Integrated Silviculture Strategy

Bulkley Timber Supply Area

Harvest, Silviculture and Retention Strategy

V 2.1

March 31, 2020

Prepared for:
BC Ministry of Forests, Lands and Natural Resource Operations and Rural Development
Resource Practices Branch
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Acknowledgements

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) commissioned this project. The project was completed by Forest Ecosystem Solutions Ltd. (Antti Makitalo) with B.A. Blackwell and Associates Ltd. (Jeff McWilliams) providing expert advice and direction in all aspects of silviculture, and Ecologic Research (Steve Wilson) providing facilitation for stakeholder meetings and expert advice in topics regarding habitat supply and biodiversity.

The overall provincial project coordination from FLNRORD was carried out by Paul Rehsler and Craig Wickland. Glen Buhr was the lead representative of the Skeena Stikine Natural Resource District and provided guidance from the district's perspective. Bryce Bancroft from Symmetree Consulting Group Ltd. provided general professional advice and coordination with other similar ongoing provincial projects.

The authors would like to acknowledge and thank the following individuals who participated in the Bulkley TSA stake holder group meetings throughout this project and contributed to the completion of this project (Table 1).

Table 1: Members of the Bulkley TSA ISS stakeholder group

Name	Organization (Member or Representative)
Alex Woods	FLNRORD, Region, Smithers
Anne Hetherington	FLNRORD, Region, Smithers
Antti Makitalo	Forest Ecosystem Solutions Ltd.
Barry Snowdon	FLNRORD, Victoria
Bob Mitchell	Bulkley Valley Community Resource Board
Brad Martin	FLNRORD, Fire Center
Brian Kolman	FLNRORD, Region, Smithers
Bryce Bancroft	Symmetree Consulting Group
Cam Bentley	FLNRORD, Region, Smithers
Curtis Paul	BCTS
Dan Turner	FLNRORD, Kamloops
Dave Ripmeester	Pacific Inland Resources
Dave Wilford	FNLRORD, Region, Smithers
Erica Lilles	FLNRORD, Smithers
Erin Hall	FLNRORD, Smithers
Garth Ehalt	Pacific Inland Resources
Gary Quanstrom	Pacific Inland Resources
Glen Buhr	FLNRORD, Smithers
Glenn McIntosh	BCTS
Hubert Burger	FLNRORD, Prince George
Jay Baker	Silvicon Services Inc.
Jeff McWilliams	B. A. Blackwell and Associates Ltd.
Jeff Walsh	FLNRORD, Fire Center
Jennifer Plummer	FLNRORD, Smithers
Jocelyn Campbell	FLNRORD, Region, Smithers
Ken White	FLNRORD, Region, Smithers
Kevin Astridge	FLNRORD, Victoria
Kevin Skarda	Canfor

Name	Organization (Member or Representative)
Laura Bolster	FLNRORD, Region, Smithers
Len Vanderstar	FLNRORD, Region, Smithers
Marie-Lou LeFrancois	BCTS
Paul Rehsler	FLNRORD, Victoria
Robyn Van Iderstine	FLNRORD, Region, Smithers
Ron Donnelly	FLNRORD, Smithers
Steffy Howard Stratton	FLNRORD, Region, Smithers
Steve Wilson	Ecologic Research
Tim Penninga	Pacific Inland Resources
Walter Tymkow	Canfor

In the course of the project, the several working groups were formed to facilitate work under specific topics. Contributors to these groups are shown in Table 2.

Table 2: Bulkley TSA ISS working groups

Silviculture Working Group	Organization
Jeff McWilliams	B. A. Blackwell and Associates
Garth Ehalt	Pacific Inland Resources
Glen Buhr	FLNRORO, Smithers
Jennifer Plummer	FLNRORO, Smithers
Tim Penninga	Pacific Inland Resources
Wildlife/Biodiversity/Habitat Working Group	**Organization**
Anne Hetherington	FLNRORD, Region, Smithers
Brian Kolman	FLNRORD, Region, Smithers
Glen Buhr	FLNRORD, Smithers
Jocelyn Campbell	FLNRORD, Region, Smithers
Len Vanderstar	FLNRORD, Region, Smithers
Tobi Anaka	FLNRORD, Region, Smithers
Blair Ells	FLNRORD, Region, Smithers
Frank Doyle	Wildlife Dynamics
Steve Wilson	Ecologic Research
Timber Working Group	**Organization**
Anne Hetherington	FLNRORD, Region, Smithers
Antti Makitalo.	Forest Ecosystem Solutions Ltd.
Brad Martin	FLNRORD, Fire Center
Carl Vandermark	Canfor
Dave Louwerse	Silvicon Services Inc.
Dave Ripmeester	Pacific Inland Resources
Erin Hall	FLNRORO, Smithers
Garth Ehalt	Pacific Inland Resources
Gary Quanstrom	Pacific Inland Resources
Glen Buhr	FLNRORO, Smithers
Jeff McWilliams	B. A. Blackwell and Associates Ltd.
Jennifer Plummer	FLNRORO, Smithers
Kevin Astridge	FLNRORD, Victoria
Laura Bolster	FLNRORD, Region, Smithers
Marie-Lou Lefancois	BCTS

Robyn Van Iderstine	FLNRORD, Region, Smithers
Ron Donnelly	FLNRORO, Smithers
Ryan Holmes	FLNRORO, Smithers
Steve Wilson	Ecologic Research

Executive Summary of the Integrated Silviculture Strategy (ISS)

<table>
<tr><td>Timber Supply</td><td colspan="2">This analysis built a dataset like the one constructed for the Bulkey TSA Timber Supply Review (TSR). The data incorporated additional THLB netdowns and management objectives that reflect the goals and objectives of the ISS. The ISS Base Case has a THLB of 204,978 ha and predicts a harvest level of 615,900 m^3 throughout the planning horizon.

The ISS Selected Management Scenario was chosen as it improved both the short- and long-term harvest forecast, and the value of the future timber supply. The ISS Selected Scenario harvest level is predicted to be 8.0 % higher than that of the ISS Base Case between years 1 and 90 (662,260 m^3 per year vs. 615,900 m^3 per year) and 9.6% higher in the long term (673,210 m^3 per year vs. 615,900 m^3 per year).</td></tr>
<tr><td>Objectives</td><td colspan="2">Maintain or increase timber supply. Increase the value of future timber supply. Maintain or improve condition of identified non-timber values.</td></tr>
<tr><td>General Strategy</td><td colspan="2">Apply harvest, silviculture and non-timber strategies to achieve objectives.</td></tr>
<tr><td>Harvest Strategy</td><td colspan="2">Forsite Consultants provided data for this project that was compiled as part of the Bulkley Higher Level Plan Order 2016 Analysis. The data included proposed harvest blocks for approximately 7 years. These blocks were incorporated into the analysis. This approach ensures that some operational reality is included in this analysis and the presented harvest strategy. As some of the harvest for the first 10 years is based on computer generated scheduling, the presented strategies and plans are at least partly conceptual and should be taken as guidelines

In the harvest forecast approximately 94% of the harvest in the first 10 years is predicted to come from stands older than 140 (age classes 8 and 9), while the combined share of all other age classes is predicted to be only 6% of the harvest).

Most of the harvest in the next 10 years is predicted to come from balsam stands (49.8%). This reflects the species profile in the TSA. The shares of spruce and pine are forecasted at 26.0% and 11.7% respectively. The predicted shares of spruce and pine harvest are reasonable given their estimated shares of the total THLB volume – 30% for spruce and 18% for pine. The rest of the short-term harvest is predicted to come mostly from hemlock volume (8%).

Approximately 95% of the harvest over the next 10 years is predicted to consist of sawlog harvest with the balance coming from stands of marginal sawlog quality. The predicted harvest of marginal sawlogs is less than their estimated share of the THLB at 14%.</td></tr>
<tr><td>Major Silviculture Strategies</td><td>Timber Volume and Value Over Time</td><td>The ISS Selected Management Scenario is designed to maximize the production value (volume times value) of the harvest over the long term.

Where timber is a primary objective, intensive management for timber volume and value under this strategy is directed to the green and yellow silviculture zones (sites with best returns and lowest risks) and away from portions of the red silviculture zones (sites with the poorest site productivity or highest risks).

Existing managed stands: The strategy consists of fertilizing the old era Sw leading stands in parts of the green and yellow silviculture zones every 10 years from age 30 to age 70.

Future managed stands: In green to yellow silviculture zones with a timber objective, the strategy promotes the establishment of a mosaic of ecologically suitable single species stands (which achieve landscape-level species composition targets) with enhanced densities specifically designed to optimize the production and value of each species. Lower planting densities are proposed for the ESSFwv and the higher elevation portion (>1,100 m) of ESSFmc to balance overall reforestations costs... The species portfolio for each BEC unit was developed with consideration of climate change and forest health risks. Further considerations are:

➢ Use average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules;
➢ Use the Climate Change Informed Species Selection (CCISS) tool to guide species portfolios;
➢ Fertilize Sx, Fdi and Pli stands at year 40 and year 50;
➢ The strategy includes planting of Cw on ecologically suitable sites; these stands are assumed to be spaced to favor Cw. No fertilization of Cw is assumed;
➢ Assume high log prices for all enhanced future regimes
➢ Use the minimum volume per ha as per the latest TSR and the age at which the 95% MAI culmination is reached as the minimum harvest criteria.</td></tr>
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The silviculture strategy sets an incremental silviculture target of 729 ha of fertilization of Sw leading stands per year for the first 5 years at the cost $364,362 per year. The fertilization program is set to decrease somewhat to 619 ha per year in the second 5-year period starting 6 years from today. The annual cost is projected at $309,523 for years 6 to 10.
If all aspects of the silviculture strategy are implemented, the size of the fertilization program is forecast to remain at this level until year 26, when it starts to decline; the population of candidate old managed stands decreases as they age. Between years 36 to 40, only 164 ha per year of fertilization are predicted. No spacing is expected over the next 10 years. A modest Cw spacing program is predicted to start in year 16 and continue with annual spacing areas ranging from 240 ha to 400 ha.
This strategy proposes higher planting densities on selected sites in the TSA. Approximately 755 ha and 758 ha of increased density planting are predicted annually for years 1 to 5 and 6 to 10 respectively. The predicted annual incremental planting costs for years 1 to 5 are $236,473 and $234,184 for years 6 to 10.
This strategy also proposes to reduce planting densities and to promote more Bl in the ESSFmw and the high elevation portion (>1,100 m) of the ESSFmc. The reduced planting densities are predicted to be applied on 383 ha annually for years 1 to 5 and on 291 ha annually for years 6 to 10. The predicted annual reduction in planting costs due to reduced densities is -$128,374 for years 1 to 5 and -$98,933 for years 6 to 10.
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<tr>
<td>Fire Prevention Strategies</td>
<td>Treatment of High Fire Risk Stands in the Urban Interface</td>
<td>
The strategy is to determine actual fire threat levels in the urban interface areas through field surveys and prescribe appropriate treatments. Treatments may focus on reducing the canopy bulk density, reducing the overall density of the stand, and /or reducing on-ground fuels.
Potential treatments for existing stands are species conversion, partial harvesting, juvenile spacing and pruning. All treatments should also include slash treatments to reduce short term hazard. Treatments to reduce fire risk within the urban interface will be carried out in accordance with community wildfire protection plans.
Treatments to reduce fire risk were modeled in a sensitivity analysis, which assumed that within a 50 m buffer from homes, farm structures and other buildings, all coniferous forest would be converted to deciduous forest.
Treatments to reduce fire risk at stand level were not modeled due to the lack of reliable data.
In case of new plantations, consideration should be given to using fire management stocking standards located at:
https://www.for.gov.bc.ca/hfp/silviculture/Fire%20Management%20Stocking%20Standards%20Guidance%20%20Document%20March%202016.pdf
</td>
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<tr>
<td>Silviculture Program</td>
<td>Annual Treatment Schedule</td>
<td>
Years 1-5
<table>
<tr><td rowspan="2">Treatment/Activity</td><td colspan="2">Years 1 to 5</td></tr>
<tr><td>Area (ha)</td><td>Annual Costs ($)</td></tr>
<tr><td>Fertilization</td><td>729 ha</td><td>$364,362</td></tr>
<tr><td>Increased (or reduced) Planting Densities</td><td>1,138 ha</td><td>$108,099</td></tr>
<tr><td colspan="2">Annual Total</td><td>$472,461</td></tr>
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<tr><td></td><td></td><td>
Years 6-10
<table>
<tr><th rowspan="2">Treatment/Activity</th><th colspan="2">Years 6 to 10</th></tr>
<tr><th>Area (ha)</th><th>Annual Costs ($)</th></tr>
<tr><td>Fertilization</td><td>619 ha</td><td>$309,523</td></tr>
<tr><td>Increased (or reduced) Planting Densities</td><td>1,049 ha</td><td>$135,251</td></tr>
<tr><td colspan="2">Annual Total</td><td>$444,774</td></tr>
</table>
</td></tr>
<tr><td rowspan="2">Outcomes</td><td>Timber Volume Flow Over Time</td><td>The ISS Selected Management Scenario was chosen as it improved both the short- and long-term harvest forecast, and the value of the future timber supply. The ISS Selected Scenario harvest level is predicted to be 8.0 % higher than that of the ISS Base Case between years 1 and 90 (662,260 m^3 per year vs. 615,900 m^3 per year) and 9.6% higher in the long term (673,210 m^3 per year vs. 615,900 m^3 per year).</td></tr>
<tr><td>Timber Value</td><td>In the long term, the ISS Selected Management Scenario is predicted to create significantly more timber value from managed stands</td></tr>
<tr><td rowspan="3">Biodiversity, Wildlife, Water</td><td>Critical issues</td><td>The Bulkley LRMP provides for broad-scale biodiversity management but a number of issues were identified through the ISS process that require management responses, including: 1) collapse in Northern Goshawk breeding area occupancy, 2) a critically low woodland caribou population; 3) declining moose, mountain goat and grizzly bear populations (to various degrees); 4) concern about the impacts of loss of critical stand attributes on the managed landscape (e.g., coarse woody debris, snags); and 5) maintaining hydrological function to support ecosystem health and services.</td></tr>
<tr><td>Implications of the learning and selected scenarios</td><td>Biodiversity indicators were generally insensitive to intensive silviculture regimes and were not negatively affected by the selected management scenario, compared to the ISS Base Case.

An ECA target of 20% could be implemented in all 4th order watersheds with a minimal impact on timber supply (0.3%).

Enforcing seral stage targets in projected Northern Goshawk territories reduced timber supply by 4.9%, while enforcing an “undisturbed” target of 90% in critical caribou habitat reduced timber supply by 7.5%.</td></tr>
<tr><td>Additional strategies</td><td>Several strategies compatible with the selected scenario were identified to improve management of specific wildlife species and biodiversity in general, including: 1) reduced stocking standards in habitats zoned for moose, mule deer and grizzly bear; 2) deactivation of non-status roads where densities exceed 0.6 km/km^2 in grizzly bear habitat; 3) review and revise current flexible reserves and leave areas to better optimize co-location of multiple values; 4) where possible, “anchor” wildlife tree patches to existing habitat features (e.g., ephemeral wetlands, seeps, rock outcrops); 5) retain or create coarse woody debris piles using various diameter and decay classes; and, 6) create missing habitat features in managed stands (e.g., snags, nesting platforms, nest and bat boxes).

The effectiveness of strategies should be tested through field monitoring tied to practices (e.g., occupancy of potential breeding and foraging areas by Northern Goshawks, marten distribution and abundance in relation to CWD retention/creation, grizzly bear population monitoring in relation to road densities and forage supply).</td></tr>
</table>

1 Introduction

The Resource Practices Branch (RPB) of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) is developing a new management unit planning framework; Integrated Silviculture Strategy (ISS). The ISS is a sustainable forest management planning framework with the objective to integrate all aspects of landscape-level and operational planning for each Timber Supply Area (TSA).

The ISS will integrate Type 4 Silviculture Strategies with timber supply review (TSR) to reduce duplication and redundancies where possible by sharing inventories, management zones, analysis units, Timber Harvesting Land Base (THLB) definitions and management assumptions. It is expected that the ISS process will improve the linkages to landscape level fire management, the Cumulative Effects Framework, the Forest and Range Evaluation Program's (FREP) multiple resource values assessments (MRVA) and other regional, management unit level or landscape level plans and strategies.

2 Context

This document is the fourth of four documents that make up an ISS. The documents are:

1. Situation Analysis – describes in general terms the current situation for the unit. The Situation Analysis forms the starting point for the initial planning group meeting to identify opportunities.
2. Data Package - describes the information that is material to the analysis including data inputs and assumptions.
3. Modeling and Analysis report –provides modeling outputs and rationale for choosing the ISS Selected Scenario.
4. **Integrated Silviculture Strategy – represents the ISS Selected management scenario which is the basis for the first iteration of the ISS. It includes an investment strategy and provides treatment options, associated targets, timeframes and expected benefits.**

When the ISS is complete, a spatial operations schedule will provide direction for harvesting and a land base investment schedule will guide Forest for Tomorrow (FFT) Annual Operating Plans.

