College of New Caledonia

CNC RESEARCH FOREST

Management Plan #3
Amendment #1: 2017 to 2022

Acknowledgements

The creation of this Research Forest was the result of the hard work and contribution of a forestry coalition that was led by the British Columbia Ministry of Forests, Lands and Natural Resource Operations and the forest Industry represented by the Council of Forest Industries. Members of the working group included the Association of British Columbia Forest Professionals, Canadian Forest Products Ltd., the Canadian Institute of Forestry, Central Interior Logging Association, Council on Northern Interior Forest Employment Relations, the Consulting Foresters of British Columbia, the Prince George Truckers Association, Spectrum Resources Group and the University of Northern British Columbia. CNC is also very appreciative of the collaboration and support of Dunkley Lumber Ltd., who is a critically important partner in the operational implementation of the Research Forest.

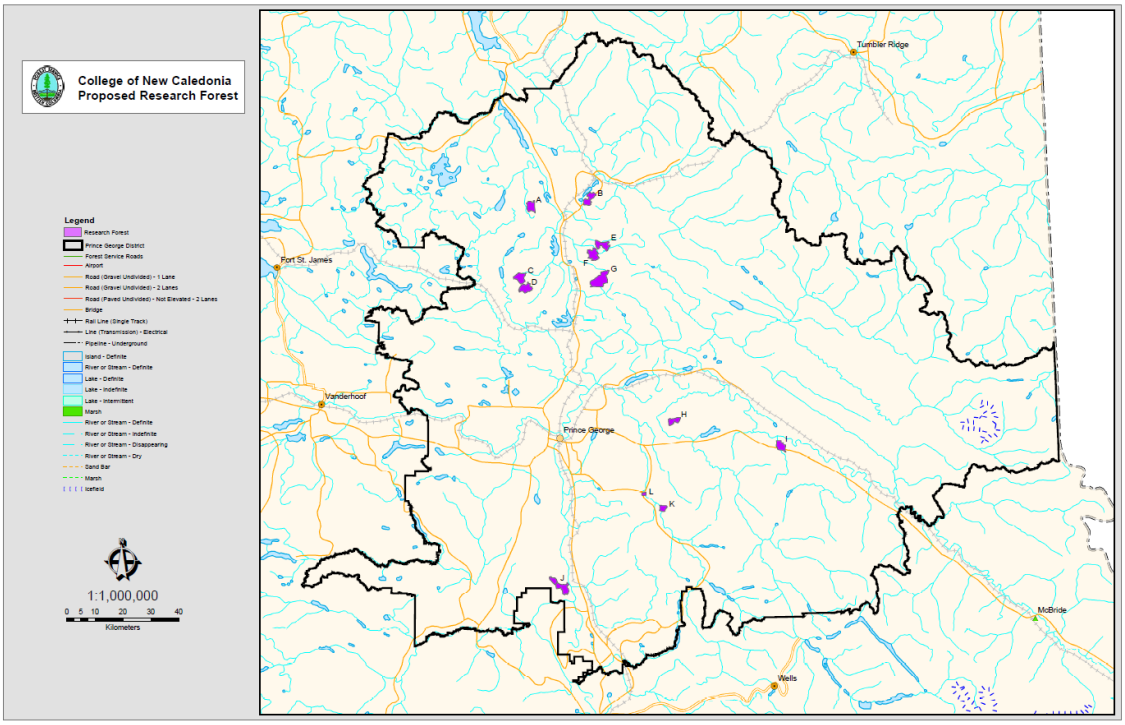
Without the foresight of these groups, there would not be a Research Forest committed to applied forestry research in central/northern British Columbia, nor would there be any form of technical forestry and natural resource education offered by the College of New Caledonia (CNC). Thanks to these efforts it will not only be possible to continue to provide technical education programming but to add another dimension to forest management research and education in the region.

With the focus on resource development of natural resources in the interior of British Columbia, it will be increasingly important to have skilled resource managers available to address the challenges ahead. They will require skills and knowledge enhanced by relevant applied research conducted in northern forest types. With assets like the CNC Research Forest and a community education focus, CNC will be able to contribute to meeting the needs of the resource sector in a significant way for some time to come.

Introduction

The College of New Caledonia Research Forest (CNC Research Forest) is comprised of 12 Units of Provincial Forest land totaling approximately 12,500 hectares, all of which are located within 100 km of Prince George as shown in Figure 1. The CNC Research Forest includes Woodlot W0210 that was issued to CNC prior to the establishment of the Research Forest. The concept for the research forest arose from efforts of a coalition of forest resource interests with a desire to maintain opportunities for a full range of post-secondary forest education in central British Columbia (BC).

Figure 1. Location of CNC Research Forest Management Units A through L



The forest tenure for the CNC Research Forest is authorized by the BC Ministry of Forests, Lands and Natural Resource Operations, through a Special Use Permit (SUP). This SUP allows the College of New Caledonia (CNC) to use the provincial forest lands primarily for the purpose of supporting a vibrant Natural Resources and Environmental Technology program at CNC by generating revenue through the implementation of sustainable forest development and resource management. The Research Forest is further intended to provide a continuing venue for education and natural resource research and innovation.

The CNC Research Forest complements other provincial research forests including the Aleza Lake Research Forest, the John Prince Research Forest, and the Alex Fraser Research Forest with a potential to form a cluster of complementary organizations focused on forest land-based research affecting the forests of central BC.

Following the inception of the CNC Research Forest, CNC established a partnership agreement with a local forest company and together have completed management and operational planning, and successfully undertaken multiple harvesting and silviculture operations. During this time, CNC has also been successfully initiating and completing research projects on the Research Forest, including significant activities funded under the Natural Sciences and Engineering Research Council (NSERC) program.

Current Management Challenges

The CNC Research Forest is located within forested landscapes that are subject to a large variety of naturally occurring forest health factors including insects, pathogens, abiotic (such as fire), and wildlife damage. These perturbations to timber, ecosystem function, and wildlife habitat are cyclical and typically result from a combination of environmental factors (e.g., hot, dry summers) and historical resource management activities (e.g., fire exclusion). At low or endemic levels, these forest health factors are an integral component of ecosystem function, however in outbreak mode certain forest health factors may cause widespread and catastrophic damage. Such is the case with the current outbreak of spruce beetle that has rapidly expanded over the last two years within the northern portion of the Prince George Natural Resource District. Under the current favorable climatic conditions (e.g. droughty summers) and the wide distribution of susceptible spruce-leading stands, spruce beetle attack is expected to continue to expand. The widespread spruce beetle-caused mortality throughout the Parsnip River drainage to the east is rapidly advancing westward. To the north of Summit Lake there are now large areas of spruce beetle west of the Crooked River.

The CNC Research Forest units north of Prince George are immediately adjacent or in the midst of very large spruce beetle populations. At the time of this plan, Research Forest Units C, D, E, F, and G were moderately to severely affected by spruce beetle. Only Unit B is at a low level of spruce beetle infestation. All of the remaining areas within Units B to G, and all of Unit A, remain under high threat of increased spruce beetle infestation. The magnitude of the current infestation and its predicted expansion has warranted a major revision to the Research Forest management plan. This will be accomplished through an update of the forest inventory, other natural resource values, and management practices.

As a result, this new management plan will reflect notable revisions to timber management practices as well as substantial revisions to the management of other natural resources. There is considerable uncertainty involved in predicting future impacts of the spruce beetle infestation, but this management plan strives to minimize the uncertainty regarding the short-term (five-year) management of timber, forest health factors, and other natural resources within the Research Forest.

Proactive detection and assessment of forest health, along with efficient forest health management and effective timber value recovery are all expected outcomes of this new management plan. Spruce sanitation and salvage harvesting within Units E and F is already underway under management plan #2, along with beetle holding treatments. The implementation of this new management plan is a vital next step in ensuring the continuation of current forest health strategies and related resource management activities within the Research Forest for the benefit of community education, local research, and the local forest industry.

The Research Forest Structure

Legislative and Regulatory Framework

Use of the provincial Forest for the CNC Research Forest is authorized under two provincial forest tenures:

Special Use Permit (SUP) S24940 was issued by the Prince George District Manager of the Ministry of Forests, Lands and Natural Resource Operations under the *Forest Act*. The term of the original SUP was five years, but was re-issued for 25 years commencing November 28, 2012. The SUP designates the specific parcels of land to be used for the Research Forest and requires that the Research Forest be managed under an approved management plan containing

detail as specified in the SUP. The *Forest and Range Practices Act (FRPA)* requirements for operational planning (Forest Stewardship Plans) do not apply to the SUP, however, most of the forest practices standards required under the *Forest Planning and Practices Regulation* are applicable.

Occupant License to Cut (OLTC) L49404 was awarded over the entire SUP area, and provides CNC the authority to harvest and remove timber. The OLTC was awarded with an expiry date of November 27, 2037 to coincide with the SUP term. The OLTC does not specify timber utilization standards as this is guided by the utilization assumed in the timber supply analysis provided in this management plan.

Role of the CNC Research Forest Society

Within the SUP document, it states that a principle purpose of the tenure is for CNC to continue to offer a vibrant and dynamic Natural Resources and Environmental Technology Program (NRET) in Prince George and to ensure program graduates are eligible to become Registered Forest Technologists with the Association of British Columbia Forest Professionals. Consistent with providing a vibrant and dynamic NRET program, graduates are now also eligible to become Registered Biology Technologists with the College of Applied Biology.

The SUP also states that the Research Forest will be managed to facilitate applied research and teaching on a wide range of topics from the environment to natural resource management, and that the Research Forest will be managed on principles of sustainability and total resource management. To ensure that these mandates are achieved, the SUP requires CNC to establish an independent governing board to oversee the management of the Research Forest. As required under the SUP, CNC established the College of New Caledonia Research Forest Society (CNCRFS) to fulfill this oversight role, which is a fully recognized society governed under the *Society Act.*
In particular, the CNCRFS is established to:

1) Provide stewardship of the Research Forest under the terms of the license;
2) Provide core funding support to CNC's Natural Resources and Environmental Technology Program; and
3) Promote applied research and innovation in the forest sector.

The CNCRFS governing board continues to operate with a broad, balanced membership and fulfills its purpose by providing direction for the management plan, approving the annual budget, and directing the financial proceeds of the Research Forest.

An agreed base funding allocation model for the NRET program is in place to provide reliable ongoing NRET funding. In addition, the CNCRFS board has full discretionary authority for the use of Research Forest revenues to fund research activities on the Research Forest, and for enhancements to the NRET program as per documented protocols, which are provided as part of Appendix A.

Role of College of New Caledonia

Although the CNCRFS provides direction and oversight, it is CNC that holds the rights and authorities under SUP S24940 and OLTC L49404, and that provides for the direct management and administrative support for all operations within the Research Forest including forest harvesting, silviculture activities, research, education, community outreach and extension services. CNC is responsible for ensuring that all requirements under the forest tenures and under the associated provincial Acts and Regulations are met, including payment of all stumpage and fees to the Province. CNC is also entrusted with managing all the revenue and expenses associated with the Research Forest operations and holding the net revenue in trust for the CNCRFS.

The vast majority of the Research Forest operations undertaken to date have been achieved through CNC's partnership agreement, resulting in CNC's partner providing the required professional and technical expertise to carry out operational planning and the subsequent harvesting and silviculture activities. In return, CNC's partner is receiving and purchasing all of the harvested timber thereby providing the revenue to support a vibrant NRET program. At the same time, the activities carried out under CNC's partnership agreement are contributing to the cumulative socio-economic benefits of the local forestry industry.

Through CNC's existing industry partnership, CNC has successfully managed and operated the Research Forest, establishing a viable net revenue flow to support both the NRET Program and expanding study and research, which is implemented through CNC's Applied Research and Innovation Department. The Research Forest benefits, along with the significant efforts of the ARI department, have allowed CNC to experience steady growth in terms of funding grants, industry and community partnerships, and dedicated research staff. As such, CNC continues to succeed in implementing the intended mandate of the Special Use Permit resulting in tangible benefits to student education, and local research and innovation.

Vision for Research and Innovation within the CNC Research Forest

CNC Research Forest Vision:
An economically self-sustaining and environmentally sustainable research forest that supports a healthy and vibrant CNC Natural Resources and Environmental Technology Program and provides applied research opportunities to the region.

CNC Research Forest Society Mission:
Provide oversight of the CNC Research Forest, including strategic planning and financial management, for the benefit of CNC's NRET Program, the Natural Resource Sector, First Nations and communities.

Foundation:
By its nature, the College of New Caledonia offers programs and courses that are relatively short term but lead to immediately applicable outcomes. Programs and activities are practical in nature and are responsive to community needs and interests while maintaining an underlying educational and research value.

The CNC Research Forest will:

1) provide ongoing fiscal support for the accredited Natural Resources and Environmental Technology Program at CNC;
2) provide a foundational land base for conducting applied research;
3) provide a foundational land base for conducting intensive silviculture research activities with specific aims to explore or determine the economic, environmental, and social benefits/costs of such treatments;
4) provide opportunities for First Nations to utilize the Research Forest land base for pertinent research projects that contribute to a better understanding of social, economic or environmental factors important to First Nations and undertake or participate in such activities;
5) link with provincial, federal and international research institutions that have extensive experience in developing value added products from the forest land base and undertake or participate in such activities;
6) provide an outdoor education environment for students;
7) provide opportunities for students to undertake or participate in applied research projects; and

8) provide an excellent forum for demonstration of resource management practices and concepts.

Objectives of the CNC Research Forest Society and CNC

Education Funding Support

1) To provide long term revenue to support CNC's accredited Natural Resources and Environmental Technology Program. This revenue is generated primarily by the harvesting and selling of timber in a manner consistent with research objectives.

Land and Resource Management

2) To take responsibility for and manage designated forestry research lands;
3) to construct and maintain an effective and environmentally sound access system on the Research Forest lands in the way of roads, bridges, and culverts; and
4) to manage and operate the Research Forest in such a manner that the landbase is able to continuously support a primary objective of applied forest research and education. Such activities will center on sustainable development of the intrinsic resource values of the research forest.

Promote and Support Partnerships in Natural Resources Research

5) To provide an opportunity to link research projects at other Research Forests in BC (e.g., Alex Fraser, Aleza Lake, Malcolm Knapp, and John Prince);
6) to promote opportunities for First Nations, communities, external agencies, institutions, organizations, and specifically CNC students to set up and establish research projects in the Research Forest;
7) to create a working partnership with the natural resource sector, the BC Ministry of Forests, Lands and Natural Resource Operations, First Nations, the Federal/provincial/International forest research community and independent forest research groups;
8) to access Federal/provincial/industrial resources and establish relevant research that link to these types of funds;
9) provide opportunities for public learning and extension activities; and
10) partner with forest research agencies to conduct applied research that focuses on issues and problems of specific importance to forests in the central interior of BC. Such projects could include but are not limited to:
    a) research into the effects of forest practices on fish and wildlife habitat, environmentally sensitive sites, and the overall health of biodiversity associated with the forests of the central interior of BC;
    b) research into the effective management of forest health factors in the predominant forest types within the central interior of BC;
    c) research into the contribution that intensive silviculture practices have on the social development of central interior communities and their economic diversity or in the maintenance or enhancement of the overall environmental health of the central interior forests of BC;
    d) research into the development of new wood products derived from the forests associated with the CNC Research Forest and their contribution to the economic and social well-being of central interior communities;
    e) investigation of the environmental health in the region, focusing on climate change, atmospheric carbon changes, and pollution elements;
    f) experimentation and study of assisted tree species migration and the adaptation of forest plant species in response to changing climate;
    g) renewable energy research;

h) exploration and experimentation with various forms of remote sensing, such as LiDAR, digital aerial photography and videography, and aerial scanning to improve the modelling and inventory of natural resources;
i) exploration of information technology applications to enhance resource management activities on the Research Forest; and
j) establishment of key research sites within the Research Forest that track a variety of environmental and biodiversity factors over time.

Term and Scope

This amended management plan commences on the effective date specified by the District Manager. Should the District Manager not specify an effective date in the notice of approval of the plan, the default effective date shall be assumed to be the date of notice of the District Manager's approval of the plan.

Management Plan # 3, Amendment # 1 is proposed for a five-year term. This term will provide an appropriate framework for strategic planning and to implement management strategies.

The plan commences on the effective date and remains in force until the earlier of:

1) five years from the effective date;
2) approval of a replacement management plan;
3) termination of the management plan by the District Manager;
4) termination of the management plan by the CNC Research Forest Society Board; or
5) termination of the Special Use Permit.

The scope and purpose of this CNC Research Forest Management Plan is:

1) to provide a strategic plan to guide forest operations and land management practices within the CNC Research Forest;
2) to ensure that the goals and management direction of the CNC Research Forest are consistent with legislated land management requirements and tenure provisions; and
3) to provide consistency and continuity in management direction with future plans.

