Quesnel Timber Supply Area
Timber Supply Review

Data Package

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1. Introduction

The data package for the Timber Supply Review (TSR) program is an organized and consistent format for supplying the basic inputs required for a timber supply analysis.

This data package summarizes the information and assumptions that will be used to conduct timber supply analysis for the Quesnel Timber Supply Area (TSA). The information and assumptions represent current performance, which for the purpose of the TSR is defined by:

- the current forest management regime — the silviculture treatments, the harvesting systems and the integrated resource management guidelines used in the area;
- the land available for forest management activities and the timber harvesting land base as defined by historical licensee performance;
- the standards used to approve or reject operational plans or prescriptions;
- land-use plans approved by Cabinet (e.g., Cariboo-Chilcotin Land Use Plan (CCLUP));
- legal objectives established under the *Forest and Range Practices Act* (FRPA) and the *Land Act* (e.g., *Land Use Objectives for the Cariboo-Chilcotin Land Use Plan*, May 2011 (LUO)); and
- other approved provincial government and joint agency natural resource management practices and policy.

The concept of current performance (the last five to ten years) should be kept in mind at all times when reviewing the data package. The purpose of the timber supply review program is to model "what is" not "what if". Anticipated changes in forest management objectives and imminent sources of data will be captured in future timber supply analyses. The information and assumptions in this data package, while representing the best knowledge and information available today, are subject to refinement during the course of the TSR process.

Each section of this data package is generally organized in the following way:

1) a short explanation of the data required with a description of data sources and other explanatory comments;
2) supporting data in the form of lists, tables or figures; and
3) a summary of the proposed modelling assumptions.

This *Quesnel TSA Timber Supply Review Data Package* is being released for public review and comment, and to support First Nations consultation. Significant comments that change data inputs or descriptions of current practices that influence the analysis will be noted in the final timber supply review documents such as the *Timber Supply Analysis Discussion Paper* and Chief Forester's *Rationale for Allowable Annual Cut Determination*.

2. Current Forest Management Considerations and Issues

2.1 Base case management assumptions

The assumptions described in this section reflect current performance with respect to the status of forest land, forest management practices and knowledge of timber growth and yield. The timber supply forecast developed from these assumptions is termed the base case timber supply forecast and is used as a baseline for assessing the impacts of uncertainties. Section 7.1, "Sensitivity analyses" identifies sources of uncertainty in data and assumptions and outlines intended sensitivity analyses that will be carried out. Additional sensitivity analyses may be performed if the initial results highlight areas of risk to timber supply.

2.2 Major forest management considerations and issues

Table 1 lists major forest management considerations and issues. Where possible, the issues are assessed directly in the timber supply analysis. If the issue does not fall within the definition of current management as described in Section 1, "Introduction", the related timber supply impacts will be assessed in a sensitivity analysis. There may be significant uncertainties in defining some current management issues. In such cases, sensitivity analysis can assist in assessing the timber supply implications and assigning degrees of risk to timber supply during the allowable annual cut (AAC) determination.

Table 1. Major forest management considerations and issues

Consideration/issue	Description
Cariboo-Chilcotin Land Use Plan (CCLUP)	The *Cariboo-Chilcotin Land Use Plan* (CCLUP) was announced by government in October, 1994. The *Cariboo-Chilcotin Land Use Plan 90-Day Report* (March 3, 1995) was accepted by government and the objectives have been reflected in a higher level plan order. The *Cariboo-Chilcotin Land Use Plan Integration Report* (CCLUPIR), which demonstrated the CCLUP objectives could be achieved given some specific adjustments to the strategies, was confirmed as "official government policy" in a June 22, 1999, memorandum signed by deputy ministers. This direction has been further refined through a series of land use planning processes. These include the Anahim Round Table and Sub-Regional Management Plans. In June, 2010, land use objectives were established by order under the *Land Use Objectives Regulation* of the *Land Act*. These objectives were amended as *Land Use Objectives for the Cariboo-Chilcotin Land Use Plan*, May 2011 (LUO). The LUO includes objectives for wildlife tree retention, old growth management areas, critical habitat for fish, community areas of special concern, lakes management, stream, wetland and lake riparian areas, mature birch retention, grasslands, scenic areas, trails, high value wetlands for moose, and grizzly bear.
Landscape and stand-level biodiversity	The establishment of old growth management areas (OGMA) and wildlife tree retention requirements under the LUO addressed many of the landscape-level biodiversity components of the CCLUP and in conjunction with recommended Biodiversity Conservation Strategy seral targets, as modified by the CCLUPIR, are considered by the district managers to be appropriate for achieving biodiversity objectives outlined in the CCLUP.

(continued)

Table 1. Major forest management considerations and issues

Consideration/issue	Description
Mountain Pine Beetle (MPB) salvage harvesting	The TSA was significantly impacted by the recent MPB infestation. The infestation peaked in 2005 and has since leveled off at approximately 90 million cubic metres of dead pine. An AAC uplift to allow for salvage has been in place since 2001. An AAC partition of 650 000 cubic metres attributable to non-pine coniferous tree species volume was implemented in the 2011 AAC determination to ensure the non-pine profile will be available to support the mid-term timber supply in the TSA.
Guidance on landscape- and stand-level structural retention in large-scale Mountain Pine Beetle salvage operations	In December 2005, the chief forester released guidance to protect hydrological values in areas subject to large-scale MPB salvage. The guidance recommended higher levels of stand retention above the targets for stand-level biodiversity.
Improved site productivity information	A site index adjustment project was completed for the TSA prior to the 2011 determination providing improved information on the productivity of pine- and spruce-leading stands. The data from this project have been combined into the Provincial Site Productivity Layer that provides improved productivity information for all commercial tree species.
Caribou habitat	Eastern and Itcha Ilgachuz caribou habitat is managed in accordance to the *CCLUP Caribou Strategy*, *CCLUP Integration Report* and the recommendations of the *Mountain Caribou Strategy, October 2000* and the *Northern Caribou Strategy, March 2002*. The caribou habitat boundaries were legally designated as a Wildlife Habitat Area (WHA) in 2004 and General Wildlife Measures (GWM) were established in 2005 and 2009 by orders under the *Government Actions Regulation* (GAR).
Mule deer	Mule deer winter range boundaries were legally designated as a WHA in 2004 by orders under the Government Actions Regulation, and General Wildlife Measures in 2007. Objectives and strategies for maintenance of MDWR are included in the CCLUP and forest management directions, including the CCLUPIR (1998) and the Identified Wildlife Management Strategy (1999).
Marginally economic forest types	The report by the Special Committee on Timber Supply, "*Growing Fibre, Growing Value*" recommends to investigate the opportunities for marginally economic forest types to mitigate mid-term timber supply deficits.
Small area-based tenures	Any newly created woodlots, community forest agreement or First Nations woodland licence areas will be considered for their role in meeting TSA forest management objectives but will not contribute to the timber supply forecast for the TSA. Expired licence areas will be returned to the analysis land base.
Kluskus Supply Block	There is additional harvest economic uncertainty within the Kluskus supply block due to long-haul distances from the most western end of the TSA. The chief forester requested in the implementation section of the previous AAC rationale that the licences and district staff monitor the timber volume that is harvested from the Kluskus supply block and to review the expected economic operability of timber within this supply block. The harvest performance in this area is currently being monitored and will be compared to analysis results.
Habitat supply modelling	Independent of the timber supply analysis, agencies including the Ministry of Forests, Lands and Natural Resource Operations (FLNR) and the Ministry of Environment (MoE), in conjunction with the Forest Analysis and Inventory Branch (FAIB), are developing an approach to habitat supply modelling that will assess habitat availability for a number of wildlife species. Habitat supply modelling will be used to assess the effect of the base case harvest levels on the habitat for a number of wildlife species.

(continued)

Table 1. Major forest management considerations and issues (concluded)

Consideration/issue	Description
Fires	Large areas are periodically burnt from wildfires in the TSA. The merchantability of the residual timber in fire damaged stands is uncertain and fibre recovery is sporadic. Future unsalvaged losses due to fires will be approximated based on recent fire occurrence and salvage performance.
Short rotation management	There is economic demand for young, small dimension trees that makes short rotation management feasible in the TSA. The timber supply implications of managing a portion of the TSA under a short rotation silviculture system will be explored.
Environmentally sensitive areas (ESA)	In the previous AAC rationale the chief forester encouraged ministry staff and the licensees to prepare more detailed and current terrain analysis to better account for areas with sensitive soil and areas prone to snow avalanche. No progress has been made on this request since the last AAC determination.
Future roads, trails and landings	In the previous AAC rationale the chief forester encouraged ministry staff and licensees to monitor and evaluate road widths and to refine the methodology for approximating future area expected to be developed into roads, trails and landings. For this review, a spatial analysis was used to estimate the area currently occupied by permanent access structures.
Volume estimates for regenerated managed stands	In the previous AAC rationale the chief forester encouraged ministry staff and licensees to continue monitoring stand development and to use these monitoring results to improve our understanding of the interaction between current management and the estimated losses to natural operational conditions in generating managed stand yield projections for the next timber supply review. A young stand monitoring program has been established within the TSA. The initial sampling data will be used for sensitivity analysis of managed stand growth and yield assumptions.
Young pine mortality	In the previous AAC rationale the chief forester encouraged ministry staff and licensees to ascertain the current and projected levels of mortality occurring in pine stands younger than 60 years of age, and to determine the implications of this mortality on the projected growth of these stands. A new vegetation resource inventory is currently underway for the TSA which will provide detailed information on the extent of MPB losses in young stands. This information will not be available in time for use in this analysis.

3. Inventories

3.1 Background information

The inventories that will be used to define the THLB and model forest management activities are listed in Table 2. The source and vintage of the information are also shown.