3 Study Area

The Bulkley TSA is in north-western BC covering four main communities: Smithers, Telkwa, Moricetown, and Fort Babine (Figure 1). The TSA is situated between the Hazelton Mountains in the west and Babine Lake in the east. The Telkwa River watershed forms the southern boundary of the TSA while its northern boundary extends to the headwaters of the Nilkitkwa River. The total area of the Bulkley TSA is 762 734 hectares.

The Bulkley TSA is part of the FLNRORD Skeena Region, North Area and is administered by the FLNRORD Skeena Stikine Natural Resource District in Smithers.

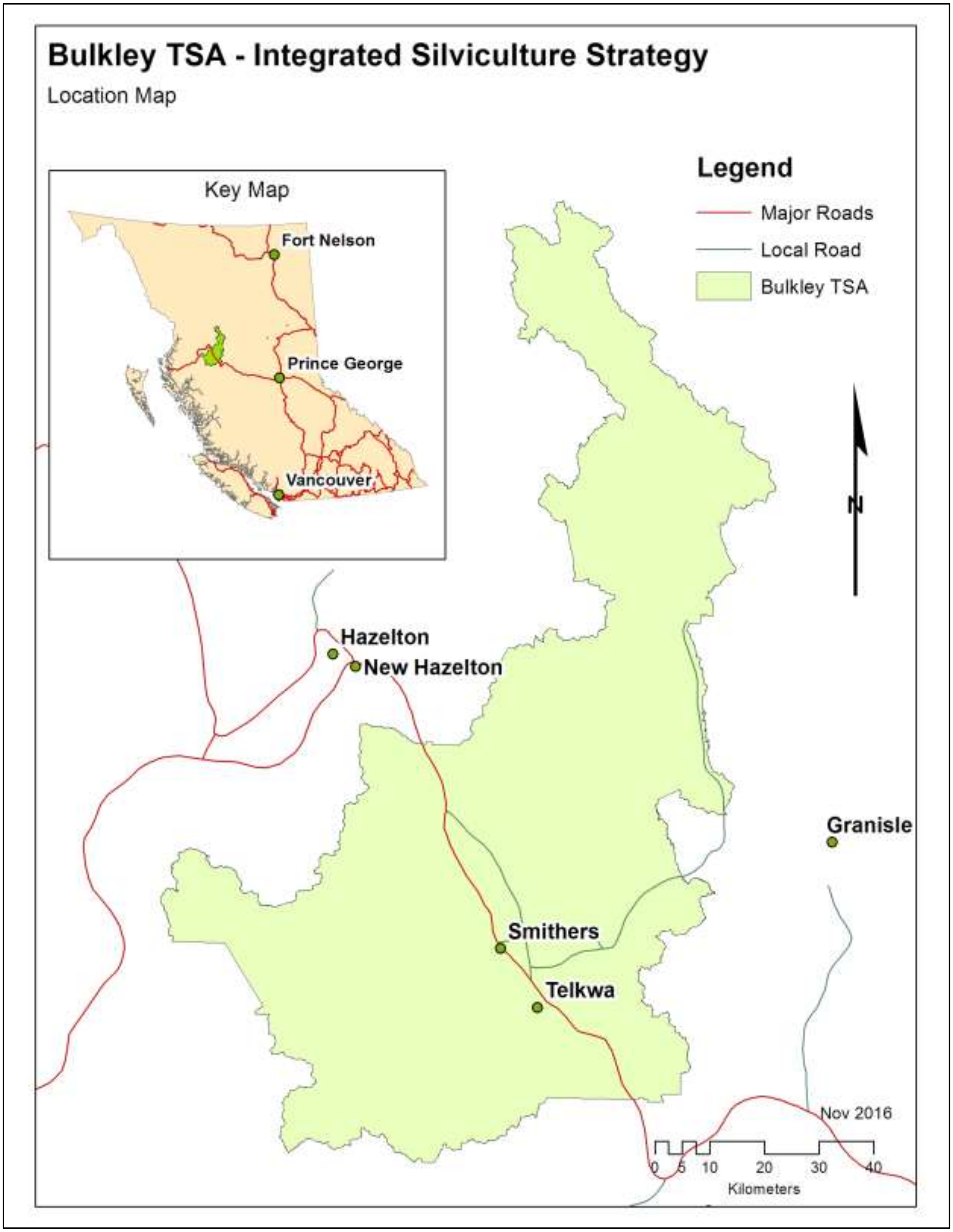

Figure 1: Bulkley TSA

4 Critical Issues

Critical issues were identified by the district staff and stakeholders during several stakeholder group meetings. The most important critical issues are listed below. Many of the critical issues cannot not be solved through this planning process; however, they are identified in this report.

The silviculture, harvest, and retention strategies discussed in this report are intended to address the critical issues that pertain to some of the TSA key values, particularly timber, water, wildlife and climate change adaptation.

4.1 Natural Forest

The natural stands in the Bulkley TSA are mostly old and mature seral stage forests. They represent the short-term timber supply and a significant portion of the mid-term timber supply for the TSA and act as a source for multiple values in the TSA, such as biodiversity, wildlife, water and other non-timber values. Climate change and cumulative effects of development are expected to put increasing pressure on the existing forest through pests, disease and fire.

4.1.1 Marginal Sawlog and Pulpwood Stands

Past timber supply reviews (TSR) have assumed that marginal sawlog and pulpwood stands will be harvested over time and converted to managed stands. Due to market conditions, these stands are generally not economic to harvest, which will reduce the mid- to long-term timber supply.

In this analysis, all areas classified as pulp were removed from the THLB. Furthermore, all areas classified as marginal sawlog located further than 1 km away from a road and all areas classified as marginal sawlog located further than 5-hour cycle time away from Smithers were removed from the THLB. Note that the marginal timber in planning cell C7 was included in the THLB.

There may be opportunities to convert some of these stands to productive managed stands. This was tested through a sensitivity analysis. Including the removed pulp and marginal sawlog areas in the THLB increased the size of the THLB by 39,111 ha (19%) to 244,089 ha. The harvest forecast increased by 17% (106,970 m3 per year).

4.2 Existing and Future Managed Forest

4.2.1 Existing Managed Forest

These stands represent the managed forests in the TSA ranging from recently reforested areas – less than 10 years of age – to older plantations up to 50 years of age. The mid-term timber supply in the TSA is largely dependent on these stands and protecting the investments in these forests is important. After residential areas and critical infrastructure, these stands have the highest priority for wildfire suppression. Also, they are a high priority for forest health surveys and subsequent remedial action, such as fill-in planting.

4.2.2 Future Managed Forest

Future plantations represent the long-term timber supply is the Bulkley TSA. These forests are required to be resilient against pests and diseases, and climate change.

4.3 Wildlife Habitat

4.3.1 Large Mammals

The Bulkley LRMP and the associated higher-level plan orders set objectives for managing wildlife habitat in the Bulkley TSA. Legal objectives are defined for moose, mountain goat, woodland caribou, grizzly bear and mule deer. According to the district, except for mule deer, the populations of all the other large mammals are in decline in the TSA. The long-term goal is to re-establish the populations of these mammals at historic levels.

The breeding population of Northern Goshawk (*atricapillus* subspecies; NOGO) has recently collapsed to very low levels in the Bulkley TSA and adjacent areas, with 95% of previously known territories being abandoned (FLNRORD 2018).

Mountain goat, grizzly bear and Northern Goshawk are all provincially blue-listed (i.e., special concern). Woodland caribou (southern mountain population) is red listed provincially (i.e., endangered or threatened) and is subject to a federal recovery strategy (Environment Canada 2014).

4.3.2 Coarse Filter Biodiversity Management

The district would like to improve the coarse filter biodiversity management in the TSA. This can be done by focusing on management of species that are strongly associated with forest structural elements that provide habitat for a range of other species. For example, managing for species such as marten and Northern Goshawk can address the habitat needs of other species that are dependent on coarse woody debris and mature and old forests, respectively.

4.4 Characterizing of Current Management

The Chief Forester of British Columbia (BC) determines the annual allowable cut (AAC) for all management units in BC. The AAC determination process is guided by provincial laws and policy with the emphasis on accounting for current and reasonably expected management. The Chief Forester rarely speculates about land use decisions and only approved and implemented plans are incorporated into timber supply reviews with uncertainties tested through sensitivity analyses.

The Bulkley ISS stakeholder group decided to incorporate some impending land use decisions, such as a new First Nations Woodland Licence (FNWL) in this analysis. In addition, the stakeholder group discussed economic issues and adopted a different approach than the TSR in dealing with marginal sawlog and pulpwood.

4.4.1 Constraints Related to the Land Base

The accounting for forest cover constraints, such as cutblock adjacency, visually effective green-up and wildlife tree retention may not be adequate in timber supply analyses. These types of constraints often require forest cover retention and control of the rate of harvest. As an example, it can be difficult to efficiently harvest remaining, adjacent timber in a visually sensitive area after the initial harvest.

The scale and distribution of stand level retention is not well understood. Better reporting and monitoring of stand level retention would contribute to more accurate analysis of the impacts of management to meet these objectives.

4.5 Emerging Constraints

Strategic decisions regarding Northern Goshawk habitat management and possibly other wildlife are expected to reduce the THLB and constrain harvest. Co-location opportunities with other values should be investigated, if new WHAs or other legal designations are established.

4.6 Impediments to Long term Value Creation

4.6.1 Tenure and Appraisal Systems and Lack of Harvest Controls

Harvesting rights within TSAs are allocated using volume-based tenure agreements. These tenures have long terms and they are renewable. However, there is no guarantee that a licensee who harvests and reforests a site according to the government regulated stocking standards will be able to harvest the regenerated stand. As a result, these tenures do not provide a framework that promotes the licensees to develop and employ preferred reforestation strategies. This is especially true if the preferred performance (stocking and species) is more risky or costly. This is a problem, as most long-term strategies that are designed to improve volume and value, commonly initially depend on investments in enhanced reforestation.

Under the current appraisal system, major licensees (holders of renewable, long term volume and area-based tenures) pay stumpage to the government to harvest timber. Simplistically, stumpage is the residual of the estimated value of the standing timber less agreed upon estimates of historical costs to access, harvest and transport the timber to market, and the costs to administer the license and reforest the harvested area as per the current stocking standards.

Value strategies, such as the one presented in this report are based on investments in enhanced reforestation. They incorporate higher establishment densities and are likely to produce a more valuable stand for a licensee to harvest in the future; however, the main beneficiary of the increased value will be the government as the recipient of higher stumpage.

Recent changes in the interior appraisal system provide an opportunity for the TSA licensees to recover the costs of planting with enhanced densities on some sites (SBSmc2, SBSdk and ESSFmc) consistent with this strategy. This is voluntary and requires the licensees to amend their Forest Stewardship Plan (FSP) stocking standards. Taking advantage of this opportunity would be is a positive step in promoting investments in basic silviculture.

It is important that investments in enhanced reforestation are made in areas where harvest is not expected to be constrained in the future and where the risk of fire or diseases to the established plantations is low. Currently there are no restrictions on the sites eligible for the appraisal allowance relative to constraints to future harvest or risk. Unfortunately, the enhanced reforestation appraisal allowance does not cover all productive BEC units (e.g.: ICHmc1, ICHmc2) in the Bulkley TSA.

Another factor influencing the viability of investments in silviculture is the lack of linkage between the assumptions that support the investment decision and whether those assumptions hold true in operations. While the public are the primary investors in improvements in forest management, the licensees control the timing of harvest. Substantial investments can be wasted, if managed stands are harvested at ages contrary to the silviculture investment rationale.

In summary, value strategies, such as the one presented in this report, cannot be implemented effectively without changes to regulations, and the tenure and stumpage system. The value strategy is based on initial investments in enhanced reforestation on preferred sites. These stands can then become preferred candidates for subsequent investments. It is of critical importance that all silviculture investments are consistent with a long-term plan considering expected harvest ages. Only in this way, can the public be confident that investments in forestry are viable. The current tenure and stumpage systems, and regulations do not provide an adequate incentive for the licensees to make investments on public forest lands in BC, nor do they allow the government to invest in basic reforestation on sites logged by licensees.

4.6.2 Conflicts Between Resiliency, Diversity and Valuable Forests

Due to a lack of cohesive, integrated and current land use objectives in most areas in British Columbia and a lack of awareness of the importance of managed stands to our forest economy, our reforestation practices over the last 30 years have been dominated by stand-level approaches where multiple objectives are attempted to be met on every hectare. This approach has led to compromises in management practices and on many sites neither timber nor non-timber objectives are achieved well.

The recent focus on reforestation practices which target stand-level diversity and resiliency as part of an overriding focus of climate change mitigation are the latest examples of strategies which rarely match up with producing value forests consistent with timber supply expectations. As a result, there is a concern that our current strategies will not support the forest economy as expected.

As part of this project we would like to remind the readers of this report of different and likely better ways to try and achieve resilience, diversity and value in our forests. The Bulkley TSA ISS addresses resilience, diversity and value at the landscape-level and through the concepts of silviculture zoning and species portfolios. The value is further addressed through the concept of “un-mixing the mixes” at the stand level.

4.7 Forest Inventory

The Bulkley Vegetation Resource Inventory (VRI) Phase I was completed in 2008. The Phase II ground and net volume adjustment factor sampling was concluded in 2010. An audit in 2012 uncovered several issues with Phase 1 VRI. The Phase 1 delineation and the species composition and stand age attribute decisions did not meet the ministry standard. Also, lack of confidence in balsam tree live / dead attribution was expressed.

Approximately 20% of the TSA was re-inventoried in 2015. In 2017, Forest Analysis and Inventory Branch (FAIB) provided a continuous inventory coverage for this project. The 2017 VRI consisted of the re-inventory portion of the TSA, and the updated inventory for the rest of the TSA. The updates accounted for past harvesting and mortality in pine stands.

The district staff and the licensees feel that a new VRI Phase 1 inventory is needed for those areas of the Bulkley TSA that were not included in the 2015 re-inventory.

4.8 Uncertainties with Growth and Yield and Modeling of Managed Stands

Our current knowledge of the growth and yield of managed stands is lacking, and our modeling of these stands is simplistic. Modeling of managed stands for TSR or other strategic analysis projects relies on silviculture data which does not provide accurate information for the attributes required for growth and yield modelling (e.g.: TASS or TIPSY). In addition, modeling of managed stands commonly uses broad groups (analysis units) which rely on averages of wide-ranging attributes. Furthermore, given the high proportion of mixed species in managed stands and the common use of models such as TIPSY (not designed to model mixed species stands), our forecasts of future species compositions and rotation ages is uncertain.

This project took a detailed approach to growth and yield modelling, and split managed stands into 3 eras. Furthermore, the BEC and slope/aspect framework was used to further refine the analysis unit groupings. The available RESULTS planting and inventory data from recently reforested stands and professional opinion from Bulkley TSA silviculture practitioners were used to formulate the managed stand yield curve inputs.

Given the importance of managed stands to the timber supply and timber value in many areas of British Columbia, more focus is needed on assessing and monitoring the growth and yield, and health of existing managed stands. Data and information collected through mid-rotation stand monitoring should be used to inform growth and yield models and improve timber supply forecasts for future managed stands.

4.9 Confusion over Timber Quality and Timber Objectives: Value versus Volume

The current provincial target for premium logs is 10% of the AAC for each TSA. In the past, a premium log was frequently defined by such characteristics as species, taper (lack of), tightness of grain, clear wood, and size. In practice, piece size is the only characteristic that could be tracked and modeled in various analyses. The volume or proportion of large logs was the main surrogate for quality.

Today many of the above-listed traits still define quality; however, bigger is only better if the rest of the log quality attributes (e.g.: taper, rate of growth, knot size/distribution) are the same or better in the bigger log. This often leads to the common misconception that managed trees grown to the same size as naturally grown mature trees in less than half the time will have the same quality and value. We need to understand that there are trade-offs between growing fewer trees to become larger as fast as possible, versus spreading the site growth potential over more stems.

It is not always clear whether the quality of managed stands is as expected. Furthermore, the quality expectations are often not defined; nor are they integrated and traded off with volume production. There is often confusion over timber objectives: maximum volume or maximum production value. Simplistically, the value of forest production is the volume harvested times the value of the harvest. Most of the past harvest in British Columbia has come from mature, natural forests. The quality, while important, was not specifically managed for. However, as we transition to harvesting managed forests, there are significant trade-offs between volume and value. Some strategies could favour volume (e.g., shorter rotations with more Pl in the interior and more Hw on the coast) and some could favour value (e.g., longer rotations with more Fd in the interior and more Cw on the coast).

In an effort to learn more about the opportunities and trade-offs associated with volume and value strategies, this project used generic industrial northern interior log sort specifications and recent market values to track the production value (together with the volume) for the managed stand portion of the harvest forecasts for each of the different scenarios tested. In addition, timber strategies were specifically developed to try to maximize volume and to maximize production value. The project participants chose the scenario that emphasized value as the selected strategy for this project.

This strategy utilizes higher establishment densities on medium to good productivity timber-producing sites in lower risk and lower cost areas to encourage the development of high quality trees with fewer, smaller branches and less stem taper. These stands should be preferred candidates for potential subsequent investments in density management and fertilization.

5 Strategic Objectives

Coarse objectives were developed for the Bulkley TSA through several stakeholder meetings. The objectives were developed for broad values considered important to the stakeholder group: economic values, environmental values and social values.