Location and Geography

The CNC Research Forest is comprised of twelve forested units located North, East and South of Prince George, BC. The units are located within 100 km of Prince George. The units span climates ranging from dry/warm to wet/cool, largely within the Sub-Boreal Spruce biogeoclimatic zone. The ecosections encompass the McGregor Plateau and the Nechako Lowlands for units located to the North and South of Prince George and the Bowron Valley and North Cariboo Mountains ecosections for those units located to the East of Prince George.

The Research Forest units are situated mostly in the Sub-Boreal Spruce biogeoclimatic zone with two units in the Interior Cedar Hemlock zone (Units H & I). The subzones that apply to each unit are listed in Table 1 along with the total area of provincial Forest that each unit occupies as per provincial Exhibit A mapping. For more information about the type of forest lands contained within the Research Forest, refer to the timber supply analysis within Appendix H of this document.

Table 1. Unit Summary Description for the CNC Research Forest

Unit ID	BEC subzone	Exhibit A Gross Area (ha)
A	SBSwk1	941.4
B	SBSwk1	1,056.2
C	SBSwk1	1,061.3
D	SBSwk1	1,103.7
E	SBSwk1	1,082.0
F	SBSwk1	1,210.0
G	SBSwk1 (SBSvk/ESSFwk2)	2,278.5
H	ICHwk4	735.5
I	ICHvk2	886.3
J	SBSdw3 (SBSmh)	1,585.7
K	SBSwk1	468.0
L	SBSmk1	158.5
Total		**12,566.9**

Natural Resource Management Objectives, Results, and Strategies

In the following sections, the purpose is to specify the objectives, results or strategies for protecting, conserving and managing the various natural resource values within the Research Forest. The objectives, results and strategies specified in this plan not only address the provincially regulated natural resources and the provincial government objectives that apply to the area occupied by the Research Forest, but they also address other important natural resource values, which are not legally recognized.

CNC also maintains a development plan for the Research Forest which contains more specific results, strategies, standards, and measures that are to be applied to fulfill the management plan direction.

Varying from the Management Plan

Upon approval, CNC has committed to implementing this management plan as written and as per any direction by the District Manager. It is expected that any variances from the following natural resource management objectives, results, and strategies will be planned and prescribed in advance with appropriate professional rationale. A variance will most often be documented through individual signed site plans but may also include documentation within the development plan or other documented information and rationale. It is expected that variances from this plan will most often be a result of various forms of research. Examples of research include conducting experimental forestry practices, establishing operational treatment trials, and undertaking educational activities.

It is also possible that a variance may be necessary due to unforeseen or changed environmental conditions or unidentified circumstances. However, in the case of a persistent unexpected environmental condition, (such as extreme, prolonged drought) or other circumstance that requires regular variance, the management plan will be revised or amended accordingly.

Some of the management plan requirements are those specified under the *Forest Planning and Practices Regulation* that apply to minor forest tenures and forest tenures without Forest Stewardship Plans. Where planned operations may not comply with a regulated requirement, then

it will be necessary for CNC to submit a request for exemption to the Minister, as per subsection 91 (1) (b) of the *Forest Planning and Practices Regulation*, specifying the type of the exemption and the rationale for the request.

No Forest Stewardship Plan Required

With no regulatory requirement for an approved Forest Stewardship Plan (FSP) applicable to the Research Forest, there is no requirement to specify results and strategies to ensure that Research Forest operations are consistent with Prince George Timber Supply Area Landscape Biodiversity Order, the established Visual Quality Objectives, and consistent with conserving and protecting cultural heritage resources. The management plan addresses these important provincial objectives with multiple commitments described later in this document.

Prince George Land and Resource Management Plan

All of the Research Forest units lie within Prince George Natural Resource District to which the Prince George Land and Resource Management Plan (LRMP) applies. This provincial plan provides overarching public and government guidance about numerous natural resource values for each Resource Management Zone identified within the LRMP. Although the objectives and strategies within the LRMP are not legalized, in many cases they have guided the implementation of existing legal provincial orders and objectives with the intent to improve the sustainable management of key resource values within the Prince George District. For more information about the sections of the LRMP that apply to the Research Forest, refer to Table 2 below:

Table 2. Resource Management Zones Identification and Management Category.

Research Forest Unit	RMZ Identification	Category of Management
Units A, C and D	#9 Weedon Lake	Enhanced Resource Management
Unit B	#6 Crooked River	General Resource Management
Units E, F and G	#5 Chuchinka Creek	Enhanced Resource Management
Unit H, K and L	#27 Willow River Valley	Enhanced Resource Management
Unit I	#46 Bowron River Valley	Settlement and Agriculture

Landscape Biodiversity and Old Forest Maintenance

Order Establishing Landscape Biodiversity Objectives for the Prince George Timber Supply Area (PGTSA)

The provincial Order Establishing Landscape Biodiversity Objectives for the PGTSA was legally established in 2004, and specifies objectives for “old forest retention”, “old interior forest” and “young forest patch size distribution” for each Natural Disturbance Unit (NDU) defined under the order (NDUs are defined by grouping similar ecosystem subzones). For simplicity of implementation, old forest is defined as any stand with an average age greater than 140 years old for the wetter NDUs and greater than 120 years old for dry to moist NDUs.

Old Forest Retention Objective

The importance of maintaining biodiversity and old forest within the Research Forest is acknowledged and, therefore, the management objective is to meet the provincial old forest

implementation guidance that specifically applies to the CNC Research Forest.[1] In particular, the provincial guidance provides an option to retain 19% of the Research Forest Crown Forest Landbase as old forest, which is defined as stands greater than 120 years old.

Interior Old Forest Objective

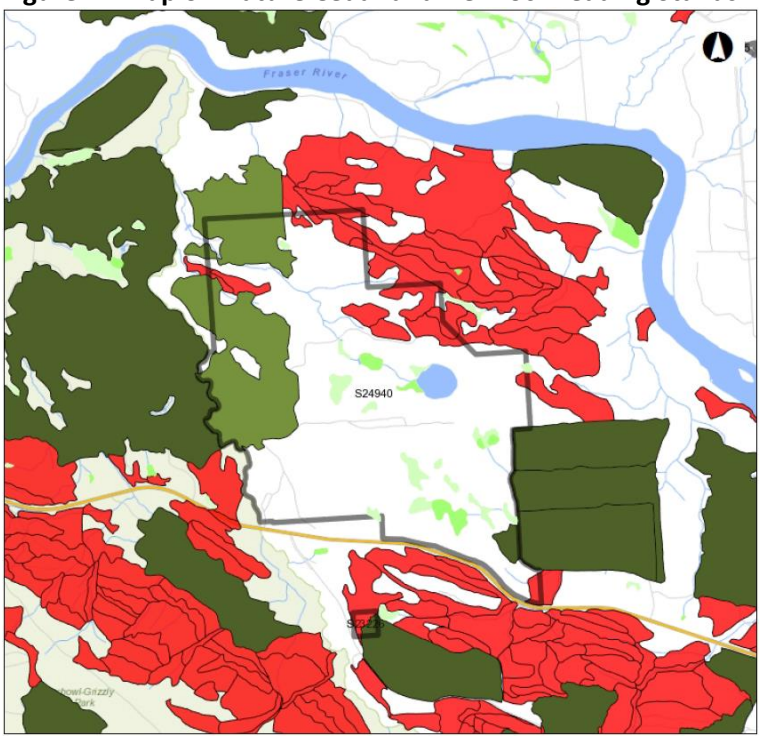
Because of the multiple small units that compose the Research Forest and the amount of existing young forest within and adjacent to the Research Forest units, maintaining Interior Old Forest as per the PGTSA Landscape Biodiversity Order is not a reasonable expectation. However, the importance of the intent of the interior old forest objectives is recognized. Consistent with that intent, the management goal is to develop strategies to retain old forest areas that are valued for their biodiversity and which will sustain multiple old forest attributes. Strategies consistent with the management goal may include but are not limited to the following, where practicable:

1) retention areas that are not within or not adjacent to riparian management areas may only contribute to the old forest percentage, if they meet a specified minimum width and size as specified within the development plan;
2) maintain old forest retention continuity with spatially identified old forest retention areas planned by other forest tenure holders;
3) anchor old forest retention on significant wildlife habitat features (e.g., nests, dens, and mineral licks) or areas supporting blue or red-listed ecosystems or species;
4) maintain a minimum buffer of forests >3m in height around all identified wildlife habitat features, as specified within the development plan;
5) within each unit, maintain a minimum percentage of old (>120 years), non-pine-leading forest stands based on area, as specified within the development plan; and
6) within Unit I, retain all mature cedar and hemlock leading stands within the approximate areas shown in red within Figure 2. This is consistent with maintaining the forested areas rated as having a moderate to high potential biodiversity value as identified on the 2008 map produced by the provincial Integrated Land Management Bureau.[2]

[1] Ministry of Forests, Lands, and Natural Resource Operations, 2009. Regional Executive Director Implementation Guidance for the PGTSA Landscape Biodiversity Objectives. https://www.for.gov.bc.ca/tasb/slrp/srmp/north/prince_george_tsa/pg_tsa_guidance_document_20091008.pdf

[2] Integrated Land Management Bureau, Province of British Columbia, 2008. Guidance Biodiversity Management of ICH in the Prince George LRMP Area.

Figure 2: Map of Mature Cedar and Hemlock Leading Stands in Unit I



Young Forest Patch Size Distribution Objective

Given the history of harvesting that occurred prior to the implementation of the PGTSA Landscape Biodiversity Objectives and given the importance of salvaging damaged pine-leading stands, the resulting young patch size distribution in and around the Research Forest is highly variable. Considering the small, multi-piece land base of the Research Forest and the small sustainable harvest level relative to the size of the Prince George Natural Resource District, the Research Forest operations are not expected to substantially influence the trend in young patch distribution within the District. As such, this management plan does not strive for harvesting patterns that are consistent with the young patch size trend expected under the PGTSA Landscape Biodiversity Order. Instead, this management plan focusses on achieving harvesting patterns that are consistent with managing the site specific natural resources as per the multitude of objectives, results, and strategies contained in this plan.

Species at Risk Conservation and Protection

At the time of this management plan there are no legally designated ungulate winter ranges, wildlife habitat areas, or wildlife habitat features to address regionally important species within or adjacent to the Research Forest.

Unit I, adjacent to Sugarbowl Park and Protected Area, is within an area identified as habitat for the southern Mountain Caribou population, which is a red-listed species. In particular, the area in and around Unit I is recognized as a movement corridor for southern Mountain Caribou between the Torpy River area and the Sugarbowl Mountain area. Managing the overall integrity of the caribou movement corridor requires due consideration when planning for forest harvesting and roads. To ensure that Research Forest operations are consistent with the intent of the movement corridor, consultation will occur with available, qualified natural resource professionals to determine any necessary measures to be implemented. This may include, but is not limited to, specified timing for all forestry practices and research undertakings, alteration of road and cutblock design,

modification of forest cover and vegetation retention, implementation of monitoring before and post-treatment, and postponement of operations. These strategies will also be undertaken where a significant wildlife habitat feature is identified prior to or during Research Forest operations.

The Research Forest units are likely to support some of the ecosystems and species at risk that have been identified by the British Columbia Conservation Data Center. As of January 2016, the Province has identified the ecosystems and the species shown in Appendix B as blue- and red-listed within the biogeoclimatic subzones that are common to the Research Forest area. The provincially listed ecosystems and species will be updated annually within the development plan.

It is expected that the other objectives and related results, strategies, and practice standards will be sufficient in conserving and protecting many of the listed species, particularly the animal species, due to their mobility and their general ability to capitalize on widespread areas and resources. The objectives for managing riparian areas are expected to provide for the continuing conservation of wetlands, lakes, and streams to allow for the continued utilization by the listed aquatic birds, amphibians, fish, and other wetland and riparian dependent species. Likewise, the direct impacts from harvesting and road building to the listed wetland ecosystems is expected to be minimized through the implementation of the riparian objectives. In a similar way, the objectives for old forest maintenance and wildlife tree and coarse woody debris retention are expected to provide for the maintenance and conservation of sufficient upland habitat to support continued utilization by the listed raptors, mammals, and invertebrates. The listed species and ecosystems that are expected to be conserved through the implementation of other management plan objectives, results, and strategies are shown in grey type in Appendix B.

After completing Terrestrial Ecosystem Mapping for all the Research Forest units, targeted for completion in summer 2017, the following strategies will be undertaken. The existence of any ecosystems identified on Terrestrial Ecosystem Mapping that are very similar or the same as the ecosystems and species listed in black type in Appendix B (and if different in the future, the ecosystems and species identified in the development plan) will be verified in the field prior to implementing any Research Forest operations that may modify or remove forest cover. Any identified ecosystems or species at risk habitat may be partially conserved or fully protected after consulting with available natural resource professionals. In addition, other forest practice modifications or research modifications may be undertaken to minimize current and future hazards to areas supporting listed ecosystems and species. As an example, hazards may include, but are not limited to, windthrow, disease, insects, or invasive plants.

Strategies to conserve or protect listed ecosystems will be implemented and adapted over time based on knowledge and expertise gained from available professionals, research findings, as well as from First Nations, the public, and stakeholders, who may have considerable experience with the listed ecosystems and species. Where new information regarding listed ecosystems or species within the Research Forest is learned, the development plan will be annually updated.

Wildlife Tree and Coarse Woody Debris Retention

Wildlife Tree Retention

The *Forest Planning and Practices Regulation* requires the following to be met (shown in italics). The objective is to meet or exceed the regulated practice requirements. For item 1, below, the minimum wildlife tree retention for any 12-month period is 10%. The regulatory requirements under items 2 to 4 remain unchanged.

1) If an agreement holder completes harvesting in one or more cutblocks during any 12-month period beginning on April 1 of any calendar year, the holder must ensure that, at the end of

that 12-month period, the total area covered by wildlife tree retention areas that relate to the cutblocks is a minimum of 7% of the total area of the cutblocks.

2) An agreement holder who harvests timber in a cutblock must ensure that, at the completion of harvesting, the total amount of wildlife tree retention areas that relates to the cutblock is a minimum of 3.5% of the cutblock.

3) For the purposes of subsection (1) and (2), a wildlife tree retention area may relate to more than one cutblock if all of the cutblocks that relate to the wildlife tree retention area collectively meet the applicable requirements of this section.

4) An agreement holder must not harvest timber from a wildlife tree retention area unless the trees on the net area to be reforested of the cutblock to which the wildlife tree retention area relates have developed attributes that are consistent with a mature seral condition.[3]

In addition, a management goal is to retain areas of wildlife trees that are valued for their ecology and wildlife habitat. Strategies consistent with the management goal may include but are not limited to the following, where practicable:

1) anchor wildlife tree retention on wildlife habitat features (e.g., nests, dens, and mineral licks) or areas containing blue- or red-listed ecosystems or species; and
2) maintain wildlife tree retention connectivity with spatially identified wildlife tree retention areas and old forest retention areas planned by other forest tenure holders.

In addition, specific strategies will be identified in the development plan for:

3) conserving large diameter standing Douglas-fir trees;
4) conserving a representative proportion of any larger Douglas-fir leading stands;
5) conserving large diameter cottonwood, birch and aspen trees;
6) conserving a representative proportion of larger deciduous leading stands;
7) retaining a minimum amount of stubbed live trees in otherwise clearcut areas; and
8) retaining non-commercial sized understory tree species, in particular spruce, balsam and Douglas-fir in otherwise clearcut areas.

Coarse Woody Debris Retention

The *Forest Planning and Practices Regulation* requires the following to be met for coarse woody debris retention (shown in italics). The objective is to meet or exceed the regulated practice requirements, so for the requirement below, the minimum logs on a cutblock is an average 16 logs per hectare, each being a minimum of 5 m in length and 7.5 cm in diameter.

An agreement holder who carries out timber harvesting must retain at least the following logs on a cutblock: If the area is in the Interior, a minimum of 4 logs per hectare, each being a minimum of 2 m in length and 7.5 cm in diameter at one end.[4]

The 16 log minimum was selected from the coarse woody debris retention data that was collected under the Province's Stand-Level Biodiversity Effectiveness Evaluation Protocol.[5]

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[3] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

[4] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

[5] 60 cutblocks within the Prince George Natural Resource District were randomly selected and assessed for coarse woody debris retention post-harvest. The 16 logs per hectare represents the 25th percentile of the number of retained logs (10m long or greater) per hectare per cutblock for all

During the term of this plan a goal is to monitor and study trends in the natural amount and distribution of coarse woody debris within forested areas within and surrounding the Research Forest. In addition, a goal is to determine which combinations of coarse woody debris attributes can be used to optimize the beneficial effects to small mammals within recent clearcut areas and young forests. Retention related practices that significantly increase beneficial effects to small mammals will be incorporated into the development plan on an annual basis and into future management plans upon scheduled revisions.