Table 2. Inventory information

Spatial data	Source	Feature name	Vintage/ download
Timber supply areas	BCGW	WHSE_ADMIN_BOUNDARIES.FADM_TSA	2014
Landscape units	BCGW	WHSE_LAND_USE_PLANNING.RMP_LANDSCAPE_UNIT_SVW	2014
Ownership	BCGW	WHSE_FOREST_VEGETATION.F_OWN	2014
Protected areas: parks and ecological reserves	BCGW	WHSE_TANTALIS.TA_PARK_ECORES_PA_SVW	2014
Community watersheds	BCGW	WHSE_WATER_MANAGEMENT.WLS_COMMUNITY_WS_PUB_SVW	2014
Managed licences	BCGW	WHSE_FOREST_TENURE.FTEN_MANAGED_LIC_POLY_SVW	2014
Indian Reserves	BCGW	WHSE_ADMIN_BOUNDARIES.CLAB_INDIAN_RESERVES	2014
Tree farm licence	BCGW	WHSE_ADMIN_BOUNDARIES.FADM_TFL	
Private land	BCGW	WHSE_CADASTRE.CBM_CADASTRAL_FABRIC_PUB_SVW	
First Nations agreement boundaries	BCGW	WHSE_HUMAN_CULTURAL_ECONOMIC.FNIRS_AGREEMENT_BOUNDARY_SVW	2014
BCTS operating area	BCGW	WHSE_ADMIN_BOUNDARIES.FADM_BCTS_AREA_SP	2014
Biogeoclimatic ecosystem classification	BCGW	WHSE_FOREST_VEGETATION.BEC_BIOGEOCLIMATIC_POLY	2014
Provincial site productivity layer	FAIB	SITE_PROD_BC	2014
Vegetation resource inventory (VRI)	BCGW	WHSE_FOREST_VEGETATION.VEG_COMP_POLY_R1	2014
RESULTS reserves	BCGW	WHSE_FOREST_VEGETATION.RSLT_FOREST_COVER_RESERVE_SVW	2014
Forest depletions	FAIB	CONSOLIDATED_CUTBLOCKS_2014	2014
Terrain stability mapping	BCGW	REG_LAND_AND_NATURAL_RESOURCE.TERRAIN_STABILITY_CAR_POLY	2014
Mule Deer winter range	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_UNGULATE_WINTER_RANGE_SP	2014
Visual landscape inventory	BCGW	WHSE_FOREST_VEGETATION.REC_VISUAL_LANDSCAPE_INVENTORY	2014
Wildlife habitat areas	BCGW	WHSE_WILDLIFE_MANAGEMENT.WCP_WILDLIFE_HABITAT_AREA_POLY	2014

(continued)

Table 2. Inventory information (concluded)

Spatial data	Source	Feature name	Vintage/ download
Proposed wildlife habitat areas	BCGW	REG_LAND_AND_NATURAL_RESOURCE.WLD_WHA_ PROPOSED_SP	2014
Old growth management areas	BCGW	WHSE_LAND_USE_PLANNING.RMP_OGMA_LEGAL_CURRENT _SVW	2014
Reconciled old growth management areas	Cariboo Region	OGMA Reconciliation Data	2014
CCLUP community areas of special concern	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP critical fish habitat	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP Grizzly Bear capability	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP L3/L1 lakes	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP lake management classes	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP high value wetlands for moose	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
CCLUP scenic areas	BCGW	WHSE_LAND_USE_PLANNING.RMP_PLAN_LEGAL_POLY_SVW	2014
Cariboo-Chilcotin land use plan legal order boundary	BCGW	WHSE_LAND_USE_PLANNING.RMP_STRGC_LAND_RSRCE_PLAN _SVW	2014
BC Mountain Pine Beetle model projected kill	FAIB	BCMPB.V11.CUMKILL.PROJECTED	2014
Digital elevation model	BCGW	WHSE_BASEMAPPING.TRIM_CONTOUR_POINTS	2011
Slope classification	FAIB	Derived using TRIM elevation points	2011
Wetland management zones (buffers)	BCGW	REG_LAND_AND_NATURAL_RESOURCE.WETLAND_MGMT_CAR_ POLY	2014
Stream management zones (buffers)	BCGW	REG_LAND AND NATURAL_RESOURCE.STREAM MANAGEMENT_CAR_POLY	2014
Lake management zones (buffers)	BCGW	REG_LAND AND NATURAL_RESOURCE.LAKE MANAGEMENT_ZONES_CAR_POLY	2014
Lake classification	BCGW	LAKE_CLASSIFICATION_CAR_POLY	2014
Forest Service road	BCGW	WHSE_FOREST_TENURE.FTEN_ROAD_SECTION_LINES_SVW	2014
Road permit road	BCGW	WHSE_FOREST_TENURE.FTEN_ROAD_SECTION_LINES_SVW	2014
Other roads (non-status)	BCGW	WHSE_BASEMAPPING.DRA_DIGITAL_ROAD_ATLAS_LINE_SP	2014

Data source and comments:

There are generally three sources of data for the analysis: corporate-level data that resides in the provincial geographic data warehouse (BCGW), data maintained by the Forest Analysis and Inventory Branch (FAIB) and local data that is stored at the branch, region or district level (DQU). One exception is the RESULTS information which is maintained by Resource Practices Branch.

3.2 Forest cover inventory

The original forest cover inventory for the Quesnel TSA was developed from air photos acquired in the 1980's and 1990's and was updated to Vegetation Resource Inventory (VRI) standard in 2005. In 2011 a new VRI was completed for the eastern side of the TSA. This side of the TSA was given priority because it largely consists of spruce-leading stands that were not impacted by the MPB. The VRI for the remainder of the TSA was postponed until the MPB infestation subsided. The inventory work has resumed this year and is expected to be completed in 2017 and will be used in the next timber supply analysis.

The age of the inventory and the severity of the MPB losses have reduced the reliability of the original inventory on the western portion of the TSA. As an interim measure, a Landscape Vegetation Inventory (LVI) will be used to model the MPB impacted areas of the TSA. The LVI utilizes Landsat satellite imagery and high resolution digital photography to map forest cover and assign attributes required for yield estimates. The current version of the LVI is based on satellite imagery and digital photos from 2013 and is the best available forest cover inventory for areas not covered by the 2011 VRI.

The inventory data have been updated for recent harvest depletions and major disturbances up to 2014. Harvested areas not recorded in the inventory were identified using the consolidated cutblock layer developed by FAIB. The cutblock layer combines VRI, forest tenure, and RESULTS spatial data to identify logged areas by year of harvest completion. The cutblock layer also includes satellite change detection data to identify any recent major disturbance areas not recorded in any of the other data sources. Some wildlife tree reserve and conservation legacy areas were not separated from the logged area in the cutblock layer. The RESULTS reserve layer will be cross-referenced to ensure these areas are not depleted from the inventory.

The TSA experienced major wildfires in 2010 and the past summer of 2014. The extent of the 2014 burned area has not yet been fully mapped. The finalized spatial data will be incorporated into the analysis as they become available. While salvage of burned timber in the THLB has averaged four percent since 1993, the potential for salvage in the burned areas is variable and uncertain so no further salvage of currently burned areas will be modelled in this analysis. The new inventory underway will evaluate the residual stand conditions in burned areas and the potential salvage will be considered in future analyses. All areas burned by wildfires that have occurred subsequent to the VRI-photo interpretation date will be reset to an age of negative five at the year of the fire to represent a five-year delay in regeneration following the burn. No adjustments for burned areas are required in the portion of the TSA modelled using the LVI because recent fires are observed in the satellite imagery and reflected in the estimated attributes. Under the Forests for Tomorrow Program it is current practice to rehabilitate managed stands that have burned since 2006. Therefore, stands burned in 2006 or after will be modelled using managed stand yield projections while stands burned before 2006 will be modelled using natural stand yield projections.

Data source and comments:

The inventory has been projected to 2014 and stand volumes have been adjusted to reflect MPB mortality and other agents observed in the annual historic forest health overview flights.

3.3 Provincial site productivity layer

The provincial site productivity layer (PSPL) provides improved site index estimates for commercial tree species. The estimates are based on ecosystem data from existing Predictive Ecosystem Mapping (PEM) or Terrestrial Ecosystem Mapping (TEM) coupled with Site Index Estimates by Biogeoclimatic Ecosystem Classification Site Series (SIBEC). Data from various growth and yield projects were used to create a biophysical model that provides site productivity estimates where PEM or TEM data are not available. A site index adjustment (SIA) project was completed for pine-leading and spruce-leading stands in the Quesnel TSA that provided improved site index information in the previous analysis. The SIA data have now been incorporated into the bio-physical model. However, a PEM was completed for the entire CCLUP area in 2008 so the productivity estimates provided by the PSPL for the Quesnel TSA will be based on the PEM using SIBEC.

Data source and comments:

Young stand monitoring plot data collected by FAIB in the Quesnel TSA show that the PSPL tends to underestimates site index. A sensitivity analysis will explore the effect on timber supply of applying a site index adjustment (SIA) to young stands based on the monitoring plot data.

4. Division of the Area into Management Zones

4.1 Management zones and tracking of multiple objectives

The concept of management zones is used to differentiate areas with distinct management objectives. For example, a zone may be based on a harvesting system, regeneration silviculture system, visual quality objectives or wildlife consideration. An area of forest may be subject to more than one management objective. Each objective can be tracked separately in the timber supply model. Land considered unavailable for timber harvesting can contribute to the achievement of other forest management objectives.

Table 3 outlines the zones or objectives that will be incorporated in the timber supply model. It does not list objectives that will be modelled by excluding areas from the THLB (e.g., riparian areas and wildlife tree areas). Further information on the modelling of these areas can be found in Section 6.2, "Integrated resource management".

Table 3. Management zones and objectives to be tracked

Management zone/objective	Source	Issue
Landscape units (LU) and biogeoclimatic ecosystem classification (BEC)	BCGW	Landscape-level biodiversity
Mule Deer winter range	ENV	Silviculture systems
Caribou habitat	ENV	Silviculture systems
Pelican and Moose habitat	BCGW	Land use plan objectives
Interior Douglas-fir stands	BCGW	Silviculture systems
Conservation legacy areas	FAIB	Hydrological values
Scenic areas	CCLUP	Visual quality objectives
Lakeshore management zones	CCLUP	Visual quality objectives
Grasslands	CCLUP	Grassland restoration
MPB-impacted stands	FAIB	Salvage and rehabilitation
Non-pine leading stands	FAIB	Harvest performance
Kluskus supply block	BCGW	Harvest performance

Data source and comments:

The higher level plan data (CCLUP) and Ministry of Environment (ENV) data resides in the provincial geographic data warehouse (BCGW). Forest Analysis and Inventory (FAIB) zones will be created as the model inputs are prepared.

4.2 Analysis units

An analysis unit is composed of forest stands with similar ecosystem, tree species composition, timber growing potential and treatment regimes. The analysis unit is primarily used to define which timber volume projection (yield table) the stand will follow subsequent to being harvested. Analysis units also act as a logical aggregation of the land base for model reporting.

Analysis units will be assigned by primary and secondary species combination and site index by increments of one metre. The silviculture treatment of both pine-leading and spruce-leading stands have been very similar over the last 10 years, therefore, these stands will be aggregated into the same series of analysis units. The one exception is spruce-leading stands with balsam as a secondary species. These stands will be aggregated with balsam-leading stands since they receive similar silviculture treatments. The minor component of hemlock and western redcedar-leading stands are typically found among the balsam-leading stands and will therefore also be aggregated in the spruce and balsam analysis unit series. Stands that contain Douglas-fir as a primary or secondary species tended to be regenerated with a large component of Douglas-fir and will therefore be aggregated into an analysis unit series. Stands within mule deer winter range will be modelled as distinct analysis units that are managed with a silviculture system that promotes Douglas-fir regeneration (see Section 6.1.6.2). Silviculture records show that deciduous-leading stands are commonly maintained as deciduous leading so an analysis unit series will be created to model these stands.

Table 4. Definition of analysis units

Analysis unit	Definition	Site index range (height in metres at 50 years)	Label
Pine and Spruce	All pine- and spruce-leading except spruce with secondary balsam.	5 to 33	PS05 to PS33
Spruce and Balsam	All balsam-leading and spruce-leading with secondary balsam.	5 to 27	SB05 to SB27
Douglas-fir	Any stands with Douglas-fir as leading or secondary.	5 to 29	F5 to F29
Mule Deer Winter Range	Stands with a component of Douglas-fir in Mule Deer Winter Range.	10 to 26	MD10 to MD26
Deciduous	All deciduous-leading.	10 to 31	D10 to D31

Data source and comments:

Silviculture treatment regimes are typically chosen based on the existing tree species and ecosystem classification. The PEM provides a BEC classification down to the site series level but the regeneration regimes in this analysis were assigned to much broader groupings (see Section 6.3.1, Regeneration). The PEM site series is only used in this analysis indirectly to assign a site index estimate using SIBEC. Grouping analysis units by site index may therefore be considered as grouping all BEC site series with similar productivity.