The objectives are expressed as statements of what ideally is desired on the land base; however, not all objectives might be realized as stated when attempting to achieve them simultaneously. The objectives are not ranked or constrained by targets; this provides maximum flexibility and learning from scenario analysis.

Each objective contains a performance measure or indicator to facilitate meaningful quantitative and qualitative comparisons between different scenarios and ultimately management options. Note that the objectives and performance measures are focused on addressing critical issues that have been raised by stakeholders; however, there are other non-listed objectives that are captured as current management, as driven by legislation and policies. These were fixed in the ISS Base Case and across all scenarios. Strategies to achieve objectives were collated into logical scenarios for comparison against the ISS Base Case.

The following matrix illustrates agreed upon management objectives (Table 3).

Table 3: Management objectives for the Bulkley TSA

Value category	Objective	Performance measure/indicator	Modeled in this Analysis	Notes
Timber	Achieve current AAC, i.e. economic harvest of the timber profile	Cubic meters harvested per year	Yes	This could be an aggregate over many years to allow year-to-year variation.
	Stable timber supply into the future	Cubic meters harvested in the long term, stable growing stock	Yes	
	Increase the volume and value of timber supply over time	Yield times average revenue (from managed stands), by product and grades, summed by year	Yes	
	Maximize carbon storage	Tonnes of carbon	No	A clear trade-off with harvesting but still an off-setting economic opportunity.
Forest Ecosystem Diversity	Maintain rare and uncommon ecosystems	Area logged in rare and uncommon ecosystems.	No	Remains a strategy objective. Needs to be considered in operations.
	Maintain diversity of seral stages	Young forest patches as per NROV	No	Patches are difficult to model explicitly. Can be tracked over time through operations and reporting.
		Maintain old forest and old interior forest	Yes/No	Old forest can be tracked in the model. Old interior cannot.
	Maintain riparian areas	% of riparian area that maintains 70% of structure and function of mature and old	No	Operational objective.
	Stand level ecosystem diversity	Maintain diversity in WTPs	No	Operational objective.
Wildlife	Forest that supports wildlife habitat	% of area replanted with modified stocking standard for grizzly bear, moose and caribou.	No	Assumptions can be built into modelling that assume specific regeneration activities for given sites/habitat
		Harvest areas reforested with tree species representative of the original BEC zone/variant	Yes/No	Future Species composition is an input to the forest estate model.
		Harvest areas reforested with mixed species composition	Yes/No	Future Species composition is an input to the forest estate model.
		Plant harvested sub-alpine fir back to sub-alpine fir	Yes/No	Future Species composition is an input to the forest estate model.
		Less planting of higher value stands in areas marginally contributing to the THLB	Yes/No	Future Species composition is an input to the forest estate model. Zoning can facilitate different regimes in different areas.

Value category	Objective	Performance measure/indicator	Modeled in this Analysis	Notes
	Maintain Habitat for Identified Species at Risk (Caribou)	% of identified critical habitat for listed SAR that meets management objectives of the Federal Species at risk act (caribou).	Yes	Habitat is tracked and modeled. The habitat target is that of the Federal Caribou Recovery Strategy, i.e. 90% of the forested area within the mapped caribou habitat should be older than 140 years.
	Maintain Habitat for Moose	% of wetlands and floodplains with >100 m buffers intact to support moose cover habitat	Yes/No	The indicator is specific to operations. This analysis tracks and models moose habitat at the landscape level. One scenario establishes 100 m buffers of mature forest around each wetland.
	Grizzly bear	Areas with road density less than 0.6 to 0.75 km/km2 within grizzly bear habitat	No	Current road density can be measured. Future road density remains an operational consideration.
		A low forage supply indicator if proportion of mid-seral is >30% in any (CWH, SBS, ICH, ESSF, IDF, MS or MH) biogeoclimatic variants within the Landscape Unit."	Yes	Tracked in analysis, enforced in some scenarios.
	Northern Goshawk	Number of identified NOGO breeding areas with breeding area management plans.	No	
		Number of >100 ha patches of >70% old structure and function to support NOGO breeding and post-fledgling habitat.	No	Patches can be tracked post-harvest, not predicted, unless areas are identified prior to modelling as reserves.
		Maintain a number of spatial territories of 2,400 ha with >60% greater than 80 years old.	Yes	The analysis tracks and models existing (6) and projected territories. Map of projected territories was provided by FLNRORD ecosystems staff and was current as of August 2019. Originally 63 territories were modeled. This was reduced to 37 (6 existing) over the course of the project.
	Mountain goat	Areas with at least 2km horizontal distance between goat habitat (cliffs/bluffs) and forest development activity	No	Strategy objective that is applied in operations. Draft UWR incorporated in some scenarios.
	Beaver and Waterfowl	Number of riparian management zones with >30% At or Ep component to support beavers and waterfowl	No	Strategy objective that is applied in operations
	Fisher	No. of suitable large, cavities/ha in SBSdk (site series)	No	Strategy objective that is applied in operations
	Wolverine	Reduce Access, maintain large CWD for dens & biodiversity for forage.	No	Strategy objective that is applied in operations

Value category	Objective	Performance measure/indicator	Modeled in this Analysis	Notes
	Marten	Coarse-woody debris (CWD)	Yes	Strategy objective that is applied mostly in operations. The analysis will track old forest in the TSA; assumption is that old forest is an indicator for CWD.
	Maintain cool S5 and S6 Stream Temperature for fish	Stream Temperature	No	Can be monitored in operations.
Water	Watershed integrity, maintain watershed function	Number of watersheds with hydrological equivalent clear-cut area (HECA) >30%	Yes	The analysis tracks and models ECA in all 4th order watersheds.
		Number of watersheds meeting Interior Watershed Assessment Procedure (IWAP) metrics (km roads/km2, # stream crossings, degree of riparian harvesting	No	Strategy objective that is applied in operations
Social	Minimize risk of catastrophic fire in interface areas	Proportion of interface area classified as moderate-high threat	No	Strategy will prescribe stand level treatments for operations. These are not modeled at the forest level.

6 ISS Base Case Analysis Assumptions

The TSR analysis assumptions were revised through stakeholder meetings to reflect current management in the Bulkley TSA. Table 4 shows the core ISS Base Case assumptions in a nutshell.

Table 4: ISS Base Case assumptions

Objectives and overall assumptions	**Characterize current management to the extent practicable**
Land base assumptions	• Incorporate projected tenures in the analysis (FNWL); • Remove the Caribou WHA from the THLB; • Remove known NOGO nests and nest buffers from the THLB; • Remove all areas classified as pulp from the THLB; • Remove all areas classified as marginal sawlog located further than 1 km away from a road from the THLB; • Remove all areas classified as marginal sawlog located further than 5-hour cycle time away from Smithers from the THLB; • Marginal Timber in Planning Cell C7 is included in the THLB. • Low site classification changed from TSR; • Use most TSR assumptions as they are; • THLB = 204,978 ha
Harvest assumptions	• Incorporate proposed harvest into the harvest forecast; • Use relative oldest first harvest rule; • Do not limit the harvest of marginal sawlogs in the timber supply model; • Incorporate natural disturbance in the NHLB.
Silviculture and log assumptions	• Use revised managed stand analysis units and yield curves; • Use the provincial site index layer as the site index source for managed stands; • Use TASS for modelling the growth and yield of managed stands; • Separate existing managed stands into eras to reflect differences in management; • Use generic industrial log sort specifications and market values to track production value from harvested managed stands
Habitat assumptions	• Report on potential (predicted) NOGO forage habitat; • Report on moose habitat; • Report on the areas of predicted Caribou habitat as per the Federal Government management direction. • Report on the ECAs for all 4th order watersheds in the TSA. • Report on the area of predicted Marten habitat in the TSA. • Report on the area of predicted undesirable Grizzly Bear habitat in the TSA.

7 Management Scenario Overview

7.1 Silviculture Zones

The THLB in the Bulkley TSA was zoned based on suitability for investment in silviculture treatments for timber production. Three zones were developed: green, yellow and red. Green depicts areas where management actions and investments are generally recommended due to higher site productivity, lower harvest costs and reduced anticipated risks. In the yellow zone caution is recommended, while the red zones denote areas where management actions and investments in forest management should be avoided due to costs and risks. Table 5 details the zoning criteria, while the THLB areas for green and yellow silviculture zones are presented in Table 6. Despite the significant areas that have been removed from the THLB for other values under the LRMP, only about 23% of the THLB is recommended for silviculture investments for timber (green zone) and only about 47% is classified as having moderate investment potential (yellow zone). The silviculture zones are illustrated in Figure 2; they are superimposed over LRMP designated Enhanced Timber Zones (ETZ)

Table 5: THLB zoning, Bulkley TSA

Category	Data Source	Green (good)	Yellow (caution)	Red (stop)
Site Productivity	Future Managed Stands (AU)	SI of leading species >19m; CWHws2; ICHmc1, ICHmc2, SBSmc2-Dry-Fresh (accounts for ~59% of THLB)	SI of leading species 15 to 19m; ESSFmc-dry-fresh-moist; SBSdk; SBSmc2-Moist-Wet; MHmm2 (accounts for ~34% of THLB)	SI of leading species <15m; ESSFmc-Wet; ESSFmk, ESSFwv
Elevation/BEC	Trim and PEM	No	No	ESSF > 1,100 m
Costs	Operability	Ground-based	Cable	N/A
	Cycle time	Regular truck <6hour cycle time	Regular truck >=6hour cycle time	N/A
Constraints to Harvest	VQO	Modification or none	Partial Retention	Retention, Preservation
	Community Watersheds	No	Yes	N/A
	WHAs	No	Yes, Partial harvest zones	Yes, No harvest zone
Other Constraints / Values	Fire Hazard; based on WUI status	Non-WUI	WUI	
Other Wildlife / Watershed Values	LRMP and/or Watersheds	Not significant	High grizzly bear, moose habitat and/or sensitive watershed	
Other Wildlife / Watershed Values	NOGO existing and projected forage areas	No	No	Yes. No treatments proposed.
Core Areas and Landscape Unit Corridors	LRMP	No	No	Yes. No treatments proposed.

Table 6: Silviculture zone areas

Age Class	Green		Yellow		Total Green and Yellow	
	THLB Area (ha)	% of Total THLB	THLB Area (ha)	% of Total THLB	THLB Area (ha)	% of Total THLB
0 to 20	9,738	5%	12,460	6%	22,198	11%
21 to 50	15,924	8%	18,574	9%	34,498	17%
51+	15,687	8%	32,298	16%	47,985	24%
Total	**41,349**	**20%**	**63,332**	**31%**	**104,681**	**51%**

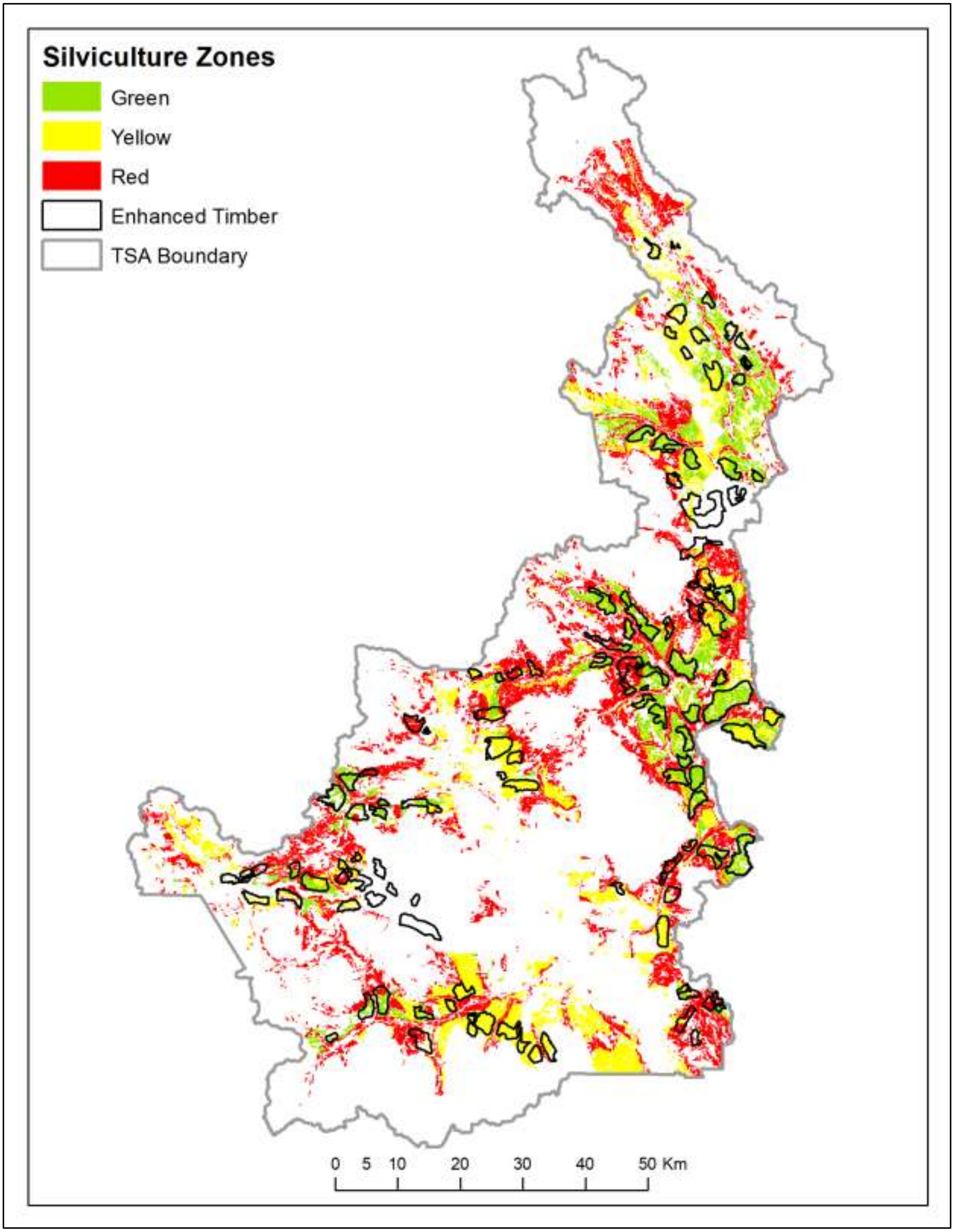

Figure 2: Bulkley TSA silviculture zones in relation to LRMP Enhanced Timber Zones

7.2 Management Scenarios

Table 7 summarizes the tested scenarios.

Table 7: Management Scenario summary

Type	Scenario	Description
ISS Base Case		Current practice, best available information
Strategies	Moose Habitat	This scenario attempted to meet the moose habitat targets in each 4th order watershed. The moose habitat targets are set at 33% mature/old seral (greater than 80 years old), 33% mid seral (41 to 80 years old) and 33% early seral (0 to 40 years old)
	Northern Goshawk (NOGO) Forage Habitat	The NOGO forage habitat target within each existing (6) and projected (57) territory is set at 60% of forest >80 years and enforced in this scenario.
	Watershed Condition	Two scenarios were completed: 1. ECA target in each 4th order watershed set at 20% and enforced. 2. ECA target in each 4th order watershed set at 30% and enforced.
	Woodland Caribou	In this scenario, the Caribou “undisturbed” habitat target is set at 90% of the forested area within the critical habitat boundary of the Telkwa caribou range, as per the Federal Caribou Recovery Strategy. The target is enforced.
	Coarse Filter Biodiversity	In this scenario the core area and landscape corridor seral stage targets were maintained as in the Base Case; however, rather than following the LRMP direction, the Biodiversity Guidebook (Ministry of Forests, 1995) targets for early (max), mature + old (min) and old (min) are used for all the other NDT/LU/BEC variant combinations.
	Combined Wildlife Habitat	This scenario adds the following to the ISS Base Case assumptions: Grizzly Bear: Enforce max 30% mid seral target by NDT/LU/BEC; NOGO: Enforce the NOGO 60% forage area target for each modelled forage area; Moose: Moose objectives stem from wetlands and the forest area around them. The objective is to maintain a 100 m buffer of mature forest (>80 years) around wetlands and apply an additional 100 m buffer within which reduced stocking standards are used after harvesting.
	Volume Scenario	Volume and value strategies are similar except for the species portfolios. Portions of the existing old era Sx leading stands were fertilized every 10 years from 30 to 70 years. The contemporary existing managed stands are not considered suitable for treatment due to the poor quality of the Pl on many sites. Future stands: On high priority timber producing sites, a mosaic of ecologically suitable single species stands with enhanced densities which vary by species were assumed to be established. There stands were fertilized in the timber supply model every 10 years from year 30 to year 70. High log values were assumed for all enhanced regimes. Lower densities were established on some of the poorer sites to reduce overall reforestation costs. The scenario was tested using two different minimum harvest criteria:

		1. Minimum volume per ha as per the latest TSR; 2. Minimum volume per ha as per the latest TSR and the age at which the 95% MAI culmination is reached.
	Value Scenario	Volume and value strategies are similar except for the species portfolios. Portions of the existing old era Sx leading stands were fertilized every 10 years from 30 to 70 years. The contemporary existing managed stands are not considered suitable for treatment due to the poor quality of the Pl on many sites. Future stands: On high priority timber producing sites, a mosaic of ecologically suitable single species stands with enhanced densities which vary by species were assumed to be established. There stands were fertilized in the timber supply model every 10 years from year 30 to year 70. High log values were assumed for all enhanced regimes. Lower densities were established on some of the poorer sites to reduce overall reforestation costs. The value strategy includes some changes in the species portfolios, including the planting of Cw on ecologically suitable sites; these stands are assumed to be spaced to favor Cw. No fertilization of Cw was assumed. The scenario was tested using two different minimum harvest criteria: 1. Minimum volume per ha as per the latest TSR; 2. Minimum volume per ha as per the latest TSR and the age at which the 95% MAI culmination is reached.
	ISS Selected Scenario	See section 8

Table 8 provides a summary of the scenario results for various indicators. The pluses and minuses depict a somewhat subjective classification of predicted indicator values for each scenario relative to the ISS Base Case. More desirable outcomes for the specific indicator are depicted with pluses (e.g., higher volume), while minuses indicate less desirable results (e.g., more poor grizzly habitat). Zeros indicate that the scenario has no significant effect on the indicator compared to the ISS Base Case.