Riparian Area and Water Quality Management

Riparian Area Management

The *Forest Planning and Practices Regulation* (FPPR) requires the following to be met regarding the establishment of riparian management areas and forest retention within riparian management areas (shown in italics):

In addition to the following, there are a number of other legal practice requirements, specified under the FPPR related to the management of riparian features and areas. These are provided in Appendix C of this plan.

Designated Riparian Management Areas [6]

The following types of streams, wetlands, and lakes are required to have the following riparian reserve zones and management zones established:

Riparian Class	*Qualities that Define Stream Class*	*Riparian Management Area (metres)*	*Riparian Reserve Zone (metres)*	*Riparian Management Zone (metres)**
S1-A	*Fish Bearing & >20m Wide with Large Flood Plain*	*100*	*0*	*100*
S1-B	*Fish Bearing & >20m Wide*	*70*	*50*	*20*
S2	*Fish Bearing & 5m to 20m Wide*	*50*	*30*	*20*
S3	*Fish Bearing & 1.5m to 5m Wide*	*40*	*20*	*20*
S4	*Fish Bearing & <1.5m Wide*	*30*	*0*	*30*
S5	*Non-Fish Bearing & >3m Wide*	*30*	*0*	*30*

60 cutblocks. The data for the 60 cutblocks was sourced from the following: Ministry of Forests, Lands and Natural Resource Operations – Forest and Range Evaluation Program (FREP), 2015. Stand-Level Biodiversity Data Verified and Collected for the North from 2006 to 2014.

[6] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

S6	*Non-Fish Bearing & <3m Wide*	*20*	*0*	*20*

**Minimum width unless active floodplain extends beyond management zone, then the width of the riparian management zone extends to the outer edge of the active flood plain.*

Riparian Class	*Qualities that Define Wetland Class*	*Riparian Management Area (metres)*	*Riparian Reserve Zone (metres)*	*Riparian Management Zone (metres)*
*W1 or W5**	*>5ha*	*50*	*10*	*40*
W3	*1 to 5ha*	*30*	*0*	*30*

** Two or more W1 wetlands within 100m of each other OR One W1 within 80m of one or more W3 wetlands OR Two or more W3 wetlands within 60m of each other, if total area >5ha*

Riparian Class	*Qualities that Define Wetland Class*	*Riparian Management Area (metres)*	*Riparian Reserve Zone (metres)*	*Riparian Management Zone (metres)*
L1-B	*>5ha to 1000ha OR If designated L1B by Minister*	*10*	*10*	*0*
L3	*1ha to 5ha*	*30*	*0*	*30*

Restrictions within Riparian Management Zones

Must ensure that the percentage of the total basal area within the riparian management zone specified in Column 2 is left as standing trees, and

- *the standing trees are reasonably representative of the physical structure of the riparian management zone, as it was before harvesting and*
- *retain enough trees adjacent to the stream to maintain the stream bank or channel stability, if the stream is S4, S5, or S6 and has trees that contribute significantly to the maintenance of stream bank or channel stability, and is a direct tributary to an S1, S2 or S3 stream.*

Column 1 Riparian Class	*Column 2 Basal Area to be Retained Within Riparian Management Zone (%)*
S1-A or S1-B stream	*≥20*
S2 stream	*≥20*
S3 stream	*≥20*
S4 stream	*≥10*
S5 stream	*≥10*
S6 stream	*Not applicable*
All classes of wetlands or lakes	*≥10*

The objective is to meet or exceed the regulated practice requirements described above, in order to conserve valuable riparian wildlife habitat, maintain stream channel stability, long-term large woody debris, shading of the stream channel and to minimize new fine organic debris and new sediment input into the stream channels. As such, the target for:

1) S4 streams is to retain ≥15% of the original basal area within the RMZ;
2) S5 streams is to retain a 20m RRZ, and retain a 20m RMZ with ≥20% of the original basal area;
3) S6 streams is to retain ≥15% of the original basal area within the RMZ of S6 streams that drain directly into a S1, S2, S3, or S4 stream;
4) W1, W3, and W5 wetlands is to retain ≥40% of the original basal area within the RMZ where there is an obvious wildlife feature identified at the time of assessment (e.g., a well-used animal trail, an animal den, raptor nest, mineral lick, heavy ungulate rutting evidence, or heavy ungulate browse) within the RMA; and
5) L1B and L3 lakes is to retain ≥40% of the original basal area within the RMZ (30m for L3 and 40m for L1B lakes) where, identified at the time of assessment, there is an obvious wildlife feature within the RRZ or RMZ, or where at the time of assessment, regulated game fish are observed or known to be present within a lake.

In the absence of an obvious wildlife feature, the retention for wetlands and lakes will be a riparian reserve zone as identified under "Designated Riparian Management Areas" and the basal area retention as stated under "Restrictions within Riparian Management Zones".

Water Quality Management

The *Forest Planning and Practices Regulation* (FPPR) requirements and the additional management plan targets specified under the "Riparian Management" section are designed, in part, to conserve water quality in streams, wetlands, and lakes. It is also recognized that minimizing the sediment delivery to streams from roads and stream crossings is critical to the overall management of water quality. Therefore, it is necessary to implement additional strategies that are known to prevent or reduce road sediment delivery to streams. This includes strategies for road location, design, maintenance and deactivation. These strategies are stated in the development plan and are consistent with the practices identified in the 2013 report by Carson and Maloney[7] which considered 4,033 sites assessed under the provincial Water Quality Effectiveness Evaluation.

Watershed Management

A description of the major drainages within each Research Forest unit along with each Research Forest unit's location within 3rd order and higher watersheds is provided in Appendix D. The watersheds are those defined by the provincial Fresh Water Atlas Assessment Watershed boundaries. Streams are those included in the provincial Fresh Water Atlas Stream Network lines.[8] The interim watershed hazard scoring is from the maps provided in 2016 by the Omineca Regional office of the Ministry of Forests, Lands and Natural Resource Operations.[9] Each Research Forest

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[7] B. Carson and D. Maloney. 2013. Provincial Water Quality Effectiveness Evaluation Results (2008-2012). Ministry of Forests, Lands and Natural Resource Operations, Resource Practices Br., Victoria BC FREP Report 35. http://www.for.gov.bc.ca/hfp/frep/publications/index.htm

[8] GeoBC, Province of British Columbia. 2016. Freshwater Atlas Dataset. http://geobc.gov.bc.ca/base-mapping/atlas/fwa/fwa_data.html

[9] Ministry of Forests, Lands and Natural Resource Operations, Omineca Regional Office. 2016. Interim Watershed Hazard Ratings for the Omineca Natural Resource Region.

unit is also examined for its potential impact on future watershed hazard conditions based on the amount of area each unit occupies within each identified watershed, the anticipated level of harvest in the next five years, the potential impact to individual stream basins, and the interim hazard scores assessed by the Ministry of Forests, Lands and Natural Resource Operations.

The results of this preliminary study of watersheds are summarized in Table 3. Where future operations within a Research Forest unit may have the potential to negatively impact conditions within one or more watersheds, this is also identified in Table 3. For these streams and watersheds, the strategy is to have a qualified professional undertake a watershed assessment to further understand the predicted watershed hazards and risks. Future forest planning, forest practices and research projects will consider the professional recommendations for reducing downstream impacts to the watersheds identified in this plan. As watershed conditions and planned harvest levels change, the development plan will be annually updated to identify the current watersheds to which this strategy applies. It is acknowledged that the ability to reduce downstream impacts outside of the Research Forest may be limited by how effectively operations may be coordinated with other forest and land tenure holders.

Table 3. Summary of Watershed Conditions within Research Forest

Research Forest Unit	Watershed Description	Interim Hazard Rating	Potential Watershed Concerns	Watershed Assessment Recommended
A	Basin that drains directly into Kerry Lake	Stream Flow – VL Sediment – VL Riparian - VL	None	N
	Basin that drains directly into Crooked River	Stream Flow – L Sediment – M Riparian - M	None	N
	5th order basin that drains into Weedon Creek	Stream Flow – H Sediment – H Riparian - M	None	N
B	Basin that drains directly into Tacheeda Lakes	Stream Flow – VL Sediment – VL Riparian - M	None	N
	Basin that drains into Horseshoe Lake	Stream Flow – L Sediment – VL Riparian - M	None	N
C	4th order basin that drains into lower section of Caine Creek	Stream Flow – H Sediment – H Riparian – M	High interim hazard ratings, along with severe spruce beetle and significant planned harvesting	Y
	Basin that drains directly into Caine Creek via small streams	Stream Flow – M Sediment – L Riparian - M	See Unit D comments for this watershed	Y
	Basin that drains directly into Merton Creek headwaters	Stream Flow – M Sediment – M Riparian - M	None	N
	Basin that drains directly into Merton Lake and	Stream Flow – M Sediment – M Riparian - M	None	N

	Merton Creek via small streams			
	Negligible portion 3rd order basin that drains into Merton Creek	n/a	None	N
D	Basin that forms part of headwaters for Caine Creek	Stream Flow –H Sediment – M Riparian - M	High interim stream flow hazard, along with severe spruce beetle and significant planned harvesting	Y
	Negligible portion 4th order basin that drains into lower section of Caine Creek	n/a	See Unit C comments for this watershed	Y
	Basin that drains directly into Caine Creek via small order streams. Same basin as described for Unit C.	Stream Flow – M Sediment – L Riparian – M	There is a small order stream basin (see Appendix D) that may be largely modified by planned harvesting in Units D and C	N
E	Basin that drains directly into the northern branch of Chuchinka Creek	Stream Flow – VL Sediment – VL Riparian – VL	None	N
	Basin that drains directly into the southern branch of Chuchinka Creek. Together Unit E and F, may have a large potential influence on this watershed.	Stream Flow – VL Sediment – VL Riparian – VM	None	N
F	Same basin as described immediately above that drains directly into the southern branch of Chuchinka Creek	Stream Flow – L Sediment – L Riparian – M	None	N
	Basin that drains directly into the mid and lower section of Angusmac Creek	Stream Flow – L Sediment – L Riparian – M	None	N
G	Basin that drains directly into the mid-section of Angusmac Creek	Stream Flow – L Sediment – VL Riparian – L	None	N
	Negligible portion of basin that drains into mid and lower section of Angusmac Creek. Same basin as described for Unit F.	n/a	None	N
	4th order basin that flows northward into the Crooked River	Stream Flow – L Sediment – L Riparian – M	None	N
	Negligible portion of 4th order basin located, mostly south of Unit G, that ultimately drains towards the Crooked River	n/a	None	N

H	Basin that drains directly into the Bowron river via small order streams	Stream Flow – VL Sediment – VL Riparian – M	None	N
	3rd order basin, mostly to east of Unit H, that drains into the Bowron River	Stream Flow – VL Sediment – VL Riparian – M	None	N
I	Basin that drains directly into the south side of the Fraser River via small order streams	Stream Flow – L Sediment – H Riparian – L	None	N
	Basin that drains directly into Hungary Creek via small order streams	Stream Flow – L Sediment – M Riparian – L	There is a small order stream basin (see Appendix D) that may be largely modified by planned harvesting in Unit I	N
J	4th order basin that occupies north western majority of Unit J and drains into Fraser River	Stream Flow – L Sediment – M Riparian – M	None	N
	Basin that drains directly into the west side of the Fraser River via small order streams	Stream Flow – L Sediment – VH Riparian – L	There is a small order stream basin (see Appendix D) may be largely modified by planned harvesting in Unit J	N
K	Basin that drains directly into the east side of the Willow River from small order streams	Stream Flow – H Sediment – M Riparian – M	None	N
	Basin that drains into Pitoney Creek	Stream Flow – L Sediment – VL Riparian – M	None	N
L	Basin that drains directly into the east side of the Willow River from small order streams. Same basin as described for Unit K.	Stream Flow – H Sediment – M Riparian – M	None	N

Soil Management

Soil Disturbance from Permanent Roads

The *Forest Planning and Practices Regulation* requires the following to be met for permanent roads (shown in italics). The objective is to meet or exceed the regulated practice requirements in order to conserve the long-term productivity of the Research Forest landbase. This will be achieved through rehabilitating sections of road that are not required for long-term access.

(1) An agreement holder must ensure that the area in a cutblock that is occupied by permanent access structures built by the holder or used by the holder does not exceed 7% of the cutblock, unless

(a) there is no other practicable option on that cutblock, having regard to

(i) the size, topography and engineering constraints of the cutblock,

(ii) in the case of a road, the safety of road users, or

(iii) the requirement in selection harvesting systems for excavated or bladed trails or other logging trails, or

(b) additional permanent access structures are necessary to provide access beyond the cutblock.

(2) If an agreement holder exceeds the limit for permanent access structures described in subsection (1) for either of the reasons set out in that subsection, the holder must ensure that the limit is exceeded as little as practicable.

(3) An agreement holder may rehabilitate an area occupied by permanent access structures by

(a) removing or redistributing woody materials that are exposed on the surface of the area and are concentrating subsurface moisture, as necessary to limit the concentration of subsurface moisture on the area,

(b) de-compacting compacted soils, and

(c) returning displaced surface soils, retrievable side-cast and berm materials.

(4) If an agreement holder rehabilitates an area under subsection (3) (a) and erosion of exposed soil from the area would cause sediment to enter a stream, wetland or lake, or a material adverse effect in relation to one or more of the subjects listed in section 149 (1) of the Act, the agreement holder, unless placing debris or revegetation would not materially reduce the likelihood of erosion, must

(a) place woody debris on the exposed soils, or

(b) revegetate the exposed mineral soils.[10]

Dispersed Soil Disturbance

The value of conserving natural soil properties within the non-roaded areas of cutblocks is recognized as important for ensuring properly functioning ecosystems and watersheds and for maximizing the long-term productivity of the forests. To achieve soil conservation across cutblocks, a management goal for each Research Forest unit, as a whole, is to limit the average dispersed soil disturbance from new harvesting to the following:

1) 5%, which is applicable to the average soil disturbance within all prescribed standard units that are predominantly comprised of sensitive soils in a Research Forest unit,
2) 10%, which is applicable to the average soil disturbance within all prescribed standard units that are not predominantly comprised of sensitive soils in a Research Forest unit, and
3) 25%, which is applicable to the average soil disturbance within all the roadside work areas within a Research Forest unit.

Visual Quality Management

The following Research Forest units are located where visual quality objectives (VQO) have been established.[11]

[10] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

[11] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Visual Landscape Inventory. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

Unit A: Modification VQO

Two map polygons with a modification VQO are established within the eastern portion of Unit A due to visibility from the Crooked River, Kerry Lake, and/or Highway 97.

Unit B: Retention and Partial Retention VQO
One narrow visual polygon with a retention VQO is established along the western edge of Unit B along Tacheeda Lakes. Two polygons representing a partial retention VQO are established across the majority of the remaining area within Unit B due to visibility from Tacheeda Lakes.

Unit G: Modification VQO
A small visual polygon with a modification VQO is established along one of the western facing slopes in the southern part of Unit G due to visibility from Highway 97.

Unit H: Modification and Partial Retention VQO
One visual polygon with a partial retention VQO and one polygon with a modification VQO occupy the southern portion of Unit H due to visibility from Highway 16 East. The slopes of Mount Bowron, within Unit H, are covered by a polygon with a partial retention VQO due to visibility from Highway 16 East.

Unit I: Partial Retention VQO
One narrow visual polygon, with a partial retention VQO, occupies the southern edge of Unit I adjacent to Highway 16 East.

Unit J: Partial Retention VQO
One visual polygon with a partial retention VQO is established over the eastern edge of Unit J due to visibility from the Fraser River.

Unit K: Retention VQO
One visual polygon with a retention VQO objective is established over the western side of Unit K due to visibility from Tsitniz Lake. Another polygon is established over the southern portion of Unit K due to visibility from Ispah Lake.

The objective for all VQO polygons is to undertake forest development so that the visible landscapes within the VQO polygons meet the definition of altered forest landscape within Sections 1 and 1.1 of the *Forest Planning and Practices Regulation*.

For further reference, the definitions of altered forest landscape specified under the *Forest Planning and Practices Regulation* are provided in Appendix E.

Recreation Management

Existing and New Recreation Use

For all Research Forest areas, the objective is to support existing and new recreational use of the provincial forest. Strategies to support this objective may include, but are not limited to, the following:

1) maintain road access to all Research Forest units;
2) install signage identifying each Research Forest unit at the main road entrance;
3) install additional signage within or near Research Forest units providing information about the area, points of interest, or ongoing Research Forest activities; and
4) develop new trails for both short-term and long-term research access, education, and recreation.