5. Timber Harvesting Land Base Definition

5.1 Details on land base classification

This part of the data package outlines the steps used to identify the Crown forest management land base (CFMLB), gross harvesting land base (GHLB) and timber harvesting land base (THLB). The Crown forest management land base is the portion of the total area with forest cover that contributes to Crown forest management objectives in the context of TSA timber supply, such as landscape-level biodiversity or visual quality objectives. The CFMLB excludes:

- private land;
- federal land and reserves;
- long-term leases;
- tree farm licence tenures;
- non-forested lands.

The GHLB is the portion of the CFMLB where timber harvesting is permitted, subject to forest management objectives and constraints. The GHLB excludes:

- miscellaneous provincial crown land not contributing to timber supply;
- woodlots, community forests and First Nations woodland licence tenures;
- federal and provincial protected areas;
- areas with legally established boundaries where timber harvesting is incompatible with management objectives for other resource values.

The THLB is the portion of the GHLB where timber harvesting is projected to occur over the long term. The THLB excludes:

- areas that are not suitable or inoperable for timber production; and
- areas without legally established boundaries where timber harvesting is incompatible with management objectives for other resource values.

Land is considered outside the THLB only where harvesting is not expected to occur. Any area in which some timber harvesting will occur remains in the THLB, even if the area is subject to other management objectives, such as wildlife habitat and biodiversity. These objectives are modelled in the timber supply analysis as forest cover constraints. The CFMLB and GHLB outside of the THLB also contribute to these other objectives.

The current timber harvesting land base may increase in size over time in the following situations:

- where management activities improve productivity or operability (e.g., the stocking of land currently classified as non-commercial brush with commercial tree species);
- through the acquisition of productive forest land (e.g., timber licence reversions).

The timber harvesting land base may also decrease in size where:

- management activities prevent the re-establishment of a productive forest (e.g., future permanent roads, grassland restoration);
- new area-based tenures or protected areas are established.

5.2 Identification of the Crown forest management land base

The following factors will be considered when identifying the CFMLB.

5.2.1 Land not administered by the Crown for TSA timber supply

Land is excluded from the Crown forest management land base when it does not contribute to TSA objectives for wildlife habitat, biodiversity or visual quality in the context of timber supply. Such land includes private land, municipal land, federal land and Indian Reserves.

Parks and protected areas are included in the CFMLB because they can be relied on to continually contribute to forest cover management objectives such as landscape-level biodiversity, visual quality and wildlife habitat objectives. The CCLUP considers small area-based tenures such as woodlots, community forest agreements, and First Nations woodland licence tenures to also contribute to Crown forest management objectives for biodiversity, although the AAC for these areas is determined under a separate process. These areas are maintained in the CFMLB but will be later removed from the GHLB since they do not contribute to the TSA timber supply.

A spatial data set of land ownership was developed using information from the Crown Land Registry and the Integrated Cadastral Information Society. Areas classified in this layer with ownership codes 62 or 69 with schedule 'C' are administered by the Crown for TSA timber supply. All others will be excluded from the Crown forest management land base and the gross harvesting land base.

A further check will be performed using current boundary mapping for tree farm licence tenures and private land to ensure all areas were appropriately excluded.

5.2.2 Land classified as non-forest

The VRI attribute 'Forest Management Land Base' (VRI FMLB) will be used to identify areas of non-forest. The VRI FMLB attribute indicates whether the VRI polygon is forested or has been forested and is capable of producing a stand of trees. Polygons that have a harvest history are included in the FMLB as well as any polygon with a site index greater than or equal to five metres. However, areas classified as alpine in the BC Land Classification Scheme (BCLCS) (Level 3 'A') are excluded from the VRI FMLB.

Areas covered by water are classified under the non-vegetated BCLCS class and will be removed at this step. A further check will be performed using the riparian mapping supporting the riparian factor (Section 5.4.1). The lakes identified in this mapping will be removed using the outer boundary of the lake riparian reserve zone (10-metre buffer on L1 and L2 lakes).

Data source and comments:

Logged areas are identified using the consolidated harvest depletion layer produce by FAIB.

There are no instances of treed alpine areas within the TSA. Treed wetlands are removed in the riparian section (5.4.1).

5.2.3 Roads and landings

The purpose of this section is to identify the portion of the land base that will be occupied by roads, trails and landings (RTL) constructed to access and facilitate harvest operations. The RTL area will be permanently removed from the CFMLB and will not contribute to timber supply or biodiversity objectives.

Separate estimates are made to reflect the loss in productive forest land due to existing and future RTL. The area within RTL is typically too small to delineate and track efficiently in a landscape-level model so they will be modelled aspatially through partial reductions to the CFMLB (i.e., the area considered to be CFMLB within each hectare will be reduced by a percentage). The reduction for existing RTL was estimated by the district engineering officer as the average maintained clearing width. The CFMLB area permanently lost to future RTL was estimated based on current performance and RESULTS data. The future RTL reduction will be applied by the timber supply model after stands are harvested for the first time.

Table 5. Estimates for existing and future roads, trails, and landings

Location	Width / reduction
Forest Service roads	25 metres
Road permitted roads	15 metres
Future RTL	0.5% of harvest area

The area within road buffers is typically too small to delineate and track efficiently in a landscape-level model so it will be modelled aspatially through partial reductions to the CFMLB.

Data source and comments:

Roads will be identified from forest tenure road mapping as roads with a description of 'Forest Service Road' or 'Road Permit' and have a status of 'active', 'retired' or 'pending'. Digital road atlas mapping will also be used but will exclude roads classed as 'resource'.

GIS was used to buffer all road lines to estimate the area of productive forest land lost to these access features. Forest Service Roads were buffered 25 metres (12.5 metres from centre line) and active/retired Road Permit Roads were buffered 15 metres (7.5 metres from centre line). This process identified approximately 3394 hectares lost due to for Forest Service Roads, and approximately 12 620 hectares lost for active and retired Road Permit Roads.

Note that the BCGW does not contain all access features. It is estimated that there are approximately 18 000 kilometers of non-status roads in the district, of which some 75% (~13 500 kms) are not captured in the BCGW. Of these, it is estimated that 50% (~6750 kms) are still accessible with an estimated width of five metres. However, the survey method to determine the amount of unoccupied growing space for the operational adjustment factor (OAF) used in managed stand yield prediction assumes a 2.7 metre influence area for a tree. This implies that a gap between trees would need to be wider than 5.4 metres to be considered unoccupied growing space. Given this assumption, no deduction will be made in the analysis for these non-status roads.

Most harvesting now uses a roadside processing system, and landings are rarely a feature of current harvest systems. There are indications that some productivity loss is associated with the use of roadside harvesting systems, but no definitive research to date has quantified a level of productivity loss. In-block roads have an estimated disturbed width average of five metres. As with non-status roads above, no deduction will be made in the analysis for in-block roads.

5.3 Identification of the gross harvesting land base

The following factors will be considered to identify the GHLB within the CFMLB.

5.3.1 Parks, protected areas and small area-based tenures

The parks, protected areas and small area-based tenures that were included in the CFMLB to contribute to Crown forest management objectives in the context of TSA timber supply will be removed at this stage.

A further check will be performed using current boundary mapping for small area-based tenures, parks and protected areas to ensure all areas were appropriately excluded. Woodlots that are no longer active will be included in the GHLB.

5.3.2 Old growth management areas (OGMA)

Old growth management areas (OGMA) are a fundamental component of the land use balance achieved by the *Cariboo-Chilcotin Land Use Plan* and are critical to the maintenance of many environmental and non-timber values in a highly managed landscape. OGMA contribute to biodiversity objectives and commonly overlap with other resource management values such as wildlife tree patches, riparian reserves, critical fish habitat, or wildlife habitat areas (WHA).

In the Quesnel TSA, OGMAs have been established under the Land Use Order (LUO) (the land use objectives for the Cariboo-Chilcotin Land Use Plan Area). The LUO is enabled through the *Land Use Objectives Regulation* (LUOR) consistent with Section 93.4 of the *Land Act*. It is applicable for the purposes of *FRPA*. The results and strategies contained in Forest Stewardship Plans (FSP) must be consistent with the objectives in the legal order.

There are three types of OGMA described under the LUO: Permanent-Static, Permanent-Rotating, and Transition. In accordance with the LUO, Transition OGMA only exists until 2030. Conditional harvesting was previously allowed in Permanent-Static and Rotating OGMA for the control and abatement of the MPB epidemic as described in the LUO and supporting direction from the Regional Biodiversity Committee (Strategy Update Note #8). Since the MPB epidemic has subsided, this allowance is no longer applicable and Permanent-Static and Permanent-Rotating OGMAs will be removed from the GHLB as no harvest areas. Transition OGMA will be modelled as available according to LUO criteria (>50% dead) until 2030 after which they will cease to exist.

It is anticipated that an amendment to the LUO will occur in 2015 that will finalize amended OGMA boundaries based on the revision of the Order due to public review and comment. If this occurs, the amended OGMA boundaries will be used in the analysis. If this LUO amendment does not take place, the current legal OGMA boundaries will be used and a sensitivity analysis will be carried out using the proposed OGMA Reconciliation boundaries (see Section 7.1).

Data source and comments:

Land Use Objectives for the Cariboo-Chilcotin Land Use Plan (CCLUP) Area – Land Use Order, May, 2011;

Regional Biodiversity Conservation Strategy Update Note 14 - The Function and Management of Old Growth Management Areas in the Cariboo-Chilcotin, March, 2011.

5.3.3 Wildlife habitat areas

The Itcha Ilgachuz caribou habitat boundaries were legally designated as Wildlife Habitat Area (WHA) in 2004 and General Wildlife Measures (GWM) were established in 2005 and amended in 2011 under *Government Actions Regulation*. The eastern caribou habitat boundaries and GWM's were legally enacted in 2009.

Areas designated as "no harvest" and mapped retention areas within enhanced conventional harvest caribou WHA (5-872 and 5-873) will be excluded from the GHLB. The GWM specifies for the enhanced conventional harvest area that 25% of the area, selected from the best caribou habitat, be set aside as no harvest area. Once this percentage is achieved, the balance of the area will be managed as conventional harvest. For modelling purposes, the next oldest stands will be excluded from the GHLB as no harvest area until the 25% target is achieved.

WHA were established for a "data sensitive species" within the TSA. Both the core habitat area and management area buffer will be removed from the GHLB for the data sensitive species at risk.

The specifics of the GAR orders and the silviculture systems modelled will be discussed in Section 6.1.6.3.

Data source and comments:

The mapped boundaries for established WHA and reserve areas were obtained from the Ministry of Environment website.

Northern/II caribou GWMs have an original effective date 2004-12-23, amended 2011-06-23. Eastern/mountain caribou GWMs came into effect 2009-12-17.

5.3.4 Critical habitat for fish

Areas of critical habitat for fish that require protection and site specific management actions were identified as part of the LUO. The LUO specifies that the areas are to be maintained as no-harvest areas. Critical fish habitat will be excluded from the GHLB.