Ideally the selected scenario generates neutral-to-positive results for all indicators.

Table 8: Scenario results summary

Scenario	Indicator							
	Volume	Value	Moose Habitat	NOGO Forage Habitat	ECA	Caribou Habitat	Marten Habitat	Poor Grizzly Habitat
Volume	+++	+++	0	0	-	0	0	++
Volume 95% MAI	+(ST),++++ (LT)	++++	0	0	-	0	0	+
Value	+++	+++	0	0	-	0	0	++
Value 95% MAI	+(ST),++++ (LT)	++++	0	0	-	0	0	+
Moose	0	0	0	0	0	0	0	0
NOGO Forage	-	-	0	+++	0	0	+	+
ECA	0	0	0	0	0	0	0	0
Caribou Habitat	--	--	0	0	0	+++	++	+
Coarse Filter Biodiversity	0	0	0	0	0	0	0	0
Combined Wildlife	---	-	+	+++	+	0	++	0

8 ISS Selected Management Scenario

Significant conclusions from the learning scenarios and sensitivity analyses include:

8.1 Sensitivity Analyses

8.1.1 Stand Quality Classification

There is uncertainty regarding the quality classification of stands. While stands of pulp and marginal sawlog quality exist, their exact area or spatial locations are not known. This analysis used VRI based definitions for stand quality and tested the impact of including all the pulp and marginal sawlog areas in the THLB. In the ISS Base Case, all areas classified as pulp were removed from the THLB. In addition, all areas classified as marginal sawlog located further than 1 km away from a road and marginal sawlog areas located further than 5-hour cycle time away from Smithers were also removed from the THLB, except for the C7 planning cell, which remained in the THLB.

Including all the pulp and marginal sawlog areas in the THLB increased the size of the THLB by 39,111 ha (19%) to 244,089 ha. The harvest forecast increased by 17% (106,970 m^3 per year).

8.1.2 Wildland Urban Interface

The Wildland Urban Interface (WUI) is any area where combustible wildland fuels (e.g. vegetation) are found adjacent to homes, farm structures or other buildings. The Wildland Urban Interface Buffer consists of areas within two kilometres of a community with a density of between six and 250 structures per square kilometre.

A sensitivity analysis assumed that within a 50 m buffer from homes, farm structures and other buildings, all coniferous forest would be converted to deciduous forest. It was further assumed that the areas within the 50 m buffer would not contribute to timber harvest and be removed from the THLB. The THLB was reduced by 1,979 ha or approximately 1%. Removing the 50 m buffer from the THLB reduced the harvest forecast by 0.8%.

8.2 Learning Scenarios

Significant conclusions from the learning scenarios and sensitivity analyses include:

- The concern over the poor pine log quality prompted the silviculture working group to review the pine quality of managed stands in the Bulkley TSA and assess its potential impacts. The impact of low Pl log quality at the forest level was tested by applying low log values to some stands. The low Pine log values caused a modest reduction in the overall harvest log value over the long term. Furthermore, assuming low log values for some stands also diminished the viability of fertilization of these stands.
- Enhanced reforestation densities using seedlings with generally higher genetic worth and aggressive fertilization regimes increased the volume and the value of the harvest forecast significantly. Reduced planting densities in some of the red zones did not appear to cause significant volume or value reductions.
- Use of the 95% maximum MAI for the minimum harvest criteria caused small decreases in the short to medium term harvest volumes but contributed to larger increases in long term volume and value.
- Biodiversity indicators were generally insensitive to intensive silviculture regimes.

- ECA target of 20% could be implemented in all 4th order watersheds with a minimal impact on timber supply (0.3%).
- Enforcing the projected NOGO forage area seral stage targets for the 6 existing territories and 57 projected territories reduced the timber supply by 4.9%, when tested against the ISS Base Case. The projected NOGO forage areas were revised during this project; the locations of some of the areas were changed and their overall number and area were reduced. The impact of enforcing the updated projected NOGO forage area seral stage targets was tested against the Selected Scenario. The timber supply forecast was reduced by 2.4% to 2.8%.
- The moose habitat targets of 33% mature/old seral (greater than 80 years old), 33% mid seral (41 to 80 years old) and 33% early seral (0 to 40 years old) are difficult to meet because much of moose habitat is outside of the THLB (63%) and cannot be controlled through harvest.

  Seral stage targets by landscape unit and BEC variant in the TSA require that mature and old targets are met. In many cases, the requirement for mature and old seral stages far exceeds the 33% of older stands required for moose habitat.
- The presumed caribou habitat target was 90% of the forested area maintained in an “undisturbed” state within the critical habitat boundary, as per the Federal Caribou Recovery Strategy. Enforcing this target reduced the ISS Base Case timber supply forecast by 7.5%. The Caribou habitat target was never met throughout the planning horizon, because of the natural disturbance assumptions incorporated in the analysis. Natural disturbance reduces the NHLB habitat area and there is not enough THLB to make up the difference.
- A combined wildlife habitat scenario enforced targets for Grizzly bear habitat, projected NOGO foraging habitat and moose habitat. The timber supply was reduced by 12% compared to the ISS Base Case.

The analysis results were presented to the Bulkley TSA ISS implementation group on November 7, 2019. The group agreed that the value scenario, with some control over the harvest age of the managed stands, should be the basis for the Selected Scenario and the Integrated Stewardship Strategy. There was also interest in trying to increase the amount of Bl in future stands where ecologically appropriate. Furthermore, concerns were expressed regarding the total silviculture budget over time. The following changes were incorporated into the Selected Scenario:

- The ESSFmc was split into upper and lower portions (based on an elevation of 1100m). New yield curves were developed for the upper and lower areas with revisions to natural ingress patterns and reforestation regimes with a priority of more Bl. Also, the upper portion of the ESSFmc was designated as red silviculture zone while the lower portion remained a yellow silviculture zone.
- The most recent projected NOGO forage areas were incorporated into the analysis file. Any projected forage areas that fell within the green and yellow silviculture zones were classified as red and excluded from intensive silviculture treatments. The NOGO forage area targets were not enforced in the Selected Scenario.
- Updated goat winter range data and assumptions were incorporated in the analysis, as per the latest Ungulate Winter Range order (U-6-007).
- The intensity of fertilization of future managed stands was reduced. Many were scheduled to be fertilized at least 4 times. Two fertilizations were removed from the regimes.
- Selected Scenario has a value focus with a 95% MAI culmination minimum harvest criteria and more species diversity with a small component of Cw.

8.3 ISS Selected Management Scenario Harvest Forecast

Figure 3 illustrates the Selected Scenario harvest forecast compared to the ISS Base Case harvest forecast; the harvest level of 662,260 m^3 per year, 8.0% higher than that of the ISS Base Case, is maintained for 90 years, when the long-term harvest level of 673,210 m^3 per year is reached. The long-term harvest level of 673,210 m^3 per year is 9.6% higher than the ISS Base Case harvest forecast.

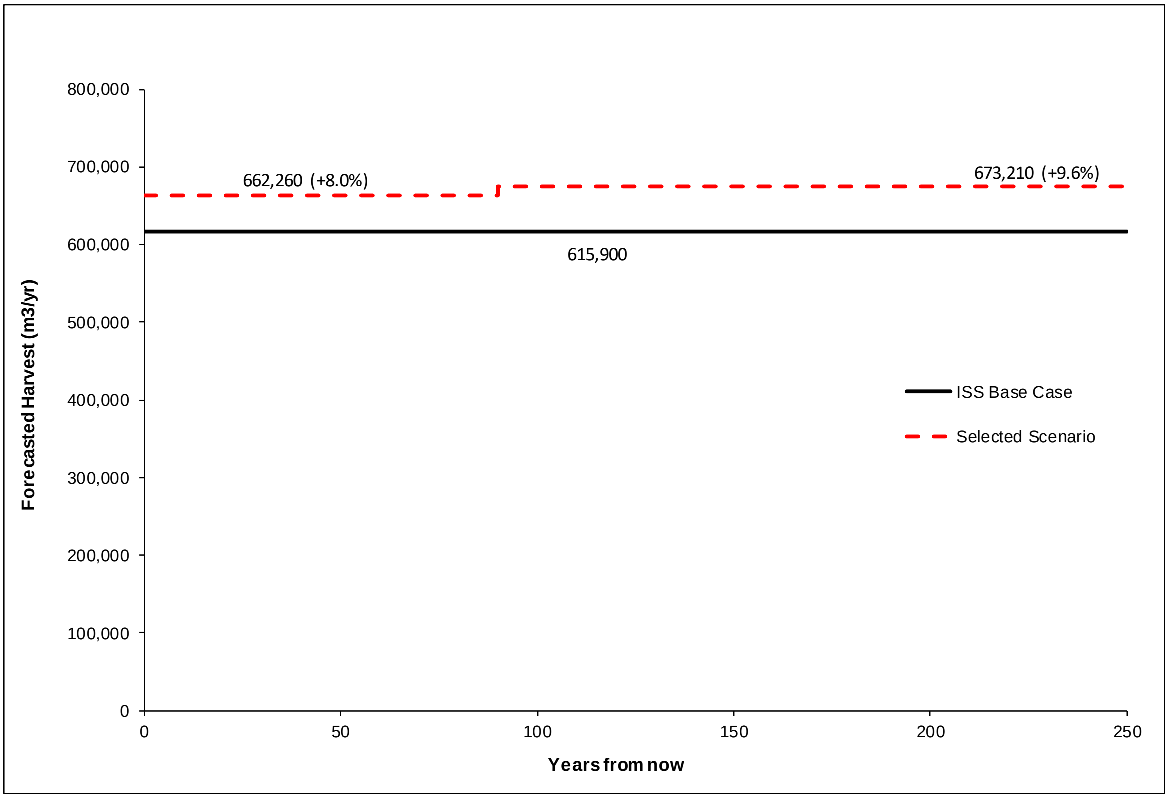

Figure 3: Selected Scenario harvest forecast

The analysis results for the ISS Selected Management Scenario are described in detail in the Modelling and Analysis Report (FESL, 2020). The summary is provided below:

- The harvest of existing managed stands is predicted to start in 35 years. In 70 years almost the entire harvest is forecasted to come from managed stands.
- During the next 50 years most of the harvest will consist of balsam and spruce. In the long term, the harvest is also predicted to comprise almost entirely of spruce and pine with small volumes of Douglas fir, cedar and balsam harvest.
- The increased growth through enhanced reforestation and fertilization results in a modestly higher average harvest volume per ha in the long term; the average harvest volume per ha is predicted to fluctuate between 270 and 310 m^3 per ha.
- The ISS Selected Management Scenario relies on the harvest of older age classes at the beginning of the planning horizon; more than 90% of the harvest is expected to come from stands older than 120 years during the first 35 years.

  In the long term, the harvest is predicted to depend mostly on age class 3 and 4 stands (41 to 80 years) and to some extent age class 5 (81 to 100 years) and older stands.

- In the long term, the ISS Selected Management Scenario is predicted to create significantly more timber value from managed stands than the ISS Base Case.

Harvest forecasts rely on a variety of assumptions that are subject to uncertainty. Forest level analyses attempt to use the best available information and the most current analyses assumptions. Consequently, the forest is expected to be harvested as modeled. It is also expected to grow as predicted through growth and yield modelling.

If forest practices differ significantly from the assumptions used in the analysis, the available timber supply can be substantially different from the forecast.

9 Harvest Strategy (10 Years)

The various strategies presented in this report are intended to form the basis for a set of tactical plans. These plans attempt to show planned management activities spatially and temporally. Tactical plans need to be consistent with the ISS Selected management scenario, i.e. the proposed operational harvesting and treatments should trend towards the objectives identified in this project and not jeopardize the achievement of those objectives.

It is important to note that in practice, tactical plans are prepared through iterative analysis – operational staff interaction and usually include a significant field component. First iterations of model-created treatment areas (harvest, silviculture) are used as a starting point for the preparation of the operational schedules. The final schedules are eventually incorporated back into to the spatial timber supply model to test the schedule in terms of its overall sustainability and consistency with the existing strategic plans. This process can be detailed and time consuming, particularly in determining access, block sizes/layout and related costs.

Forsite Consultants provided data for this project that was compiled as part of the Bulkley Higher Level Plan Order 2016 Analysis. The data included proposed harvest blocks for approximately 7 years. These blocks were incorporated into the analysis by forcing the timber supply model to harvest them during the first 10 years. This approach ensures that some operational reality is included in this analysis and the presented harvest strategy. As some of the harvest for the first 10 years is based on computer generated scheduling, the presented strategies and plans are at least partly conceptual and should be taken as guidelines when developing final operational harvest schedules or tactical silviculture treatment plans (e.g., fertilization or spacing).

9.1 Age Classes and Species

Old age classes dominate the THLB and CFLB in the Bulkley TSA. Approximately 52% of the THLB is older than 140 years, while age classes 3 and 4 are not well represented.

Balsam is the leading species on approximately 59% of the CFLB area in the TSA. The share of spruce is 17% while pine is the dominant species on 19% of the land base. Pine-leading and spruce-leading stands are more plentiful in the Timber Harvesting Land Base (THLB) (23% and 25%) than in the CFLB. While still most common, balsam-leading stands have less of a share in the THLB (48%).

In the harvest forecast approximately 94% of the harvest in the first 10 years is predicted to come from stands older than 140 (age classes 8 and 9), while the combined share of all other age classes is predicted to be only 6% of the harvest (Table 9).

Table 9: Predicted harvest by age class

Years	Total Harvest by Age Class (m^3)							Total
	Age Class							
	3	4	5	6	7	8	9	
1 to 5	0	0	10,518	30,057	86,967	1,709,542	1,476,015	3,313,100
6 to 10	490	1,679	52,598	93,259	130,432	1,285,379	1,749,263	3,313,100
Total	**490**	**1,679**	**63,116**	**123,316**	**217,400**	**2,994,922**	**3,225,278**	**6,626,200**
Years	**Total Harvest by Age Class (%)**							**Total**
	Age Class							
	3	4	5	6	7	8	9	
1 to 5	0.0%	0.0%	0.3%	0.9%	2.6%	51.6%	44.6%	100.0%
6 to 10	0.0%	0.1%	1.6%	2.8%	3.9%	38.8%	52.8%	100.0%
Total	**0.0%**	**0.0%**	**1.0%**	**1.9%**	**3.3%**	**45.2%**	**48.7%**	**100.0%**

Most of the harvest in the next 10 years is predicted to come from balsam stands (49.8%). This reflects the species profile in the TSA. The shares of spruce and pine are forecasted at 26.0% and 11.7% respectively (Table 10). The predicted shares of spruce and pine harvest are reasonable given their estimated shares of the total THLB volume – 30% for spruce and 18% for pine. The rest of the short-term harvest is predicted to come mostly from hemlock volume (8%). Figure 4 illustrates the predicted harvest over the next ten years by age class and species.