Provincial Parks, Protected Areas, and Ecological Reserves

Where operations are near or adjacent to designated parks, protected areas, or reserves, the objectives and strategies pertaining to recreation are those stated under the section "Provincial Designations and Forest/Land Tenures".

Provincial Recreation Sites and Trails

The following recreational features are located adjacent to or near Research Forest units.[12]

ATV & Snowmobile Road Routes – Unit K and L

The Willow-Coalmine Forest Service Road, which runs along the northern boundary of Unit L, is identified as an ATV and snowmobile route when the road is not being actively maintained for industrial purposes.

The Willow Forest Service Road (FSR), which runs past the south west corner of Unit K, is identified as an ATV and snowmobile route when the road is not being actively maintained for industrial purposes.

Tsitniz Lake / Camp Friendship and Recreation Reserve – Unit K

Camp Friendship is located next to Tsitniz Lake. A provincial Recreation Reserve encloses the area around Tsitniz Lake and the nearby area between the Willow Forest Service Road and the Willow River.

Ispah Lake – Unit K

A provincial Recreation Site is established on Ispah Lake along the Willow FSR, just south of Unit K.

Tacheeda Lakes Recreation Sites – Unit B

The Tacheeda Lakes Middle and Tacheeda Lakes Point Recreation Sites are established on Tacheeda Lakes just north of Unit B.

Tacheeda Lookout Trail

A provincial Recreation Trail has been established along the trail to the Tacheeda Fire Lookout site. This trail runs towards the east, just north of Unit B.

Fishhook Lake Recreation Site – Unit B

A provincial Recreation Site is established on Fishhook Lake, just south of Unit B.

The strategy for all these recreation features is to consult and seek input from the Ministry of Forests, Lands and Natural Resource Operations when undertaking forest development and research project planning. The coinciding strategy is to achieve results from forest development, silviculture practices, and research projects that are consistent with the continued recreational use and enjoyment of the existing sites, trails, and camps.

[12] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Visual Landscape Inventory. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

Road and Trail Access Management

The objective is to maintain a reliable road network, and trail network where applicable, to and within each Research Forest unit to support continuing access for forest operations, educational sites, research sites, First Nation use, stakeholder use, and general recreational use by the public.

For roads that are required for temporary operational or research access the objective is to reduce their footprint to conserve the available productive forest soils and to reduce water quality and watershed impacts over the long-term. This will be accomplished by rehabilitating or deactivating the non-necessary road sections. Rehabilitation will occur as described under section 36 of the *Forest Planning and Practices Regulation* and therefore will involve re-vegetating the former road area.

Research Site Locations

CNC and its research partners have established numerous sites and areas that have and are supporting natural resource monitoring, studies, and trials. Some of these sites and areas are used for multiple years of study while others may only be used for one season. Tracking these sites over time is important as there may be value in revisiting inactive sites to support or complement future study and research. The previously established research site locations that are within or immediately adjacent to the Research Forest units are shown on the maps in Appendix F along with a table summarizing specific information for each research site.

In addition to the sites established by CNC, one pre-existing provincial research site has been identified within the CNC Research Forest. It is located in Unit D and is shown on provincial maps as EP 0886.13.09. It is identified as a fertilization trial. Its approximate location is shown on the Unit D map in Appendix F. Depending on its current condition and the applicability of the previous data collected, this site may be excluded from harvesting, road development, and silviculture practices for a significant period of time.

The development plan, which provides more specific guidance for future forest and research operations, will be annually updated for new additions and changes to research site locations.

Provincial Designations and Forest/Land Tenures

The following provincial Parks, Protected Areas, and Ecological Reserves were identified using the geographic data provided by DataBC, Province of British Columbia.[13]

Tacheeda Lakes Ecological Reserve

Unit B of the Research Forest is situated immediately adjacent to the west side of the Tacheeda Lakes Ecological Reserve. The reserve is composed of 526ha of mostly mature spruce-leading forests within the McGregor Plateau ecosection of which only 0.64% is under designated

[13] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Visual Landscape Inventory. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

protection. Although small, the ecological reserve contributes 11.85% of the overall protected areas system of the McGregor Plateau.[14]

The primary purpose of this Provincial Ecological Reserve is to protect the mature forest ecosystems representative of the wet cool Sub-Boreal Spruce subzone (SBSwk1 subzone) and its transition with the Engelmann Spruce-Subalpine Fir Zone (ESSFwk2 subzone).[15] This type of Provincial Reserve is not created for outdoor recreation. Most ecological reserves, however, are open to the public for non-destructive pursuits like hiking, nature observation and photography. As well, research and educational activities may be carried out but only under permit.[16]

Sugarbowl-Grizzly Den Provincial Park and Protected Area

Unit I is situated immediately east of the northern part of the Sugarbowl-Grizzly Den Park and Protected area.

The primary roles of the park and protected area are to protect critical habitat for the Mountain Caribou, protect the historically significant Grand Canyon of the Fraser, and to provide outstanding backcountry recreation opportunities within one hour of Prince George via the Sugarbowl and Viking Ridge Trails. The secondary role of the park and protected area is to provide representation of the Upper Fraser Trench ecosection and the Interior Cedar-Hemlock very wet, cool variant (ICHvk2) biogeoclimatic zone.[17]

Fraser River Provincial Park

Unit J is situated immediately adjacent to the southern boundary of Fraser River Park which encompasses an area along the west side of Fraser River just north of the confluence of Naver Creek and the Fraser River.

The primary role of Fraser River Park is to provide representation of the Quesnel Lowlands ecosection, and moist hot and dry warm Sub-boreal Spruce forests. Fraser River Park currently provides the greatest extent of representation in the protected areas system of the Quesnel

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[14] British Columbia Ministry of Environment, Omineca Region. 2005. BC Parks Webpages, Tacheeda Lake Ecological Reserve: Purpose Statement and Zoning Plan. http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/tacheeda_lake_er/tacheeda_lake_er_ps.html

[15] British Columbia Ministry of Environment, Omineca Region. 2005. BC Parks Webpages, Tacheeda Lake Ecological Reserve: Purpose Statement and Zoning Plan. http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/tacheeda_lake_er/tacheeda_lake_er_ps.html

[16] British Columbia Ministry of Environment. 2013. BC Parks Webpages, Tacheeda Lakes Ecological Reserve Webpage. http://www.env.gov.bc.ca/bcparks/eco_reserve/tacheeda_er.html

[17] British Columbia Ministry of Environment, Omineca Region. 2005. BC Parks Webpages, Sugarbowl-Grizzly Den Provincial Park and Protected Area: Purpose Statement and Zoning Plan. http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/sugarbowl_grizzly/sugarbowl_grizzly_ps.pdf?v=1450743905560

Lowlands ecosection and Sub-boreal Spruce moist hot (SBSmh) and Sub-Boreal Spruce dry warm, Blackwater variant biogeoclimatic zones. In the future, a secondary role will be to provide backcountry recreation access to the Fraser River, and opportunities for wildlife and nature-related recreation associated with a large river valley.[18]

The area provides excellent elk, deer and moose winter range. The high ungulate winter range values can be attributed to the south easterly facing slopes, the lower elevation and milder climate which contributes to a lower snow depth.[19]

The strategy for all of the Parks and the Ecological Reserves is to consult with available expertise within the British Columbia Ministry of Environment and the British Columbia Ministry of Forests, Lands and Natural Resource Operations when proposing operations immediately adjacent to the Parks or Reserve Boundaries. The coinciding strategy is to achieve outcomes from forest and research operations that do not limit the achievement of the current, primary purposes, and secondary purposes where applicable, of the potentially affected Parks and Ecological Reserves.

Adjacent or Overlapping Provincial Resource Stakeholders

Tree Farm License 30

Tree Farm License 30, held by Canadian Forest Products Ltd, is located immediately adjacent to the eastern boundary of Unit G of the Research Forest.[20]

Forestry License to Cut, Special Use Permit, Road Permit, and Road-use Permit Holders

It is recognized that over time, there may be forestry licenses to cut and special use permits issued and held by various persons who may be operating adjacent to Research Forest units. In most cases, it is expected that these users will be advised of the CNC Research Forest when issued their license or permit and that they will contact CNC as necessary to coordinate planning and operations.

Forest License Holders

There are numerous holders of small and large volume-based forest licenses within the Prince George Timber Supply Area who operate immediately adjacent to the Research Forest and who may require new road access or the use of existing roads within the Research Forest.

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[18] British Columbia Ministry of Environment, Omineca Region. 2005. BC Parks Webpages, Fraser River Provincial Park: Purpose Statement and Zoning Plan. http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/fraser_river/fraser_river_ps.pdf?v=1459895694354

[19] British Columbia Ministry of Environment, Omineca Region. 2005. BC Parks Webpages, Fraser River Provincial Park: Purpose Statement and Zoning Plan. http://www.env.gov.bc.ca/bcparks/planning/mgmtplns/fraser_river/fraser_river_ps.pdf?v=1459895694354

[20] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Tree Farm License. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

The strategy for all Research Forest units, in respect of adjacent or overlapping forest tenure and permit holders, is to consult with available forest tenure and road permit holders when proposing operations that may influence a neighboring license area or may involve shared road use. This may include, but is not limited to, consultation regarding timing of operations, road access planning, shared road use, old forest retention planning, and wildlife tree retention planning.

Because new forest tenures and permits are regularly issued and existing tenure and permits holders change over time, the development plan will be annually updated to identify current forest tenure and permit holders.

Trapping, Guiding, and Range Tenures

The Research Forest is widely spread over a number of trapping and guiding tenures. These tenure holders are identified in Table 4 along with each overlapping forest unit.

Trapping cabin locations near the boundary of Unit J (trapping license 710T003) are identified within the provincial natural resources dataset.

A hunting camp near the northern boundary of Unit E (guiding license 716G001) is identified within the provincial natural resources dataset.

Table 4. Trapping and Guiding Licenses Overlapping with the Research Forest[21]

Unit	Trapper	Provincially Mapped Cabins or Other Sites	Guide/Outfitter	Provincially Mapped Cabins or Other Sites
A	716T008, 724T004		724G002	
B	716T008		716G001	
C	724T004, 714T010		724G002	
D	724T004		724G002	
E	716T007, 716T008		716G001	Hunting Camp
F	716T007, 716T006		716G001	
G	716T006, 716T005		716G001	
H	707T004		707G001	
I	705T012		705G001	
J	710T003	Two Cabins	710G003	
K	707T001, 709T004		709G001	
L	709T004		709G001	

It is recognized that in some cases the activities associated with a trapping license may also be associated with a First Nation's treaty or aboriginal rights. Therefore, some trapline holders or users may be contacted more than once about proposed Research Forest operations as a result of information being provided directly to stakeholders as well as First Nations' offices.

[21] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Traplines and Guide Outfitter Areas. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

Units K and L, near the Willow River, are located within a range tenure associated with the licensed hunting guide territory.[22]

The strategy, in respect of the overlapping trapping, guiding and range tenures, is to consult with available trappers and guides (guides hold the range tenures) when proposing operations that may influence a trapline, guiding area, or range resources. This may include, but is not limited to, consultation regarding timing of operations, road access planning, shared road use, old forest retention planning, and wildlife tree retention planning.

The specific timing of operations may be very important to trapping, guiding, and range tenure holders. Therefore, prior to initiating operations that may influence their territories, the holder will be notified of the commencement date and the approximate duration.

Because trapping and guiding license holders change over time and new range tenures may be issued, the development plan will be annually updated to identify current trapping, guiding, and range tenure holders.

Mining Tenure and Notice of Work

There are mining tenures within all the units of the Research Forest, but there is only one active Notice of Work for current exploration or mining activities, which is located in the area of Unit L along the Willow River.[23]

With respect to the ongoing mining operations affecting Unit L and in the event of a new Notice of Work, the strategy for all Research Forest units is to consult with available expertise within the British Columbia Ministry of Energy and Mines and the British Columbia Ministry of Natural Gas Development and consult with the exploration/mining proponent in coordinating forestry development and research activities with exploration and mining activities. This may include, but is not limited to coordination of road access management, old forest retention planning, and wildlife tree retention planning.

Other Land Tenures

A communications site and an associated access right-of-way is located within the southern end of Unit G.

The objective, in respect of the overlapping land tenure right-of-way, is to appropriately involve the Ministry of Forests, Lands and Natural Resource Operations in planning regarding forest development and research projects, so that any existing and future use of the communication site and right-of-way may be appropriately accommodated.

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[22] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Range Tenure. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

[23] DataBC, Province of British Columbia. 2016. Natural Resources Dataset – Mineral, Placer and Coal Tenure. https://catalogue.data.gov.bc.ca/dataset?sector=Natural+Resources&download_audience=Public

Adjacent Land Owners

The western boundary of Research Forest Unit B is immediately adjacent to privately held land as is displayed on the management plan Content Maps within Appendix G.[24]

The strategy, in respect of these lands is to consult with the land owner when proposing operations that may influence the adjacent lands. This may include, but is not limited to, consultation regarding timing of operations, road access planning, shared road use, visual quality planning, old forest retention planning, and wildlife tree retention planning.

Archaeological and Cultural Heritage Resources

There are no previously identified archaeological sites within or immediately adjacent to the Research Forest units, but there is potential for new findings with the completion of future assessments.

There is also potential for future cultural heritage resource findings within or adjacent to Research Forest units. When discussing cultural heritage resources, this plan is referring to resources, sites or features important to the culture, traditional use, treaty rights and aboriginal rights of a First Nation. It is recognized that a cultural heritage resource may have various meanings that are unique to a First Nation and unique to a Nation's treaty and aboriginal rights. By regularly referring proposed operations to affected First Nations, there will be multiple opportunities for a First Nation to communicate about cultural heritage resources and provide the necessary knowledge, advice, and input to CNC.

The objective with respect to Archaeological and Cultural Heritage Resources is to provide reasonable opportunities for potentially affected First Nations to be involved in the assessment and the management of archaeological and cultural heritage resources. In order to achieve this objective, the following strategies will be undertaken:

1) offer opportunities for First Nations members to be involved in identifying and assessing archaeological and cultural heritage resources;
2) all proposed cutblocks and roads will be referred to the affected First Nation(s) for a period of 30 days in advance of operations (or another length of time as agreed with the affected First Nations), so that the First Nations have an opportunity to offer knowledge and input;
3) where operations are planned to remove forest cover, the following assessments will be undertaken to identify archaeological and cultural heritage resources and to provide recommendations regarding their conservation and protection:
    a) where an area is not covered by a provincially recognized Archaeological Predictive Model or a previous Archaeological Overview Assessment, an Archaeologist will undertake an Archeological Overview Assessment and/or Preliminary Field Assessment to identify potential archaeological sites and to identify cultural heritage resources;
    b) where an area is covered by a provincially recognized Archaeological Predictive Model or Mapping or a previous Archaeological Overview Assessment, an Archaeologist will

[24] DataBC, Province of British Columbia. 2016. Geographic Dataset – TANTALIS – Crown Tenures. https://catalogue.data.gov.bc.ca/dataset?q=tantalis&download_audience=Public&type=Geographic&sort=score+desc%2C+record_publish_date+desc&page=1

undertake an Archeological Overview Assessment and/or Preliminary Field Assessment to identify potential archaeological sites and to identify cultural heritage resources; and

c) Where the potential for a cultural heritage feature is identified by a First Nation or a person with interests in the area, an Archaeologist will undertake an Archaeological Overview Assessment and/or Preliminary Field Assessment to identify cultural heritage features or potential archaeological features.
d) where there is potential for archaeological resources as identified by a First Nation, a person with interests in the area, an Archaeological Predictive Model, an Archaeological Overview Assessment or Preliminary Field Assessment, an Archaeologist will undertake or oversee an Archaeological Impact Assessment;

4) archaeological or cultural heritage resource findings from any field assessments completed by an Archaeologist are to be shared with the affected First Nation(s) for a period of 30 days in advance of operations (or another length of time as agreed to with the affected First Nations), so that the First Nation(s) has a reasonable time to offer knowledge and input;
5) reasonable efforts to incorporate a First Nation's input regarding conservation or protection of an archaeological or cultural heritage site will be undertaken, particularly as it relates to a treaty right or an aboriginal right; and
6) where a previously unidentified site, which is expected to be an archaeological or cultural heritage site, is discovered while undertaking a forest practice or research, the forest practice or research will be modified or stopped to protect the remaining site until it may be assessed, referred, and incorporated into plans and final designs as described in items 1 to 5 above.

