ALRF Management Plan # 3

Appendix D

Timber Supply Review and Analysis #3

For the Period 2018 - 2023

May 7, 2018

Aleza Lake Research Forest

3333 University Way
Prince George, BC
V2N 4Z9

Timber Supply Review #3

2018 – 2023

Aleza Lake Research Forest Society

For Submission to

Ministry of Forests, Lands, Natural Resources Operations,
and Rural Development

Prince George Natural Resource District

May 7, 2018

Prepared by

___________________________________ ______________________________

Colin Chisholm RPF #4755
Assistant Forest Manager
Aleza Lake Research Forest Society

Date

ALRFS Manager Approval

___________________________________ ______________________________

Michael Jull RPF ##2137
Manager, Aleza Lake Research Forest Society

Date

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Contents

Executive Summary

This timber supply review (TSR) and analysis forecasts the sustainable harvest levels for the period of 2018-2023 for Aleza Lake Research Forest (or “ALRF”), based on existing forest inventory, land use and management patterns, and land use objectives consistent with ALRF Management Plan #3 (MP3). The ALRF is managed under SUP 23615, and Occupant License to Cut L45514.

A significant change in the ALRF landbase since the last TSR was an amendment to the ALRF tenure area approved by MoFLNRO in January 2015, adjusting some ALRF boundaries to geographic features rather than lot survey boundaries. This amendment resulted in only slight net change in ALRF area, but does improve forest and landscape planning effectiveness for both non-timber and timber values.

Sustainable harvest flow modeling was completed using the Forest Planning Studio – ATLAS (or “FPS”) software. A “Base Case” timber-supply scenario is presented based on objectives set by government, those set by the ALRF as per Management Plan #3, and as indicated by current practices, the best available knowledge, and growth and yield modeling based on site indices provided by the Province. Alternative timber-supply scenarios are examined to compare potential impacts on long term timber supply based on alternate management objectives or growth and yield assumptions.

In the conservative Base Case, the total harvestable land base (THLB) is 5,787 hectares and FPS modeling forecasts sustainable annual harvest flows for the first decade, 0 to 10 years from present, at 20,800 m^3 of coniferous volume per year. In the second decade, 11-20 years from present, the harvest level declines to 18,500 m^3 per year, and in the third decade, 21 to 30 years from now, to a forecast low of 16,500m^3 per year. Over the following decades, the forecast timber harvest recovers to an even flow harvest level of 20,800m^3 per year as second-growth stands mature.

This TSR also examines sustainability of timber supply for deciduous tree species at the ALRF *separately* from coniferous volumes and landbase, and forecasts a sustainable deciduous harvest flow of about 830m^3 per year on average.

Introduction

The gross area of the Aleza Lake Research Forest (or ALRF, SUP 23615, Occupant License to Cut L45514) is 9002 ha. This area excludes Ecological Reserve #84 which is fully surrounded by the research forest, and a small portion of Schedule A lands fee simple owned by the University of Northern British Columbia.

These forest lands are located within the Willow River Wet Cool Sub-boreal Spruce (SBSwk1) biogeoclimatic subzone in the east-central plateau of BC. The forest is dominated by spruce and subalpine fir stands with minor deciduous-leading stands of aspen and birch, and cottonwood stands along the Bowron River floodplain which is the southern boundary of the research forest. The lands are dominated by generally rich fine textured clay to silty lacustrine and sandy glaciofluvial soils.

Relative to the broader surrounding region, the ALRF area has a long history of both harvest and research activities. The first timber harvest entries occurred on the ALRF in 1919/20. Shortly after, the area was established as a provincial research station from 1924 to 1963. A variety of partial-cut and clearcut systems have been used at the ALRF over the last 100 years.

The Aleza Lake Research Forest Society (ALRFS) was provided management of this tenure area in 2001 via the above tenure documents. The ALRFS, a not-for-profit provincially-registered society, is managed by a professional staff that reports to a Board of Directors represented by the University of Northern British Columbia, the Province, and a member of forest-community.

This timber supply review examines the capacity of the current forest lands to provide a sustainable timber harvest flow, while taking into consideration the various public objectives for surrounding landscape and the stated management objectives as per ALRF Management Plan #3 (MP3). Readers may reference the ALRF Management Plan, which this TSR is a part, for greater detail and discussion of specific management objectives.

The intent of this report is to provide information and recommendations that support decision making for the next five years of allowable annual cut for timber, and includes a review of key objectives for these forest lands - including higher-level objectives set by government for the ALRF tenure, and more specific objectives as per ALRF Management Plan # 3.

Administrative Requirement and Status

Special Use Permit 23615 requires the ALRFS to complete a management plan, and five-year timber supply analysis consistent with this plan, i.e.:

> *"The Permittee must submit for the approval of the district manager, once every five years, or more often if the district manager consider that special circumstances require, a management plan that contains the following: …*
>
> *(d) A timber supply analysis that analysis the short and long term availability of timber for harvesting in the Permit area, including the impact of management practices on the availability of timber*

The previous ALRF timber supply review was approved by the District Manager, Prince George Forest District, in 2010 and for the period of 2010 – 2015. In December of 2015, the district manager (DM) authorized an extension of the allowable annual cut (AAC) to the end of 2017.

Changes to ALRF boundaries since the previous Timber Supply Review

Since the previous timber supply review, there has been a significant change to the ALRF tenure boundaries.

With the approval of amendments to the boundaries of SUP 23615 and LTC 45514 in January 2015 by MoFLNRO, the tenure area boundaries of the research forest were significantly altered, though the aggregate area of the ALRF remained similar (see Fig. 1). Significant area and boundary changes include the removal of lands to the south of the Bowron River, and compensatory additions in land area along the east and west boundaries of the forest. The net tenure area change was minimal (0.2% increase or 18 ha), and these boundary changes do affect the stand composition for the forest.

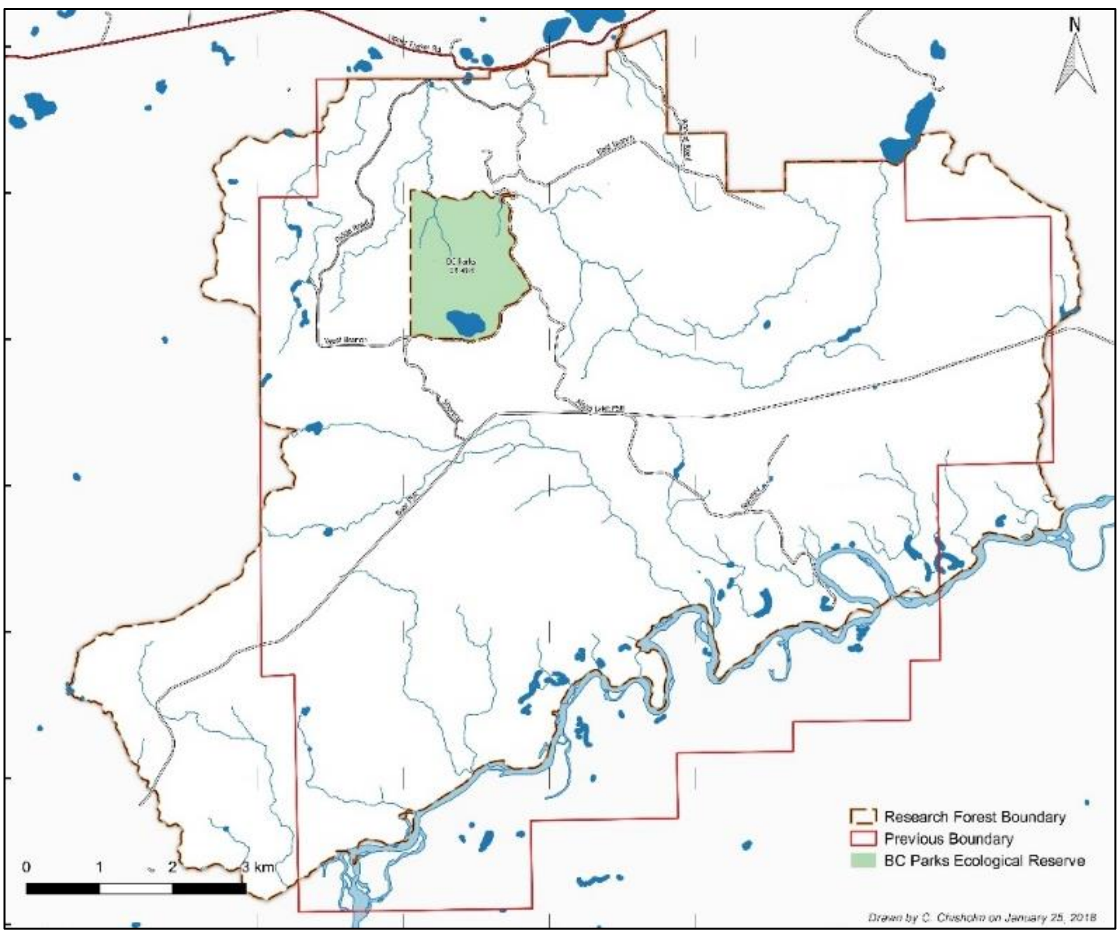


Figure 1 Aleza Lake Research *Forest: Current and past (pre-2015) tenure areas.*

Introduction of the Base Case

Through this timber supply review, the "Base Case" is presented as the baseline timber supply projection scenario which conservatively integrates key objectives and forest inventory data from both government and the ALRF (as per MP#3), and the best available information. Additional scenarios are provided for discussion and for comparison against the Base Case. The following discussions on key objectives, data analysis and processing, and the forest land base relate primarily to the development of the Base Case scenario.