Table 10: Predicted harvest by species

Years	Total Harvest by Species (m³)					Total
	Species					
	Balsam	Deciduous	Hemlock	Pine	Spruce	
1 to 5	1,650,109	57,701	383,395	386,397	835,498	3,313,100
6 to 10	1,833,111	57,673	148,471	388,220	885,625	3,313,100
Total	**3,483,220**	**115,374**	**531,866**	**774,617**	**1,721,123**	**6,626,200**
Years	**Total Harvest by Species (%)**					**Total**
	Species					
	Balsam	**Deciduous**	**Hemlock**	**Pine**	**Spruce**	
1 to 5	49.8%	1.7%	11.6%	11.7%	25.2%	100.0%
6 to 10	55.3%	1.7%	4.5%	11.7%	26.7%	100.0%
Total	52.6%	1.7%	8.0%	11.7%	26.0%	**100.0%**

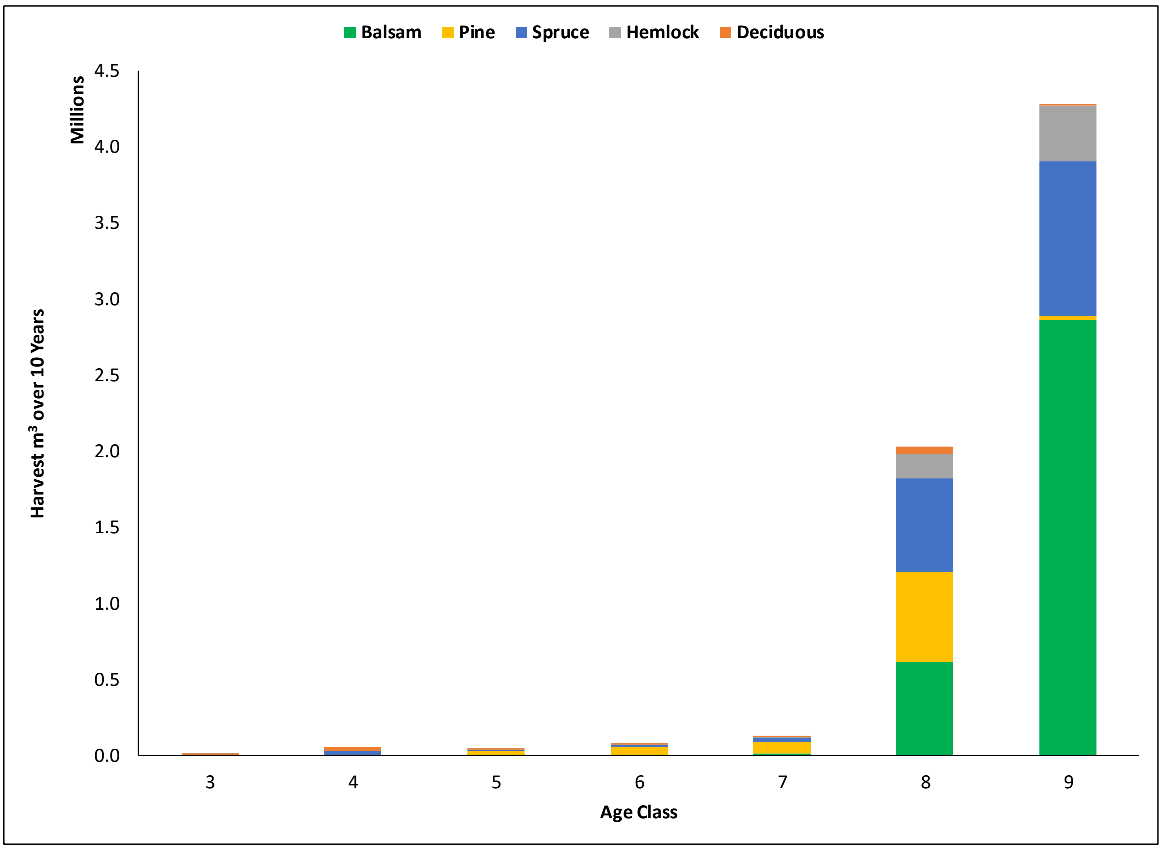

Figure 4: 10-Year harvest forecast by age class and species

9.2 Harvest by Log Quality

Approximately 95% of the harvest over the next 10 years is predicted to consist of sawlog harvest with the balance coming from stands of marginal sawlog quality (Table 11). The predicted harvest of marginal sawlogs is less than their estimated share of the THLB at 14%. However, as noted before in this document, there is uncertainty regarding the log quality classification of stands.

Table 11: Predicted harvest by log quality

Years	**Harvest by Log Quality (m^3)**		
	Log Quality		
	Marginal Sawlog	**Sawlog**	**Total**
1 to 5	149,253	3,163,847	3,313,100
6 to 10	188,169	3,124,931	3,313,100
Total	**149,253**	**3,163,847**	**3,313,100**
Years	**Harvest by Log Quality (%)**		
	Log Quality		
	Marginal Sawlog	**Sawlog**	**Total**
1 to 5	4.5%	95.5%	100.0%
6 to 10	5.7%	94.3%	100.0%
Total	**5.1%**	**94.9%**	**100.0%**

9.3 Spatial Harvest Schedule

The harvest schedule for the first 10 years of the planning horizon created by the model is presented in Figure 5 and Figure 6.

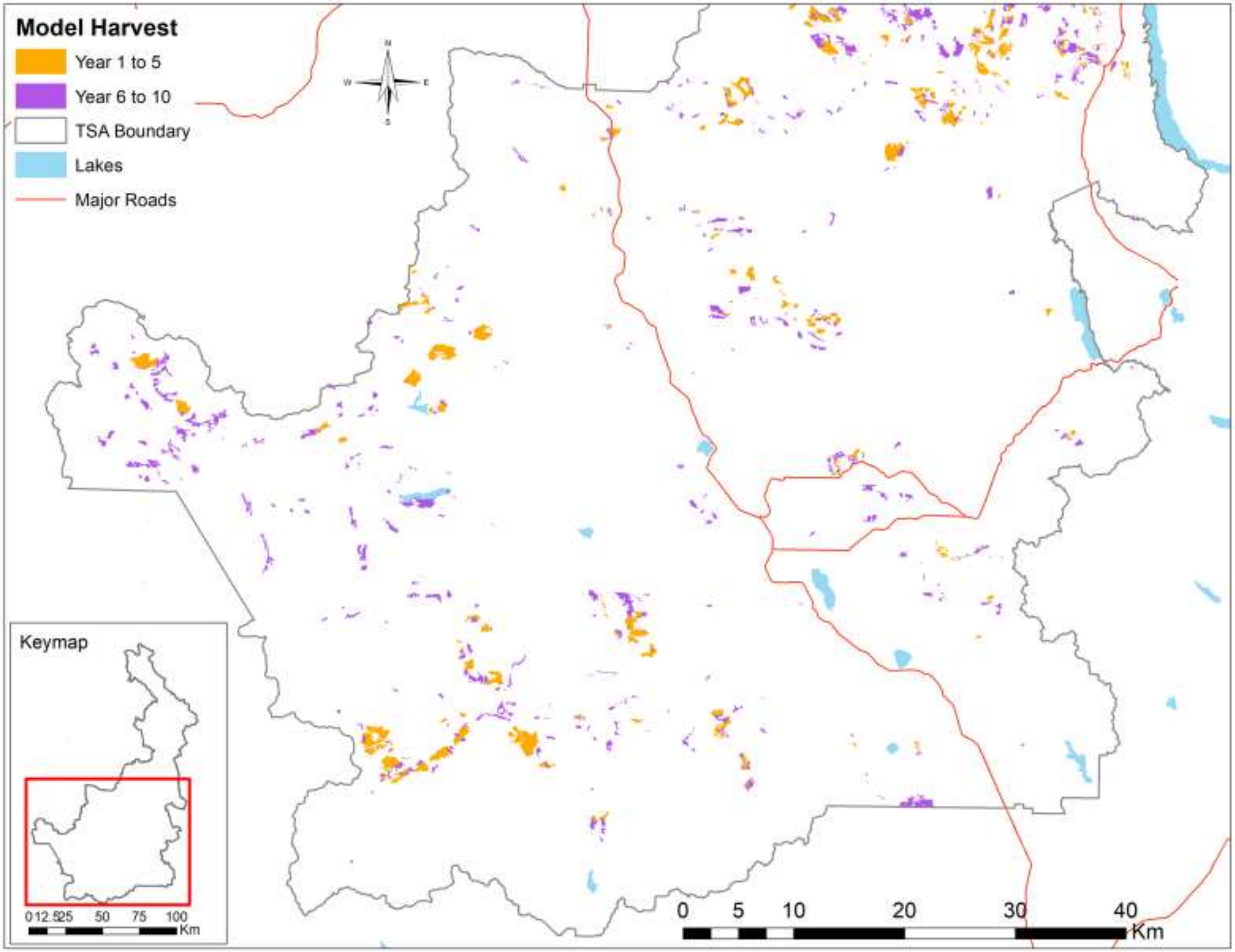

Figure 5: Conceptual harvest schedule, South; years 1 to 10

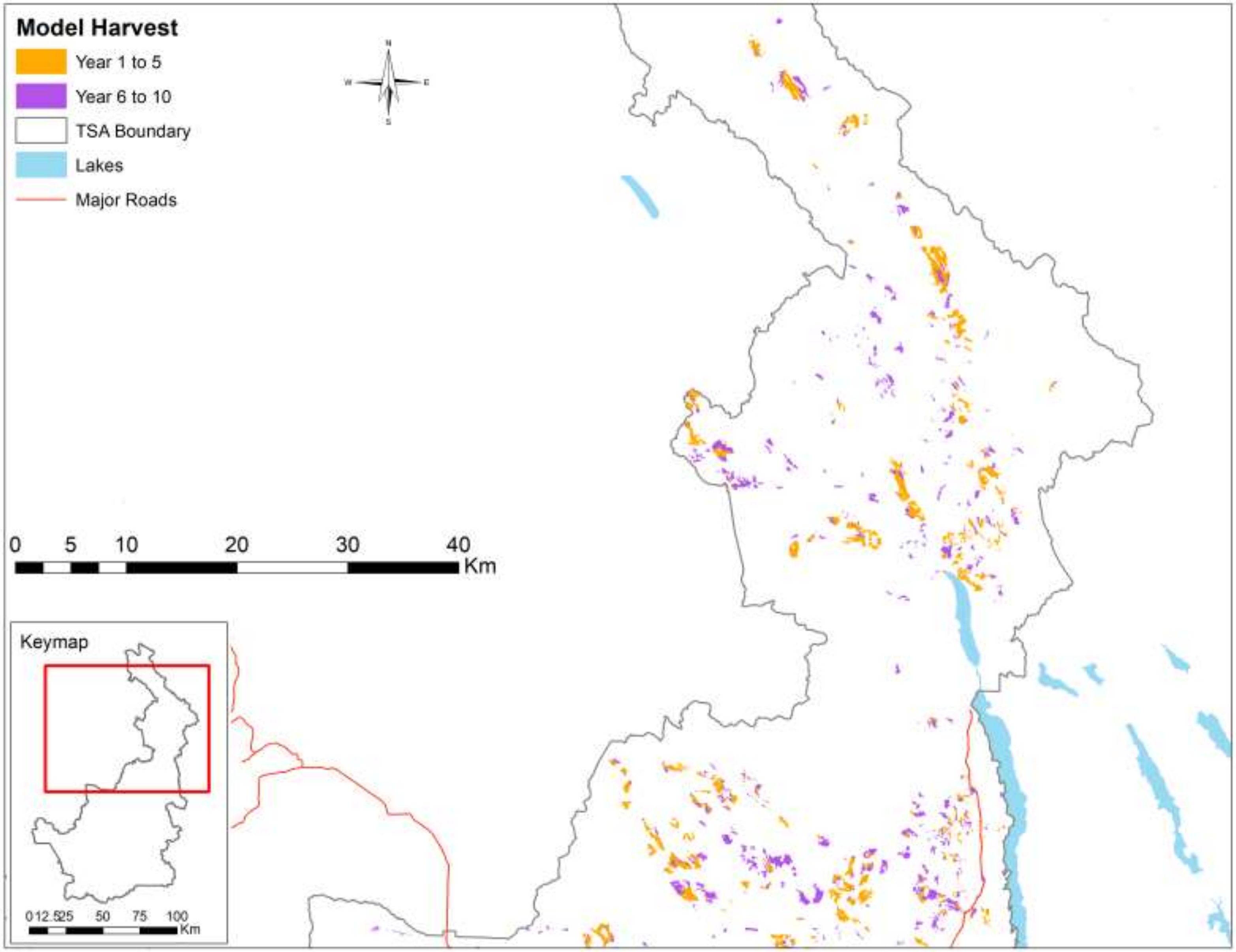

Figure 6: Conceptual harvest schedule, North; years 1 to 10

10 Silviculture Strategy

This silviculture strategy was designed by the Bulkley TSA silviculture working group.

10.1 Existing Managed Stands

The strategy consists of fertilizing existing old managed Sw leading stands in parts of the green and yellow silviculture zones every 10 years from age 30 to age 70.

10.2 Future Managed Stands

On high priority sites with a timber objective, the strategy promotes the establishment of a mosaic of ecologically suitable single species stands (which achieve landscape-level species composition targets) with enhanced densities specifically designed to optimize the production and value of each species. Lower planting densities and higher components of Bl are proposed for the higher elevation portion (>1,100 m) of ESSFmc and for the ESSFwv. Further considerations are:

- Use average expected genetic worth for each species from seed available under the Climate Based Seed Transfer (CBST) rules;
- Consider Climate Change Informed Species Selection (CCISS) species portfolios;
- Fertilize Sx, Fdi and Pli stands at ages 40 and 50;
- The strategy includes planting of Cw on ecologically suitable sites. These stands are assumed to be spaced to favor Cw. No fertilization of Cw is assumed;
- Use high log values for enhanced regimes;
- Use the minimum volume per ha as per the latest TSR and the age at which the 95% MAI culmination is reached as the minimum harvest criteria.

Table 12 shows the chosen species profiles and recommended treatments for future managed stands. The recommendation for other BEC units is to follow current regeneration practises as modeled in the Base Case (forest health incorporated).

Table 12: Chosen species profiles for the Selected Scenario; future managed stands

BEC	Silv Zone	Spp1/Target Plt (sph)/ Incr Treatments	Spp2/Target Plt (sph)/ Incr Treatments	Spp3/Target Plt (sph)/ Incr Treatments
SBSmc2/ Dry-Fresh	Green/ Yellow	Pl/2000/ fert (20%)	Sx/1600/ fert (70%)	Fdi/1400/ fert (10%)
SBSmc2/ Moist-Wet	Green/ Yellow	Pl/1800/ fert (30%)	Sx/1400/ fert (70%)	
ICHmc1/ All	Green/ Yellow	Sx/1600/ fert (60%)	Fdi/1400/ fert (20%)	Cw/1200/ JS (20%)
SBSdk/ All	Green/ Yellow	Pl/1800/ fert (20%)	Sx/1400/ fert (70%)	Fd/1200/ fert (10%)
ESSFmc/ Lower/ Dry-Fresh	Green/ Yellow	Pl/1800/ fert (20%)	Sx/1400/ fert (60%)	Cw/1200/JS (20%)

BEC	Silv Zone	Spp1/Target Plt (sph)/ Incr Treatments	Spp2/Target Plt (sph)/ Incr Treatments	Spp3/Target Plt (sph)/ Incr Treatments
ESSFmc/ Lower/ Moist	Green/ Yellow	Pl/1800/ fert (30%)	Sx/1600/ fert (70%)	
ESSFmc/ Upper/ Dry-Fresh	Red	Bl/800 (70%)	Sx/800 (30%)	
ESSFmc/ Upper/ Moist-Wet	Red	Bl/800 (70%)	Sx/800 (30%)	
ESSFwv/ Dry-Fresh	Red	Bl/800 (60%)	Sx/800 (30%)	Pli/800 (10%)
ESSFwv/ Moist-Wet	Red	Bl/800 (60%)	Sx/800 (30%)	Pli/800 (10%)

10.3 Fertilization

The silviculture strategy sets an incremental silviculture target of 729 ha of fertilization of Sw leading stands per year for the first 5 years at the cost $364,362 per year. The fertilization program is set to decrease somewhat to 619 ha per year in the second 5-year period starting 6 years from today. The annual cost is projected at $309,523 for years 6 to 10.

Without field assessments it is uncertain whether fertilization of some modeled existing stands is viable. On the other hand, some old era Pl stands might benefit from fertilization; this was not modelled or assumed in this project. It is recommended that a fertilization plan be developed for the TSA including field assessments of potential fertilization candidates.

Assuming all aspects of the silviculture strategy are implemented, the size of the fertilization program is forecast to remain at this level until year 26, when it starts to decline; the population of candidate old managed stands decreases as they age. Between years 36 to 40, only 164 ha per year of fertilization are predicted (Table 13).

The fertilization of future managed stands starts at year 41 as the fertilization program increases to approximately 750 ha per year at the cost of $373,433. In hundred years approximately 2,500 ha of fertilization is predicted annually at the cost of $1.3 million (Table 13).

Figure 7 and Figure 8 illustrate the predicted fertilization areas spatially for the next 10 years. The presented spatial depiction is conceptual; the above recommended fertilization plan will provide a more accurate fertilization area forecast over the next 5 years.