Forest Health Management

As per the "Current Management Challenges" section of this management plan, the Research Forest is expected to experience notable occurrences of forest pathogens, insects, and other forms natural damage within all types of forest stands. This presents a regular challenge for on-going timber supply management and for implementing strategies to conserve and protect various forest resources. Given the significant ongoing and future forest health hazard for both mature and young timber, forest health management is expected to be an ongoing management focus.

All Forest Health Factors

The objective for forest health management is to minimize the risk to timber loss while conserving and protecting natural resources consistent with all the objectives within this plan. This is to be achieved by (the following strategies do not apply to existing pine mortality from mountain pine beetle):

1) implementing annual aerial detection and assessment of forest health factors;
2) implementing ground reconnaissance, inspections, or assessments for any areas identified having a non-endemic level of forest health factors from aerial detection or other fieldwork;
3) undertaking previously recognized insect trapping and baiting treatments to hold or suppress insect populations where there are non-endemic levels of insect attack and where adjacent stands are assessed with a high hazard for insect attack;
4) undertaking experiments within mature forests, young forests, and clearcut areas to evaluate new trapping and baiting treatments for conifer bark beetles.
5) undertaking sanitation and salvage harvesting treatments of various sizes and forms within stands greater than 50 years old, prior to sawlog shelf-life expiry, where there is a moderate to high likelihood of the stand being reduced to less than 140m3/ha of net live conifer timber;
6) where possible, coordinate forest health treatments with adjacent forest tenure holders to improve effectiveness of treatments for areas within and outside of the Research Forest;

7) subject to considering biodiversity, riparian, water quality, and wildlife habitat values, undertaking sanitation treatments, and re-stocking if necessary, in young, managed stands (0 to 20 years old) where there is moderate to high likelihood of not achieving 160m3/ha of conifer yield by age 65 without treatment (the volume threshold will be evaluated on the average yield of the existing cutblock containing the effected stand);
8) subject to considering biodiversity, riparian, water quality, and wildlife habitat values and subject to provincial funding, undertaking partial cut or clearcut sanitation and salvage harvesting treatments, and re-stocking, if necessary, in intermediate aged stands (21 to 50 years of age) where there is moderate to high likelihood of not achieving 160m3/ha of conifer yield by age 65 without treatment (The volume threshold will be evaluated on the average yield of the existing cutblock or the expected future cutblock containing the effected stand. The maximum forecasted mid-term timber supply effect of forest health treatments in stands 21 to 50 years old is to be less than an average of 500m3/year during the 10 to 60-year period.); and
9) when considering isolated occurrences of forest health factors, other than bark beetle, the minimum treatment size is 15ha.

When undertaking harvesting treatments under objectives 3, 4 or 6, the objectives concerning retention of trees are to be achieved regardless of forest health factors.

Mountain Pine Beetle Salvage

The remaining areas of mountain pine beetle damaged pine-leading stands within the Research Forest are now reaching the end of their economic shelf-life due to remaining volume per hectare and degradation of wood quality.

The objective for pine-leading stands killed by mountain pine beetle is to salvage remaining fibre value and return sites to productive conifer forests, subject to considering biodiversity, riparian, water quality, and wildlife habitat values. This will be achieved through the following strategies:

1) salvage harvesting damaged pine-leading areas greater than 15ha, if there is remaining pine sawlog shelf-life as determined through an in-field assessment, where the average net tree size is greater than 0.18m3/tree and average tree height is greater than 22m and where the remaining live trees are not expected to achieve 160m3/ha of conifer yield by age 65 (this only applies when undertaking the harvest of adjacent stands where the average volume per hectare across all the areas – pine salvage area and adjacent stands -- is greater than 180m3/ha of net conifer timber); and
2) isolated damaged pine-leading stands less than 15ha or stands that have exceeded sawlog shelf live as determined from an in-field assessment, will be considered for rehabilitation treatments and full re-stocking where the remaining live trees are not expected to achieve 160m3/ha of conifer yield by age 65 (rehabilitation treatments are dependent on the availability of provincial funding).

Spruce Beetle Sanitation and Salvage

A very large outbreak of spruce beetle attack on mature spruce trees is being experienced largely in the northeast portion of the Prince George Forest District (Parsnip River and Crooked River drainages). At the time of writing this management plan, this current outbreak has affected the majority of the mature spruce timber throughout Research Forest Units C and D. As well, a large amount of attack has been detected in Units E, F, and G. Greater than endemic levels of spruce beetle attack have also been observed in portions of Unit B.

The objective with respect to spruce beetle is to rapidly reduce beetle populations within all Research Forest units and rapidly recover the commercial value of attacked trees. This will be achieved through the following results and strategies:

1) within areas that are not prescribed for the conservation of natural resources, the goal is to limit non-salvaged losses from spruce beetle to 20,000m3 over five years;
2) undertaking the regular detection, treatment, sanitation, and salvage of spruce beetle affected areas as per the strategies under the section "All Forest Health Factors"; and
3) collaborating with business partners to implement hauling and milling strategies consistent with current best management practices distributed by the Ministry of Forests, Lands, and Natural Resource Operations.

Vegetation Management

Invasive Plants

The objective is to minimize the introduction and spread of invasive plant species where Research Forest operations causes soil disturbance. Where the invasive plants are found to occur within the Research Forest, the objective is report the occurrences and support necessary treatments to reduce or remove the invasive plants. Strategies to achieve these objectives may include, but are not limited to the following:

1) revegetate portions of disturbed soil to reduce the conditions favorable to establishment of invasive plants;
2) rehabilitate unnecessary short-term roads so they are not a vector for the establishment of invasive plants;
3) record the occurrence of the species identified as noxious within all regions of the Province and those identified as noxious within the Fraser-Fort George Region as per the Field Guide to Noxious Weeds and Other Selected Invasive Plants of British Columbia;
4) report the occurrence of invasive species to the Northwest Invasive Plants Council so that they may determine any necessary treatments to reduce or remove invasive plants; and
5) subject to available resources, provide assistance and support to the Council in undertaking invasive plants treatments.

Deciduous and Brush Competition for Conifer Trees

Deciduous trees, brush-type plants, and herbaceous plants are valued for their contribution to fish and wildlife habitat and overall ecosystem and species diversity. However, where they are suppressing conifer growth, deciduous and brush competition may require direct treatment to achieve the stocking and timber objectives in this plan.

The objective is to reduce deciduous and brush competition where prescribed stocking standards are at risk of not being met or free growing achievement may be significantly delayed. This will be achieved by:

1) implementing a variety of brushing treatments, including but not limited to, manual brushing treatments, prescribed fire, animal grazing, and herbiciding to remove or suppress the growth of deciduous trees, brush-type plants, and herbaceous plants where conifer-leading regeneration is prescribed;
2) undertaking experiments within cutblocks to evaluate new brushing and vegetation suppression techniques targeted at deciduous trees, brush species, and herbaceous plant species;
3) consulting with potentially affected stakeholders and First Nations when proposing any herbiciding operations for a period of 30 days in advance of operations (or another length

of time as agreed to with the affected stakeholders and First Nations), so that the stakeholders and First Nations have an opportunity to offer knowledge and input; and

4) limiting the type or amount of brushing treatments if they may materially affect the retention of trees and other plants that are important to achieving objectives within areas prescribed for the conservation and protection of natural resources.

Timber Growth and Yield Management

Managing Timber for Forest Products

Consistent with the current and foreseeable demand for timber products, the objective is to manage forests stands to maximize the yield of sawlog quality conifer trees. For all Research Forest units, this means a priority on the production of quality spruce trees. Despite the previous, it is recognized that the dominance of spruce regeneration may be reduced in respect of other tree species that are expected to be better adapted for yield under predicted climate and ecosystem conditions.

In order to help inform future tree regeneration and future timber yield decisions, applied research and innovation is expected to continue regarding tree species adaptation and survival outside of their current natural range of ecology and climate.

Non-Sawlog Wood Fibre

The objective for non-sawlog wood fibre is to explore, study, and implement options for recovering and utilizing all wood fibre that is remaining after fulfilling the conservation and protection objectives for all forest resource values.

Natural Non-Productive Forest and Natural Non-Commercial Cover

Areas that were naturally non-productive forest or non-commercial cover (brush cover) are valued for their unique habitat qualities and contribution to overall ecosystem and species diversity.

The objective for any individual area that is naturally non-productive or non-commercial cover (equal to or greater than 0.2ha) is to avoid reforestation and avoid alteration of the soil and soil moisture attributes. The existing vegetation cover in these areas may be disturbed at the time of harvest to facilitate efficient operations.

Problem Forest Types

Areas that are naturally hemlock and cedar leading forests are valued for their unique habitat qualities and contribution to overall ecosystem and species diversity. As described under the section titled, “Interior Old Forest Objective”, natural hemlock and cedar leading stands within Unit I will be conserved for biodiversity. Within Unit H, the objective is to further explore the economic recovery of timber and wood fiber value from hemlock and cedar stands. The conversion of mature hemlock and cedar leading stands to other conifer species may be undertaken; however, a representative portion of the natural hemlock and cedar stands will be retained consistent with the “Old Forest Retention” and “Wildlife Tree Retention” sections.

Regeneration of Forest, Use of Seed, and Free Growing Stands

Regeneration of forests remains a fundamental goal that is vital to achieving this plan’s many other objectives for future timber products and the maintenance of ecosystem and wildlife habitat functioning.

Tree Seed

The objective is to realize the growth and yield benefits from provincial tree seed improvement, while allowing experimentation with different seed sources to facilitate continuing study into assisted tree species migration and species adaptation to climate change.

The Chief Forester's Standards for Seed Use will be used in the selection and utilization of seed for conifer regeneration in cutblocks within all Research Forest units. The application of the seed that does not meet the Chief Forester's Standards is subject to not significantly increasing the risk to future timber supply and subject to achieving the conservation and protection objectives for all natural resource values.

Tree Species and Tree Density Selection

The objective is to realize the growth and yield benefits from implementing provincial stocking standards while allowing experimentation to facilitate continuing study into assisted tree species migration and species adaptation to climate change.

The provincial Reference Guide for FDP Stocking Standards will be used to prescribe preferred and acceptable conifer tree species and minimum stocking densities within each differing ecosystem association within each cutblock.

To facilitate further study, the following exceptions to the provincial standards may be implemented.

1) There is strong preference for regenerating spruce on all Research Forest units, but this preference may be reduced in respect of other tree species that are expected to be better adapted for growth and yield under the predicted climate and ecosystem conditions.
2) The experimentation and monitoring of planted conifer species expected to be better adapted for growth and yield under predicted climate and ecosystem conditions may be a focus of research in all Research Forest units. The planting of such tree species is subject to not significantly increasing the risk to future timber supply and subject to achieving the conservation and protection objectives for all natural resource values.
3) Where it may be demonstrated that long-term yield is not expected to be reduced, then different free growing criteria may be applied than is recognized through the provincial Reference Guide for FDP Stocking Standards. Different procedures for assessing free growing may also be applied than is recognized in the provincial Silviculture Surveys Procedures Manual.
4) To increase conifer yield (volume per hectare) and conifer timber quality (reduced large branch production), increasing target planting densities will be considered for all ecosystem associations showing a target stocking of 1000 stems/ha or greater within the provincial Reference Guide for Stocking Standards. The total density considered will be supported by growth modelling or best information that demonstrates the beneficial volume gains.
5) Within prescribed riparian management areas, the achievement of free growing status is dependent on each assessed tree meeting a minimum height, along with minimum form and health criteria. Conifer free growing status is not dependent on conifer height relative to competing brush species or deciduous trees or conifer position relative to competing brush species or deciduous trees.

Tree Regeneration Delay

The objective is to minimize average conifer regeneration delay to minimize the time that any area is not yielding conifer volume. The expectation is that the majority of tree planting will be implemented the next spring or summer season following the completion of harvesting.

Tree Planting

The objective is to optimize the site selection for the majority of planted trees to ensure improved conifer seedling survival and initial growth.

As such, a minimum intertree spacing of 1.6m may prescribed for any ecosystem association. A minimum intertree spacing of less than 1.6m may be prescribed where site conditions, soil conditions or necessary site preparation severely limit optimum planting sites.

Silviculture Treatments

The objective is to minimize silviculture treatment time to minimize the time that any area is not yielding acceptable conifer volume or quality.

Where a prescribed conifer area is determined to require silviculture treatments, such as, but not limited to, site preparation, brushing, fill-planting, or forest health sanitation, then the treatment(s) is to be undertaken within two growing seasons of detection.

Allowable Annual Cut Analysis

Current Timber Supply Analysis and Modelling

A new timber supply review (TSR) was undertaken during the summer of 2017. This review was necessary due to the significant changes resulting from a new forest inventory, new terrestrial ecosystem mapping, rapid expansion of spruce beetle attack within Units A, B, E, F, and G, the large amount of area and timber volume harvested since the 2016 TSR, and new biodiversity strategies being implemented within areas affected by large-scale salvage harvesting.

Given the scope of new resource information and the desire to improve modelling of current management practices, new TSR software (PATCHWORKS™, by Spatial Planning Systems Inc., Ontario) was deployed using the new timber inventory, new resource data, and revised management assumptions. The new TSR modelling framework is expected to provide further refinement possibilities for future TSR, while immediately improving the projection of timber yield and creating harvesting scenarios that better approximate current Research Forest practices.

All inventory and resource data was updated to its known condition post-March 2017, and therefore the current TSR fully accounts for large amount of timber volume removed via salvage operations since the last TSR.

The full details of the TSR are available within the Analysis Report and Data Package, which are contained in Appendix H.

The Timber Harvesting Land Base Netdown

When the new forest inventory, new road inventory, new stream inventory, new digital elevation model (from LiDAR data) was analyzed, it resulted in significantly different land base netdowns and available timber harvesting land base. A more restrictive definition for operable slopes was also applied, along with projected riparian reserve area that is more reflective of current practices. In total, the resulting THLB was 82% of the size of the THLB defined in 2016. Table 5, below, summarizes the new land base netdowns and resulting THLB. Where there is a significance difference (>10%) between the areas defined in this TSR verses the areas defined in 2016, they are highlighted in Table 5.

It is possible that the new forest inventory overestimated the amount of low-productivity stands, resulting in a smaller THLB than is actually available. It is also possible that the more restrictive definition for operable slopes resulted in a smaller THLB than is actually available. These factors will be review closely during the next TSR. For this TSR, they represent an undefined upward pressure on the projected mid-term harvest level.

Table 5. Timber Harvesting Land Base Net Down

Land Base Assignment Category	2017 Gross Area (ha)	2017 Effective Area (ha)	2016 Effective Area (ha)	2017 % Total Area	2017 % of CFLB
Total Area	*12,567*	*12,567*		*100%*	
Less:					
Non-Forest / Non-Productive	*221*	*221*	*149*	*2%*	
Existing Roads	*83*	*80*	*174*	*1%*	
Crown Forested Land Base (CFLB)		*12,266*			*100%*
Less:					
Physically Inoperable / Steep Slopes	*776*	*664*	*12*		
Low Productivity (SI <8 or never reaches 140 m³/ha)	*1,522*	*979*	*654*	*5%*	*5%*
Problem Forest Types:					
Black Spruce	*154*	*0*		*0%*	*0%*
Deciduous	*354*	*5*		*0%*	*0%*
Hemlock & Cedar Outside Unit H	*117*	*105*		*1%*	*1%*
Riparian Reserve Zones	*779*	*402*	*214*	*3%*	*3%*
Timber Harvesting Land Base (THLB)		*10,111*	*11,377*		*82%*
Less Aspatial Netdowns**:					
Stand Level Retention (9%)		*910*	*1,365*		*7%*
Net Effective Harvestable Land Base		*9,201*	*10,012*		*75%*

Volume Netdowns for Wildlife Tree Retention Areas (Stand level Retention)

Future wildlife tree retention areas (WTRA) are not applied spatially to the timber harvesting land base, rather they are represented by a 9% reduction in the timber yields. The management plan minimum requirement for WTRA is that 10% of the harvest area is to be retained as WTRA. Because the THLB was thoroughly netted down for all riparian reserves, low-productivity areas, non-operable slopes and problem stands, it is expected that over 3% of the future WTRA will include these non-THLB areas. The combined effect of the netdown for the non-THLB areas, along

with the 9% yield netdown strictly for WTRA is intended to be consistent with the management plan requirements.

Area Netdowns for Riparian Reserves

All of the individual riparian reserve areas were identified by applying the appropriate riparian buffer width identified in Table 6, to all the classified stream reaches identified within the CNC stream inventory, which was updated in early 2017.