Key Objectives for the Base Case

Sustainable Yield Forecasting

The primary objective of this timber supply review and analysis is to provide a systematic quantitative basis for determination of future harvest levels within this tenure area by the Province. This will be based on the best available information, including information and management objectives set by government and by the ALRFS, data sources from government, and the ALRF, and will be facilitated through timber supply modeling. See Appendix D-1 for a full list of data sources utilized in this analysis.

Objectives set by Government

Biodiversity Objectives

Minimum objectives for "Old Forest" retention for the ALRF are set by the Province through biodiversity guidance documents (ILMB, 2009). The old forest (>140 years) minimum for the research forest is set at 28% of the Crown forest land base. It is also noted that this biodiversity objective for the ALRF tenure area is managed independently from areas outside the ALRF. Please refer to ALRF Management Plan # 3 for more detail on Old Forest management at the ALRF including Old Growth Management Areas (or OGMA's).

Visual Quality Objectives

Visual Quality Objectives or VQOs have been specified by government along the northern portion of the forest via the *Order establishing Scenic Areas in the Prince George Forest District* (2005) as per the *Government Actions Regulation*. This spatially explicit objective set by government follows the Upper Fraser road and sets objectives relating to viewscapes adjacent to this main public road. The objective stated in the Order for this area is: 'Modify'. Following a review of available provincial guidance and discussion with Ministry staff, and considering the subdued, generally rolling nature of terrain in the area, it was determined that actual on-block retention levels to achieve VQO's are generally modest. For example, planning a harvest unit within this area would simply require windfirm retention of trees in appropriate locations, to modify the visual impact of a harvest opening from highway viewpoints. As such, although a polygon within the VQO area is acknowledged in analysis, no volume based restraints are applied and it is expected that any significant need to create visual screening could be accomplished through in-stand tree retention overlapping with other management objectives (e.g. wildlife tree retention areas).

Other Land Constraints

Management Plan #3 – ALRFS Management Objectives

The terms and conditions of ALRF Management Plan #3, especially as they relate to both current forest level and stand level management, have been considered and where possible and appropriate modeled in the scenarios described below.

Specific Management Plan #3 sections especially pertinent to this timber supply review and analysis include:

12.2 Biological Diversity Objectives

See discussion above under objectives set by government.

12.4 Water Quality and Aquatic Habitats

For the purpose of this timber supply review known-to-be or modeled-to-be fish bearing were provided a spatially explicit retention buffers. Specific wildlife tree retention for the protection of riparian features is detailed within the main management plan in MP#3.

13.5 Forest-level Tree Species Composition Targets

This TSR focuses on the sustainable management of the tenure area's currently commercially coniferous management. Additionally, the nature of the growth and yield curves used to support this model, generated in winVDYP and TIPSY, do not lend themselves to the ingress of other species. For example a stand that is planted to 100% spruce will overtime receive natural ingress of numerous other species (e.g. sub-alpine fir, birch, aspen, and others. As the model does not capture this species diversification over time it is unable to speak to landscape level species composition targets.

14.2 Cutblock size and harvesting adjacent to another cutblock

As there are a wide variety of cumulative patch size distributions stated in MP3, ranging from 0.5 ha to large continuous clear cuts of up 120 ha, green up restrictions have not been applied in modeling. *See Table 17 ALRF landscape-level acceptable targets and range of patch-size distribution.*

Timber Supply Analysis Process

This timber supply analysis included the following major steps:

1. Model selection and recruitment of expertise in model development
2. Model development including the
    a. Collection of all applicable data sources
    b. Generation of a 'resultant' datafile,
    c. Quality assurance including peer review by qualified professionals
3. Growth and yield data curve generation, based on ALRF specific forest cover using winVDYP for natural stands and TIPSY for planted and future stands
4. Development of the Base Case including netdown to the Total Harvestable Landbase (THLB)
5. Consideration of alternate scenarios
6. Comparison of results
7. Forecast timber harvest flows, and

8. Further recommendations and management options for maintaining and potentially enhancing potential future ALRF timber supply.

Model Selection – Decision Support System

As with prior ALRF Timber Supply Analyses (2005, 2010), a model was chosen that would both allow for reliable and effective forest-level modelling, as well as effective incorporation of ALRF data and analyses into UNBC's classroom teachings. That is, with the completion of this analysis, UNBC instructors would be able to use this analysis and associated data as a 'real-world' example, and for laboratory exercises. Additionally, modeling required the ability to incorporate a wide variety of objectives, and thereby the models act as Decision Support Systems.

Previous TSR Model: LURCH

In previous TSR's for the ALRF (2005, 2010), the "LURCH" model was used. LURCH was developed by Dr. Stephen Dewhurst (formerly of UNBC). This model was objective-driven and the solutions are reached via through stochastic-heuristic optimization techniques, and a simulation through optimization approach. The model provided spatially and temporally explicit scenarios that could be evaluated as to how they met each objective (Kessler et al., 2001). Unfortunately, development of the LURCH model ceased a number of years ago, and due to limited available expertise on how to parameterize and run the model, LURCH was no longer considered to be a viable option for use by the ALRF.

Current TSR Model: Forest Planning Studio - ATLAS

Forest Planning Studio – ATLAS (or "FPS"), originally developed at the University of British Columbia (UBC) by Dr. John Nelson (ret.) of the UBC Faculty of Forestry, was the model selected to facilitate the current ALRF TSR process. FPS is curated by UBC, and is well documented including tutorials (Man, 2016; Nelson, 2003; Perdue and Nelson, 2009). Additionally, the UBC site provides tutorials for operating this model (UBC, Faculty of Forestry, n.d.). Similar to LURCH, FPS provides a modeling framework provides modeled solutions that are spatially and temporally explicit while incorporating various objectives.

FPS is a spatially explicit forest-level model that can generate reports on every forest stand / polygon in the model at each planning period including outputs as harvest status, stand age, and timber volumes (Man et al., 2013). The FPS harvest scheduling model is widely used, and has been used to examine harvest scheduling for numerous forest landscapes examples include: Malcolm Knapp Research Forest and the Alex Fraser Research Forest (Man et al., 2013), John Prince Research Forest (Grainger, 2016), Canfor's TFL 48 (Seely et al., 2008), and BC's Arrow Timber Supply Area (Nelson, 2006).

In FPS, non-timber objectives can be stated either spatially or aspatially. These objectives are modeled through the a constraint mechanism where portions of the forest must meet specific forest cover objectives (Perdue and Nelson, 2009). An example of spatially-explicit management with this TSR is the designation of all OGMA polygons as non-harvestable in the Base Case scenario. In two of the alternate scenarios this constraint is removed. Conversely, the targets for wildlife tree retention (WTR) are aspatially managed in this TSR.

In contrast to LURCH, FPS requires the analyst to provide quantitative objectives and to input them in such a way that areas are explicitly included or excluded from harvest, scheduled at specific time, have a net area reduction, or meet a minimum or maximum age class requirement.

The FPS software and ALRF dataset will be used to support UNBC forest planning teaching and laboratory exercises. ATLAS-FPS provides a similar workflow to common commercial forest planning software, and thereby can prepare students with 'real-world' challenges in forest planning and forecasting.

As noted by Man (2016), FPS data preparation produces a 'resultant' file that is compatible with commercial models (such as Woodstock TM). Stands are 'grown' in the model based on supplied growth and yield curves. The curves generated use the provincial standard GY models: "Variable Density Yield Projection" (VDYP) and "Table Interpolation Program for Stand Yields (TIPSY)(MOFLNRO, 2018a, 2018b). See Appendix D-2: Growth and Yield of Analysis Units for a list of inputs used for growth and yield modeling.

FPS has been designed and used effectively for timber supply review (Nelson, 2003; Perdue and Nelson, 2009). Other uses of this model have included the examination of carbon accounting and sequestration (Man et al., 2013); an examination of harvest planning on recreation opportunities (Harshaw and Sheppard, 2003), and the impacts of Mountain Pine Beetle (Seely et al., 2008).