Data source and comments:

Critical fish habitat area boundaries are from *Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan*, May 19, 2010 and amended April 18, 2011. Map 4.

5.3.5 Class A lakes

The Kluskus lakes and several other lakes within the TSA are classified as Class A. The LUO includes a legal spatial data set that defines buffers around these lakes that are classified as no harvest. These buffer areas will be excluded from the GHLB.

The management of lake classes B to E through limits on disturbed area will be discussed in Section 6.2.4.

Data source and comments:

The class A lakes are identified in *Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan*, May 19, 2010 and amended April 18, 2011. Map 6.

Lake management zone boundaries are provided by the lake buffer mapping that also provides riparian management and reserve zones for lakes used in Section 5.4.1.

The LUO also defines a lake riparian area around L1 and L3 lakes that is excluded from harvest. Only a small portion of one lake is located within the TSA and this area is already excluded as a "Class A" lake.

5.3.6 Recreation and historic trails

The LUO identifies regionally important trails and defines a 50-metre management zone on either side of the trail. The LUO specifies that at least 85% of the current forest basal area must be maintained within the buffer. This requirement will be approximated in the analysis by randomly selecting 85% of the management zone area to be excluded from the GHLB.

Data source and comments:

The land base reduction for identified trails reflects the *Land Use Order (LUO) for the Cariboo-Chilcotin Land Use Plan*, May 19, 2010 and amended April 18, 2011. Map 10.

5.3.7 Mature birch retention

The LUO identifies mature birch areas located along the Quesnel River that are culturally significant to First Nations. The LUO specifies that at least 40% of the existing mature birch be maintained within cutblocks for First Nations cultural use. This will be modelled by randomly selecting 40% of the mature birch areas for removal from the GHLB.

Data source and comments:

The land base reduction for mature birch reflects the *Land Use Order (LUO) for the Cariboo-Chilcotin Land Use Plan*, May 19, 2010 and amended April 18, 2011. Map 7.

5.4 Identification of the timber harvesting land base

The following factors will be considered to identify the THLB within the GHLB.

5.4.1 Riparian reserve and riparian management zones

Riparian habitat along streams and around wetlands will be modelled as managed according to the *Forest Practices Code Riparian Management Area Guidebook* (1995). Table 6 lists the area reductions to be applied to account for riparian reserve zones (RRZ) and riparian management zones (RMZ). The zone widths are consistent with those specified under FRPA.

The area within RRZ and RMZ is typically too small to delineate and track efficiently in a landscape-level model so they will be modelled aspatially through partial reductions to the THLB.

Table 6. Riparian management areas

Description	Class	Reserve zone width (metres)	RRZ reduction (%)	Management zone width (metres)	RMZ reduction (%)
Streams	S1-A	0	—	100	20
	S1-B	50	100	20	50
	S2	30	100	20	50
	S3	20	100	20	50
	S4/S5	0	—	30	25
	S6	0	—	20	5
Wetlands	W1/W5	10	100	40	25
	W2	10	100	20	25
	W3/W4	0	—	30	25

Data source and comments:

Riparian reserve zones and riparian management zones for streams, lakes, and wetlands have been mapped for the CCLUP area. Each stream, lake, and wetland class was spatially identified, classified and then buffered as described in Table 6.

5.4.2 Areas considered inoperable

Areas that are inoperable within the TSA are generally associated with steep slopes. Steep slopes are unlikely to be harvested because of unstable terrain and sensitive soils. Also, steep slopes require the use of different harvest systems such as cable logging. Inoperable areas will be identified as follows:

- Slopes that exceed 70% within landscape units east of the Fraser River. These landscape units have forest types suitable for cable harvesting on slopes between 40% and 70%, and cable harvesting has been employed as current practice in this area.
- Slopes that exceed 40% in the remainder of the TSA. Forest types make this portion of the TSA unsuitable for harvesting on slopes greater than 40%.

Very remote areas of the TSA may be considered inoperable due exceedingly long-haul distances. The high costs associated with the long-haul distance can make the economics of harvesting some areas uncertain. In the Quesnel TSA, the Kluskus supply block is located in most western end of the TSA and harvesting in this block requires very long-haul distances. There has been recent harvest performance in this supply block so no area will be removed from the THLB as inoperable due to long-haul distances. However, the contribution of the Kluskus supply block to the timber supply will be explored through sensitivity analysis.

Some areas may be considered inoperable due to the presence of non-commercial species. No areas were removed from the THLB due to non-commercial species.

Data source and comments:

Slope angle is derived from the provincial digital elevation model. Cutting permit appraisal data used to support the minimum harvest criteria factor (Section 6.1.4) provides information on average slope. The data shows that no cutting permit issued for ground skidder harvest since 1999 has exceeded 36%. The appraisal data for cable harvest systems were limited but no permits were issued for slopes greater than 64%.

A portion of the TSA east of the Fraser River had a terrain stability assessment completed in 2005. The majority of the mapping falls within the TFL and only a limited area of the TSA is covered (16 000 hectares of potentially unstable terrain and 3100 hectares of unstable terrain). A sensitivity analysis will explore the effect on timber supply of removing the unstable and potentially unstable terrain in place of the slope-based removals where the terrain mapping exists.

5.4.3 Low site exclusions

Sites may have low productivity either because of inherent limiting site factors such as nutrient availability, exposure, or excessive moisture. Stands with very low site productivity will not produce a future managed stand within an economically feasible time frame.

Low sites will be identified as natural stands that have yield projections that do not achieve the minimum harvestable volume criteria (Section 6.1.4) and will never be eligible for harvest in the timber supply forecast. Since these stands are not harvestable they should not be included in the THLB.

Data source and comments:

The evaluation will be made using the VRI projection of the combined live and dead volume so that stands are not removed due to MPB losses.

5.4.4 Cultural heritage and archaeological resources

An Archaeological Overview Assessment (AOA) for the Quesnel Forest District was completed in 1998 and was revised in 2009. The assessment was used extensively over the last 16 years to determine where Archaeological Impact Assessments (AIA) were performed. First Nations consultation occurs during the cutting permit adjudication process on a site specific level.

Most known archeological sites are small and many are found in areas with additional ecological or environmental constraints. These sensitive lands are typically excluded from the THLB through the placement of reserve or no-harvest zones. Discussion with district staff indicates that additional area over and above that already excluded to account for other values is anticipated to be minimal. Therefore, no specific additional land base reduction will be applied for cultural heritage resources.

6. Current Forest Management Assumptions

6.1 Harvesting

Currently, harvesting in the Quesnel TSA is predominantly concentrated in MPB impacted pine-leading stands. Modelling will reflect the current practice by focusing the short-term harvest on stands identified for salvage.

The analysis will attempt to address the uncertainty in future practices when the forecasted supply of MPB salvage stands has been depleted. Various sensitivity analyses will explore the timber supply through the mid-term. However, the base case will be established using the current practices documented in the following sections.

6.1.1 Timber volume estimates

The VRI provides an estimate of the timber volume within mature stands. The inventory volume is estimated using the Variable Density Yield Prediction (VDYP) model version 7. VDYP generates a yield table forecasting the growth of each stand that is used in the annual update of the VRI. These yield tables will be used to estimate the harvest volumes in the analysis.

Regulated forest management within the TSA dates back to approximately 1959. Therefore, all stands 55 years and younger with a harvest history are anticipated to have harvest volumes that reflect forest management practices such as planting and density control. These stands, and all future regenerated stands, will be modelled with harvest yields estimated using Table Interpolation Program for Stand Yields (TIPSY) model version 4.3 (July 3, 2014 release). The TIPSY model inputs used to generate managed stand yield tables are based on current regeneration silviculture practices and will be discussed in Section 6.3.1. Also, the managed stand yields will be forecast using the improved productivity estimates from PSPL discussed in Section 3.3.

6.1.2 Merchantable timber specifications

The merchantable timber specifications define the maximum stump height, minimum top diameter inside bark (dib) and minimum diameter at breast height (dbh) by species and are used in the analysis to calculate merchantable volume. The merchantable timber specifications are described in Table 7.

Table 7. Merchantable timber specifications

	Utilization		
Leading species	**Minimum dbh (cm)**	**Maximum stump height (cm)**	**Minimum top dib (cm)**
Pine	12.5	30	10.0
Other species	17.5	30	10.0

Data source and comments:

The specifications represent current merchantability standards, licensee requirements and current performance.

6.1.3 Volume exclusions for deciduous in coniferous stands

One or more species in mixed-species stands may be unmerchantable. For example, the deciduous species in a predominantly coniferous stand may not be harvested. District staff estimates that 80% of deciduous species volume within a coniferous-leading stand is typically left standing and the remaining 20% is harvested. This practice will be modelled by reducing the deciduous volume component of natural stand yield estimates by 80% in conifer-leading stands.

Data source and comments:

The reserved standing deciduous volume is left in addition to the wildlife tree retention area requirements. It will not be considered to contribute to the wildlife tree retention targets discussed under silviculture systems in Section 6.1.6.1.

6.1.4 Minimum harvest criteria

Minimum harvestable criteria define the minimum age and volume at which harvesting is expected to be feasible. While harvesting may occur at the minimum requirements at certain points in the forecast in order to provide the maximum sustainable timber supply, most stands will not be harvested until well past the minimum ages because other resource values take precedence (e.g., limits to the maximum area disturbed) or the objective to maintain reasonably consistent, as opposed to widely fluctuating, timber supply.

A minimum harvestable volume will be used to determine whether existing natural stands enter the harvest queue. A combination of minimum harvestable volume and a minimum harvestable age, identified as the age at which 95% of the maximum mean annual growth increment is achieved, will be used to determine when existing and future managed stands enter the harvest queue. Sensitivity analysis will evaluate the effect on timber supply of changes to both the minimum harvestable age and volume.

The FLNR Electronic Commerce Appraisals System (ECAS) was used to review the data collected from cutting permits issued over the last 20 years. The appraisal data provide information on the potential harvest volume by species and harvest system for each cutting permit. It also provides descriptive information about the cutblocks such as harvest area and slope.

The ECAS data show that average harvest volume per hectare in the TSA has been decreasing since the peak of the MPB outbreak. The average has decreased from approximately 280 m^3/hectare in 2005 to 170 m^3/hectare in 2013. This decrease can be attributed to a harvest sequence that prioritized highest volume stands for salvage then progressed to lower volume stands in the later years of salvage harvesting. It also reflects sawmill efficiencies that were developed over that time that allow for the processing of smaller, lower volume trees.

Unfortunately, the timber volume estimates in ECAS are not directly comparable to VRI volume estimates because they do not include defect volume. Dead trees that have decayed beyond merchantability criteria are considered defect volume and are not included in the appraisal. In contrast, the VRI volumes estimates include defect volume. In current practice this defect volume is still harvested and may be sold as chips and is not accounted for in the AAC. It is uncertain how much the lost defect volume contributes to the trend in decreasing average appraised harvest volume.