Table 6. Riparian Buffers Applied

Riparian Class	Qualities that Define Riparian Class	Effective Riparian Buffer (m)
S1 – B	Fish Bearing & > 20m Wide	54
S2	Fish Bearing & 5m to 20m wide	34
S3	Fish Bearing & 1.5m to 5m wide	44
S4	Fish Bearing & < 1.5 m wide	5
S5	Non-Fish Bearing & >3m wide	5
S6	Non-Fish Bearing & <3m wide	5
W1 or W5	>5 ha	26
W3	1 to 5 ha	12
L1-B	>5 Ha to 1000ha	26
L3	1 ha to 5 ha	12

Modelling Timber Yield

For natural stands, the current TSR projects the timber yield of every individual forest polygon based on its individual stand attributes using the provincial Variable Density Yield Prediction (VDYP). This is intended to produce more accurate projections of yield for any sized portion of the Research Forest.

Managed stands are defined as those disturbed through harvesting post-1987. For managed stands, 7 new analysis units were developed, which were intended to more accurately reflect the species regeneration occurring or expected to occur in the future. The attributes of the 7 analysis units are provided in Table 7. Yield curves for each of these analysis units are derived from the Table Interpolation Program for Stand Yields (TIPSY) using the area weighted average provincial site index of the applicable ecosystems.

Table 7. Analysis Units for Managed Stands

Current Leading Species	Planted Species Composition	Regen Delay (yr)	OAFs		Method		Initial Density
			1	2	Type	%	
Balsam	Sx6Bl4	1	15	5	Plant	100	1600
Cedar	Sx3Cw3Hw3Bl1	1	15	5	Plant	100	1600
Douglas Fir	Fd5Sx3Pl2	1	15	5	Plant	100	1600
Hemlock	Hw5Sx3Bl10Cw10	1	15	5	Plant	100	1600
Pine	Pl7Sx3	1	20	5	Plant	100	1600
Black Spruce	SB5SX5	1	15	5	Plant	100	1600
Spruce	Sx7Bl3PL1	1	15	5	Plant	100	1600

To account for decay, waste and breakage in managed stands, operational adjustment factors (OAF) are utilized in the TIPSY model. An OAF1 of 20% was applied for pine-leading stands and 15% for all other species, while OAF2 increases from 0% to 5% by the time the stands reach 100 years of age. For natural stands, the VDYP model already includes loss factors in its yield projection.

Assumptions Applied in Analysis

Pine Mortality

This analysis assumes that the MPB outbreak has ended and there will be no further MPB mortality. In the Research Forest, the estimated level of pine mortality in affected mature stands is 92%, which equates to a median stand-level mortality of 46%. In the Research Forest, the area-weighted average time-since-death in MPB-impacted stands is 11 years. Merchantable pine volume within an attacked stand decreases over time as dead stems degrade. For the purpose of this analysis, the remaining standing dead pine volume was considered unusable and did not contribute to stand and harvest volume. This assumption represents and small, undefined upward pressure on the available short-term harvest level.

Spruce Mortality

For Units A to G, the assumption is that all stands >99 years old with a component of spruce (regardless of the percentage of spruce) will experience approximately 83% damage from spruce beetle and/or windthrow by year 1.

For Units H, I, J, K, and L, the assumption is that spruce beetle management may be more effective, but the mortality results will be similar where beetle attack is successful. Any spruce-leading stands may have 83% mortality applied in year 1, starting with the oldest spruce-leading stands. The accumulation of spruce beetle mortality was stopped when 33% of the total spruce-leading volume within a unit was selected for mortality.

To account for the future degradation of dead spruce (referred to as shelf-live), 10% of the dead spruce volume was discounted each year, starting 1 year post-attack. After 11 years, none of the dead spruce volume is considered useable.

Other Stand Mortality and Timber Volume Losses

Other stand disturbances or losses that may not be recovered, or non-recoverable losses (NRL), were considered. This analysis adopted the NRL used for the Prince George TSR V, which were pro-rated to the Research Forest based on the area of THLB relative to the Prince George TSA. This came to 1,420 m^3/yr. This amount was subtracted from modelled outputs prior to reporting. This represents over 7% of the available harvest volume projected for the mid-term period. This assumption, may be over estimating losses for the Research Forest, where it is much easier to effectively recover losses, compared to the entire PGTSA. This may represent a small upward pressure on the available harvest volume projected for the mid-term.

Landscape Level Biodiversity

As per the requirements in this management plan, this TSR is modelled such that 19% of the Crown forest is to be maintained over 120 years of age. This is the assumption in the Base Case and for the recommended Scenario. Since the research forest is composed of several geographically separate parcels, a specific minimum threshold has been assigned to each parcel as shown in Table 8. These minimum percentages per Research Forest unit were also maintained during the modelling.

Table 8. Landscape Level Biodiversity Old Seral Retention Targets

Research Forest Unit	Projected Old Non-Pine Percentage
A – Kerry Lake	10%
B – Tacheeda Lakes	14%
C – Caine Creek	10%
D – Caine Creek	10%
E – Chuchinka Creek	10%
F – Chuchinka Creek	10%
G – Angusmac Creek	10%
H – Purden Mountain	25%
I – Hungary Creek	25%
J – Fraser River	10%
K – Willow River	25%
L – Willow River	10%
Total for All Units	19%

Long-Term Wildlife & Connectivity Corridors

Within Research Forest Units A, B, E, F, and G the approximate locations of long-term biodiversity wildlife connectivity corridors were identified and these features were incorporated into the modeling planning file. Stands within this these corridors are eligible for harvest if they are over 119 years old and if no more than 34% of the corridor area within each Research Forest Unit is less than 60 years old.

Prescribed Wildlife Tree Retention Areas (WTRA)

The location of prescribed WTRA as of April 2017 were identified, and these features were incorporated into the modelling planning files. WTRA are not available for harvest until the cutblock with which they are associated has attributes consistent with a mature seral condition. To approximate this in the harvest modelling, WTRA were locked from harvest eligibility for 59 years from the WTRA established date.

Future Roads

No reduction of the future land base was applied for future road development as the majority of roads are planned for rehabilitation, and as more roads are developed across all Research Forest units, a larger percentage of rehabilitation is expected to ensure impacts to natural resources and the productive land base are minimized. This assumption likely represents about a 1% downward pressure on the available harvest projected for the mid-term.

Visual Quality Objectives

Visual quality objectives (VQOs) are addressed in the model using Plan to Perspective (P2P) ratios and Visually Effective Green-up (VEG) heights determined for 5% slope class increments, as well as VQO by percent alterations.

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

resulting average limit of alteration calculated for each visual quality objective class is shown within the second column in Table 9.

Table 9. VQO by Percent Alterations

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

Minimum Volume per Hectare and Minimum Age

In order for a stand to be considered economic and eligible for harvest within the model it must meet the minimum volume per hectare (MVH) of 140 m^3/ha and or when the stand achieves 95% of the culmination mean annual increment (CMAI), whichever is more constraining. Stands that never meet the MVH are removed from the THLB. When assessing balsam (sub-alpine fir) stands against the 140 m^3/ha minimum, the volume of all natural balsam was reduced by 30%. Recent harvesting in old, natural balsam stands has demonstrated that well over 30% of the balsam volume is either not recovered or not useable. When modelling the harvest volume, the entire balsam volume is recorded and contributes to the allowable annual cut.

Volume Utilization by Species

When forecasting available harvest volume, the utilization standards specified in Table 10 were applied.

Table 10. Utilization Standards

Species	Minimum Diameter at Breast Height (DBH) cm	Maximum Stump Height (cm)	Minimum Top Diameter (cm)
Lodgepole Pine	12.5	30.0	10.0
Other Conifer	17.5	30.0	10.0
Deciduous	17.5	30.0	10.0

Lifespan of Forest Stands

This analysis assumed that stands could not age more than 350 years. After this time, if not harvested, they were assumed to regenerate to an unmanaged stand.

Harvest Modelling Objectives

The concept of harvest priorities (e.g. oldest first) is not relevant in an optimization/heuristic model. However, within Patchworks, it is necessary to weight various targets or objectives relative to each other so that solutions reflect management priorities. In this analysis, the harvest volume target was weighted substantially lower than all other targets to insure that non-timber objectives were not sacrificed to deliver volume. Using this approach harvest volume is attractive to the model only when all other issues have been addressed (e.g. old seral objectives). Weighting takes into account the scale of different units associated with targets (ha verses m^3 vs %'s) when setting weightings.

Patchworks generates millions of alternative solutions and ranks them depending on how well they achieve the user's objectives. For this reason the user must decide when to terminate the search for a better solution. A search is terminated when a specific defined criterion for a 'stable' solution has been achieved. This helps ensure that differences between scenario results occur because of model input differences and not from extra effort spent finding a better solution. For the purpose of this project, Patchwork results were accepted once the objective function improved by less than 0.001% over 250,000 iterations.

Harvest Block Size Limitations

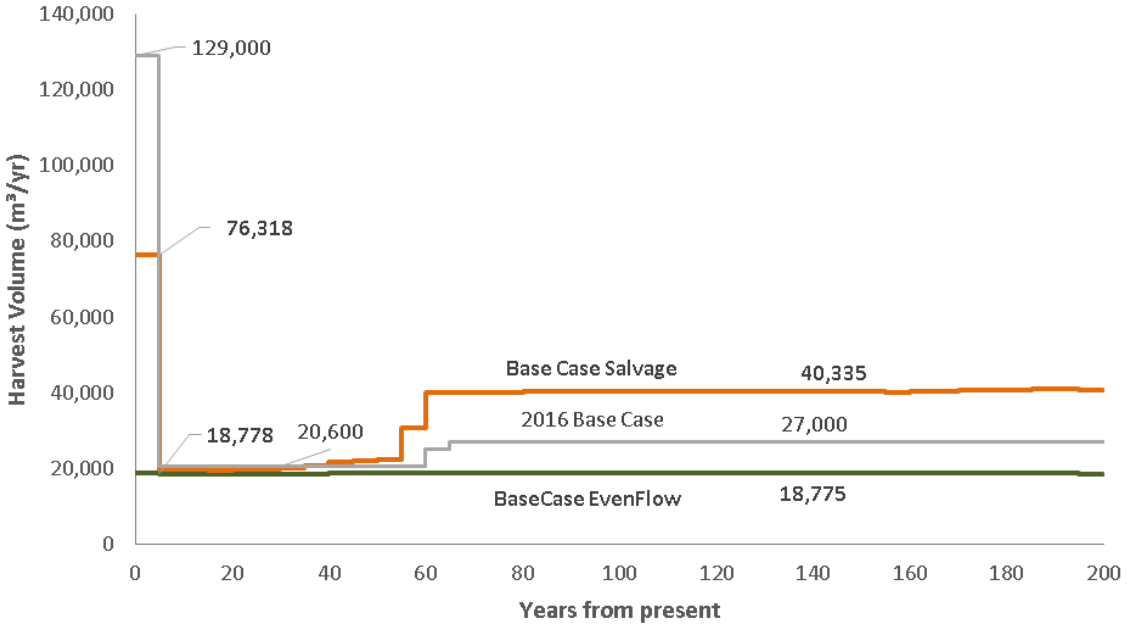
Patchworks is a fully spatial forest estate model that can incorporate real world operational considerations into a strategic planning framework. It is unique in its ability to dynamically assess spatial relationships during modeling and adapt solutions to achieve spatial objectives. To better approximate actual harvest patterns, factors were applied to limit harvesting via multiple small blocks. Forest polygons were grouped into blocks with a target size of 20ha, while ensuring that only stands with similar key attributes were grouped together. In addition, the occurrence of very small (fragmented) forest polygons were minimized as part of the data preparation.

Base Case and Timber Supply Sensitivity Scenarios

Modeling results are presented for two candidate base case scenarios: an even-flow timber supply scenario, and a scenario where even-flow constraints are relaxed in order to capture and salvage timber damaged by spruce beetle. The even-flow base case scenario was used as a benchmark for the salvage scenario to ensure harvest levels did not go below what can be achieved in even-flow scenario. This ensured that salvage harvest scheduling did not deplete or liquidate green timber that can be harvested in subsequent periods where the timber supply forecast is low. The results of these two base case scenarios are shown in Figure 3. The 2016 base case is also shown for reference (the one year difference between these scenarios is not reflected in Figure 3).

Modeling shows that under an even-flow scenario, approximately 18,775 m^3/yr can be maintained. When even-flow constraints are relaxed for the salvage scenario, modeling shows that an initial harvest rate of approximately 76,000 m^3/yr is required to salvage timber assumed to be killed by the spruce beetle. The 2016 analysis showed a much higher initial harvest rate, however much of that volume was already harvested in winter 2016/2017 in a large salvage operation. Relaxation of even-flow constraints also results in significant increase in the long-term harvest level. This increase is largely due to the adoption of managed site indexes for future managed stands.

Figure 3. Harvest over Time for Base Case Scenarios relative to the 2016 Base Case



Timber supply sensitivity analysis was also undertaken to understand the influence of changes in key factors and circumstances (scenarios) to projections of available harvest. In particular, the sensitivity analysis considered the affect of the following:

1) Higher Spruce Mortality within Research Forest Units H, I, J, K and L: 66% of the total spruce volume within spruce-leading stands is killed by spruce beetle
2) Shorter Spruce Shelf-Life: Dead spruce volume becomes fully unusable at year 6 rather than year 11
3) Hemlock-leading Stands within Research Forest Unit H are considered Problem Forest Types: All Hemlock-Leading stands with Unit H are removed from the THLB
4) Biodiversity Corridors Removed: The requirement for long-term biodiversity corridors is removed.
5) Biodiversity Corridor Constraints are Revised: Harvesting is permitted within biodiversity corridor providing no more than 34% of area is less than 30 years instead of 60 years.
6) Salvage Harvesting in First Period Only: Salvage harvesting is only permitted for the first 5 years.

The resulting effect of the six different scenarios on the projected short-term (Initial rate), mid-term, and long-term harvest levels is summarized in Table 11. For a further explanation of the reasons for the changes in the harvest levels, refer to the Sensitivities to the Base Case section of the Analysis Report in Appendix H.

Table 11. Harvest flow summary for modeled scenarios

	Harvest Rate (m^3/yr)			Percent Change Relative to Salvage Base Case		
Sensitivity Description	**Initial Rate**	**Mid-Term**	**Long-Term**	**Initial Rate**	**Mid-Term**	**Long-Term**
Salvage Base Case	76,318	19,569	40,422	-	-	-
Higher Spruce Mortality	91,281	16,396	40,207	20%	-16%	-1%
Shelf-Life	71,977	17,723	40,359	-6%	-9%	0%
Hemlock	76,721	16,131	39,013	1%	-18%	-3%
No corridor	89,729	20,137	42,185	18%	3%	4%
Revised Corridor	80,746	18,955	41,468	6%	-3%	3%
1st Period salvage only	86,907	17,679	40,473	14%	-10%	0%
Final Recommended	72,523	18,992	39,721	-5%	-3%	-2%

Final Recommended Timber Supply Scenario

The sensitivity analysis demonstrated that the critical mid-term period is sensitive to higher spruce mortality, decreased spruce shelf-life, utilization of hemlock-leading stands and accelerating harvest in the first 5 years, while it was not sensitive to the implementation of biodiversity/wildlife corridors. Given the management desire to avoid over-estimating the available mid-term harvest level, the final recommended scenario and harvest level adjusted the base case assumption regarding Hemlock-leading stands. The base case assumption does not fully reflect current knowledge and practice concerning hemlock timber merchantability and contributes to a potential over-estimation of available mid-term harvest. For the final recommended scenario, stands within Unit H with greater than 60% hemlock or cedar volume were removed from the THLB.