Consultant Expertise

At the beginning of the process to develop this timber supply review, Mr. Mark Perdue MSc. RPF, of Forsite Consultants Ltd. Perdue was hired on contract by the ALRF Society to provide expertise and technical assistance to ALRF staff in developing this model specifically for the ALRF landbase and TSR. Perdue has expertise with timber supply analysis, including specific expertise with FPS, having used this model for other clients and having taught the model while completing his graduate studies with Dr. Nelson at UBC. Also, Perdue provided the initial model based on ALRF data sources, and provided additional training, coaching, and peer review to ALRF staff (Colin Chisholm RPF) of subsequent on subsequent versions of the model.

Model Development

Data Sources

Numerous data sources were used in the generation of this model including sources from DataBC (e.g. VRI, RESULTS, Visual Quality Objectives). In addition, local knowledge of forest professionals familiar with the ALRF was periodically used to check or correct forest cover polygon attributes. Specific data used to verify or correct forest cover data included empirical survey data, aerial photography, and aerial laser scanning. Please refer to Appendix D-1 (Data Sources) for a full list of data used in this timber supply analysis, including the data source, and a brief description.

Resultant File

Using the data sources referenced above a resultant GIS file was generated. A resultant GIS file is an essential data file that integrates all of the applicable forest, non-forest inventories, spatially explicit management and administrative designations into a single data structure that are used for modeling Man (2016).

GIS System and Quality Assurance

Free and open source software GIS software was used to generate the resultant files including the application of unison functions to meld various layers together, and to ensure that the data was topologically correct, meaning that there were no overlapping polygons and not gaps between them.

Ensuring topological integrity is an essential quality assurance step to ensure the correct accounting of each polygon in the area of interest. Software packages used included SAGA GIS and QGIS (Conrad et al., 2015 and QGIS Development Team, 2017).

Growth and Yield Data

Commercial and Non-commercial Species

For the purpose of this TSR, the sustainable harvest of current commercially viable coniferous trees is examined including: hybrid spruce (*Picea glauca x engelmanni),* sub-alpine fir (*Abies lasiocarpa*), Interior Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta var. latifolia*), and to a very minor extent planted western larch (*Larix occidentalis*). As such, deciduous leading stands were not included and deciduous volumes were netted out. A discussion of deciduous volume utilization and sustained yield is included – see 'Scenario D: Deciduous volume analysis'.

Growth and yield (GY) curves were generated for coniferous stands at the ALRF, including natural stands, plantations established before 2000 (B-class seed), and plantation established after 2000 which include modeling of genetic gain (A-class seed). To reduce the number of GY curves needed stands were grouped using like characteristics into Analysis Units (AUs). GY curves were subsequently generated for each AU. The AUs were established for stands of similar forest cover and site indices. For example, natural spruce leading stands (>40% Sx) with a site index (SI) between 15 and 20 were grouped together. For each AU the species composition and site index was determined using an area weighted average of each polygon in the AU. GY curves for natural stands were generated using MoFLNRORD's *winVDYP* model with the weighted species composition, and SI provided by the VRI. The Ministry's TIPSY model was used to generate second growth plantation GY curves utilizing the weighted species composition or species composition that would represent best current or future plantation establishment practices. The site index used for these curves was provided by the Provincial Productivity Layer.

Please refer to Appendix D-2 (Growth and Yield of Analysis Units) for a full list of the AUs, including the GY model, site indices, and species composition used to generate each GY curve.

Analysis Unit Conversions

The ATLAS/FPS model allows for stand conversions (i.e. harvesting of one tree species combination or mix, and regeneration of the area to another species, mix, or seed source). As such a natural stand, with growth modelled using a natural stand GY curve will convert to a second growth stand using an appropriate second growth yield curve. For example, an existing natural spruce leading stand with a site index of 17 will be modeled using Analysis Unit (AU) #17015 when the model harvests this area the GY curve is changed to a class 'A' seed spruce leading plantation in the site index class of 15 - specifically AU 37015. Please refer to Appendix D-3 (Analysis Unit Conversions) for specific details on how the model simulates harvest and conversion from one AU to another.

The Base Case

The total area considered in this TSR totaled 9,288 hectares, and includes the gross area of the ALRF, Ecological Reserve 84, and Schedule A lands owned by UNBC. From this total area the net forested land base was determined to be 8,526 ha and the total harvestable land base (THLB) was determined to be 5,787ha with future net THLB of 5,021ha. The full list of area net downs is provided in Table 1.

Summary of the THLB Net Down

Lands excluded from the THLB totaled 762 hectares, and included Ecological Reserve 84, UNBC's Schedule A Lands, and non-forested lands. However, forested lands in these areas were considered as contributing to the pool of old forest for the entire area.

Non-contributing forest lands total 2,777 hectares. These are areas within the tenure are that are not suitable for sustainable forest management and are non-commercial stands that are western hemlock, black spruce, or deciduous leading, or other low productivity sites or have other administrative designations (e.g. government research installations, Land Act designations such as gravel pits or long term lease agreements), or areas set aside to meet other management objectives incompatible with timber harvesting (ALRF research sites, OGMA's).

Some additional area required proportional area net-downs (aspatial reductions). These are areas where higher retention is required to meet management objectives and are modeled aspatially. These include Visual Quality Objectives (VQO) set by government and ALRF special management zones. Though as stated above, these VQO's allow for modification of viewscapes, i.e. allow harvesting while setting up simple methods to reduce impacts on visual quality; for modeling with FPS, it is assumed that this 10% netdown for visual quality management is included in within stand WTRs.

For the Base Case, the gross total harvestable land is 5,787 ha. Over the modeling period, this area is netted down to 5,021 ha., through a percentage aspatial reductions assigned to Wildlife Tree Reserves, and the spatially-explicit reduction for new haul roads. In the FPS model these aspatial reductions are calculated as a percent volume retained within a stand polygon, i.e. - a reduction to volume yield when a harvest is simulated for a stand.

Biodiversity

As previously discussed, the specific landscape-level objectives for biodiversity for the research forest have been set by government as a minimum 28% old forest as a percentage of the Crown forest landbase. The ALRF, through MP3 and reflected in this TSR, has chosen to meet this target through the establishment of a spatially explicit OGMA along with minor aspatial contributions. This Base Case meets old forest objectives through the establishment of spatially-defined OGMA's, while other scenarios examine the possibility of meeting old forest objectives through aspatial management options.

Table 1: Total Harvestable Land Base – Net-down Table

	Gross Area	Net Area	Propor-tional Reduction	Proportional Net-Area Reduced	Running total *Reductions*	Running total *Remaining*
Total Gross Area *(hectares)*						**9288.2**
Excluded Lands						
Non-Forest Land						
Private Land *Schedule A Lands*	16.5	16.5	100%	16.5	16.5	9271.7
Ecological Reserve 84	268.8	268.8	100%	268.8	285.2	9003.0
Non-Forest Land						
Water-bodies (rivers and lakes)	37.2	37.2	100%	37.2	322.4	8965.8
NP and Brush	263.9	255.1	100%	255.1	577.5	8710.7
Roads	185.4	184.9	100%	184.9	762.4	8525.8
Non-Contributing Lands						
Non-Commercial Forested Land						
Non-Commercial Conifers (Sb & Hw)	393.3	385.0	100%	385.0	1147.4	8140.8
Deciduous Leading	334.8	307.9	100%	307.9	1455.4	7832.8
Low Productivity Sites *(SI < 10)*	275.1	11.8	100%	11.8	1467.1	7821.1
Riparian Reserves	417.7	210.0	100%	210.0	1677.1	7611.1
Reserves						
Other Tenures	23.4	17.1	100%	17.1	1694.2	7594.0
Government Research Installations	32.5	25.6	100%	25.6	310.8	8977.4
Recreational Reserve	38.4	25.4	100%	25.4	1702.5	7585.7
ALRF Research Installations	52.1	47.5	100%	47.5	1750.0	7538.2
ALRF Old Growth Management Area	2563.8	1747.0	100%	1747.0	3497.0	5791.2
Proportional Reductions to the THLB						
VQO Polygons	63.6	33.9	10%	3.4	3500.4	5787.8
Field Education Centre SMZ	3.1	3.1	30%	0.9	3501.3	5786.9
Total Harvestable Land Base						**5786.9**
Future Net Downs						
Future Road Area (spatially explicit)	13.3	13.3	100%	13.3	3514.6	5773.6
WTPs *portion of THLB*		5786.9	13%	752.3	4266.9	5021.3
FUTURE TIMBER HARVEST LAND BASE						**5021.3**

Current and Future Roads

The area of current roads was calculated based on 2015 ALRF LiDAR data indicating the actual cleared road right-of-way widths. Mean widths were calculated and them existing road lines were buffered according to this data.

Future in-block roads are modeled as productive land, and as such, no reduction is calculated for these sites. It has been the practice of the ALRF over the last 5 years to rehabilitate in-block roads, returning them to productive forest. This does provide a potential minor uplift to future stand yields but does not impact near term harvest flow forecasting.