Table 13: Annual fertilization area and costs

Year	Annual Fertilization Area (ha)	Annual Costs
5	729	$364,362
10	619	$309,523
15	623	$311,583
20	635	$309,523
25	599	$291,523
30	493	$234,113
35	284	$124,907
40	191	$81,896
45	776	$373,443
50	784	$375,835
55	1,382	$675,168
60	1,498	$729,533
65	1,393	$673,205
70	1,764	$856,117
75	2,027	$1,000,231
80	2,498	$1,235,977
85	2,598	$1,294,348
90	2,636	$1,309,791
95	2,544	$1,256,216
100	2,536	$1,252,271

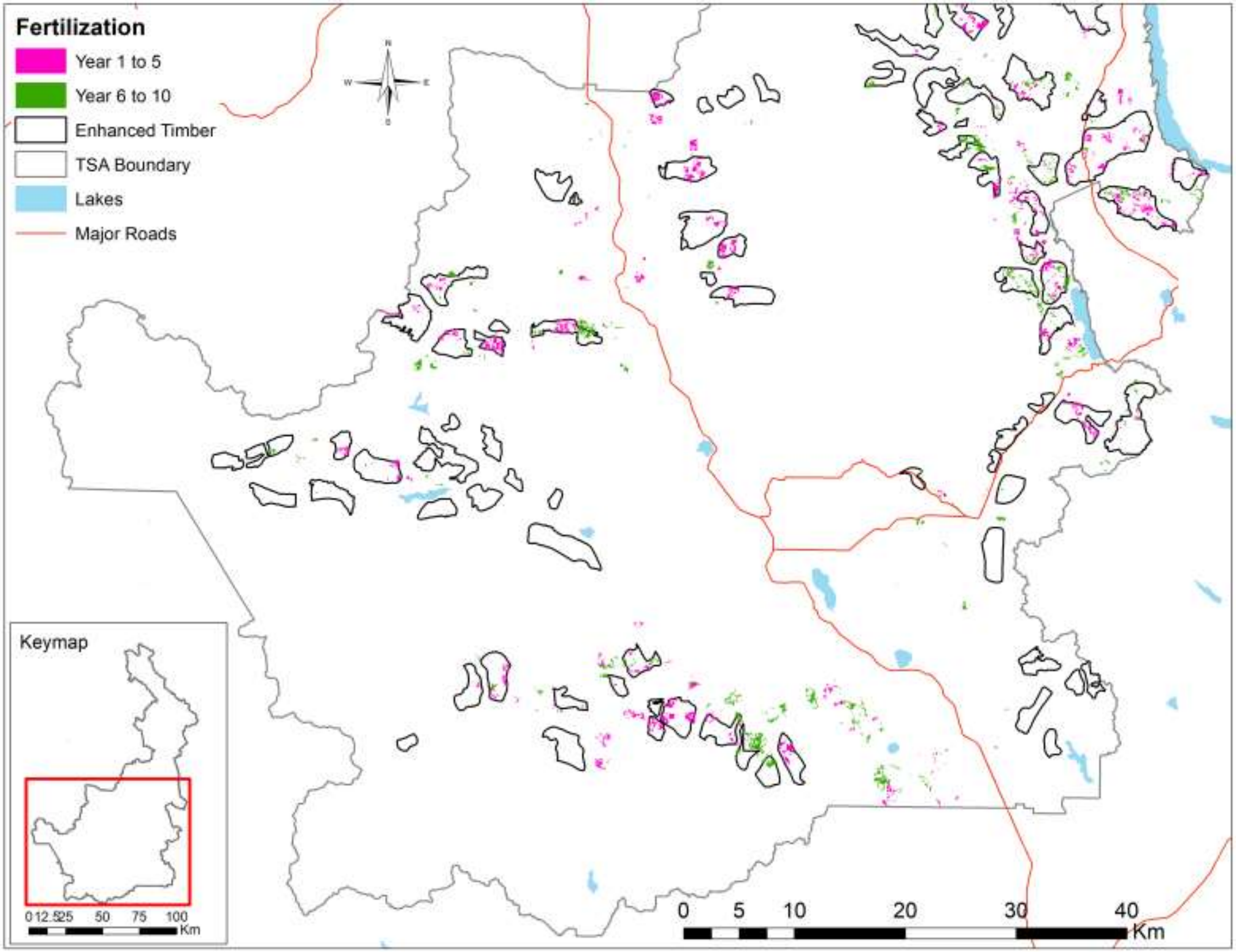

Figure 7: Predicted areas for fertilization, south

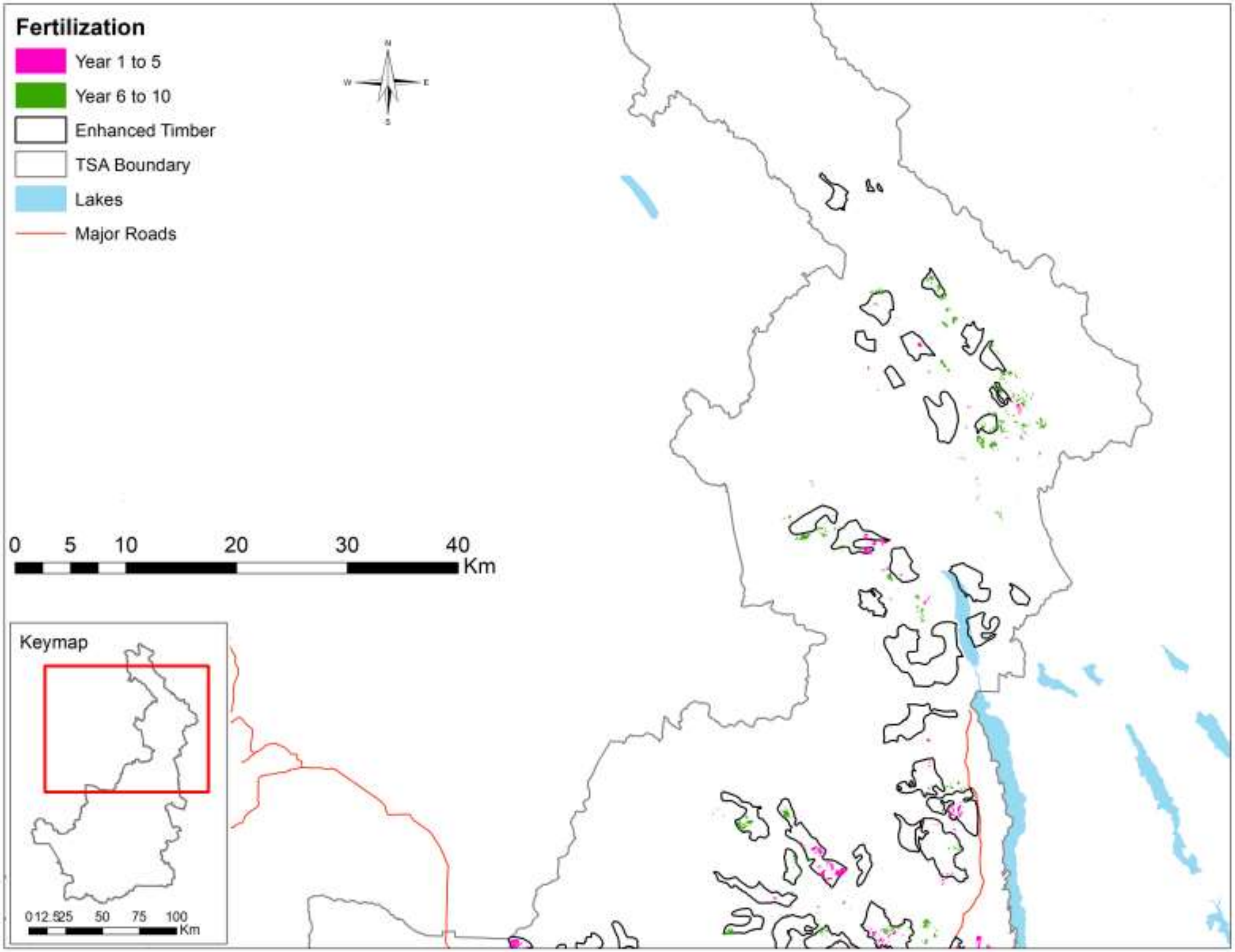

Figure 8: Predicted areas for fertilization, north

10.4 Spacing

No spacing is expected over the next 10 years. A modest Cw spacing program is predicted to start in year 16 and continue with annual spacing areas ranging from 240 ha to 400 ha.

The silviculture strategy includes Cw planting with enhanced densities and juvenile spacing favoring Cw on appropriate sites. Spacing is recommended to be part of the regime to ensure that the planted Cw does not get overtopped by faster growing natural infill such as Hw and Pl. Pre-free growing brushing of competing conifers is a lower cost alternative to spacing.

Significant natural infill is not likely on many sites where the Cw is planted. For this reason, spacing might not be required and the assumed spacing costs of $2,500 per hectare likely overestimate the true costs.

10.5 Enhanced Reforestation and Reduced Densities in High Elevation Sites

As shown above in Table 12 this strategy proposes higher planting densities on selected sites in the TSA. Approximately 755 ha and 758 ha of increased density planting are predicted annually for years 1 to 5 and 6 to 10 respectively. The predicted annual incremental planting costs for years 1 to 5 are $236,473 and $234,184 for years 6 to 10 (Table 14).

This strategy also proposes to reduce planting densities for the high elevation portion (>1,100 m) of ESSFmc and all of the ESSFwv as discussed above (Table 14). The reduced planting densities are predicted to be applied on 383 ha annually for years 1 to 5 and on 291 ha annually for years 6 to 10. The predicted annual reduction in planting costs due to reduced densities is -$128,374 for years 1 to 5 and -$98,933 for years 6 to 10.

Table 14 also shows the net costs of increased and decreased planting densities. In the table the savings from reduced planting densities in the high elevation portions of ESSFmc and ESSFwv are used to compensate for the costs for higher planting densities elsewhere.

Table 14: Projected annual area and costs for increased and reduced density planting

Treatment/Activity	Years 1 to 5		Years 6 to 10	
	Area (ha)	Costs ($)	Area (ha)	Costs ($)
Increased Planting Densities	755 ha	$236,473	758 ha	$234,184
Reduced Planting Densities (Elk)	383 ha	-$128,374	291 ha	-$98,933
Annual Total (net)	**1,138 ha**	**$108,099**	**1,049 ha**	**$135,251**

10.6 Annual Treatment Costs

The total predicted short-term treatment costs are $472,461 annually during the first 5 years and $444,774 annually between years 6 and 10 (Table 15).

Table 15: Projected annual area and costs by treatment for the silviculture strategy

Treatment/Activity	Years 1 to 5		Years 6 to 10	
	Area (ha)	Costs ($)	Area (ha)	Costs ($)
Fertilization	729	$364,362	619	$309,523
Increased (or reduced) Planting Densities	1,138 ha	$108,099	1,049 ha	$135,251
Annual Total		**$472,461**		**$444,774**

10.7 Surveys and Studies

In this analysis, managed stands were grouped into analysis units based on leading species, growth rating and management status. This grouping inherently assumes that any stand belonging to a group exhibits certain characteristics, such as site index, density, and species distribution identically. All stands within an analysis unit are assumed to grow and respond to silviculture treatments in a similar fashion. In practice, this is not the case. The actual stands within each analysis unit will vary in site index, species composition and physical condition. Some may not be suitable candidates for silviculture treatments for a variety of reasons. Therefore, all candidate areas need to be surveyed and their suitability for treatments confirmed before final investment decisions are made.

The surveys within the urban interface area are likely funded by the Union of BC Municipalities (UBCM). Fire threat mitigation will be discussed below under section 11.

11 Wildfire Management

The draft Bulkley Zone Fire Management Plan (FMP) was developed in 2016. Its focus is to provide concise information for those involved in wildfire response. The FMP also identifies proactive resource management activities meant to reduce the threat of wildfires on resource values. The proactive measures have not been detailed in the FMP yet as to their exact location and nature.

The BC Wildland Fire Management Strategy (Government of BC, 2010) has five main components, two of which directly pertain to this plan.

- Reduce fire hazards and risks (particularly in and around communities and other high-value areas) and,
- Implement land, natural resource and community planning that incorporates management of wildland fire at all appropriate scales. Treatments to reduce fire risk within the urban interface will be carried out in accordance with community wildfire protection plans.

Silviculture treatments can be used to reduce wildfire risk and consequences to infrastructure, property and other values. Treatments such as thinning can reduce wildfire risk at the stand-level and timber development planning together with silviculture treatments, which are designed to create temporal and spatial variation, can be valuable tools also at the landscape-level.

On the other hand, intensive silviculture treatments to produce timber should be strategically located in areas with minimal longer-term risk of loss from wildfire. The silviculture zoning described in Section 7.1 is based on this type of prioritization. Table 16 shows generalized forest management priorities for wildfire management from the BC Wildland Fire Management Strategy.

The Wildland Urban Interface (WUI) is any area where combustible wildland fuels (e.g. vegetation) are found adjacent to homes, farm structures or other buildings. The WUI buffer consists of areas within two kilometres of a community with a density of between six and 250 structures per square kilometre. The data in the Bulkley TSA was updated to 2015 for built structures and provided by FLNRORD for this analysis. It helps identify developed areas that may be at risk due to wildfires and can help guide planning processes for modifying or reducing the amount of forest or range fuels to mitigate the risk of fire in the built environment.

Historically, wildfire planning has been carried out separately from strategies such as this. In the Bulkley TSA, a Provincial Strategic Threat Analysis (PSTA) of wildfire risk has been completed for the WUI at the strategic level to inform the government's landscape fire management planning and fuel treatment programs. The PSTA risk ratings are based on the VRI, and field observations often contradict the VRI classification. For this reason, this plan does not identify candidate treatment areas. Rather, it recommends that surveys be carried out to confirm risk ratings in those areas within the WUI where VRI based ratings indicate concerns. In high or extreme rated areas treatments should be recommended and implemented.

Treatments to reduce fire risk were modeled in a sensitivity analysis, which assumed that within a 50 m buffer from homes, farm structures and other buildings, all coniferous forest would be converted to deciduous forest. The results of the sensitivity analysis are described in Section 8.1.2.

Table 16: Stand-level management priorities for wildfire management

Treatments		Treatment Outcome (Fire Perspective)	Lower priority where	Higher priority where
Harvesting	Clearcut	Reduce fuel loading and eliminate crown fire risk (short term)		High values and high hazards exist; create fuel breaks
	Partial cut	Reduce crown bulk density - reduce crown fire risk (1); may increase surface fuel loading (2)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
Silviculture	Enhanced Reforestation	May have surface fire potential, depending on residual slash load and grass/ herbaceous fuel loading	Burn probability is highest; avoid lost silviculture investments	
	Alternate Reforestation (4)	May have surface fire potential, depending on residual slash load and grass/ herbaceous fuel loading		Burn probability is highest; mitigate losses and protect values
	Prescribed Burn / Ecosystem Restoration	Maintains a natural fire return interval		High values exist with high hazard and risk; treat fuels and improve forest health/habitat
	Spacing to normal stocking levels	Reduce fuel loading – lower fire intensity; may increase surface fuel loading	Burn probability is highest; avoid lost silviculture investments	
	Spacing to lower densities combined with fuel reduction	Reduce fuel loading – lower fire intensity (5)		High values exist to protect community and Infrastructure High risk interface area (3) identifies a need to treat fuels; mitigate risk Burn probability and fire intensity criteria are the highest; mitigate fuel loading
	Fertilization	May increase crown bulk density and higher surface fuel loading (due to increased growth of understory vegetation)	Burn probability is highest (except in interface); avoid lost silviculture investments Avoid treating areas in the WUI (increased fuel loading and crown bulk density).	Burn probability is lower; avoid lost silviculture investments. Treat areas outside of the WUI.

Treatments		Treatment Outcome (Fire Perspective)	Lower priority where	Higher priority where
	Pruning	Increase crown base height. Pruned branches will increase surface fuel loading unless they are removed, or decay over time.		Burn probability is lower; avoid lost silviculture investments. High risk interface areas – provided surface fuel loading is reduced concurrent with the pruning treatment.
Rehabilitate	Knockdown and site preparation	Reduce fuel loading and eliminate crown fire risk (short term)		High risk interface area (3) identifies a need to treat fuels; mitigate risk
	Plant and brush	May have surface fire potential, depending on residual slash load	Burn probability is highest; avoid lost silviculture investments	

(1) This treatment may also increase crown fire potential in certain areas due to increased air flow through the stand. Care needed with surface fuel load and crown base height

(2) Higher surface fuel loading can result in more intense surface fires. Higher intensity surface fires have the potential to increase crown fire potential.

(3) Identified through a Community Wildfire Protection Plan (CWPP) or Provincial Strategic Threat Analysis (PSTA)

(4) Encourage deciduous or other fire-resistant species

(5) Intensity (I) is a function of the heat of combustion (H), weight of the fuel (W) and rate of spread of a fire (R) I=HWR

11.1 Potential Treatments

At the stand level, silviculture treatments usually focus on reducing the canopy bulk density. For existing stands, this can be accomplished through partial harvesting and in some cases pruning treatments, which also reduce the possibility of ground fires reaching into the tree canopy. Networks of static fuel breaks can also be valuable to landscape-level fire risk reduction.

Wherever new plantations are established in the WUI, consideration should be given to fire management stocking standards: https://www.for.gov.bc.ca/hfp/silviculture/Fire%20Management%20Stocking%20Standards%20Guidance%20%20Document%20March%202016.pdf

The intent of a fire management stocking standard is to create and sustain stand conditions that achieve the objectives set for fire management in a given area within a WUI. Usually the goal is to reduce the probability of aggressive fire behaviour in a stand by decreasing the likelihood of crown fire and/or rapid high intensity ground fire. In general, fire management stocking standards are not expected to produce optimal stands for timber and therefore should be used mostly within the WUI.

General examples of fire management stocking standards are:

- Increased use of deciduous species for reforestation in high fire threat areas. Deciduous species may also be desirable for contributing positively towards habitat and biodiversity objectives.
- Increased use of species with smaller canopy bulk density.
- Reduced stocking densities to set up stands with reduced canopy bulk densities

12 Retention Strategy

The Bulkley Land and Resource Management Plan (LRMP) provides for the management of biodiversity in the Bulkley TSA. The biodiversity objectives consist of specific objectives for seral stage distributions, ecosystem representation, connectivity, tree species diversity and stand structure.