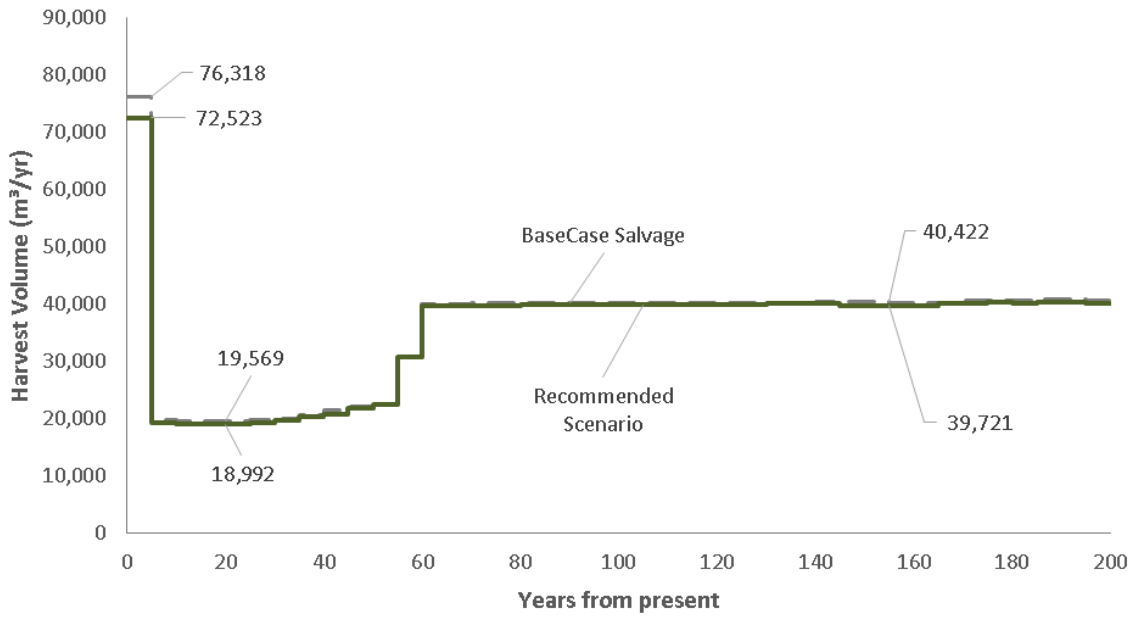
Aside from the revised hemlock-leading assumptions, the final recommended timber supply scenario does not apply changes to the base case scenario. The spatially identified biodiversity corridors continue to apply in the final, recommend scenario, including the restriction that no greater than 34% of the biodiversity corridors within a unit may be less than 60 years of age at any time.

Further confidence in the projected mid-term harvest level is gained through the application of netdowns for low productivity stands and operable slopes, along with inclusion of significant non-salvageable losses. Collectively these factors represent a measurable upward pressure on the projected mid-term harvest volume, which is reduced slightly by the decision to apply no reduction for future roads.

The recommend TSR scenario projects a short-term (five year) harvest level of 72,500 m3 per year, to be followed by a mid-term harvest level of 19,000 m3 per year starting in year six. The harvest flow of the recommended scenario is displayed within Figure 4.

The TSR revealed that the new CNC forest inventory is underestimating volume in old, mature spruce and balsam stands by an average of approximately 33%. The full explanation of the mature forest volume underestimation within the CNC forest inventory is provided within the Inventory Volume Comparison section of the Analysis Report within Appendix H. Since old spruce and balsam stands contribute virtually all of the projected short-term harvest volume, the 72,500 m3 per year actually represents an estimated **108,000 m3 per year of annual harvest during the first five years, which is the recommended allowable annual harvest for the period from August 2017 to August 2022.**

Figure 4. Harvest flow comparison - Salvage base case vs. Salvage 1st period only



Managing Allowable Annual Cut

For the purposes of reducing uncertainty about sustainable harvest levels and reliable forecasting, the management plan timber supply analysis is planned to be updated every five years or more often, if new information or circumstances change significantly, as is currently the situation with increasing spruce beetle hazard and mortality.

When tracking current harvest against the allowable annual cut determined by the District Manager, provincial harvest billing volume as recorded in the Harvest Billing System will be used. This is consistent with the direction provided in the District Manager's approval letter, of January 20, 2017, for CNC Research Forest Management Plan #3.

First Nations' Territory

McLeod Lake Indian Band – Tse'Khene (Sekani) Territory

Research Forest Units A to G, which are located to the north of Prince George, are within the traditional lands of the Tse'Khene peoples. The collective aboriginal rights of the Tse'Khene peoples of the Crooked River area are represented by the McLeod Lake Indian Band.

West Moberly First Nations

The West Moberly First Nations have claimed that their existing Treaty 8 rights apply to the area which encompasses Research Forest Units A to G.

Halfway River First Nation

The Halfway River First Nation has claimed that their existing Treaty 8 rights apply to the area which encompasses Research Forest Unit A.

Lheidli T'enneh First Nation

Research Forest Units H to L, which are located east and south of Prince George, are within the traditional lands of the Lheidli T'enneh peoples. The collective aboriginal rights of the Lheidli T'enneh peoples within the areas surrounding the city of Prince George are represented by the Lheidli T'enneh First Nation.

Nazko First Nation

Research Forest Unit J, which is located south of Prince George along the west side of the Fraser River, is within the traditional lands of the Nazko peoples. The collective aboriginal rights of the Nazko peoples of the Blackwater River area are represented by the Nazko First Nation.

For further information regarding objectives and strategies to involve First Nations in planning and operations, refer to the sections titled, "First Nations Involvement and Information" and "Archaeological and Cultural Heritage Resources".

First Nations Information Sharing and Involvement

First Nations Involvement in the CNC Research Forest Society

First Nations' representation on the CNC Research Forest Society Board of Directors (Board) is a fundamental membership goal within the bylaws of the CNC Research Forest Society. In previous years, Board membership included First Nation's representatives, but the Board is currently operating without any First Nations members. The Board invites the McLeod Lake, Lheidli T'enneh, Nazko, West Moberly and Halfway River Nations to participate on the Board.

First Nations Strategic Planning Involvement

CNC welcomes the involvement of First Nations in strategic planning processes regarding future resource development and future research. Sharing and seeking input on specific operational plans is not the sole focus of First Nations involvement. Regular, proactive involvement in CNC's ongoing operational and research strategies is the desired goal to ensure that all stages of planning and operational implementation are respectful of the preferred management direction of each First Nation. CNC is striving to develop improved relationships and protocols with each First Nation to improve future planning and to improve the mutual benefits derived from the continued operation of the Research Forest.

First Nations Consultation Regarding Management Plan

Upon providing the proposed management plan to Ministry of Forests, Lands and Natural Resource Operations, it is expected that the Province will undertake consultation with affected First Nations, and directly involve CNC in the consultation process as appropriate. Prior to submission for approval to the District Manager, all First Nations' input will be summarized and considered in the proposed plan, along with any revisions to the plan to address the input. All of this information will be submitted with the proposed plan, which will be considered in the District Manager's approval decision.

In December 2015, a CNC letter was sent to affected First Nations requesting early input into a potential revision to the existing Research Forest management plan. After preparing this new management plan, a letter was sent to the same First Nations in early June 2016 informing that a new management plan has been prepared and that CNC is seeking input from First Nations. Near the same time, the Ministry of Forests, Lands and Natural Resource Operations also sent a letter to First Nations inviting consultation on the potential District Manager approval determination for this management plan.

Sharing and Involvement in Specific Resource Operations

CNC commits to providing First Nations all proposed plans for forest development operations within the Research Forest. When seeking input on significant operations, the proposed plans will be provided well in advance of implementation so that there is ample time to consider input. Where the proposed harvesting or resource extraction is small in area (less than 15ha) and proposed to control forest health factors (ex. spruce beetle), or otherwise time sensitive, CNC may respectfully notify the First Nation or request the First Nation's assistance in expeditiously resolving the Nation's input. The information from this process will be provided to the Ministry of Forests, Lands and Natural Resource Operations for their ongoing consideration of Treaty rights and aboriginal rights related to the Research Forest administration.

Aside from the above, CNC may also regularly contact First Nations for input and advice regarding an individual forest practice, a site plan, research implementation, research results, management of individual sites or areas within the territory, or early input on a proposed management plan amendment or replacement. The goal is regular and meaningful First Nation involvement in CNC's planning processes and the implementation of operations.

First Nations Related Research and Innovation

The Research Forest is intended to provide educational and applied research and innovation benefits to all the peoples of the region, and therefore CNC supports educational and research projects that may fulfill a need that is important to First Nations' and their territory. CNC is continuously willing to discuss ideas for new research projects or research activities that may supplement or support previously established innovative projects. CNC's interest in cooperative projects with First Nations is not limited to the CNC Research Forest units.

Public Input and Review

To ensure a fair opportunity for public input, any proposed replacement or amended management plan that requires approval by the District Manager will be advertised for public review for a period of at least 60 days, prior to being delivered to the District Manager. At least 60 days before the plan is to be submitted to the District Manager for an approval decision, the proposed plan will also be distributed to the Ministry of Forests, Lands and Natural Resource Operations, adjacent major

forest tenure holders, guiding license holders, and trapping license holders so all may review and provide input regarding the proposed plan. Other stakeholders and other concerned members of the public may also receive a proposed plan at least 60 days prior to submission to the District Manager.

A proposed plan will also be made available to the public at the CNC campus in Prince George, at least 60 days before being submitted to the District Manager. This allows for anyone, who may be interested in or affected by the plan, to easily review and provide direct input to CNC. A representative of CNC will be available during this period to meet directly with the public and natural resource stakeholders to discuss and receive input on the proposed plan.

Prior to submission to the District Manager, all input will be summarized and considered in the proposed plan. Any revisions to the plan to address input will also be identified in the proposed plan. All of this information will be submitted with the proposed plan, which will be considered in the District Manager's approval decision.

An opportunity for public review of this management plan was advertised in the Prince George Citizen Newspaper starting on June 11th, 2016. This management plan was made available through the CNC main website and hard copies were available at the Prince George campus during the review period. Prior to the advertisement, letters, along with a copies of this management plan, were sent from CNC to all potentially affected trappers, guides, and adjacent forest licensees requesting input prior to submitting the plan to the District Manager.

Notifying and Reporting to Government

CNC will be annually reporting new cutblock openings into the provincial RESULTS database, and for existing cutblock openings in RESULTS, annually reporting changes to prescribed tree stocking, prescribed soil disturbance, the net area to reforest, forest inventory, and regeneration status.

In addition, an annual report of operations will be submitted to the Prince George District Manager by June 1st of each year that summarizes the previous year's activities, including but not limited to harvesting, road building, planting, other silviculture practices, old forest retention areas, forest health management, research, and educational activities.

Requirement for Forest Professionals and Other Professionals

This management is plan is to be prepared by or supervised by a Registered Professional Forester (RPF) and subsequently signed by that RPF. Any future updates or amendments to the plan will also require the appropriate involvement and certification of a RPF.

The development plan and any updates and amendments will also be prepared or supervised and subsequently signed by a RPF.

Other Professionals must be involved or provide professional certification when undertaking certain types of planning, resource assessments, field preparation, recommendations, and supervision of works. This may include, but is not limited to Professional Archaeologists, Professional Biologists, Professional Engineers and Professional Geoscientists.

Periodic Management Plan Review

Coinciding with each review of the timber supply analysis, every five years or less, all management plan content and objectives will be reviewed to ensure consistency with new information, First Nations rights and interests, non-timber Stakeholder use, public interest, and the current state of the natural resources. It is expected that a management plan amendment or replacement will occur every five years, which will involve an opportunity for public review and First Nations consultation. At any time, the District Manager may also direct CNC to replace the existing management plan and specify conditions which the new management plan must address.

Prior to undertaking a management plan amendment or replacement, upfront input may be requested from those who may be most affected by the plan. It is also important to recognize that prior to releasing any amended or new plan to the public, the CNC Research Forest Society Board and CNC Board of Directors must acknowledge and support the plan. This independent oversight of any new plan is critical to upholding the intended purpose of the Research Forest.

Development Plans and Site Plans

A development plan will be created and maintained for the Research Forest that provides more detail about forest practices and related research that may be undertaken. It does require submission to the District Manager, but will be regularly maintained by CNC to provide clear direction concerning the achievement of the management plan direction. The development plan will also include the regeneration stocking standards and free growing standards that are to apply to each ecosystem association or groups of ecosystem associations within a cutblock.

Site plans for individual cutblocks and roads will be completed in advance of any primary forest activity but are not submitted to the District Manager unless requested. Site plans will not be completed for minor road upgrading works necessary to improve road safety and reduce environmental impacts. Site plans for cutblocks will include the area prescribed for regeneration, the stocking standards and free growing standards that apply to each ecosystem association, the allowable amount of soil disturbance, the location of roads, and identify how the content and objectives of this management plan will be achieved. Site plans will be amended from time to time to adjust for changing conditions, previously unidentified resources, and to allow for the modification of forest practices consistent with this management plan.

A RPF must confirm that a site plan may not be required where very limited harvesting and road building operations are involved.

Licensee Commitments

In carrying out this management plan, the intent is to meet the principles of sustainability and total resource management specified under Special Use Permit S24940.

It is the responsibility of CNC, as the holder of the Special Use Permit S24940, to implement the content of this management plan and any other direction of the District Manager, upon approving the plan.

Signatures of persons required to prepare plan.

Preparing Forester *I certify that the work described herein fulfills the standards expected of a member of the Association of British Columbia Forest Professionals and that I did personally prepare the work.*		
	Carl Pollard, R.P.F. Manager, Research Forest College of New Caledonia	***Date***
CNC Research Forest Society *I certify that this management plan is authorized on behalf of The College of New Caledonia Research Forest Society.*		
	Trevor Joyce, R.P.F. *Chair,* College of New Caledonia Research Forest Society	***Date***
Authorized Licensee Signature		
	College of New Caledonia Board of Directors	***Date***

Appendix A: Research Forest Funding for the Natural Resources and Environmental Technology Program

The Natural Resources and Environmental Technology (NRET) program offered at CNC's Prince George campus is a two year provincially and nationally accredited program that meets the educational requirements of a Registered Forest Technologist in British Columbia and also the requirements of a Registered Biology Technologist under the College of Applied Biology in British Columbia.

All College programs, including NRET, are regulated by an Education Council. There are multiple processes in place to review programs in a structured and meaningful way. Internally this is done through student feedback, industry feedback, faculty engagement with other institutions and industry, and through the support of the College Board-appointed Program Advisory Committee, which meets regularly. There are also external accreditation processes such as that required by the Association of BC Forest Professionals.

Accreditation processes ensure that programs are of suitable rigor that they can be recognized as a technology and additionally that there is enough appropriate forestry content that the NRET program meets the standard of a professional forest technology offering. The process works to ensure that programming is delivered by qualified faculty supported by suitable laboratory staff and facilities meet expectations for classrooms, lab facilities, supplies and equipment resources suitable for a forest technology program.

The College has developed a protocol for distribution of revenues from the proceeds of the Research Forest. The Research Forest Society has accepted the protocols dated February 14, 2012 as the approved process for distribution of Research Forest revenues. The protocol agreement identifies the three purposes of the CNC Research Forest Society in order of priority.

Listed below are examples of discretionary expenses that may be funded through revenues derived from Research Forest operations. The list is not an exhaustive list but attempts to capture the types of funding that could be allocated in addition to base budget Core funding responsibilities provided by CNC to run a program as approved by Education Council.

- Salaries and supplies relating to special projects and program enhancements.
- Additional resources to support NRET student success, especially for Aboriginal students and students with disabilities.
- Additional student financial aid such as scholarships or bursaries.
- Release time for faculty doing NRET curriculum development that is not required by the College.
- Capital equipment purchases for the program that is not able to be purchased through the wider CNC capital budget.
- Additional marketing costs and advertising costs to promote the program.
- Membership in professional organizations where these exceed the requirement of CNC but are still within the interest of the NRET program.
- Support for NRET students or employees participating in approved field trips or conferences.
- Support for NRET students or employees participating in approved international exchanges or international field schools.

