_u7_015.pdf			
Approved UWR: Moose, Elk and Mountain Goat	*U-7-017* *(*AP1, AP2)	Maintain forest cover so that min. 20% of each UWR unit has coniferous-leading stands ≥ 100 years and crown closure ≥ 40%. Maintain forest cover so that min. 25% of each UWR unit has stands (regardless of leading species) ≥ 80 years and crown closure ≥ 40%. Maintain min. 20 % forested stands in each UWR unit are < 20 years. Max disturbance to forest cover (i.e. WTRA) should not exceed 200 m from any point in opening.	Conifer-leading: Min 20% ≥ 100 years and CC ≥ 40% Other-spp-leading: Min 25% ≥ 80 years and CC ≥ 40% All stands: Min 20% < 20 years
http://www.env.gov.bc.ca/wld/documents/uwr/u-7-017_order.pdf			
Draft WHA: Northern Caribou	Migration		Max 35% of forest < 40 years
Draft UWR – Mule Deer		Within Tanizul Community Forest (outside of TSA)	Not Modelled
Community Watersheds			Max 30% of stands (by CWS) < 2 m
Visual Quality Objectives: Prince George District *GAR Order*	Preservation (P)	No visible activities – perspective view below VEG	Max 0%
	Retention (R)	Activities not visually evident – perspective view below Visually Effective Green-up (VEG)	Max 0.8%
	Partial Retention (PR)	Activities visible but minimal – perspective view below VEG	Max 4.3%
Visual Quality Objectives: Mackenzie District	Retention (R)	Activities not visually evident – perspective view below VEG by Visual Absorption Capacity (VAC)	Low - Max 0.1% Med - Max 0.7%

Constraints	Units	Criteria (Based on Timber Impact)	Modelling
Non-Legal but recommended			High - Max 1.5%
	Partial Retention (PR)	Activities visible but minimal – perspective view below VEG by VAC	Low - Max 1.6% Med - Max 4.3% High - Max 7.0%
Stuart / FSJ LRMP – Resource Management Zones	Multi-Value	Integration of a wide range of resource values – access relatively unrestricted, exception of specific areas recommended for special mgmt. consideration	
	PPA (Protected Areas)	Minimum intervention	
	Resource Development	Intensive resource development – managed with consideration for other resource values and within guidelines of specific zone objectives and strategies – emphasis on mineral extraction, harvesting, while minimizing impacts on other resource values through IRM strategies – access relatively unrestricted	
	Settlement / Agriculture (S&E)	Farming, proposed settlements	
	Special Management	Managed for wide array of resources but in general indicate need for sensitive resource mgmt. – resource development may proceed as long as impacts to other resource are minimized and values are maintained	
https://www.for.gov.bc.ca/tasb/slrp/pdf/lrmp/Fort%20St%20James_LRMP.pdf			