12.1 Biodiversity

Seral stage objectives are set to maintain biodiversity by sustaining a natural seral-stage distribution in each landscape unit (LU), natural disturbance type (NDT) and BEC variant. The targets are set for early seral (maximum), mature and old seral (minimum), and old seral (minimum).

The Bulkley HLPO also sets targets for patch size distributions as a resource objective. The intent of this objective is to allocate harvesting spatially in the landscape while maintaining block size limits.

The adopted seral stage targets ensure effective retention throughout the TSA. This analysis revealed that the rotation age of stands within various landscape unit and BEC variant combinations was controlled by seral stage targets and varied from 74 to 261 years.

12.2 Ecosystem Representation and Connectivity

The Ecosystem Network, consisting of Core Ecosystems (CE) and Landscape Riparian Corridors (LRC) facilitate ecosystem representation and connectivity in the Bulkley TSA. CEs are established to maintain biodiversity, represent a cross section of naturally occurring ecosystems, maintain some areas with interior forest conditions, and retain representative examples of rare and endangered plant communities. LRCs are designed to provide habitat connectivity and reduce fragmentation by maintaining landscape corridors dominated by mature tree cover and containing most of the structure and function associated with old forest.

CEs are protected from range use and timber harvest with some exceptions. Timber harvesting may be allowed, if it is necessary to protect the integrity and function of the ecosystem or provide access for forest health control activities or timber harvesting of isolated timber outside of the core ecosystem. Timber harvesting for mineral and energy exploration and development is allowed.

The guideline for management within landscape corridors is to maintain 70 percent of the existing structure and function of the forest within these corridors. This objective allows for the harvest of these corridors over a period of 270 years. Industrial, agricultural, recreational and tourism activities are permitted if they are compatible with the objectives of the landscape corridor.

Some zones have flexible boundaries and could be shifted to better optimize values. For example, reviewing current protection with respect to existing biodiversity “anchors” such as rare and endangered ecosystems, Northern Goshawk territories, and secure habitats for grizzly bear could lead to revisions to zones that could provide improved protection for values within the existing LRMP/HLPO legal and policy framework.

While core ecosystems are intended to protect a cross-section of naturally occurring ecosystems, including representative examples of rare and endangered plant communities, specific targets for ecosystem representation have never been formally established in the Bulkley TSA. To do so would require an analysis and subsequent grouping of distinct ecosystems in the TSA, and the setting of target proportions to maintain in an “unmanaged” state within core ecosystems and other reserve areas. This process is foundational to ecosystem-based management approaches (Price et al. 2009).

12.3 Tree Species Diversity

The objective is to maintain a diversity of coniferous and deciduous species that represent the natural species composition for each biogeoclimatic subzone. The Chief Forester has provided direction on tree species diversity.

12.4 Stand Structure

It is expected that a variety of old forest attributes, such as coarse woody debris and standing dead and live trees are maintained. This can be accomplished by many means including wildlife tree patch retention. The LRMP HLPO established legal objectives for wildlife tree patch retention with targets by landscape unit and BEC subzone. These targets are reflected in licensee forest stewardship plans (FSP).

Where possible, wildlife tree patches should be anchored to existing habitat features (e.g., ephemeral wetlands and seeps, rock outcrops, large cottonwood trees) to maximize their biodiversity value.

12.5 Wildlife Objectives

Legal objectives are defined for moose, mountain goat, woodland caribou, grizzly bear and mule deer.

12.5.1 Moose and Mule Deer

Moose and mule deer are important species to Indigenous communities and for recreational hunters. While mule deer populations in the Bulkley TSA are considered stable, moose have declined, mirroring declines elsewhere in the BC interior (Mumma and Gillingham 2019) and elsewhere in North America (e.g., Arsenault et al. 2019, Severud et al. 2019). The causes of this decline are not clear but could be associated with increasing vulnerability to hunting through landscape change (i.e., more roads and higher visibility), increased prevalence of disease and other consequences of warming winters.

The HLPO requires that woody browse, visual screening, security, thermal and snow-interception cover are provided in identified moose and deer winter habitat. The habitat is managed through Forest Stewardship Plans (FSPs) and no additional land base exclusions or forest cover constraints are currently required. Planning should leverage existing reserves and leave areas to provide habitat connectivity among suitable habitats for these species access should be planned to minimize access and to provide visual screening.

12.5.2 Mountain Goat

BC has the largest mountain goat population of any jurisdiction in the world and the majority of BC's mountain goats reside in the Skeena region. As a blue-listed species that is geographically restricted to specific habitats, mountain goats are significant conservation concern.

The LRMP and HLPO identify mountain goat habitat and require that thermal and snow interception cover and forage are provided in these habitat areas. Because mountain goats appear to be particularly sensitive to human disturbance, activities are to be limited in these areas. It is also expected that forested cover adjacent to escape terrain is maintained.

In addition to management required under the LRMP and HLPO, there is a legal Ungulate Winter Range (UWR) order and associated General Wildlife Measures that specify habitat retention and operating guidance within and close to UWR boundaries. The Selected Management Scenario removed some goat winter range polygons from the THLB as per the GAR order and designated them as retention areas.

12.5.3 Woodland Caribou

The range of the Telkwa Woodland Caribou herd overlaps the Bulkley TSA south of Smithers. Telkwa Caribou are of the northern ecotype, which are characterized by their use of high-elevation, windswept ridges and low elevation pine-lichen forests in winter, and by their use of alpine and subalpine parkland forests in the summer. Historic population estimates varied between 60 and 250 animals, and more recently the population peaked at 114 in 2006 after transplants in the late 1990's (Cichowski 2014). The population has since declined to 18.

Although ecologically the Telkwa caribou herd behaves like northern mountain caribou, their range falls within the federal Southern Mountain Ecological Area and they are *Threatened* along with southern mountain caribou under the federal *Species at Risk Act* (SARA). A federal recovery strategy partially identifies Critical Habitat and related protection requirements (Environment Canada 2014). The Species at Risk Act does not apply directly to provincial Crown land; however, the Provincial Government is expected to demonstrate effective protection of federally designated Critical Habitat.

Provincially, strategic management direction for Telkwa caribou is addressed primarily through the Ministry of Environment's Identified Wildlife Management Strategy (MWLAP 2004) and the consequent legal order establishing a Wildlife Habitat Area (#6-333). This WHA consists of a core no-harvest area and a conditional harvest zone at lower elevations where LRMP legal objectives set by government apply. General Wildlife Measures in the conditional harvest zone specifies old and young seral stage retention thresholds by biogeoclimatic subzone variants. Retention levels do not apply if licensees or BCTS prepare an acceptable Caribou Management Plan that meets results-based objectives consistent with the WHA Order. Deactivation of in-block and operational roads is also required.

The core no harvest zone creates a retention area of 43,424 ha of forest. The conditional harvest zone (17,375 ha of THLB) remains in the THLB with cover constraints imposed on harvest operations.

The provincial government is currently developing a new, province-wide caribou recovery plan that will likely bring all of BC caribou management in closer alignment with the Critical Habitat requirements of the federal recovery strategy. As a result, the ISS Base Case included woodland caribou habitat as an indicator. The tracked habitat target was set such that 90% of the forested area within the mapped caribou habitat should be older than 140 years. Although the recovery strategy did not directly reference this target, it was proposed in an early draft of the SARA Section 11 agreement between the provincial and federal governments.

This indicator was reported in the ISS Base Case and the enforcement of the habitat target was tested in a separate learning scenario. Enforcing the target reduced the ISS Base Case timber supply forecast by 7.5%.

12.5.4 Grizzly Bear

While no longer hunted in BC, grizzly bears remain a conservation concern because of their low reproductive rates and vulnerability to mortality, particularly among adult females. Because of this, maintenance of "secure" habitats, where there is little risk of conflicts with humans, is considered a key requirement for sustaining populations.

While grizzly bears are habitat generalists, they require an abundance of high-quality forage, particularly in the fall when they are required to gain weight prior to hibernation. Salmon and berries dominate their diets at this critical time. As a result, maintaining suitable foraging areas is also a management priority.

Four Landscape Unit Plans (LUP) contain grizzly bear habitat objectives.

The Babine Landscape Unit (LU) plan defines high value grizzly bear habitat areas, mixed forest habitat grizzly bear areas, and moderate value grizzly bear habitat. It sets guidelines for the management of grizzly bears in all three habitat types. For example, road development and the number and duration of entries are limited within moderate value grizzly bear habitat.

The Babine LU contains three grizzly bear management units: Boucher Creek Wetlands management unit, the Nichyeskwa South management unit and the Nichyeskwa North management unit. The objectives of these units are primarily to allow for the movement of grizzly bear between important landscape features and to reduce the potential for human-bear contact.

The Serb Creek watershed is designated as a Special Management Zone 2 (SM2) in the Copper LUP. Objectives for the Serb watershed focus on lowering the harvest intensity, managing the viewscape from Serb Creek, maintaining the integrity of the wetland ecosystems and controlling the impact on grizzly bears. The grizzly bear related objective is to discourage interactions between grizzly bears and people in the Serb Watershed by restricting access and timber harvest timing.

The Nilkitkwa LUP designates Barbeau Creek as a Special Management Zone 1 (SM1) with objectives that include protecting grizzly bear habitat. Tree cutting is limited only to that required for approved mineral exploration, development, and related access purposes.

The Telkwa LUP designates the Telkwa River sub-unit as an SM2 with several objectives including maintaining grizzly bear habitat. Most of this objective is managed through designated core ecosystems and landscape corridors, which with their harvesting restrictions provide forest cover for wildlife.

This analysis placed harvest constraints on the grizzly habitat in the Babine LU. It did not track suitable Grizzly bear habitat. Rather, it tracked poor Grizzly habitat in each LU and BEC variant. Poor habitat was defined as more than 30% mid seral stage (41 to 80-year-old stands) in each LU/BEC variant. Shrub and berry production in mid-seral forests is generally low and therefore unsuitable for grizzly bears. The area of mid seral stage is predicted to increase modestly in the TSA over the next 100 years. In the long term, the mid seral stage area is forecasted to remain under 100,000 ha.

12.6 Coarse Filter Biodiversity Management

As noted before in this document, one of the objectives of the Skeena Stikine Natural Resource District is the improvement of the coarse filter biodiversity management in the TSA. This can be done by focusing on representative small furbearers, such as marten, and a representative old-seral species such as the northern goshawk (NOGO).

12.6.1 Marten

The American marten is an important furbearer for Indigenous and other trappers and is widely distributed in BC. Marten in the SBS prefers mixed conifer stands and in particular those with complex structure near the ground, including large logs and decaying stumps, shrubs, and shade-tolerant seedlings. Maintaining habitat for marten is considered positive for general biodiversity, because suitable marten habitat is also suitable for a host of other species, including fisher, mule deer, woodpeckers and other mature forest bird species (BC Ministry of Forests, Lands and Natural Resource Operations 2014).

Coarse woody debris (CWD) is considered an indicator for marten habitat. Late seral stage (older than 250, or 140 for SBSmc, SBSmc2 and SBSdk) was used in this analysis as a surrogate for high volumes of CWD and therefore marten habitat. While marten habitat is predicted to decline over time, the management of the late seral stage and the associated late seral stage targets together with core areas and landscape corridors ensure that large areas are retained for marten habitat over time. The area of marten habitat is predicted to remain above 120,000 ha over time.

12.6.2 Northern Goshawk

The Northern Goshawk is quickly becoming a management priority in the Skeena region because of a recent collapse in the breeding population. Only 5% of known, previously suitable breeding territories were found to be occupied during a survey of the Kalum, Nadina and Skeena Stikine Districts in 2014 (Doyle 2015). As a previously yellow-listed species with no legal habitat protection, most of the breeding areas had been subject to at least some forest harvesting. However, as Doyle (2015) noted, "the near total collapse of the breeding population across the region may far exceed the potential impact of this single factor" (page 3). In addition to habitat impacts, high black fly abundance is now thought to be contributing to nestling mortality through blood loss, trauma and parasitic infection.

In response to the population decline, FLNRORD has prepared an action plan that focusses on maintaining a distribution of potential breeding and foraging areas in suitable condition throughout the range of the species in the Bulkley TSA and elsewhere in the region (FLNRORO 2018).

For the Bulkley TSA ISS, known Northern Goshawk nests, including a 100-ha buffer, were removed from the THLB for the ISS Base Case and for all scenarios. In addition, suitable forage habitat associated with these nests (8,845 ha) was tracked.

To accommodate action plan's recommendation to maintain a network of potential territories, the ISS incorporated a draft map of forage habitat areas received from FLNRORD in Smithers. Their general criteria for developing the network of projected forage areas was as follows:

- BEC Zones: CWH, ICH, SBS;
- Age Class: >60% greater than 80 years (age class 5 and greater);
- Territory Area: 2400 ha;

The foraging habitat requirement was enforced in the NOGO scenario, but not in the Selected Scenario; it was only reported as an indicator. In the long run, approximately 50% of the forest remains as NOGO foraging habitat. However, as the foraging habitat distribution is not controlled, individual forage areas may contain less than the desired target of foraging habitat.

In a revised coverage, these requirements were met through co-location with existing reserves and leave areas to the extent practicable. In all the previous scenarios the maximum projected forage habitat was 119,293 ha. The updated maximum forage habitat area for the TSA was reduced to 67,405 ha. The updated predicted NOGO forage areas utilize the NHLB well. Only 29% of the forested forage area is now located in the THLB, while the rest are in the NHLB. The predicted forage areas are shown in Figure 9.

Co-locating the predicted forage areas in reserves and other NHLB areas reduced their potential impact. A sensitivity analysis using the most up-to-date predicted NOGO forage areas in the model was completed to assess the potential timber supply impact of adopting the predicted NOGO forage areas in resource management. The short and mid-term harvest forecast was reduced by 2.8% and the transition to the long-term is delayed by 30 years. The long-term harvest forecast was reduced by 2.4%. The comparison was made against the Selected Management Scenario.

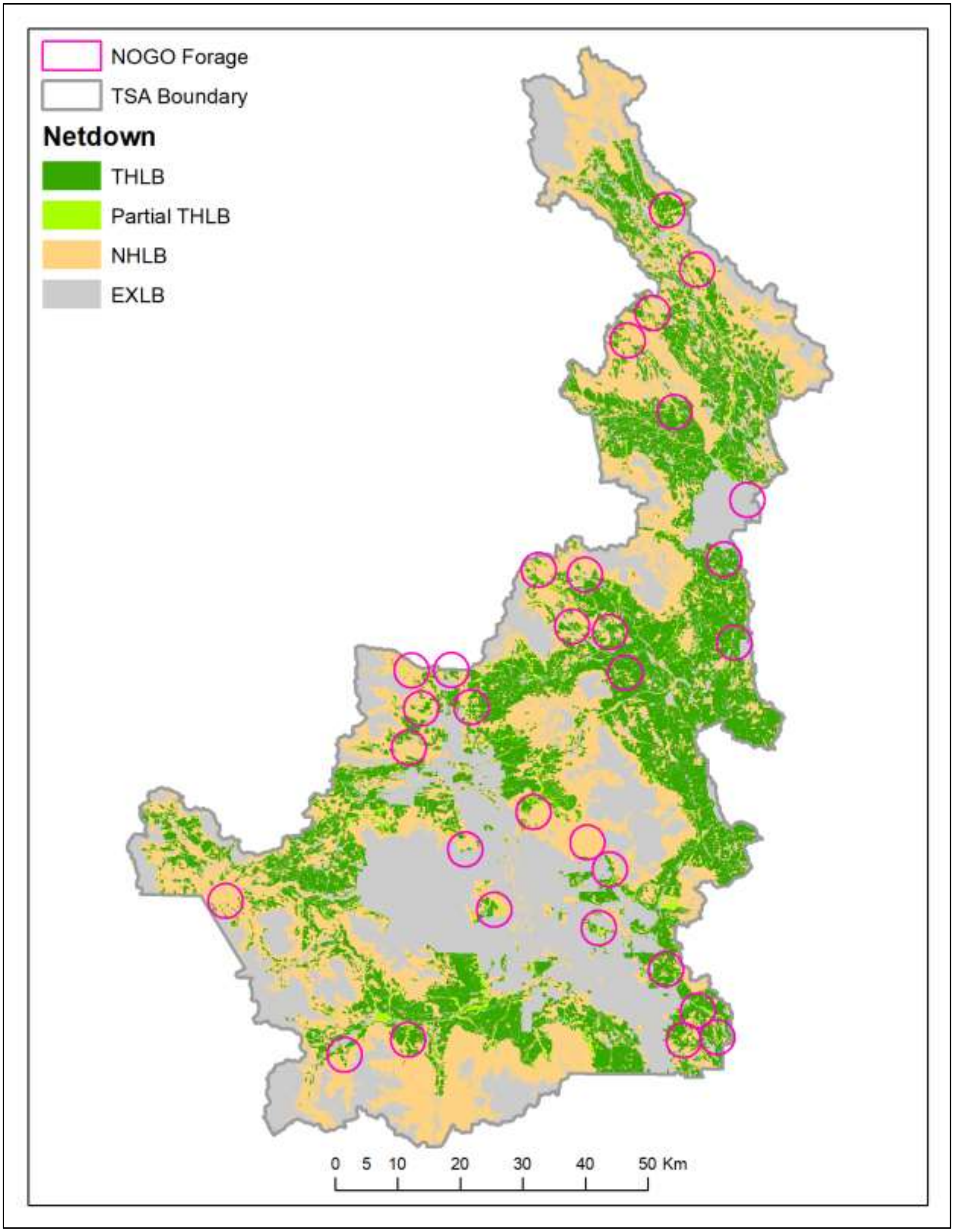

Figure 9: Predicted NOGO forage areas

12.6.3 Combined Wildlife

In addition to objectives focused on marten and Northern Goshawk to partly address coarse filter biodiversity, this was further explored by developing a scenario to address species affected by early (moose), mid (grizzly bear) and late seral (Northern Goshawk) habitat conditions. This represented an innovative approach to combine management of different indicator species into a single scenario and address management of broad-scale biodiversity more comprehensively.