To identify the current trends in recent harvesting in terms of VRI volumes the Quesnel District staff performed an analysis that combined cutting permit boundaries with the VRI. The cruise-based cutting permit areas submitted from September 1, 2014 to March 1, 2015 were overlapped with the inventory and the VRI stands within each permit were summarized. The objective was to identify the lowest volume stands harvested so the VRI stands were classified into volume per hectare classes by increments of five cubic metres per hectare. A large amount of variation was found in the lowest volume per hectare classes due to inconsistencies between cutting permit mapping and VRI stand mapping. Therefore, the volume per hectare found at the lowest tenth percentile of the total cutting permit area was selected as the minimum to account for the inconsistencies. The lowest volume per hectare identified at this point was 110 cubic metres per hectare.

The cruise-based cutting permit data included a very limited pool of cutting permits issued for cable harvesting systems. Use of the cable harvest system is limited in the Quesnel TSA. West Fraser Mills harvesting experts reported that, under current practice, a minimum volume of 200 cubic metres per hectare is required for cable harvesting to be feasible. This value will be used as the minimum harvest criteria for the cable harvest system portion of the land base identified in the areas considered inoperable factor (Section 5.4.2).

Table 8. Minimum harvestable criteria

Harvest system	Minimum volume (m^3/ha)
Ground	110
Cable	200

There is economic demand for young, small dimension trees that makes short rotation management feasible in the TSA. The timber supply implications of managing a portion of the TSA under a short rotation silviculture system will be explored through sensitivity analysis.

Data source and comments:

Beyond the Beetle – A Mid-term Timber Supply Action Plan. FLNR, October 2012;

Quesnel TSA – Type 4 Silviculture Strategy. Forsite Consultants Ltd., July 2013;

Quesnel TSA Timber Supply Analysis 2010;

Cable harvesting minimum volume was obtained from West Fraser Timber – personal communication.

A minimum harvestable volume of 120 m^3/hectare was modelled in the timber supply analyses supporting the previous AAC determination, the Mid-Term Timber Supply Project and the recent Type IV Silviculture Analysis. This value was derived as the minimum first percentile of the average volume per hectare of the cutting permits in the appraisal data at that time. Note that the first percentile was reasonable when summarizing a list of cutting permits whereas the tenth percentile was require in the current study that summarized a list of the VRI stand fragments within the cutting permits.

6.1.5 Harvest scheduling

Priorities and limits will be placed on the harvest within certain stand types, management zones, or regions of the TSA to reflect salvage operations and other forest management objectives. Setting harvest level targets on individual management zones will also facilitate the determination of an AAC that may be partitioned by these management zones. Table 9 describes the harvest scheduling priorities and limitations that will be modelled in the analysis.

The first priority will maintain the salvage of stands with heavy MPB mortality. When all available stands with a majority of dead volume have been harvested, or reach the 15-year shelf life, the second priority will be placed on stands with some dead volume. The objective is to rehabilitate the stands that are not likely to recover to full growth potential through ingress and crown closure. The last priority will be all other stands with little or no mortality. These stands will be required to support the timber supply through the mid-term. Within each priority grouping stands will be harvested in order of highest volume first.

Table 9. Priorities for scheduling the harvest

Priority	Stand types	Description or objective
1	> 50% dead volume	MPB salvage
2	10% - 50% dead volume	Stand rehabilitation
3	All others	Conserve growing stock

6.1.6 Silvicultural systems

The predominant silvicultural system in the TSA is an even-aged system using clearcutting with various levels of retention. This system is best suited to the natural disturbance cycles of the tree species within the TSA.

Other silviculture systems are used to achieve management objectives for mule deer winter range and mountain caribou habitat. The modelling of these systems will be described in the following sections.

6.1.6.1 Clearcut with reserves

Clearcut harvesting is performed in conjunction with wildlife tree retention established to meet stand-level biodiversity objectives. The LUO specifies that when harvesting removes more than 50% of the pre-harvest basal area or where harvest is part of a shelterwood (i.e., northern caribou terrestrial lichen sites) wildlife tree retention (WTR) areas must be established. The minimum percentage of harvested areas for wildlife tree retention by landscape unit and BEC is specified in Schedule 1 of the LUO.

A portion of the WTR area may be located adjacent to the cutblock in areas outside of the THLB. A Forest and Range Evaluation Program project surveyed 217 retention areas in the TSA. The survey showed that current practice typically places approximately 50% of the WTRA in already constrained areas, such as OGMA and RRZ. Therefore, only 50% of the LUO retention target will be reserved within the area selected for harvest by the model. The WTRA will be retained for the full rotation length.

Subsequent to the second AAC increase in 2004 for MPB salvage, the chief forester provided *Guidance on Landscape- and Stand-level Structural Retention in Large-Scale Mountain Pine Beetle Salvage Operations* (December 2005) which recommended increased levels of stand-level retention in large MPB salvage cutblocks to protect hydrological values. A local *Quesnel Forest District Enhanced Conservation Strategy* (2006) was prepared to define the amount of stand-level retention required in large-scale salvage operations. The objective of the strategy is to maintain an average of 20% of salvage cutting authorities in reserves classified as a Conservation Legacy Areas (CLA). The WTRA already reserve an average of approximately 7% so an additional 14% over the legislated WTRA is required. A review of the established CLA recorded in RESULTS spatial data found that approximately 15% of the CLA have been located in areas excluded from the THLB. Therefore, only 85% of the CLA requirement, approximately 12%, will be will be modelled as a reserve established at the time of harvest in salvage priority areas.

The strategy states that CLA are expected to persist for 30 years to allow the surrounding salvage area to recover to a point where harvest of the CLA will not compromise wildlife or hydrological values. The CLA reserves established during the harvest forecast will therefore be made available for harvest in the model 30 years after the date of the initial harvest. All existing CLA identified in the RESULTS spatial data will be reserved from harvest until 2040.

Data source and comments:

The timber supply model creates a proportional reserve area at the time of harvest using a probability function. The reserve areas are restricted from harvest until the re-entry period has passed. The age and volume of the forest in reserve areas are maintained and the forest continues to contribute management objectives such as landscape-level biodiversity.

There are no Interior Douglas-fir stands being managed under uneven-aged silviculture systems. Stands in the IDF zone outside of special habitat management areas will be modelled as managed using clearcut with reserves.

Licensees have been exempted from the requirement to retain 7% wildlife tree retention under Section 66 of the FPPR because they have adopted alternative results and strategies in their FSPs that follow the CCLUP's stand level biodiversity targets.

Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan, May 19, 2010. Amended April 18, 2011.

Quesnel Forest District Enhanced Conservation Strategy (2006).

6.1.6.2 Selection systems in mule deer winter range

Mule deer winter range (MDWR) boundaries were legally designated as WHA in 2004 under *Government Actions Regulation* (GAR), and General Wildlife Measures (GWM) in 2007. Objectives and strategies for maintenance of MDWR are included in the CCLUP and forest management directions, including the CCLUPIR (1998) and the Identified Wildlife Management Strategy (1999).

Forests within winter range are managed using site plans that maintain or promote Douglas-fir and maintain or enhance the number of large old trees that provide the best snow interception and litterfall that are essential to winter habitat. Two variants of the selection system are prescribed:

- small group selection systems are used in the transition and deep snowpack zones; and
- clumpy single tree selection systems are used in the shallow and moderate snowpack zones.

Both systems prescribe regeneration silviculture that enhances the amount of Douglas-fir within the stand relative to the pre-harvest composition. Regeneration assumptions for these selection systems are discussed in Section 6.3.1.

In the GWM, an exception is made for stands with no component of Douglas-fir. These stands are prescribed to be managed without MDWR management objectives and will be modelled under the clearcut with reserves silviculture system.

Transition and deep snowpack zone MDWR

The small group selection system is intended to produce a multi-aged forest stand made up of small even-aged patches. The small harvest openings will produce shrub forage and make it more accessible in deeper snow conditions. The openings are intended to be large enough to allow Douglas-fir regeneration and still be small enough to minimize frost problems. This is accomplished by harvesting the MDWR in multiple passes that only remove a proportion of the area.

The GWM prescribe the proportion of area that may be removed during harvesting within the MDWR habitat classes as shown in Table 10. The combination of the prescribed cutting cycle and the proportion of area harvested per pass results in the effective rotation length that increases across the habitat classes. The GWM also specify that stands are only available for harvest if the basal area is 40 square metres per hectare or greater. Stands that currently have a basal area below 40 square metres per hectare will be initially be reserved from harvesting for one cutting cycle in the timber supply forecast.

Table 10. MDWR small group selection cutting cycle

Stand structure habitat class	Area harvested per pass (%)	Minimum cutting cycle (years)	Effective rotation (years)
Low	33	40	120
Moderate	25	40	160
High	20	40	200

Timber supply modelling of MDWR in the CCLUP area has historically relied on harvest volume adjustment factors to represent the limiting effects of longer rotations on timber availability. These adjustments are no longer required in the current analysis since the timber supply model will be regulating the rate of harvest to match the effective rotation lengths.

Shallow and moderate snowpack zone MDWR

The clumpy single-tree selection system is intended to maintain a stand structure that is beneficial to MDWR over time through limits placed on the minimum basal area retained following harvest and requirements for post-harvest increases in Douglas-fir composition.

A multiple pass silviculture system will be modelled following the rate of harvest criteria specified by the GWM as shown in Table 11. The basal area retained following harvest under the single-tree selection system will be modelled by applying harvest volume reduction factors. The reduction factors used were developed for the *Cariboo-Chilcotin Land Use Plan Timber Targets Analysis* conducted by the Mule Deer Winter Range Committee. These factors represent the expected loss in volume as compared to a Douglas-fir stand managed under a multiple-pass silviculture system with no MDWR requirements.

Table 11. MDWR single-tree select volume retention

Stand structure habitat class	Area harvested per pass (%)	Minimum cutting cycle (years)	Effective rotation (years)	Volume retention reduction (%)
Low	25	30	120	0
Moderate	25	30	120	11
High	25	30	120	44

The *Timber Targets Analysis* estimated that the GWM basal area retention targets for low stand structure habitat class could be achieved just by managing a stand under a multiple-pass silviculture system. Therefore, no volume reduction factor will be applied and only the multiple pass system will be modelled.

Data source and comments:

The volume retention reduction assumptions for transition and deep snowpack zone MDWR were obtained from the *Cariboo-Chilcotin Land Use Plan Timber Targets Analysis* conducted by the Mule Deer Winter Range Committee and reflect the requirements of the *Government Actions Regulation* Amended Order #U-5-001, U-5-002 and U-5-003 – Ungulate Winter Ranges Cariboo-Chilcotin Land Use Plan, Transition and Deep Snowpack, 2007.

The volume retention reduction assumptions for shallow and moderate snowpack zone MDWR were obtained from the *Cariboo-Chilcotin Land Use Plan Timber Targets Analysis* conducted by the Mule Deer Winter Range Committee and reflect the requirements of *Government Actions Regulation* Amended Order – #U-5-001, U05-002 and U-5-003 – Ungulate Winter Ranges, Cariboo-Chilcotin Land Use Plan, Shallow and Moderate Snowpack, 2007. For the Quesnel TSA, the Shallow/Moderate GAR order included the SBSmh in the maps and Appendix 2 but, in error, omitted this BEC unit from the Tables 1 and 2. Additional small areas of SBSdw1 and SBSdw2 were also included in subsequent BEC line changes and/or the original BEC mapping. The GAR order applies to all BEC zones within MDWR boundaries.