Future permanent haul roads are modeled explicitly in the model. The ALRF is well roaded, and thereby construction of additional permanent roads will be relatively limited. However, for areas where the need for future permanent roads was identified these future roads areas were added to the database. These sites are modeled as current natural stands, and upon harvesting are converted to non-forested. As such existing current volumes are tallied in the model but second growth does not occur on these sites.

Spruce Beetle

Currently in the Prince George Timber Supply Area, there is increasing concern regarding the impact of a bark beetle, Spruce Beetle (IBS) or *Dendroctonus rufipennis*. In the Omineca Natural Resource Region as a whole, more than 340,000 hectares have been impacted by IBS and is regarded to be the largest outbreak in 30 years (MOFLNRO, 2018c). ALRF forest professionals are currently monitoring IBS activity at the research forest including the identification of susceptible stands. IBS activity is elevated at time of TSR preparation, and will continue to be monitored. However, given the long history of forest management at the research forest and the diverse age class structure that exists at the ALRF, the current working assumption for the TSR is that IBS impacts are manageable within current and forecast cut levels. At this point, no scenarios have been developed to elevate cut levels to manage IBS.

Current Inventory

Before modeling the planned sustained yield for the research forest, it is important to first examine the current state of the forest. According to all the inventory data the forest is dominated by spruce and sub-alpine fir with over 85% of the forest area covered by these two species. Mature forests (age class 5+) cover make up 57% of the entire research forest. See Figures 2 and 3. Using a 'crashdown' technique in FPS, the model suggests that there is 750,000 m^3 of current standing volume. The 'crashdown' technique sets harvest levels targets far in excess of standing volume and thereby simulates the harvest of all available volume.

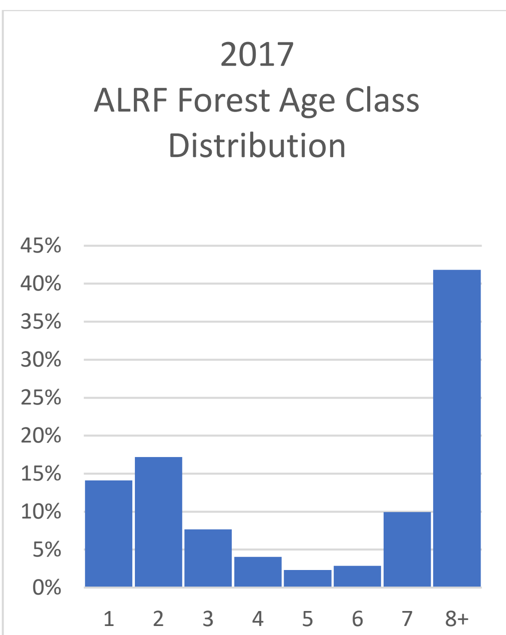


Figure 2: Current Age Class

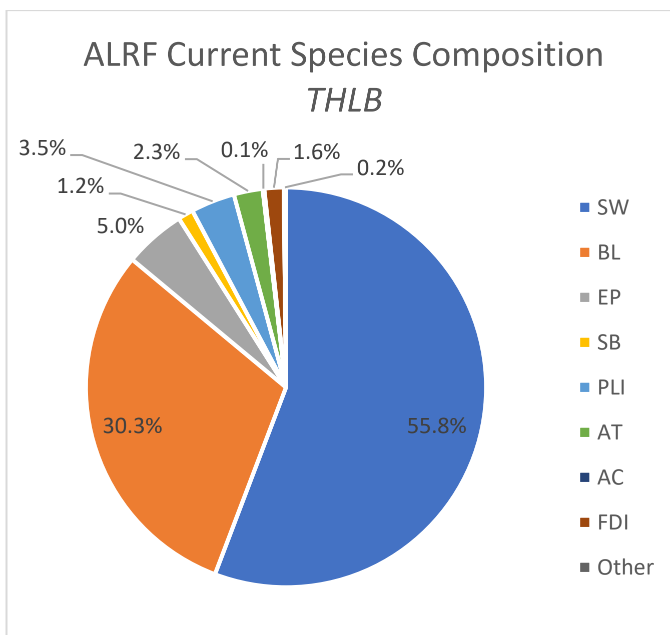


Figure 3: Species Composistion

Base Case Results

Table 2 and Figure 4 show the modeled sustained harvest levels for the research forest following all the assumptions above. As modelled by FPS, sustainable annual harvest flows for the first decade (0 to 10 years from present) of 20,800 m^3 of coniferous volume per year. In the second decade (11-20 years from present) this harvest level declines to 18,500 m^3 per year, and in the third decade (21 to 30 years from now) to a forecast low of 16,500m^3 per year. Over the following decades, the forecast timber harvest recovers to an even flow harvest level of 20,800m^3 per year as second-growth plantations mature.

Age Class distribution trends over the modeled time are illustrated in Figure 5. Age classes 8 and 9 start at over 40% in the analysis, and decrease to just over 30% before returning to jthe near-40% level. It is important to understand that "old" polygons (those stand polygons > 140 years of age) remain old in this model – that is the model does note reset individual stands (i.e. simulated stand death) by having the stand ages reset to zero. This is an understood and accepted assumption in this model that help reflect natural patterns of small gap disturbance dynamics common to the ecology and the predominant natural disturbance patterns of this area. It is also assumed that a portion of these old age class stands will have natural age class 6-7 characteristics.

Harvest Flow

Year from Present	Mean Annual Harvest Level
10	20,800
20	18,500
30	*16,500*
40	17,000
50	18,500
60	19,500
70	20,000
80	20,400
90	20,800
…	20,800
250	20,800

Table 2 (above): Base Case harvest flow

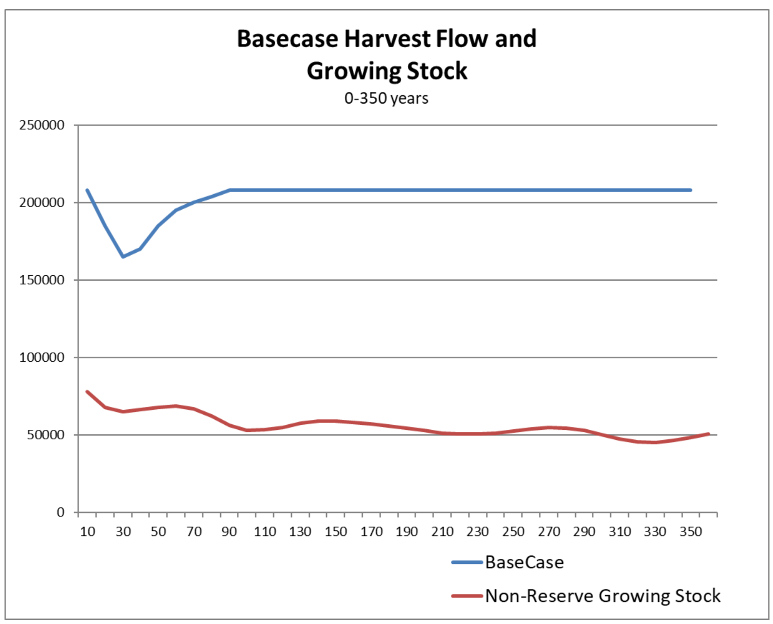


Figure 4: Base Case harvest flow

Trends in Forest-Level Age Class Composition over Time

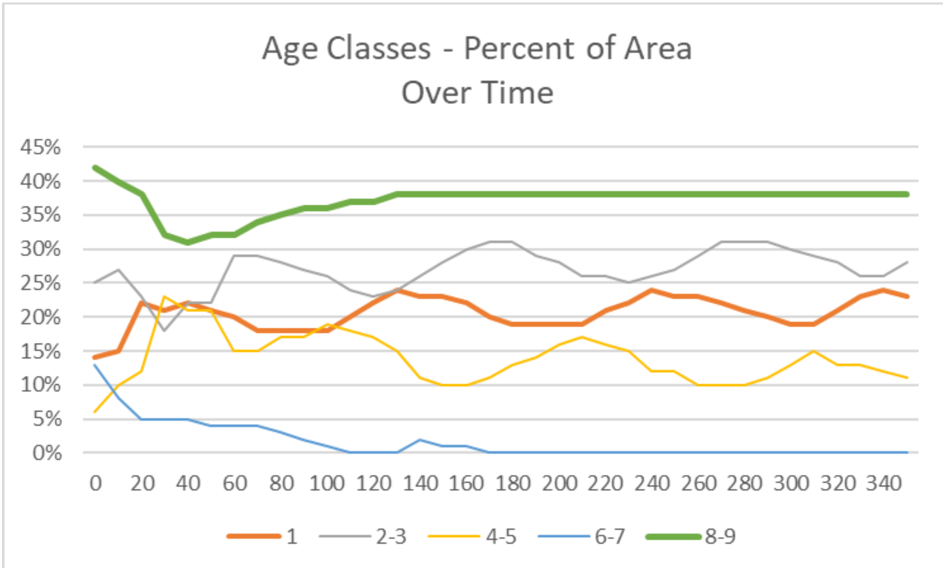


Figure 5: Age Class compositions over the modeled planning horizon

Sensitivity Analysis

Overview

The Base Case scenario above suggests the harvest flow given all of our current management objectives and standard growth and yield assumptions. However, some of these assumptions need to be examined further, and this is the role of the additional sensitivity-analysis scenarios. Three additional scenarios are examined. And, a fourth discussion scenario is provided examining the potential for sustained yield harvesting of deciduous species.