12.7 Water Resources

Maintaining hydrological integrity to sustain water quantity and quality is key to maintaining a wide range of values and was incorporated in the Bulkley TSA ISS via the application of Equivalent Clearcut Area (ECA) targets. An ECA of 20% or less is considered desirable. The achievement of ECA was not controlled in the ISS Base Case; it was only reported as an indicator for all the 4^{th} order watersheds.

A learning scenario tested the impact of enforcing the ECA targets of 20% and 30% in all 4^{th} order watersheds. Setting the ECA target for each 4^{th} order watershed at 20% reduced the timber supply by 0.3%, while setting the ECA target at 30% for each 4^{th} order watershed had no impact on timber supply.

13 Opportunities for Colocation of Reserves and Constrained Areas

In 2015 the Chief Forester initiated the Provincial Stewardship Optimization/THLB Stabilization project. The intent of the project is to optimize placement of forest stewardship reserves while minimizing the timber supply impacts of these reserves and providing more stability for the Timber Harvesting Land-base (THLB). In practical terms, the intent is to find more efficient ways throughout the province to meet all the SAR requirements, and objectives for the 11 FRPA values. This can potentially be done by investigating different combinations of locating the many constraints on timber harvesting. The primary objective is to improve stewardship while simultaneously providing stability to the THLB by optimizing the placement of spatial constraints (colocation), without changes in land use plans or legislation.

In practise, where colocation opportunities exist, they are often small in scale and may require site level review to ensure that the required habitat elements exist in proposed areas. Plans such as this ISS can only investigate potential colocation opportunities at a landscape level.

In the Bulkley TSA there are additional opportunities to explore co-location of value-specific reserves and practices to leverage the effectiveness of management actions. Specifically, there is possible overlap among combinations of the following:

- Goshawk foraging
- Moose winter range
- Fisher and Marten habitat
- Caribou habitat
- Visual quality objectives

An example of a co-location approach provided by the FLNRORD Skeena Region is presented in Table 17.

Table 17. Example of co-locating values and assigning management objectives and prescriptions.

Value	Objectives	Structural Attributes	Quantity-quality-distribution	Silviculture systems
Goshawk only	Meet Goshawk biological requirements with clear-cut with reserves only	For forage: >60% M+O >=ac5 For breeding: 100 ha M+O >ac5		Clear-cut with reserves
Goshawk with VQO	Manage to the VQO:P-PR and lower %'s of M if conventional. Management to VQO:R-PR if partial cutting.	Veg is ~20 years for conventional Tree ht and vol Stems removed/ha Non-conventional		Clear-cut with reserves, clear-cut with variable retention Non-conventional treatments
Goshawk with Landscape Connectivity Corridor	Manage to the corridor.	>70% existing M+O >ac5 conifer	Maintain interior forest stand conditions of 100 m	Any silviculture system that meets objectives

14 Stand-level Treatments

Within co-located areas where harvest is allowed, there are also stand-level strategies that can improve habitat for specific species or biodiversity values in general. These include:

- Retention or creation of CWD piles;
- Snag creation;
- Creation of canopy gaps to vary stand structure and improve light penetration and shrub growth;
- Creation of missing habitat features, e.g., nesting platforms, additional of nest boxes, etc.

14.1 Reduced Stocking in Wildlife Habitat

Reduced stocking standards can be considered in wildlife habitats designated in HLP zones for moose, mule deer and grizzly bear. Lower stocking can encourage vigorous shrub growth that provides critical forage for these species.

The timber supply/ habitat supply implications of adopting new stocking standards in these areas requires addition analysis.

15 Road/Access Management

Human access is considered a significant risk to grizzly bear populations and large, unroaded areas of "secure" habitat are associated with higher grizzly bear survival (e.g., Lamb et al. 2017). Deactivation of non-status roads within grizzly bear habitat, where road densities exceed 0.6 km/km^2 could benefit populations and is consistent with the provincial Cumulative Effects Framework. Reducing road densities can also benefit other species (e.g., moose and deer) by reducing hunting pressure.

16 Conclusions

The preparation of the Bulkley TSA ISS was a cooperative process with stakeholders identifying critical issues in the TSA and contributing to the strategy development to address those issues. The most significant conclusions are listed below:

- The ISS Base Case development identified differences between current management and the way TSR defines current management, particularly with respect to the land base available for harvest:
  - ✓ Proposed area-based tenures (FNWL) were incorporated in the analysis and removed from the THLB;
  - ✓ Removed known NOGO nests and nest buffers from the THLB;
  - ✓ Removed all areas classified as pulp from the THLB;
  - ✓ Removed all areas classified as marginal sawlog located further than 1 km away from a road from the THLB;
  - ✓ Removed all areas classified as marginal sawlog located further than 5-hour cycle time away from Smithers from the THLB;
  - ✓ Marginal sawlog in Planning Cell C7 was included in the THLB.
  - ✓ Low site classification changed from TSR
  - ✓ Elk damage and forest health factors (Swiss Needle Cast, Root Rot) were incorporated in the analysis. The scenario accounting for forest health factors was used as the basis for comparison for silviculture scenarios.
- Some of the critical issues that were identified in the project relate to policy and/ or legislation. Policy and/or legislative changes are required; some critical issues, such as tenure security cannot be addressed through strategic planning.
- Analysis scenarios tested a variety of feasible management strategies.
- The project found significant differences among management scenarios on impacts to various values, particularly projected $-value.
- Chosen biodiversity indicators were generally not sensitive to inputs used in various timber value and volume scenarios.
- Biodiversity and habitat scenarios attempted to enhance biodiversity and/or habitat. This generally reduced timber supply, or had no impact on timber supply (ECAs)
- The ISS Selected Management Scenario includes incremental silviculture investments that in the short-term proposed modest treatment areas and expenditures. This scenario is projected to lead to higher long-term timber value while performing at least as well on non-timber values as the comparison scenarios.
- The harvest assumptions must be followed (at least broadly) to achieve the indicated outcomes.

17 Learnings and Recommendations

17.1 Ongoing process

The Bulkley TSA ISS is an on-going process. For some time, the analysis dataset could be used to analyse the implications of proposed policies and/or legal designations.

17.2 Integration into adaptive management

There is an opportunity to integrate the ISS into planning as part of the adaptive management process that incorporates monitoring results related to past harvest and silviculture investments to management. Furthermore, the implications of emerging issues and the effectiveness of potential management responses can be tested.

17.3 First Nations

No First Nations participated in this project. This iteration of the ISS included no specific objectives related to First Nations' values.

The ISS would benefit from the inclusion of a full range of First Nations' values and First Nations' participation in selecting the harvest, retention and silviculture strategies.

Including First Nations' representatives as part of the planning team is desirable. This is an area that requires Provincial direction.

17.4 Co-location

The sensitivity analysis of enforcing the predicted NOGO forage area targets in the TSA revealed that thoughtful placement of new reserves or constrained harvest areas can reduce the timber supply impact. There may be additional opportunities to co-locate reserves and management practices related to other values to improve biodiversity management. Specifically, using key habitat attributes or features (e.g., wetlands, seeps, karst) as "anchors" and designing the landscape to maintain connectivity and a continuous supply of elements such as abundant shrubs, dead and dying trees, complex stand structure, and abundance coarse woody debris, including logs of large diameters classes in different states of decay. This will serve specific wildlife species of concern as well as broad-scale biodiversity.

17.5 Incorporation of Provincial Issues

It is important that as provincial issues emerge, there is recognition of those issues and how to incorporate them into a planning process such as the ISS. For example, managing for carbon has been identified as a provincial issue and will benefit from future iterations of the ISS.

17.6 Forest Inventory and Other Inventories

It is often difficult to fully analyze and understand some management issues using a strategic resource inventory, as the data may not be collected to the level of interest. As an example, the project attempted to use fire threat ratings in the urban interface areas for treatment prescriptions. However, the fire threat ratings are based on the VRI, which in turn is not sufficiently detailed to provide direction on tactical treatments without field verification. A higher resolution, more tactical inventory would be beneficial for tactical planning.

17.7 Limitations of Growth and Yield Modeling

Data on the growth and yield modeling of mixed species managed stands is lacking, making estimates of future species compositions, yields and timber values problematic. The use of TASS, which incorporates some stand dynamics for mixed species stands and allows the simulation of stands with both planted and natural trees (vs TIPSY[1], which does not include any stand dynamics and does not accommodate modeling of stands with planted and natural components), is time consuming.

Future iterations should take the learnings from the use of TASS and of the importance of the development of managed stand analysis units and their attributes from available data.

An improvement would be to incorporate BEC data into the development of analysis units as in this analysis, because this ecological framework is strongly tied to management and natural processes.

The impact of pests and diseases on the growth and yield of managed stands is not well understood. Operational foresters continue to express concerns over these impacts and often argue that the growth and yield modelling in BC may not adequately account for pests and diseases.

17.8 Limitations of Habitat Supply Modeling

Predicting the response of wildlife populations to future forest management is associated with a variety of challenges. First, wildlife populations are subject to a variety of stressors and factors that are not directly related to the state of habitats and how they are managed. Populations can be affected by stochastic events (e.g., severe winters), predator-prey dynamics, hunting pressure, as well as other factors and their interactions that are often poorly understood and beyond our ability to model with any precision or accuracy.

Second, populations are affected by habitat elements that may not be predicted accurately by changes in the supply or configuration of habitat. For instance, Northern Goshawks are strongly influenced by prey abundance (e.g., snowshoe hare cycles) that occur largely independently of forest management. Moose, deer and caribou numbers have likely dropped in part due to predator populations that have been expanding for decades following the end of large-scale predator control.

Third, the supply of important habitat elements, although forestry related, might not be predicted with accuracy through current models. For example, the supply of CWD can be predicted only coarsely by the distribution and abundance of old forest. There are many factors that affect CWD volumes that are beyond our current ability to model.

Finally, even where suitable habitat is closely tied to habitat characteristics that can be predicted through forest estate modeling, all of the limitation and caveats of the models as they relate to forestry also apply to any related habitat supply forecasts.

As a result, interpretation of the implications of the Bulkley TSA ISS scenarios for wildlife species should be interpreted cautiously. Even successful management that provides a continuous supply of suitable

[1] https://www2.gov.bc.ca/gov/content/industry/forestry/managing-our-forest-resources/forest-inventory/growth-and-yield-modelling/table-interpolation-program-for-stand-yields-tipsy

habitat may underperform expectations for reasons unrelated to forest management and unintended consequences are always a risk.

17.9 Challenges to implementation of the Selected Strategy

17.9.1 Value or Volume

This project identified the need to address the issue of value versus volume as a specific objective from a provincial and localized perspective. While the selected management strategy in this ISS emphasizes actions that favor the long-term value of the harvested timber, the implementation of this strategy may be difficult due to increased up-front costs and the perceived recipient of the long-term benefits. There needs to be clear provincial direction on the use of provincial funding for creation of added value beyond the present approach.

17.9.2 Challenges for Implementation

There are significant challenges to successful implementation of many components of this strategy under the current forest management framework in British Columbia (tenure and regulatory systems). The Crown (the people of BC/government) owns the resource and has passed the responsibility for much of its management to timber tenure holders, including the timing and location of harvest, and basic reforestation.

This system provides for efficient harvest scheduling and timely reforestation with ecologically suitable tree species; however, it does not promote long-term investments by the tenure holders. Furthermore, the current forest management framework can make it difficult for government to invest effectively in incremental silviculture regimes (a series of treatments that span the whole rotation) to meet integrated objectives without appropriate changes in policy.

For example, on areas primarily designated for timber production, the Bulkley TSA Selected Management Strategy recommends investments in enhanced basic reforestation (higher densities) on selected sites. Analysis showed that these regimes could contribute to an improvement in the value recovered from the timber harvest over the longer term, if the treated stands are not harvested too soon.

The key to achieving the benefits of this strategy require investments in basic silviculture and fertilization, and that harvesting occurs within a certain age range. The government does not currently have means to control the time of harvest.

17.9.3 Following the plan

The implementers of this plan may be tempted to take the figures and specific direction from this strategy and accept them as a “rule”. Rather, they are conceptual and should be taken as guidelines when developing tactical harvest schedules or tactical silviculture treatment plans.

The higher-level harvest direction and findings are important. The timber profile and its approximate harvest as per the profile is necessary.

17.10 Recommendations

- Establish local timber objectives with licensees to facilitate the achievement of the harvest strategy.
- Advocate for and develop a TSA-wide tactical plan with licensees to guide the achievement of the harvest and silviculture strategies.

- Work with Forest Analysis and Investment Branch to look for modifications to TSR based on the ISS Base Case approach, particularly when modelling the growth and yield of managed stands.
- Better integration of additional landscape level fire management planning – e.g., where to use fire stocking standards, where to place fire breaks. This will require more detailed data and involvement of other landowners.
- Improve ties to provincial and regional Cumulative Effects initiatives This could include:
  - ✓ Aligning ISS indicators with cumulative effects values
  - ✓ Incorporating cumulative effects thresholds as ISS management objectives (as was done in this project for the 30% mid-seral cap for grizzly bears)
  - ✓ Providing landscape forecasting support for cumulative effects teams
  - ✓ Reporting on implications of cumulative effects values and thresholds on timber supply
- Tie all future funded treatments to a risk assessment approach and mapping as described in the Silviculture Strategy.
- Where possible, recommended treatments should be identified in a manner that they can be clearly articulated for funding sources to promote implementation.
- A monitoring plan for implementation is needed to track whether the assumptions provided in this strategy promoting the desired outcomes are being followed. If not, the reasons for not following the assumptions must be understood and addressed.
- Pursue opportunities within the legal and policy framework of the LRMP/HLPO to optimize biodiversity management through better co-location and reserve design and retention of important habitat elements.
- Test the effectiveness of biodiversity objectives explored in this ISS through field monitoring tied to practices (e.g., occupancy of potential breeding and foraging areas by Northern Goshawks, marten distribution and abundance in relation to CWD retention/creation, grizzly bear population monitoring in relation to road densities and forage supply).

18 List of Acronyms and Tree Species Codes

18.1 List of Acronyms

Acronym	Description
AAC	Annual Allowable Cut
BEC	Biogeoclimatic Ecosystem Classification
CBST	Climate Based Seed Transfer
CCISS	Climate Change Informed Species Selection
CE	Core Ecosystems
CWD	Coarse Woody Debris
ECA	Equivalent Clearcut Area
ETZ	Enhanced Timber Zone
FAIB	Forest Analysis and Inventory Branch
FESL	Forest Ecosystem Solutions Ltd
FLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
FMP	Fire Management Plan
FNWL	First Nations Woodland License
FREP	Forest and Range Evaluation Program
FRPA	Forest and Range Practices Act
FSP	Forest Stewardship Plan
HECA	Hydrologically Equivalent Clearcut Area
HLPO	Higher Level Plan Order
ISS	Integrated Silviculture Strategy
IWAP	Interior Watershed Assessment Procedure
LRC	Landscape Riparian Corridor
LRMP	Land and Resource Management Plan
LT	Long-term
LU	Landscape Unit
MAI	Mean Annual Increment
MRVA	Multiple Resource Values Assessment
MWLAP	Ministry of Water, Land, and Air Protection
NDT	Natural Disturbance Type
NHLB	Non-Harvestable Land Base
NOGO	Northern Goshawk
NROV	Natural Range of Variation
PSTA	Provincial Strategic Threat Analysis
RPB	Resource Practices Branch
SAR	Species at Risk
SARA	Species at Risk Act
SM1	Special Management Zone 1
SM2	Special Management Zone 2
ST	Short-term
TASS	Tree and Stand Simulator
TIPSY	Table Interpolation Program for Stand Yields

Acronym	Description
THLB	Timber Harvesting Land Base
TSA	Timber Supply Area
TSR	Timber Supply Review
UWR	Ungulate Winter Range
VRI	Vegetation Resource Inventory
VQO	Visual Quality Objective
WHA	Wildlife Habitat Area
WUI	Wildland Urban Interface

18.2 Tree Species Codes

Species Code	Species Name
Ba	Amabilis fir
Bl	Sub-alpine fir
Cw	Western redcedar
Fd	Douglas fir
Hw	Western hemlock
Pli	Interior Lodgepole pine
Sw	White Spruce
Sx	Hybrid Spruce

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