6.1.6.3 Selection system in caribou habitat

Eastern caribou and Itcha Ilgachuz caribou will be modelled in accordance with the *CCLUP Caribou Strategy*, *CCLUP Integration Report* and the management recommendations of the *Mountain Caribou Strategy* (October 2000) and the *Northern Caribou Strategy* (March 2002, updated 2011). The Itcha Ilgachuz caribou habitat boundaries were legally designated as WHA in 2004 and General Wildlife Measures were established in 2005 and amended in 2011 under *Government Actions Regulation*. The eastern caribou habitat boundaries were legally established in 2009.

The caribou habitat designated as no harvest and reserve areas within conventional harvest WHA were removed from the GHLB (Section 5.3.3) and the remaining habitat areas will be modelled as managed under the silviculture systems described below.

Mountain Caribou

The Eastern caribou area will be modelled following the GAR Order – Wildlife Habitat Areas #5-088 to 5-117 Mountain Caribou – Quesnel Highlands Planning Unit. The general wildlife measures within the order specify that the modified harvest areas be managed by group selection harvesting that is limited to 33% of each stand by area on an 80-year cutting cycle.

Northern Caribou

The Itcha Ilgachuz caribou area will be modelled following the GAR Amended Order – General Wildlife Measures: Wildlife Habitat Areas #5-086, 5-087, 5-118, 5-872 and 5-873. Only WHA 5-086, 5-872 and 5-873 are located within the TSA. A modified harvest system is prescribed by the order for WHA 5-086 and an enhanced conventional harvest system is prescribed for 5-872 and 5-873.

Modified Harvest - WHA 5-086

The largest of these northern caribou habitat areas is WHA 5-086. The order specifies that 80% of the area of each landscape unit within the WHA be managed as terrestrial lichen sites and 20% as arboreal lichen sites. It then defines arboreal sites as commonly occurring in the MS xv zone adjacent to wetlands, creeks and other sources of humidity. It defines terrestrial lichen sites as commonly located in the SBPS zone.

WHA 5-086 is largely covered by the MS xv zone (89%) and is only partially covered by the SBPS zone (11%). The arboreal lichen sites will be modelled by randomly selecting 20% of the MS xv zone within each landscape unit in the WHA. The remainder of the landscape unit, which includes the SBPS mc zone, will be modelled as terrestrial lichen sites.

The order specifies that the arboreal lichen sites be managed by group selection harvesting that is limited to 33% of each stand by area on an 80-year cutting cycle. Terrestrial lichen sites are specified as managed by irregular shelterwood harvest limited to 50% of each stand by area on a 70-year cutting cycle.

Enhanced conventional harvest - WHA 5-872 and 5-873

The order specifies that the two smaller northern caribou WHA be managed under an enhanced conventional harvest system that retains 25% of the forest area as unlogged in each WHA. The order references mapping that identifies areas already reserved that meet over half of the 25% target. The remaining reserve area is to be identified and mapped by the licensees. The order describes the best available caribou habitat as usually mature or older forest (> 100 years) with the highest levels of lichen.

The mapped existing reserves cited in the order and the additional area required to achieve the 25% target will be removed as part of the identification of GHLB (Section 5.3.2). The remaining area will be modelled no differently from areas outside of the WHA managed under clearcut with reserves silviculture system.

Table 12. Caribou habitat silviculture systems

Wildlife habitat area	Silvicultural system	Area harvested per pass (%)	Minimum cutting cycle (years)	Effective rotation (years)
Mountain caribou	Group selection	33	80	240
Northern caribou modified harvest - arboreal lichen sites	Group selection	33	80	240
Northern caribou modified harvest - terrestrial lichen sites	Irregular shelterwood	50	70	140

Data source and comments:

GAR Order – Wildlife Habitat Areas #5-088 to 5-117 Mountain Caribou – Quesnel Highlands Planning Unit.

GAR Amended Order – General Wildlife Measures: Wildlife Habitat Areas #5-086, 5-087, 5-118, 5-872 and 5-873.

Spatial data obtained from MoE website.

6.1.6.4 Restoration of grassland benchmark areas

The CCLUP and the LUO specify silvicultural practices that facilitate the restoration of open grassland condition in the mapped grassland benchmark area. This is primarily achieved by not replanting grassland areas following harvest.

The grassland benchmark areas will be modelled with no regeneration and will be excluded from the THLB and CFMLB following the first harvest.

Data source and comments:

Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan, May 19, 2010. Amended April 18, 2011.

Map 8 and Spatial Dataset, Cariboo-Chilcotin Grassland Benchmark Areas.

There are no grassland restoration activities planned in the near future for the Quesnel Natural Resource District.

6.1.6.5 Clearcut with reserves in American white pelicans WHA

The CCLUP lists the three Kluskus Lakes and Pantage Lake as important pelican feeding lakes. In January of 2003, WHA for American White Pelicans were established under Order – Wildlife Habitat Area # 5-007. The order contains general wildlife measures that limit new permanent forest service roads and restrict access by season. Since it only limits the timing of harvesting, the pelican WHA will be modelled no differently from areas outside the WHA managed under clearcut with reserves silviculture system.

Data source and comments:

Order – Wildlife Habitat Area # 5-007.

Spatial data obtained from MoE website.

6.1.6.6 Clearcut with reserves in high-value moose wetlands

High value wetlands for moose that require protection and site specific management actions were identified as part of the LUO. The LUO specifies harvest systems that retain sufficient vegetation to provide security and thermal cover for wintering moose adjacent to high value wetlands, identified on map 11, and adjacent to W1, W3 or W5 wetlands, including shrub-carrs.

For the purposes of the analysis, it will be assumed that OGMA, WTRA, critical fish habitat, riparian reserve and management zones, and operational retention of shrub and immature tree layers adjacent to these areas will address this requirement. The remaining THLB in the areas adjacent to high value wetlands will be modelled as managed under clearcut with reserves silviculture system.

Data source and comments:

High value wetlands for moose boundaries are from Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan, May 19, 2010. Amended April 18, 2011. Map 11.

There is some concern whether the current management measures are adequate to meet the thermal cover requirement of the LUO. Further investigation is ongoing but may not be ready for this TSR determination.

6.1.6.7 Clearcut with reserves in grizzly bear habitat areas

There are no grizzly bear wildlife habitat areas established in the Quesnel Natural Resource District. Areas of critical grizzly bear foraging habitat that require protection and site specific management actions were identified as part of the LUO. The LUO specifies retention of security cover adjacent to critical foraging habitats. These are identified as salmon and trout spawning reaches and shoals, and herb-dominated avalanche track and run-out zones on southerly and westerly aspects, in very high, high and moderate capability grizzly bear units.

For the purposes of the analysis, it will be assumed that OGMA, WTRA, silvicultural practices, critical fish habitat, riparian reserve and management zones, and operational retention of shrub and immature tree layers adjacent to these areas will address this requirement. The remaining THLB in the habitat areas will be modelled as managed under clearcut with reserves silviculture system.

Data source and comments:

Grizzly bear very high, high and moderate capability unit boundaries are from Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan, May 19, 2010. Amended April 18, 2011. Map 12.

6.2 Integrated resource management

The modelling of management objectives for biodiversity, visual quality, and hydrologic values will be discussed in this section. Management objectives for mule deer winter range and caribou habitat are achieved through application of a range of silviculture systems as described in Section 6.1.6.

6.2.1 Landscape-level biodiversity

The seral stage retention objectives were derived from the *Biodiversity Guidebook* as modified by the Biodiversity Conservation Strategy (1996). The CCLUP Biodiversity Conservation Strategy defined landscape units and biodiversity emphasis options (BEO) for seral stage distributions.

The LUO defines the age at which stands are considered "old forest" by BEC zone. The age definitions for "mature forest" and the retention target percents for both "old forest" and "mature plus old forest" (M+O) were provided in the Biodiversity Conservation Strategy (summarized in Table 14 below).

In the Cariboo region, the old-seral target is deemed to be fully met by parks and CCLUP no harvest areas which include Permanent-Static and Permanent-Rotating OGMA. Therefore no modelling considerations are required for maintaining old-seral targets in the analysis. Mature-plus-old biodiversity requirements will be modelled using the mature-plus-old seral targets from the Biodiversity Conservation Strategy, applied to the current seral condition of the CFMLB, using BEC variant portions of landscape units as the assessment units.

The Biodiversity Conservation Strategy noted that non-valley bottom biogeoclimatic units less than 5000 hectares in size (and valley bottom units less than 1000 hectares in size) within a landscape unit are not required to meet all seral stage targets within that specific area. This is because natural disturbances could potentially alter the seral condition across a large part of a small NDT-BEC unit. *Update Note #2: Amalgamation of Small NDT-BEC Units in Relation to Assessment of Seral Objectives and Old Growth Management Area Planning* provides guidance on the grouping of small units in order to meet landscape unit targets. The amalgamations listed in *Schedule 2 BEC Unit Amalgamations Applicable to Implementation of Mature + Old Seral Targets* (*Schedule 2 of the CCLUP Seral Distribution Assessment,* 2007) will be modelled in the analysis.

The regional Biodiversity Conservation Strategy subdivides forests within NDT 4 into two ecological groups, the fir group and the pine group, for purposes of seral stage assessments. Seral stage retention targets must be met separately within each group. The fir group includes forests where natural disturbances are characterized by stand maintaining events and late seral or climax forests are dominated by Douglas-fir or ponderosa pine. The pine group includes forests where natural disturbances are predominantly stand replacing events and the late seral or climax forests are dominated by other species, primarily lodgepole pine or spruce. The Biodiversity Conservation Strategy specifies different old seral age criteria and different minimum seral stage retention targets to the two groups.

Table 13. Definition of NDT 4 fir group and pine group

Fir group	Pine group
• Douglas-fir or ponderosa pine-leading; • Lodgepole pine-leading with a major component of Douglas-fir or ponderosa pine in the principal or secondary canopy layers; or • Trembling aspen-leading with a major component of Douglas-fir or ponderosa pine and no species characteristic of wet sites such as spruce or cottonwood in principal or secondary canopy layers.	• Lodgepole pine-leading and do not have a major component of Douglas-fir or ponderosa pine in principal or secondary canopy layers; • Spruce, redcedar, cottonwood, or white birch-leading; or • Trembling aspen-leading and do not have a major component of Douglas-fir or ponderosa pine or a minor or greater component of spruce, redcedar, cottonwood, or birch in principal or secondary canopy layers.

The mature plus old seral stage retention constraints will be modelled within each landscape unit using the ages and targets listed in Table 14. If an NDT/BEC unit is currently in deficit of the targets, the timber supply model will recruit from the oldest stands the area required to meet the target. The unit will continue to contribute to timber supply if any merchantable stands remain after the oldest stands are recruited.

Table 14. Mature plus old seral requirements by NDT/BEC

NDT	BEC zone	Mature age (years)	Mature plus old seral requirement by biodiversity emphasis (%)		
			Low	Intermediate	High
1	ICH	>100	17	34	51
1	ESSF	>120	19	36	54
2	SBS	>100	15	31	46
2	ESSF	>120	14	28	42
3	SBPS	>100	8	17	25
3	SBS	>100	11	23	34
3	MS	>100	14	26	39
4	IDF – Fir Group	>100	22	43	65
4	IDF – Pine Group	>100	11	23	34

Data source and comments:

Table derived from the Biodiversity Conservation Strategy for CCLUP, July, 1996 (Table 7, pg. 40).