Scenario #1: Old Forest through Aspatial Management

In contrast to the Base Case, this scenario meets old forest biodiversity objectives through aspatial management of old forest. Although a spatially explicit OGMA, as in the Base Case, provides specific areas for old forests and natural processes one drawback is that the OGMA area is removed from the THLB. In this scenario old forest targets are managed aspatially and in doing so an additional 1,747 ha is made available in the THLB – though the entire THLB is constrained on a percent area basis, to contribute the area needed to meet the landscape level biodiversity targets.

Scenario #2: No Biodiversity Objective Constraints

In contrast to the Base Case, in this scenario biodiversity targets are not considered. In doing so an additional unconstrained 1747 ha is added to the THLB.

Scenario #3: Measured Site Index

The accuracy of the site index metrics provided by the Provincial Productivity Layer (PPL) and SIBEC site indices have been examined over the years by comparisons to the field performance and measured site indices of second-growth plantations (i.e. - Farnden, 2006 for Prince George and Fort St. James Districts; and JS Thrower and Associates, 2016 for Mackenzie District).

The ALRF has similarly conducted field surveys to evaluate the measured site index of its second growth stands. Findings, summarized in Table 3, indicate that measured site indices (SI) for spruce stands are distinctly different than the SI provided in the Provincial Site Productivity Layer (PPL). Spruce plantations at the ALRF consistently show a measured SI that is 30% higher than expected from the PPL .

A limited ALRF survey sample size examined lodgepole pine site indices. The ALRF-specific data suggest that measured SI and modeled site index for lodgepole pine are similar.

It is also noted from this data that Aerial Laser Scanned LiDAR data is effective at providing similar heights, and thereby SI, as those measured in the field. Further examination of SI derived from LiDAR is planned as this provides an opportunity to examine site index for all site across the research forest.

		Site Index		
ID	Leading Spp	Emp. Data	RS Data (median)	PPL
93I001-028	Sx	27.0	26.8	20.8
93J010-002_A	Sx	27.3	26.3	20.6
93J010 20	Sx	25.1	24.4	19.5
57029	Sx	28.5	27.5	19.2

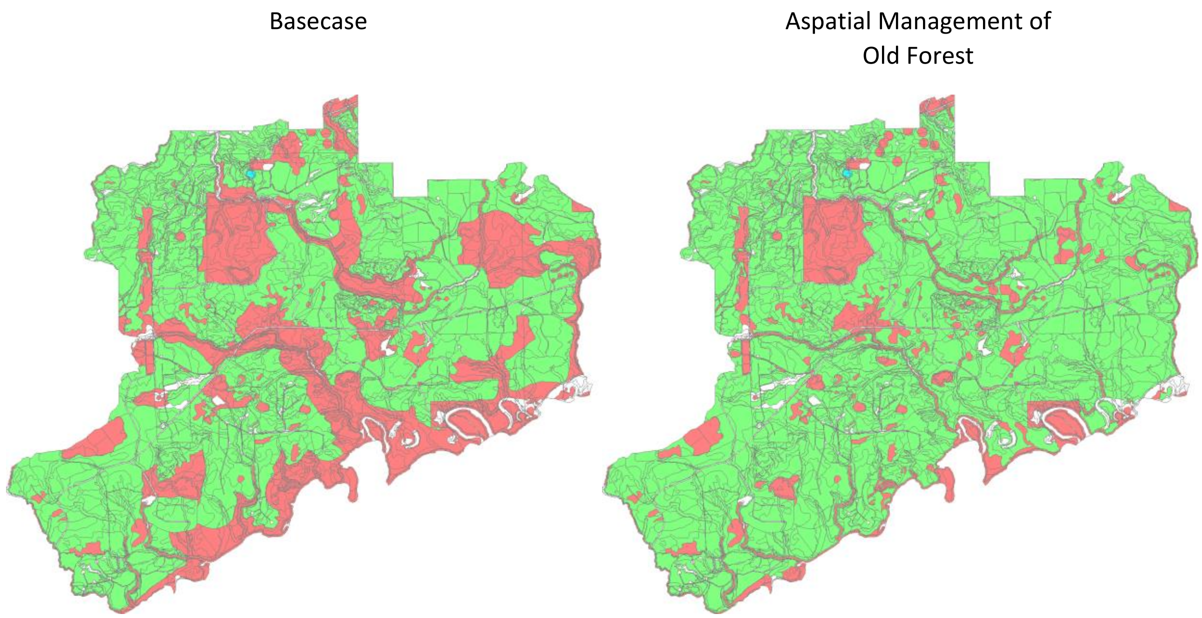
Table 3: Site Index Comparisons. Three SI measures are provided per opening based on heights captured through: a) Field measured empirical data, b) LiDAR (RS), and c) PPL, is the SI from the provincial productivity layer.

For this scenario, the growth and yield data is modified. AUs for spruce leading plantations are modeled with a 30% increase to SI capped to a maximum of SI 27. AUs with other leading species remained the same as the base case. Also for this scenario the management assumptions of the Base Case are unaltered (e.g. spatially constrained landbase – spatially explicit OGMA).

Scenarios Comparisons

Spatial constraints

Figure 6 compares map images of the Base Case THLB and the ‘Old Forest through Aspatial Management’ THLB. With no spatial OGMA in the latter scenario a significantly larger amount of land in available for harvesting (an additional1,747 ha) . Areas presented in Figure 1 are listed in Table 3:



Comparison of THLB and Old Forests.

Figure 6:

ALRF THLB and Spatially Constrained Forest. Green areas are THLB; salmon colored areas are constrained lands that are not harvested in the model. The Base Case is more spatially constrained then then ‘Aspatial Management of Old Forest’, and ‘No Biodiversity Objective Scenarios’

Old Forest Contribution

Table 4: Comparison of the amount of old forest lands that are reserved in each scenario.

	Base Case *Old Forest through Spatial OGMA*	Old Forest through Aspatial Management	No Biodiversity Objective Constraints	Measured Site Index *Area constrained as per Base Case*
THLB (hectares)	5,787	7,534 (10 % constrained)	7,534	5,787
Current Area in Old Forest[1] (≥140years)				
Private Lands Schedule A	0.0	0.0	0.0	0.0
Ecological Reserve 84	242.0	242.0	242.0	242.0
Non-Commercial Conifers	275.0	275.0	275.0	275.0
Low Productivity Sites	7.3	7.3	7.3	7.3
Riparian Reserves	150.0	150.0	150.0	150.0
Other Tenures	7.5	7.5	7.5	7.5
Gov. Research Instalations	0.4	0.4	0.4	0.4
ALRF Research Installations	43.0	43.0	43.0	43.0
Recreational Reserve	0	0	0	0
OGMA	1465.8	0	0	1465.8
Total Spatial Old Forest	**2191.0**	**725.2**	**725.2**	**2191.0**
Percent of Gross Area	*24%*	*7.8%*	*7.8%*	*24%*
Wildlife Tree Retention	*10%*	*10%*	*10%*	*10%*
Additional Aspatial Retention	*0.0*	*10%*	*0.0*	*0.0*
Total % Area as Old Forest	***34%***	***27.8%***	***17.8%***	***34%***

[1] Only considering polygons that are currently 140 years or older. Additional forested and non-forested polygon areas exist in the categories above but as they are currently not old they are not tallied here. It should also be noted that the Prince George Biodiversity Order allows for up to 20% of areas within Spatial OGMAs to be non-forest, or non-old forest polygons.

Scenario Results

Forecast harvest flows for the Base Case and the alternative biodiversity scenarios are presented in Figure 7. The 'No-biodiversity' objective scenario is not presented as this was nearly equivalent to the 'Aspatial Old Forest Management' Scenario. As expected the Base Case has the lowest harvest levels, as additional non-timber forest values are given significant priority, and site index is assumed to be lower based on provincial data. Table 5 provides a comparison of the modeled harvest flows for all of the scenarios.