Landscape unit area data will be compared to *Area of Mature plus Old and Old Forest above Minimum Guidelines - Seral Run 2013 - Crown Forest Area*. Any significant differences will be discussed with FLNR land use planning staff.

6.2.2 Stand-level biodiversity

Wildlife tree retention areas are established to meet stand-level biodiversity objectives as part of the clearcut with reserves silviculture system. Section 6.1.6.1 provides further information regarding the modelling of wildlife tree retention and additional stand-level retention required in large-scale salvage operations.

6.2.3 Scenic areas

Management of known scenic areas is guided by visual quality objectives (VQO) that are defined by the LUO.

Each visual polygon has been assigned one of four VQO ratings: preservation, retention, partial retention, and modification. Harvesting within scenic areas will be modelled with a limit on the amount of disturbed area (area below visually effective green-up height) within each visual polygon. The disturbance limits, which vary by VQO and visual absorption capability (VAC), will be modelled using values recommended in *Procedures for Factoring Visual Resources into Timber Supply Analyses* (1998) as shown in Table 15.

Table 15. Disturbance limits for scenic areas

VQO	Maximum area disturbed (%) by VAC			Visually effective green-up height (m)
	Low	Medium	High	
Preservation	0	0.5	1	3
Retention	1.1	3.0	5	3
Partial retention	5.1	10.0	15	3
Modification	15.1	20.0	25	3

The LUO also identifies scenic corridors and specifies that harvest areas must mimic existing natural and vegetation patterns. This requirement was not modelled since it does not place any restriction on the rate of harvest.

Data source and comments:

A visual absorption capability has not been provided for some visual polygons. The mid-point of the range of disturbance limits for the VQO will be modelled for these visual polygons.

Scenic polygon boundaries and VQO assignments are consistent with the *Land Use Order Objectives for the Cariboo-Chilcotin Land Use Plan*, May 19, 2010, amended April 18, 2011.

6.2.4 Lakes management

The LUO defines lakeshore management zones around lakes classes A to E. Schedule 2 of the LUO specifies limits to the area disturbed when either partial harvesting or clearcut harvesting within the lakeshore management zones. Similar to scenic areas, the lake classes are assigned ratings: preservation, retention, partial retention, and modification. A re-entry period of 20 years is specified in place of visually effective green-up height. The Class A lake LMZ are designated as no harvest and were removed from the THLB (Section 5.3.4). The other lake classes will be modelled following the Schedule 2 disturbance limits under clearcutting shown in Table 16.

Table 16. Disturbance limits for lakeshore management zones

Lake class	Rating	Maximum area disturbed (%)	Re-entry period (years)
B	Retention	10	20
C	Partial retention	20	20
D	Modification	30	20
E	Modification	50	20

Data source and comments:

Lakeshore management zone assumptions are from the LUO for the Cariboo-Chilcotin Land Use Plan, May 19, 2010. Amended April 18, 2011. Maps 6a and 6b.

6.2.5 Adjacency and cutblock size

Adjacency and cutblock size restrictions under *FRPA* (*Forest Planning and Practices Regulation* (FPPR) Sections 64 and 65) require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested and that cutblocks must be less than 60 hectares. However, if a licensee provides a strategy in their Forest Stewardship Plan for establishing cutblocks that emulate natural disturbance patterns, the harvesting will be exempt from adjacency and cutblock size restrictions. Under current practice, cutblocks are typically established with boundaries that follow natural contours and WTRA protect areas that are less frequently disturbed by natural processes. Therefore, licensees are exempted from these requirements under Section 12.4 of the *FPPR*.

Data source and comments:

The 'Integrated Resources Management' constraint used as a surrogate for modelling cutblock adjacency restrictions will not be applied.

6.3 Silviculture

Silviculture activities are carried out to ensure the regeneration of young forests on harvested areas, enhance tree growth or improve wood quality in selected stands. The following sections describe the modelling assumptions related to silviculture.

6.3.1 Regeneration

Following harvest, stands will be forecast to follow a regeneration silviculture prescription based on the analysis unit of the stand. The prescription details, such as species composition, genetic gain, regeneration delay, and density, will be used as inputs to TIPSY to produce managed stand yield curves.

Current practice in regeneration silviculture will be summarized using RESULTS data. Regeneration survey data collected since 2003 will be averaged by analysis unit species groupings to provide TIPSY inputs for future managed yield curves. The yield curve for each analysis unit within the species groupings will therefore only vary by site index. The regeneration assumptions for future managed stands are presented in Table 17. The RESULTS data will be pooled by the pre-harvest leading species since analysis units will be assigned by the current stand composition. This will also reveal any trends in changing species composition. The density will be based on the uncapped number of well-spaced stems. The stands are assumed to have regular spacing so they will be modelled using the "planted" option in TIPSY.

Table 17. Regeneration assumptions for future managed stands by pre-harvest leading species

Analysis unit	Regen delay (years)	Percent composition (%)	Density (stems/ha)	Genetic gain (%)
Pine and Spruce	2	Pl 68 / Sx 21 / Ba 3 / Fd 2 / At 4	1,210	Pl 2.1 / Sx 12.5 / Fd 0.8
Spruce and Balsam	1	Pl 18 / Sx 69 / Ba 9 / Fd 1 / At 2	1,371	Pl 1.1 / Sx 10.3
Douglas-fir	2	Pl 52 / Sx 21 / Ba 1 / Fd 13 / At 11	1,371	Pl 1.6 / Sx 17.5 / Fd 4.5
Deciduous	3	Pl 1 / Sx 20 / Fd 2 / At 74	1,417	Sx 16.3
MDWR	2	Pl 13 / Sx 5 / Fd 79 / At 3	1,371	Pl 1.6 / Sx 17.5 / Fd 4.5

Stands within mule deer winter range are managed under silviculture systems that maintain and promote the amount of Douglas-fir within the stand (Section 6.1.2.2). The General Wildlife Measures for MDWR specify that the Douglas-fir component of regenerating stands must be 20% greater than the original composition. The average Douglas-fir component in the MDWR is currently 59% so the increased regeneration target will be modelled as 79%. All other regeneration assumptions for the MDWR will be identical to the Douglas-fir leading analysis units.

Although existing managed stands were harvested and regenerated in the past, information on the silviculture practices used to establish these stands is required by TIPSY in order to produce managed stand yield curves to model their future growth. Free-growing survey data collected since 1993 will be averaged by analysis unit species groupings to provide TIPSY inputs for existing managed yield curves.

The regeneration assumptions for existing managed stands are presented in Table 18. Existing managed stands are currently between 11 and 55 years (stands 10 years or less will be modelled using future managed stand yield curves). The RESULTS data will be pooled by the survey plot leading species since the analysis units will be assigned based on the existing stand composition. The density will be based on the total stems per hectare in RESULTS. The stands are assumed to have developed towards irregular spacing by this age so they will be modelled using the "natural" option in TIPSY.

Table 18. Regeneration assumptions for existing managed stands by current leading species

Analysis unit	Regen delay (years)	Percent composition (%)	Density (stems/ha)
Pine and Spruce	2	Pl 73 / Sx 13 / Ba 2 / Fd 2 / At 7	6,451
Spruce and Balsam	1	Pl 14 / Sx 45 / Ba 33 / Fd 1 / At 4	3,694
Douglas-fir	2	Pl 51 / Sx 10 / Ba 1 / Fd 24 / At 12	5,090
Deciduous	3	Pl 25 / Sx 11 / Ba 1 / Fd 7 / At 54	8,357

The young stand monitoring project found that model bias occurred due to differences in species composition between TSR analysis assumptions and ground plots. A sensitivity analysis will explore the implication to timber supply of using the ground plot average species composition by analysis unit for existing managed stand yields.

Data source and comments:

The amount of growing stock with genetic gains planted averaged between 11 and 55 years ago was not significant so no genetic gains will be modelled for existing managed stands.

Existing stands currently less than 10 years old will be modelled using the future managed stand yield tables. Survey data from these stands will be used to inform the assumptions used to generate future managed stand yield tables. Therefore, it is reasonable to apply the resulting curves to these stands.

District staff believe there is an emerging trend towards relying on natural regeneration that is not yet evident in the data. A sensitivity analysis will explore the possible implications of this trend to timber supply.

6.3.2 Operational adjustment factors

Operational adjustment factors (OAF) are used to adjust volume estimates from TIPSY to account for factors that affect achievement of optimal growth. The yield tables generated by TIPSY reflect the growth relationships observed in research plots established by FLNR and industry. Research plots were generally located in fully stocked, even-aged stands of uniform site and in forests with little or no pest activity. The influence of stand density on yield is reflected in the yield tables but full stocking is assumed. As a result, TIPSY yields reflect the potential yield of a specific site, species and management regime given full stocking. The OAF are required to adjust these potential yields to better reflect actual conditions.

Two types of OAF are available in TIPSY to account for elements that reduce potential yields. The standard OAF 1 value of 15% will be applied to account for less than ideal tree distributions, small non-productive areas, endemic pests and disease, and random risks such as windthrow. The standard OAF 2 value of 5% to account for decay, waste and breakage will also be applied.

6.3.3 Not satisfactorily restocked (NSR) areas

Areas that are not satisfactorily restocked (NSR) are identified in the RESULTS data. NSR areas are classified as either backlog NSR (harvested prior to 1987) or current NSR. There is currently no backlog NSR in the TSA. Current NSR is assumed to regenerate within the regeneration delay listed in Table 17.

6.4 Natural disturbances

6.4.1 Mountain pine beetle (MPB)

The extent and severity of the MPB infestation was forecast in previous analyses using the BC Mountain Pine Beetle Model (BCMPB). At that time the analysis was concerned with the spread of the infestation and the following progression of mortality losses. Now that the MPB outbreak has subsided the extent of the mortality forecast by BCMPB has not substantially changed since 2007. Therefore, the BCMPB will not be used as a direct input to this analysis and incremental changes in mortality will not be modelled.

The LVI provides a current estimate of the live volume remaining within MPB-impacted stands. In addition, the LVI sample data were used to build a mortality function that estimates the dead volume within these stands. The LVI is considered the best available information because of the currency of the data and it provides information on the residual species composition and stand structure resulting from the mortality.

In areas of the TSA not covered by the LVI the VRI estimates of mortality will be used. Estimates of dead volume were added to the VRI in 2012 to provide an analysis ready dataset for strategic decision makers. Conversion of live standing volume to dead volume followed predictions made using the BCMPB model and the 2010 aerial overview surveys. An estimate of the year of disturbance for this stand mortality was evaluated using satellite image analysis to determine the year of death. The loss predictions were applied to the individual VRI stands. The VRI does not account for any changes in other stand attributes such as species composition or stand structure resulting from the mortality.

6.4.1.1 Shelf life

Pine trees impacted by MPB start to degrade upon death. The loss of quality affects the value of the timber and the products that may be produced from the fibre. It is generally accepted that the quality of the wood from infested trees moves from dimension lumber quality through to pulp and secondary products, such as biofuels, in the years following death.