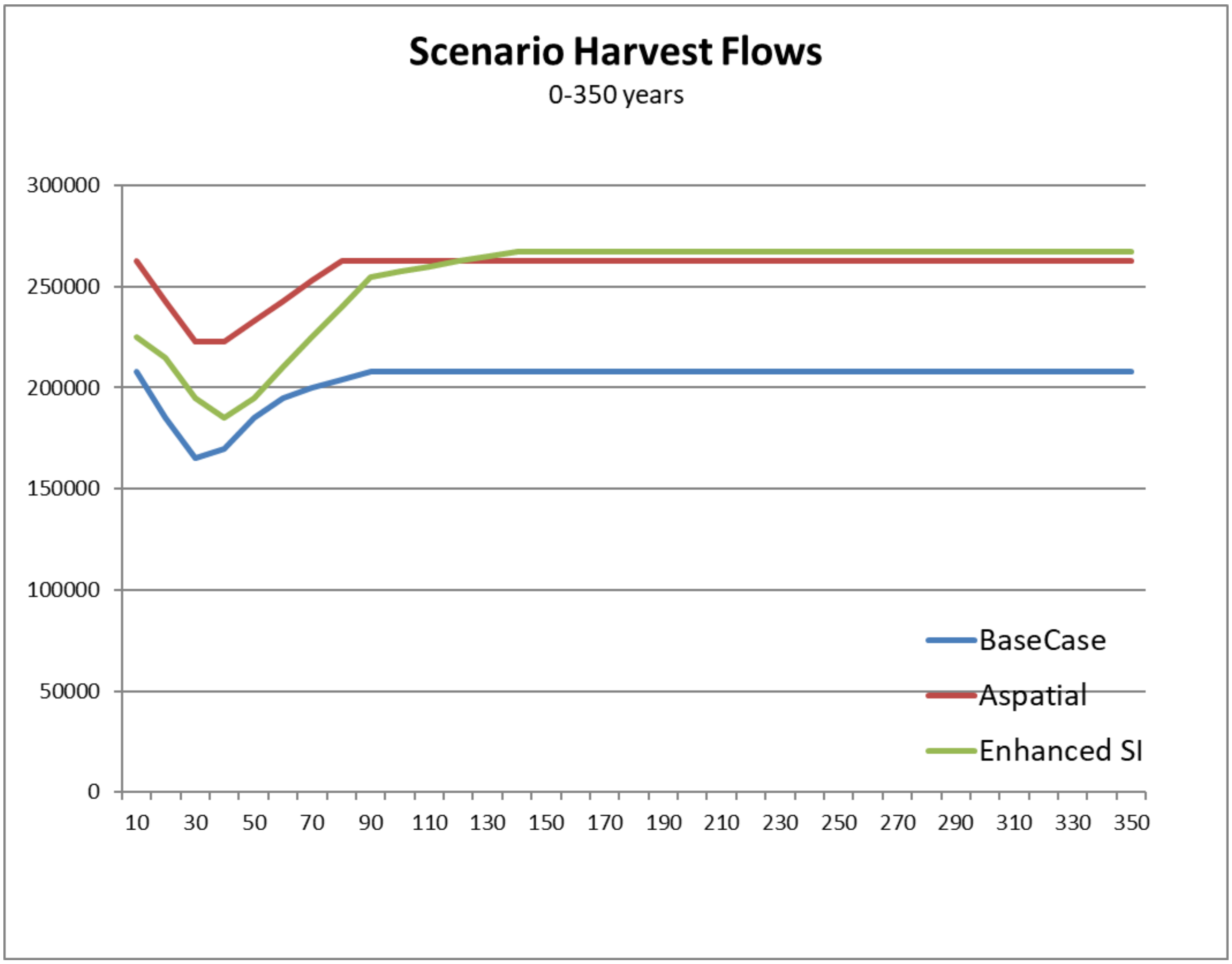


Figure 7: The 'Enhanced Site Index' scenario, which has the same spatially explicit constraints as the Base Case surprisingly has the highest long range even flow harvest forecast.

Table 5: Forecast mean annual sustainable harvest levels for each scenario

YEAR	BASE CASE	ASPATIAL	NO BIODIVERSITY	ENHANCED SI
10	20,800	26,300	26,500	22,500
20	18,500	24,300	24,400	21,500
30	16,500	22,300	22,400	19,500
40	17,000	22,300	22,400	18,500
50	18,500	23,300	23,400	19,500
60	19,500	24,300	24,400	21,000
70	20,000	25,300	24,900	22,500
80	20,400	26,300	25,400	24,000
90	20,800	26,300	25,900	25,500
100	20,800	26,300	26,400	25,750
110	20,800	26,300	26,500	26,000
120	20,800	26,300	26,500	26,250
130	20,800	26,300	26,500	26,500
140+	20,800	26,300	26,500	26,750

Figure 8 provides a visual representation of expected old forest following the modeled harvest. What is distinct from these map images is that only scenarios with a designated OGMA have continuous clear connectivity of old forest cover over time in the modelled scenarios.

Base Case

Aspatial Management of Old Forest

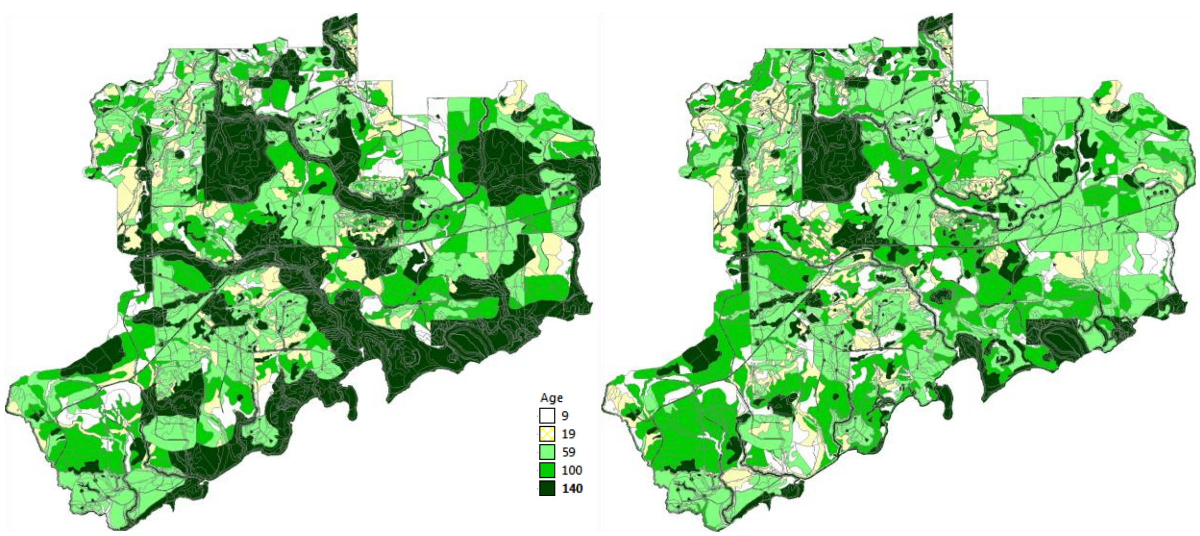


Figure 8:
Modeled Old Forest *following 350 years of management by scenario.* Note that harvested polygons will have an additional 13% wildlife tree retention that are not visible in the maps above.

Scenario D: Deciduous Volume Analysis

To explore future management possibilities for deciduous tree species, the ALRF undertook an additional simple timber supply analysis for commercially viable deciduous species. For this scenario, stands that are Aspen or Birch leading, or where aspen and or birch make up a minimum of 30% of the stand (and that were not excluded from the THLB for administrative reasons) were considered for analysis. Other deciduous trees (e.g. black cottonwood) were not considered as this species is less commercially viable. Additionally, the majority of these cottonwood leading stands is in the OGMA along the Bowron River floodplain and thereby administratively excluded from the THLB. Weighted mean stand species compositions were generated for birch and aspen stands, and growth and yield curves were generated using winVDYP.

Through this form of modeling and using a standard culmination are of 80 years (close to maximum MAI for most Analysis Units) a sustained harvest of 830m^3 / year is feasible for the research forest (see Table 6).

Table 6: Modeled Deciduous Volume by Analysis Unit

Analysis Unit	Species Composition							Hectares	MAI 80yrs m³/year	At Ep proportional MAI 80	Annual Deciduous Volume Available
	Ac	At	Bl	Ep	Fdi	Pli	Sw				
At_leading	1%	61%	9%	10%	0%	1%	19%	48.5	4.4	3.0	148
Ep_leading	1%	0%	15%	68%	0%	0%	16%	32.5	4.7	3.3	106
Bl_At		21%	44%	1%	0%	0%	33%	2.2	1.7	0.3	1
Pli_At		29%	0%	0%	0%	52%	18%	74.8	3.9	1.2	87
SW_Ep		11%	8%	19%	0%	4%	58%	496.0	3.3	1.0	488
TOTAL											**830m³/year**

Recommendations

This timber supply analysis the Base Case conservatively forecasts for the coming decade, a coniferous harvest level of 20,800m^3 per year. As modelled, this will ensure a harvest level that is in-line with all of Management Plan #3's objectives – including timber and non-timber goals. This forecast harvest level and designated retention, specifically the OGMA, in the Base Case allows for sustainable harvest flow while ensuring future research opportunities to examine natural forest ecosystem dynamics.

The Enhanced Site Index scenario suggests that future timber supply 30 years in the future and beyond could be significantly higher than the forecast provided by the Base Case. However, near term cut levels in the next 2 are only slightly elevated when compared with the Base Case. As such near term harvest levels should reflect the Base Case and going forward further field assessments and investigations at the ALRF are planned to test and/or validate the measured site index scenario.

Although higher volumes can be reached while theoretically managing old forest on an aspatial or non-spatial basis there are significant losses to other values through these latter approaches. These include loss of connectivity of old forest types and interior old forest attributes by aspatial Old Forest management, for wildlife habitat and biodiversity.

Subject to market opportunities, timber harvest of deciduous volume at the ALRF can be managed sustainably at an average level of 830 m^3 / year. There is no overlap of these deciduous volume forecasts with coniferous volumes. Therefore, it is recommended that the ALRF track and manage deciduous volume separately from coniferous volume in the ALRF's allowable annual harvest. Such monitoring can be accomplished using the Province's Harvest Billing System (or HBS), if it is ensured that coniferous and deciduous volumes are placed in separate scale strata. Alternately, as the province has no legal requirement to monitor cut control or issue cut control statements for Occupant Licenses to Cut (Prince George District, 2016), management of deciduous volume could be managed by the ALRF using a professional reliance model, and reported to the Province as needed.

Recommendations for Future Timber Management and Timber Supply Analyses

Enhance Forest Inventory

The ALRF has high quality LiDAR data for the entire research forest. As such, it is now feasible to generate an enhanced forest inventory, which will give a clearer understanding of the standing inventory, and provide greater clarify what the near-term harvest levels should be. Additional, LiDAR metrics can also be used to measure plantation performance and allow for more accurate assessments of site index.

Second Growth Forest Growth and Yield Monitoring

The Enhanced SI scenario suggests that future harvest levels could potentially be significantly higher in the long run then the Base Case suggests. As such it will be important to the ALRF to establish long-term GY plots in existing and future plantations. This will assist with improving the accuracy of growth and yield modeling for future timber supply analyses.

Commercial Thinning

As ALRF plantations mature, there will be in increased opportunities for commercial thinning for forest stand improvements, demonstration, and timber utilization. The earliest plantations at the ALRF were established in mid-1960's, and are now 50 years old. Within the coming decade, ALRF is considering operational opportunities for commercial thinning and intermediate cuts in certain stands to enhance timber quality attributes and mid-term timber supply. Early utilization of timber volume may provide a potential uplift to harvest levels in the 3rd decade and beyond.

As early entries are made into stands metrics of pre-harvest stand attributes, utilization, remaining stand volumes, and post-treatment stand volume release and growth will be gathered to inform future TSRs.

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Appendices: Supplemental and Supporting Information

Appendix D-1: Data Sources

Data Description	Layer Name	Data Source	Description	Vintage	Integrated into Resultant GIS
Administrative Linework					
Area of Interest	AOI_26910	ALRF	Outer boundary of the area of interest	2015	Yes
ALRF SUP	alrf	ALRF	The ALRF Special Use Permit 23	2015	Yes
UNBC Private Lands	UNBC	Data BC	A small parcel of UNBC land borders the research forest along the north boundary. The ALRF is in discussion with UNBC to manage this land on behalf of the University	2015	Yes
Merged BEC Landscape Units	n/a	Data BC	These Units are noted for refernce however as per the __ document the ALRF has it's own specified biodiversity objectives set at 30% old forest.	2016	n/a
Indian Reserves	n/a	Data BC	No overlap. The closest reserve is Shelley reserve "Fort George 2" 35 km to the west. It is noted that the research forest is within the traditional lands of the Lheidli T'enneh	2016	n/a
Other Tenures and Leases	O_Tenures	Data BC	Other tenures and Land Act leases listed overlapping with the research forest include: BC Hydro right of ways along the north boundary, the regional district landfill (non-active), a gravel quary (not activated), and Bowron Fiver Outfitters camp.	2016	yes
Agricultural Reserves	n/a	Data BC	A significant portion of the forest is listed in the ALR. However, none of this land is being used for agricultural purposes. This data is provided for reference only and is not included in this analysis	2016	n/a
Parks	Parks	Data BC	Ecological Reserve 84 is internal to the research forest. Although excluded from the THLB. The park area is included for the purposes of calculating Old Forest Biodiversity Objectives.	2016	Yes

Inventories					
Biogeoclimatic Zone	n/a	Data BC	The ALRF is located fully within the SBS wk1 (NDT2) - arcmap.gov.bc.ca was used to query this information however it was not inorperated as an input into the model as there are no differences across the forest	2016	n/a
DTM - Elevation	DTM	ALRF	1m Raster LiDAR derived digital elevation model	2016	n/a
DTM - Slope	Slope	ALRF	1m Raster LiDAR derived slope model	2016	n/a
Vegetation	vri	Data BC	Vegetation resource inventory	2016	yes
New Forest Covers	resultsData	Data BC	RESULTS Inventory data	2016	yes
Forest Cover Edits	fc_edits\	ALRF	A number of vri polygons have reported out of date forest covers. New forest covers were generated using based available data from field surveys, aerial image interpretation, and LiDAR data modeling These are incorporated into the resultsData above	2016	yes
Provincial Productivity Layer	productivity	Data BC	The Site Productivity Dataset provides site index estimates for the entire province for commercial tree species. The estimates are based on available ecosystem data (spatial delineations and descriptions) from existing PEM (Predictive Ecosystem Mapping) and TEM (Terrestrial Ecosystem Mapping) datasets, coupled with SIBEC (Site Index Estimates by BEC Site Series: 2013 Approximation) data. In areas where no PEM or TEM data are available, site index estimates are based on biophysical data and species ranges.	2016	*yes*
Roads	roads	ALRF	Roads data from DATA BC was enhanced using ALRF LiDAR data, adjusting roads to actual 'on-the-ground' interpretation	2016	yes

Road Buffers	road_buffers	ALRF	Buffers are based on aerial image and LiDAR data model interpretation. For example the width of the Aleza Forest Road right of way width was measured at regular (<300m) intervals to provide the mean buffer distance Update: where NP-Roads in the resultsData will be used instead of putting them here. ... otherwise NP-roads become double counted.	2016	yes
Management Guidenace					
Recreation Reserves	Rec.	Data BC	Recreational Reserve Forest File ID REC1092 "Bowron River" is located on the Southern boundary of the research forest	2016	yes
Visual Quality Objectives	vqo	Data BC	Visual quality objectives are set along the Upper Fraser Road corridor and are of some concern along the north boundary of the forest	2016	yes
Wildlife Habitat Areas	n/a	Data BC	Wildlife Habitat Areas; Ungulate Winter Range; Caribou habitats have no overlap with the research forest. The closest identified area are concern are : • Mule Deer Winter Range along the west side of Purden Park 12kms to the south • Mule Deer Winter Range along the Willo River 10km to the South East • Caribou Corridors in the McGregors 20km to the east.	2016	n/a
Ungulate Winter Range	n/a	Data BC		2016	n/a
Caribou	n/a	Data BC		2016	n/a
LRMP Guidance	LRMP_660m	ALRF	Guidance from the Prince George LRMP suggests preserving the Bowron Flood plain. The floodplain is modeled using the ALRF DTM model to an elevation of 660m as per the LRMP. There should be some interpretation here with regard to the full application of this area. This is non-binding guidance and it is suggested that the ALRF OGMA meets and or exceeds the intent of the LRMP direction.	2016	yes integration through OGMA

Field Education Centre Management Area	FieldEdCentre	ALRF	Special management zone around field education centre. The emphasis here is to ensure reduced fire fuel loading and partial harvest systems within this SMZ	2016	yes
ALRF Research Sites	ResearchReserves	ALRF	Long term research sites (e.g. Percy Barr) research plots	2016	yes
MoFLNR	GovResearch	DataBC	Long term research installations managed by government	2015	yes
Old Growth Managent Areas	OGMA	ALRF	A non-legal OGMA has been established by the ALRF. See Management Plan #3 for a discussion of this OGMA	2016	yes
Hydrologic Features					
Streams	streams	ALRF	A new streams layer has been generated by the research forest based on DTM hydrologic modeling.	2016	n/a
Stream Buffers	RMA_Streams	ALRF	Fish Bearing Streams have been buffered for RMA as per LMH 66	2016	yes
	RMZ_Streams	ALLF	Fish Bearing Streams have been buffered for RMZ as per LMH 66	2016	yes
River	Rivers	Data BC	River water body polygons	2016	n/a used VRI polygons
River Buffers	RMZ_Bowron	ALRF	Riparian Reserve Zones as per LMH 66	2016	yes
	RMA_Bowron	ALRF	Riparian Management Areas as per LMH 66 - chp. 15	2016	yes
Lakes	lakes	Data BC	Lake waterbody polygons	2016	n/a used VRI polygons
Lake Buffers	RRZ_L1	ALRF	Riparian Reserve Zones as per LMH 66	2016	yes
	RMA_Lakes	ALRF	Riparian Management Areas as per LMH 66 - chp. 15	2016	yes
Wetland	wetlands	Data BC	Wetlands water body polygons	2016	n/a used VRI polygons
Wetland Buffers	WetL_RMA	ALRF	Riparian Management Areas as per LMH 66 - chp. 15	2016	yes
	WetL_RRZ	ALRF	Riparian Reserve Zones as per LMH 66	2016	Yes

Appendix D-2: Growth and Yield of Analysis Units

Growth and Yield for Natural Stands

winVDYP – Data Input Table

Top 3 species were used for modeling stand species composition. Deciduous volumes were netted out based on percent composition.