Shelf life is the length of time since death during which a specific merchantable product can be produced from the dead pine. It is dependent on several factors, including market access and conditions, and available milling technology. Shelf life will not be modelled in this analysis since these factors are product specific and can change widely over short time frames. Instead, it will be assumed that the dead trees have some commercial use as long as the trees are standing. Dead trees will be assumed to remain standing for 15 years after attack. Once the trees fall to the ground it will be assumed the stems quickly rot and will have no commercial use.

To examine the possible impacts and contribution to the harvest forecast of volume from dead trees, the analysis will display forecasts for grouped periods of years since death (YSD): two years or less, three to five years, six to ten years, and 11-plus years. These classes can be used to approximate the amount of volume available within the shelf life period for various products.

6.4.1.2 Unsalvaged MPB stands

MPB-impacted stands that remain unsalvaged will continue to grow and develop as complex stands. The stand structure will be highly variable depending on the number and distribution of residual live trees and the amount of understory advance regeneration. The ability to model stand development following a major disturbance is currently limited and the LVI does not provide sufficient stand structure information.

If an MPB-impacted stand is not salvaged the live component estimated by the LVI will be modelled to continue to grow as a poorly stocked stand. In areas not covered by the LVI, the original VRI species composition will be forecast to continue growing but will be reduced by the VRI estimated percent mortality. No release, advance regeneration or ingress will be modelled because of the great uncertainty around residual stand conditions. If the live volume component is above the minimum harvest criteria (or eventually grows to achieve the minimum) the stand may contribute to the timber supply. The contribution of these stands to the harvest forecast will be tracked and a sensitivity analysis will explore the significance of this uncertainty to the base case.

The new VRI currently underway will provide a better estimate of the residual stand structure in unsalvaged stands. This information can then be used in future analyses to better model stand recovery following MPB. As salvage is still underway, the area of stands that will remain unsalvaged is also a large uncertainty that will become clearer by the next analysis.

6.4.1.3 Young stand mortality

The BCMPB model was built with the assumption that stands less than 60 years old would not be attacked by MPB. Similarly, the LVI and its dead volume estimate function was only generated for stands greater than 60 years old. However, at the peak of the outbreak, extreme beetle behaviour resulted in pine mortality in stands as young as 21 years. In this analysis, the majority of stands below 60 years are assumed to be managed stands. The exceptions are stands 55 to 60 years as well as stands originating from wildfires.

District staff surveyed about 1000 hectares of recently declared free-growing stands (1 to 20 years) in 2007 and did not detect any measurable levels of MPB activity in the very young stands. Managed stands below 40 years were evaluated for MPB mortality under the Forests for Tomorrow and Forest Investment Account programs. Stands that were found to have significant mortality and met the return on investment criteria were rehabilitated. All stands with minor mortality were surveyed and the inventory attributes have been updated to reflect the losses. Therefore, adjustments to account for MPB losses for managed stands below 40 years old will not be modelled.

The Southern Interior Region staff conducted surveys of pine-leading stands 21 to 40 years to determine the level of impact. The survey of 10 224 hectares conducted in 2007 found an average mortality rate of 39%, with rates exceeding 50% in 33% of the stands. Attack levels greater than 20% were observed in 65% of the stands and 95% of the stands had some level of attack (L. MacLaughlan, 2008). These same stands were surveyed in 2013 with little increase to the initial attack levels (L. MacLauglan, personal communication).

No sources of information were identified that could provide an estimate of the mortality in stands 40 to 60 years old. Therefore, the results of the Southern Interior Region survey will be extended to all natural stands below 60 years (wildfire origin) and the small area of managed stands 40 to 60 years. These stands will be modelled with a volume reduction of 39%.

6.4.2 Unsalvaged losses

Periodic natural disturbances caused by extreme weather, fire, or epidemic forest health factors can result in large volume losses if the impacted stands are not salvaged. These events are accounted for by averaging the recorded periodic volume losses over the recorded time frame to approximate an average annual volume loss. This volume is deducted from the growing stock each year in the timber supply model forecast.

A summary of the timber volume losses caused by forest health factors was produced by FAIB using the inputs compiled to run the BCMPB model. The annual forest health aerial overview survey was compared with the annual harvest area mapping. Any THLB area that was identified with a forest health factor and had no record of harvesting was considered to result in an unsalvaged loss. The volume of the stand at the year the health factor was observed was derived from the VRI. The unsalvaged volume loss was estimated as a percentage of the stand volume according to the forest health severity rating (ranging from 75% for very severe to 5% for low). The annual unsalvaged losses are summarized by health factor in Table 19.

Table 19. Unsalvaged losses

Year	Annual unsalvaged loss (cubic metres per year)				
	Fire	Flooding	Douglas-fir Beetle	Spruce Beetle	Western Balsam Bark Beetle
1999		2,507	412	215	11,810
2000	1,093	127	1,216	150	1,155
2001	445	1,472	4,564	6,340	61,332
2002		582	5	8	113,451
2003	223	136	1,003	1,696	292,016
2004	49,713	2,336	4,036	20,893	42,307
2005	189			10,848	24,816
2006	190,747		9,822	111,817	11,783
2007	895		16,306	2,365	47,961
2008	87		19,440	56	1,409
2009	182,929		13,421	330	5,726
2010	592,769	188	1,111	403	9,495
2011	231	152	798	1,801	1,193
2012	61	908	3,939	124	39,549
2013	253	2,463	232		29

The annual volume loss due to fire and flooding averaged over the 15 years of records is 68 700 cubic metres. The average annual loss due to epidemic beetle infestations over the same time frame is 59 826 cubic metres. An area with a volume of 128 526 cubic metres will be disturbed each year in the timber supply forecast to represent these unsalvaged losses.

Data source and comments:

Losses due to the recent catastrophic MPB infestation are not included in the summary. The losses due to the outbreak were on a scale too large to work feasibly in this approach to modelling unsalvaged losses. The frequency of natural disturbances at this scale is an uncertainty that will be addressed in future timber supply reviews as the disturbances occur.

6.4.3 Disturbance outside of the timber harvesting land base

Natural disturbances that occur outside of the THLB do not affect the timber supply but they may influence seral stage management objectives such landscape-level biodiversity. If a major disturbance occurs to a stand outside of the THLB and it no longer provides old seral values, it may be necessary to reserve additional old stands within the THLB to meet old seral retention targets. Modelling natural disturbances outside of the THLB also helps provide a reasonable forecast of the total growing stock on the land base over time.

Disturbances outside of the THLB will be modelled based on natural disturbance event return intervals from the *Forest Practices Code Biodiversity Guidebook*. The return interval varies by BEC and NDT. A probability function based on the *Biodiversity Guidebook* return interval, old age and young age will be used by the timber supply model to randomly assign disturbance areas outside of the THLB each forecast period.

7. Sensitivity Analyses, Modelling and Reporting

7.1 Sensitivity analyses

Sensitivity analyses are additional timber supply forecasts that are carried out to explore the implications to the timber supply from uncertainty in management assumptions or data quality. These analyses typically change one variable while holding all others constant to see if there is a disproportionate change in the timber supply. The magnitude of the increase or decrease in a particular variable should reflect the degree of uncertainty surrounding the assumption. Sensitivity analysis may help identify variables that have the potential to alleviate or exacerbate points of constrained timber supply in the forecast. By conducting a number of sensitivity analyses it is possible to determine which variables have the strongest influence on the base case harvest levels.

Table 20 presents the standard sensitivity analyses that are generally performed to support the TSR process along with some analyses to explore issues unique to the Quesnel TSA. Additional sensitivity analyses may be included after the base case has been completed if new uncertainties are identified.

Table 20. Sensitivity analyses to be performed

Issue	Sensitivity levels
Timber harvesting land base	Use gross THLB
Natural stand yields	+ / - 10%
Existing managed stand yields	+ / - 10%
Future managed stand yields	+ / - 10%
Minimum harvestable age	+ / - 5 years
Minimum harvestable volume	90 m^3/ha, 100 m^3/ha, 120 m^3/ha
Short-rotation pine harvest	35 - 40 years harvest age
Green-up height	+ / - 1 m
Visual quality objectives	Lower disturbance limits
Utilization	All species at 12.5 cm DBH
Deciduous	Exclude deciduous leading
Dead pine fall-over age	+ / - 5 years
Abandon MPB salvage	Harvest in live stands only
Young stand monitoring site index adjustment	Apply SIA to existing managed stands
Young stand monitoring species composition	Use YSM average species mix in existing managed yield curves
Young stand monitoring health / MPB mortality	Apply reduction for losses in managed stands
OGMA Reconciliation	Use the revised OGMA boundaries
Kluskus harvest performance	Remove Kluskus supply block
Terrain stability mapping	Exclude unstable and potentially unstable
Genetic gain	Apply no genetic gain
Natural regeneration	Increase pine natural regeneration

Data source and comments:

Short-rotation pine harvest: There is a local interest in harvesting of immature pine stands to supply fibre for specialty wood products. A young pine harvest sensitivity analysis will assess the timber supply implications of immature pine harvest. A partition of approximately 1200 hectares per year for young pine has been suggested. The impact of short- rotation harvesting will be assessed by forcing the model to harvest 1200 hectares per year in stands 41 – 60 years old (age class 3).

Natural regeneration: The use of natural regeneration for pine is increasing in the TSA. A sensitivity analysis of increasing natural regeneration will assess the timber supply impacts of increased natural regeneration on harvested pine stands. This impact will be assessed by modelling all stands >70% pine modelled using a natural regeneration strategy.

OGMA Reconciliation Project: An OGMA Reconciliation Project is currently underway that proposes a scenario for OGMA additions, deletions, and conversions from one type to another. The project is intended to address significant areas of OGMA surpluses and deficits that currently exist in different assessment units due to BEC line changes that occurred 2006 to 2009, and significant harvest of permanent-rotating OGMA that has not been replaced as required since they are part of the permanent OGMA target. It is anticipated that an amendment to the LUO will occur in 2015 that will finalize the proposed OGMA boundaries based on the revision of the Order due to public review and comment. If this LUO amendment does not take place before this AAC determination is made, the current legal OGMA boundaries will be used for the base case analysis and a sensitivity analysis will be carried out using the proposed OGMA reconciliation boundaries.

7.2 Modelling and reporting

The Standard Timber Supply Model (StTSM) will be used for this analysis. StTSM is run using the Spatially Explicit Landscape Event Simulator (SELES). StTSM is approved for use in timber supply analysis by FAIB and the results of the analysis will be peer reviewed. The model will be set to examine spatial forest inventory data on a one-hectare grid level.

7.3. Habitat supply analysis

The timber supply review will include a habitat availability analysis for moose, grizzly bear, marten, lynx, and northern goshawk. These are species that occur across the TSA and have life requisites which can be measured by available forest inventory attributes the timber supply model can track over time (e.g., current mature plus old). Mule deer and caribou will not be included in the habitat supply analysis because the CCLUP has specific direction to address their habitat requirements.

A habitat supply model will be used to project the amount of suitable habitat available for each of these species if harvesting occurs at the levels projected in the base case and if forest management and harvest priorities are the same as assumed in the base case. Each species will have an individual report produced in a graphical format showing how habitat supply, in hectares of suitable habitat, is influenced by the projected timber harvesting.