Analysis Unit	AC	AT	EP	FDI	BL	HW	LT	Lw	LW2	PLI	SB	SW	SI
11010	10%	0%	53%	0%	8%	0%	0%	0%	0%	0%	23%	5%	13.2
11015	61%	9%	4%	0%	11%	0%	0%	0%	0%	0%	0%	15%	18.0
11020	6%	32%	31%	0%	11%	0%	0%	0%	0%	0%	0%	19%	20.5
11030	83%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	17%	30.0
12015	0%	0%	0%	0%	31%	44%	0%	0%	0%	0%	0%	24%	15.0
13005	0%	0%	6%	0%	15%	0%	0%	0%	0%	0%	70%	10%	6.7
13010	0%	0%	2%	0%	14%	0%	1%	0%	0%	0%	58%	25%	11.5
13020	0%	0%	0%	0%	30%	0%	0%	0%	0%	0%	70%	0%	21.0
14005	0%	0%	3%	0%	51%	0%	0%	0%	0%	0%	21%	25%	8.4
14010	0%	0%	6%	1%	57%	1%	0%	0%	0%	0%	5%	30%	13.2
14015	0%	1%	4%	3%	58%	0%	0%	0%	0%	1%	1%	34%	16.5
14020	0%	0%	1%	0%	50%	0%	0%	0%	0%	2%	0%	46%	20.7
14025	0%	0%	0%	40%	50%	0%	0%	0%	0%	0%	0%	10%	25.0
16010	0%	0%	0%	55%	0%	5%	0%	0%	0%	0%	0%	40%	12.0
17005	0%	0%	0%	0%	33%	0%	0%	0%	0%	0%	22%	44%	9.0
17010	0%	0%	3%	1%	35%	0%	0%	0%	0%	0%	2%	57%	13.8
17015	2%	1%	3%	2%	31%	0%	0%	0%	0%	0%	0%	61%	16.0
17020	2%	2%	4%	1%	24%	0%	0%	0%	0%	0%	0%	67%	20.7

Growth and Yield for Second Growth

TIPSY - Data Input Table

							Genetic Gain %			Age for Genetic Gain								
Analysis Unit	Species 1	%	Species 2	%2	Species 3	%3	1	2	3	1	2	3	SI	SPH	Regen.	OAF1	OAF2	Interior/ Coastal
25010	PL	55	SW	40	Bl	5	0	0	0	0	0	0	13	1500	P	15	5	I
25015	PL	65	SW	30	Bl	5	0	0	0	0	0	0	16	1500	P	15	5	I
25020	PL	70	SW	30			0	0	0	0	0	0	22	1500	P	15	5	I
25025	PL	70	SW	30			0	0	0	0	0	0	25	1500	P	15	5	I
26015	FD	80	SW	20			0	0	0	0	0	0	17	1500	P	15	5	I
26020	FD	80	SW	20			0	0	0	0	0	0	20	1500	P	15	5	I
27015	SW	90	BL	10			0	0	0	0	0	0	19	1500	P	15	5	I
27020	SW	90	BL	10			0	0	0	0	0	0	21	1500	P	15	5	I
27025	SW	90	BL	10			0	0	0	0	0	0	26	1500	P	15	5	I
35005	PL	80	SW	20			1.5	18	0	10	10	0	7	1800	P	15	5	I
35010	PL	80	SW	20			1.5	18	0	10	10	0	12	1800	P	15	5	I
35015	PL	80	SW	20			1.5	18	0	10	10	0	18	1800	P	15	5	I
35020	PL	80	SW	20			1.5	18	0	10	10	0	21	1800	P	15	5	I
35025	PL	80	SW	20			1.5	18	0	10	10	0	25	1800	P	15	5	I
36005	FD	60	SW	40	Bl	10	0	2	0	10	10	0	7	1500	P	15	5	I

Analysis Unit	Species 1	%	Species 2	%2	Species 3	%3	Genetic Gain % 1	2	3	Age for Genetic Gain 1	2	3	SI	SPH	Regen.	OAF1	OAF2	Interior/ Coastal
36010	FD	60	SW	30	Bl	10	0	2	0	10	10	0	12	1500	P	15	5	I
36015	FD	60	SW	30	Bl	10	0	2	0	10	10	0	17	1500	P	15	5	I
36020	FD	60	SW	30	Bl	10	0	2	0	10	10	0	22	1500	P	15	5	I
37005	SW	90	BL	10			17.5	1	0	10	10	0	7	1500	P	15	5	I
37010	SW	90	BL	10			17.5	1	0	10	10	0	12	1500	P	15	5	I
37015	SW	90	BL	10			17.5	1	0	10	10	0	19	1500	P	15	5	I
37020	SW	90	BL	10			17.5	1	0	10	10	0	21	1500	P	15	5	I
37025	SW	90	BL	10			17.5	1	0	10	10	0	26	1500	P	15	5	I

Appendix D-3: Analysis Unit Conversions

Natural Stands		
Description	**StartingAU**	**Conversion**
Nat_Dec_SIL10	11010	37010
Nat_Dec_SIL15	11015	37015
Nat_Dec_SIL20	11020	37020
Nat_Dec_SIL25	11030	37030
Nat_HW_SIL10	12015	37015
Nat_SB_SIL5	13005	37005
Nat_SB_SIL10	13010	37010
Nat_SB_SIL15	13020	37020
Nat_BL_SIL5	14005	37005
Nat_BL_SIL10	14010	37010
Nat_BL_SIL15	14015	37015
Nat_BL_SIL20	14020	37020
Nat_BL_SIL25	14025	37025
Nat_FD_SIL10	16010	36010
Nat_SW_SIL5	17005	37005
Nat_SW_SIL10	17010	37010
Nat_SW_SIL15	17015	37015
Nat_SW_SIL20	17020	37020

Planted Stands *no genetic gain*		
Description	**StartingAU**	**Conversion**
Man_PL_SIL0	25000	35000
Man_PL_SIL5	25005	35005
Man_PL_SIL10	25010	35010
Man_PL_SIL15	25015	35015
Man_PL_SIL20	25020	35020
Man_PL_SIL25	25025	35025
Man_FD_SIL0	26000	26000
Man_FD_SIL5	26005	36005
Man_FD_SIL10	26010	36010
Man_FD_SIL15	26015	36015
Man_FD_SIL20	26020	36020
Man_FD_SIL25	26025	36025
Man_SW_SIL0	27000	37000
Man_SW_SIL5	27005	37005
Man_SW_SIL10	27010	37010
Man_SW_SIL15	27015	37015
Man_SW_SIL20	27020	37020
Man_SW_SIL25	27025	37025
Man_LW_SIL15	28015	37015

Planted and Future Stands *with Genetic Gain*		
Description	**StartingAU**	**Conversion**
Gen_PL_SIL0	35000	35000
Gen_PL_SIL5	35005	35005
Gen_PL_SIL10	35010	35010
Gen_PL_SIL15	35015	35015
Gen_PL_SIL20	35020	35020
Gen_PL_SIL25	35025	35025
Gen_PL_SIL30	35030	35030
Gen_FD_SIL5	36005	36005
Gen_FD_SIL10	36010	36010
Gen_FD_SIL15	36015	36015
Gen_FD_SIL20	36020	36020
Gen_FD_SIL25	36025	36025
Gen_SW_SIL0	36030	36030
Gen_SW_SIL5	37005	37005
Gen_SW_SIL10	37010	37010
Gen_SW_SIL15	37015	37015
Gen_SW_SIL20	37020	37020
Gen_SW_SIL25	37025	37025
Gen_SW_SIL30	37030	37030

Future_Roads	54015	90000
NCFLB	90000	90000