Appendix B: Prince George Forest District Red and Blue Listed Ecological Communities and Species

Prince George Forest District Red/Blue Listed Ecological Communities.[25]

English Name	BC List	Ident-ified Wildlife	Biogeoclimatic Units	Ecosystem Group
mountain alder / red-osier dogwood / lady fern	Blue		ICHwk4/Fl02; SBSvk/Fl02; SBSwk1/Fl02	Terrestrial - Flood: Flood Lowbench (Fl)
scrub birch / water sedge	Blue		ESSFwk2/Wf02; ICHwk4/Wf02; SBSvk/Wf02; SBSwk1/Wf02	Wetland - Peatland: Wetland Fen (Wf)
slender sedge / common hook-moss	Blue		SBSmk1/Wf05; SBSwk1/Wf05	Wetland - Peatland: Wetland Fen (Wf)
shore sedge - buckbean / hook-mosses	Blue		SBSwk1/Wf08	Wetland - Peatland: Wetland Fen (Wf)
shore sedge - buckbean / peat-mosses	Blue		SBSmk1/Wb13	Wetland - Peatland: Wetland Bog (Wb)
swamp horsetail - beaked sedge	Blue		ICHwk4/Wm02; SBSdw3/Wm02; SBSwk1/Wm02	Wetland - Mineral: Wetland Marsh (Wm)
tamarack / low birch / bluejoint reedgrass - sedges / peat-mosses	Red		SBSdw2;SBSdw3	Wetland - Peatland: Wetland Fen (Wf)
hybrid white spruce - paper birch / devil's club	Blue		SBSmh/07	Terrestrial - Forest: Mixed - moist/wet
hybrid white spruce / ostrich fern	Red	Y	SBSmh/08	Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Coniferous - moist/wet
hybrid white spruce / hardhack / oak fern	Red		SBSwk1/06	Terrestrial - Forest: Coniferous - moist/wet
hybrid white spruce / hardhack - prickly rose	Blue		SBSdw3/06	Terrestrial - Forest: Coniferous - mesic
hybrid white spruce / foam lichens	Red		SBSdw2/00	Terrestrial - Forest: Coniferous - dry
black spruce / common horsetail / peat-mosses	Blue		SBSdw3/Wb09; SBSwk1/Wb09	Wetland - Peatland: Wetland Bog (Wb)
black spruce / skunk cabbage / peat-mosses	Blue		ICHvk2/Ws09; SBSvk/Ws09; SBSwk1/Ws09	Terrestrial - Forest: Coniferous - moist/wet; Wetland - Mineral: Wetland Swamp (Ws)

[25] British Columbia Ministry of Environment. 2016. BC Species and Ecosystems Explorer Application. https://catalogue.data.gov.bc.ca/dataset?q=tantalis&download_audience=Public&type=Geographic&sort=score+desc%2C+record_publish_date+desc&page=1

black spruce / buckbean / peat-mosses	Blue		ICHvk2/Wb11; SBSdw2/Wb11; SBSwk1/Wb11	Wetland - Peatland: Wetland Bog (Wb)
lodgepole pine - black spruce / red-stemmed feathermoss	Blue		SBSdw2/07; SBSdw3/05	Terrestrial - Forest: Coniferous - mesic; Terrestrial - Forest: Coniferous - moist/wet
lodgepole pine / black huckleberry / reindeer lichens	Blue		SBSvk/09; SBSwk1/02	Terrestrial - Forest: Coniferous - dry
lodgepole pine / black huckleberry - velvet-leaved blueberry	Blue		SBSvk/02; SBSwk1/03	Terrestrial - Forest: Coniferous - dry
Sandberg's bluegrass - slender wheatgrass	Red		SBSdw3	Terrestrial - Grassland: Grassland (Gg)
(balsam poplar, black cottonwood) - spruces / red-osier dogwood	Red		ICHwk4/Fm02; SBSwk1/Fm02	Terrestrial - Flood: Flood Midbench (Fm);Terrestrial - Forest: Broadleaf - moist/wet
Douglas-fir / Douglas maple / step moss	Red		SBSmh/04	Terrestrial - Forest: Coniferous - dry
Douglas-fir - hybrid white spruce / knight's plume	Blue		SBSmk1/04; SBSwk1/04	Terrestrial - Forest: Coniferous - dry
Douglas-fir - hybrid white spruce / electrified cat's-tail moss	Blue		SBSdw2/05	Terrestrial - Forest: Coniferous - dry
Douglas-fir - hybrid white spruce / thimbleberry	Blue		SBSmh/01; SBSmh/05; SBSmh/06; SBSvk/03	Terrestrial - Forest: Coniferous - dry; Terrestrial - Forest: Coniferous - mesic
Douglas-fir - lodgepole pine / clad lichens	Blue		SBSdw2/02; SBSdw3/02; SBSmh/02; SBSmh/03	Terrestrial - Forest: Coniferous - dry
Drummond's willow / bluejoint reedgrass	Blue		SBSdw3/Fl05	Terrestrial - Flood: Flood Lowbench (Fl)
Sitka willow / Sitka sedge	Blue		SBSvk/Ws06; SBSwk1/Ws06	Wetland - Mineral: Wetland Swamp (Ws)
scheuchzeria / peat-mosses	Blue		SBSdw3/Wb12; SBSvk/Wb12	Wetland - Peatland: Wetland Bog (Wb)
western redcedar / devil's club / ostrich fern	Red	Y	ICHvk2/05	Terrestrial - Flood: Flood (Highbench);Terrestrial - Forest: Coniferous - moist/wet
western redcedar / falsebox	Blue		ICHwk4/03	Terrestrial - Forest: Coniferous - dry; Terrestrial - Forest: Coniferous - mesic
tufted clubrush / golden star-moss	Blue		SBSwk1/Wf11	Wetland - Peatland: Wetland Fen (Wf)
western hemlock - western redcedar / clad lichens	Blue		ICHvk2/02; ICHwk4/02	Terrestrial - Forest: Coniferous - dry

Plant and Animal Red/Blue Listed Species at Risk by BEC Zone.[26]

Animal species are shown in grey type and plant species are shown in black type.

Scientific Name	English Name	BC List	Ident-ified Wildlife	Name Category	Biogeoclimatic Subzone
Acipenser transmontanus pop. 3	White Sturgeon (Nechako River population)	Red		Vertebrate Animal	
Acipenser transmontanus pop. 5	White Sturgeon (Upper Fraser River population)	Red		Vertebrate Animal	ICH;SBS
Acorus americanus	American sweet-flag	Red		Vascular Plant	SBSmh;SBSwk
Acroloxus coloradensis	Rocky Mountain Capshell	Blue		Invertebrate Animal	ESSF;SBS
Anaxyrus boreas	Western Toad	Blue		Vertebrate Animal	ESSF;ICH;SBS
Ardea herodias	Great Blue Heron, *herodias* subspecies	Blue	Y	Vertebrate Animal	ICH;SBS
Asio flammeus	Short-eared Owl	Blue	Y	Vertebrate Animal	ICH;SBS
Botaurus lentiginosus	American Bittern	Blue		Vertebrate Animal	ICH;SBS
Buteo platypterus	Broad-winged Hawk	Blue		Vertebrate Animal	ICH,SBS
Carex sprengelii	Sprengel's sedge	Red		Vascular Plant	SBSmh
Cicindela hirticollis	Hairy-necked Tiger Beetle	Blue		Invertebrate Animal	ESSF;ICH;SBS
Colias meadii	Mead's Sulphur	Blue		Invertebrate Animal	ESSF
Colias pelidne	Pelidne Sulphur	Blue		Invertebrate Animal	ESSF;ICH
Contopus cooperi	Olive-sided Flycatcher	Blue		Vertebrate Animal	ESSF;ICH;SBS
Cypseloides niger	Black Swift	Blue		Vertebrate Animal	ESSF;ICH;SBS

[26] British Columbia Ministry of Environment. 2016. BC Species and Ecosystems Explorer Application. https://catalogue.data.gov.bc.ca/dataset?q=tantalis&download_audience=Public&type=Geographic&sort=score+desc%2C+record_publish_date+desc&page=1

Dolichonyx oryzivorus	Bobolink	Blue		Vertebrate Animal	ICH;SBS
Draba fladnizensis	Austrian draba	Blue		Vascular Plant	SBSmk
Dryopteris cristata	crested wood fern	Blue		Vascular Plant	ICHvk;ICHwk;SBSmk
Epilobium halleanum	Hall's willowherb	Blue		Vascular Plant	ICHwk;SBSwk
Euphagus carolinus	Rusty Blackbird	Blue		Vertebrate Animal	ESSF;SBS
Galba parva	Pygmy Fossaria	Blue		Invertebrate Animal	SBS
Gulo luscus	Wolverine, *luscus* subspecies	Blue	Y	Vertebrate Animal	ESSF;ICH;SBS
Hirundo rustica	Barn Swallow	Blue		Vertebrate Animal	ESSF;ICH;SBS
Malaxis brachypoda	white adder's-mouth orchid	Blue		Vascular Plant	SBSvk
Malaxis paludosa	bog adder's-mouth orchid	Blue		Vascular Plant	SBSdw;SBSwk
Meesia longiseta		Blue		Nonvascular Plant	ESSF;SBS
Megalodonta beckii	water marigold	Blue		Vascular Plant	SBSmk
Myotis septentrionalis	Northern Myotis	Blue		Vertebrate Animal	ICH;SBS
Myrinia pulvinata		Red		Nonvascular Plant	SBSmh
Nephroma occultum	cryptic paw	Blue		Fungus	ICH
Numenius americanus	Long-billed Curlew	Blue	Y	Vertebrate Animal	ICH;SBS
Nymphaea tetragona	pygmy waterlily	Red		Vascular Plant	SBSmk; SBSwk
Oeneis jutta chermocki	Jutta Arctic, *chermocki* subspecies	Blue		Invertebrate Animal	ESSF;ICH;SBS
Oxytropis campestris var. *davisii*	Davis' locoweed	Blue		Vascular Plant	SBSmh
Pedicularis parviflora ssp. *parviflora*	small-flowered lousewort	Red		Vascular Plant	ICHwk;SBSmh;SBSmk;SBSwk

Pekania pennanti	Fisher	Blue	Y	Vertebrate Animal	ESSF;ICH;SBS
Pelecanus erythrorhynchos	American White Pelican	Red	Y	Vertebrate Animal	ICH;SBS
Physella propinqua	Rocky Mountain Physa	Blue		Invertebrate Animal	ESSF;SBS
Physella virginea	Sunset Physa	Blue		Invertebrate Animal	ESSF;ICH;SBS
Planorbula campestris	Meadow Rams-horn	Blue		Invertebrate Animal	ESSF;ICH;SBS
Podiceps nigricollis	Eared Grebe	Blue		Vertebrate Animal	ESSF;ICH;SBS
Pohlia elongata		Blue		Nonvascular Plant	ESSF;ICH
Pyrola elliptica	shinleaf wintergreen	Blue		Vascular Plant	SBSdw;SBSmh
Rangifer tarandus	Caribou (southern mountain population)	Red	Y	Vertebrate Animal	ESSF;ICH
Rangifer tarandus	Caribou (northern mountain population)	Blue	Y	Vertebrate Animal	ESSF;SBS
Rhodobryum roseum		Blue		Nonvascular Plant	ICHwk;SBSwk
Salvelinus confluentus	Bull Trout	Blue	Y	Vertebrate Animal	ESSF;ICH;SBS
Somatochlora brevicincta	Quebec Emerald	Blue		Invertebrate Animal	ESSF;ICH
Somatochlora forcipata	Forcipate Emerald	Blue		Invertebrate Animal	ESSF; SBS
Sparganium fluctuans	water bur-reed	Blue		Vascular Plant	SBSmk
Sphaerium striatinum	Striated Fingernailclam	Blue		Invertebrate Animal	ESSF;ICH;SBS
Sphagnum wulfianum		Blue		Nonvascular Plant	ICH;SBS
Taraxia breviflora	short-flowered evening-primrose	Red		Vascular Plant	SBSmk
Torreyochloa pallida	Fernald's false manna	Red		Vascular Plant	ICHwk

Tympanuchus phasianellus columbianus	Sharp-tailed Grouse, *columbianus* subspecies	Blue	Y	Vertebrate Animal	SBS
Ursus arctos	Grizzly Bear	Blue	Y	Vertebrate Animal	ESSF;ICH;SBS

Appendix C: Additional Riparian Management Requirements under the *Forest Planning and Practices Regulation*

In addition to those items provided under "Riparian and Water Quality Management" section, these are further legal requirements under the *Forest Planning and Practices Regulation* that are applicable to the Research Forest:

Restrictions within Riparian Reserves

None of the following may be carried out in a riparian reserve zone:

1) *grazing or broadcast herbicide applications for the purpose of brushing;*
2) *mechanized site preparation or broadcast burning for the purpose of site preparation;*
3) *spacing or thinning;*
4) *cut, modify or remove trees, except for the following purposes:*
   a) *felling or modifying a tree that is a safety hazard, if there is no other practicable option for addressing the safety hazard;*
   b) *topping or pruning a tree that is not wind firm;*
   c) *constructing a stream crossing;*
   d) *creating a corridor for full suspension yarding;*
   e) *creating guyline tiebacks;*
   f) *carrying out a sanitation treatment. This does not include clearcut harvesting for bark beetles;*
   g) *felling or modifying a tree that has been windthrown or has been damaged by fire, insects, disease or other causes, if the felling or modifying will not have a material adverse impact on the riparian reserve zone. This does not include clearcut harvesting for bark beetles;*
   h) *felling or modifying a tree for the purpose of establishing or maintaining an interpretive forest site, recreation site, recreation facility or recreation trail.*[27]

[27] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

Appendix D: Preliminary Stream and Watershed Study

The stream basins of interest that are discussed below are identified in Figures D-1, D-2, and D-3. Maps of the watersheds that are described below are provided in Figures D-4, D-5, and D-6

Unit A – Weedon Creek and Kerry Lake-Crooked River Watersheds

Watershed Description

The east side of Unit A drains west towards Kerry Lake and the Crooked River via three primary streams and the west side drains west via one stream that drains into a large stream network that flows northward into Weedon Creek.

Unit A occupies the following areas within 3 distinct watersheds:

1) Less than 3% of the lands that drain directly into the Kerry Lake portion of the Crooked River. The interim Stream Flow Hazard Score is very low and the interim Sediment Hazard Score is very low.
2) Approximately 3% of the lands that drain directly into the Crooked River via an unnamed 4th order stream that enters the Crooked River upstream of Kerry Lake. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is moderate.
3) Less than 7% of the lands that drain into a large unnamed 5th order stream that flows northward into Weedon Creek. The interim Stream Flow Hazard Score is high and the interim Sediment Hazard Score is high.

Expected Watershed Impacts

Unit A has little area influence within any of the identified watersheds, and a moderate level of harvest is expected within the next 5 years. Due to previous, notable watershed impacts from Unit A operations are not expected.

Unit B – Tacheeda Lakes and Horseshoe Lake Watersheds

Watershed Description

Most of Unit B drains west directly into Tacheeda Lakes via seven stream pathways. The southeast portion of the unit drains towards Horseshoe Lake, which lies to the south and which ultimately drains in Tacheeda Lakes.

Unit B occupies the following areas within 2 distinct watersheds:

1) Approximately 14% of the lands that drain directly into Tacheeda Lakes. The interim Stream Flow Hazard Score is very low and the interim Sediment Hazard Score is very low.
2) Approximately 7% the lands that drain into Horseshoe Lake, which is a 4th order watershed that drains into Tacheeda Lakes. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is very low.

Expected Watershed Impacts

Unit B does have a notable influence on the watershed area that drains directly into Tacheeda Lakes, however the rate of harvest is largely controlled by visual quality objectives, which limits the amount of area that may be under recent harvest to a small percentage of the landscape. Due to the visual quality limitations, and the coinciding moderate level of harvest within the next 5 years, notable watershed impacts from Unit B operations are not expected.

Unit C – Caine Creek and Merton Creek Watersheds

The eastern side of Unit C drains via two streams that feed a larger stream network that flows to the northeast into Caine Creek. The western side of Unit C drains towards the Merton Creek system.

Unit C occupies the following areas within five distinct watersheds:

1) Approximately 10% of the lands of a 4th order stream network that drains directly into the lower portion of Caine Creek. The interim Stream Flow Hazard Score is high and the interim Sediment Hazard Score is high.
2) Approximately 3% of the lands that drain directly into Caine Creek via small order streams. Caine Creek is a 5th order stream in the mid-lower part of the drainage basin. The interim Stream Flow Hazard Score is moderate and the interim Sediment Hazard Score is low.
3) Less than 3% of the lands that drain into Merton Creek upstream of Merton Lake (Merton Creek headwaters). Merton Creek is a 4th order stream. The interim Stream Flow Hazard Score is moderate and the interim Sediment Hazard Score is moderate.
4) Less than 6% of the lands that drain directly into Merton Lake or Merton Creek near the outlet of Merton Lake. The interim Stream Flow Hazard Score is moderate and the interim Sediment Hazard Score is moderate
5) Less than 1% of the lands that drain into a 3rd order stream that flows into Merton Creek. Due to minimal influence on this watershed the interim hazard scoring is considered immaterial.

Expected Watershed Impacts

Unit C does have a notable influence on the area of the 4th order watershed that drains directly into the lower portion of Caine Creek. This watershed has high interim hazard scoring for both Stream Flow Hazard and Sediment Hazard. Due to widespread spruce beetle attack, a high harvest level is expected within the next five years. Accordingly, operations within Unit C, in combination with future beetle mortality and existing land modifications, may have the potential to negatively impact downstream conditions within the 4th order watershed and within the lower Caine Creek watershed.

Unit D – Caine Creek Watershed

The northern side of Unit D drains via one primary stream that feeds the upper portion of Caine Creek. The southern side of Unit D drains towards a stream network that feeds the headwaters of Caine Creek.

Unit D occupies the following areas within three distinct watersheds:

1) Approximately 16% of the lands that form the headwaters of Caine Creek, which is a 3rd order stream within the upper part of the drainage basin. The interim Stream Flow Hazard Score is high and the interim Sediment Hazard Score is moderate.
2) A negligible amount of lands that drain into a 4th Order stream network that drains directly into the lower portion of Caine Creek. Due to minimal influence on this watershed the interim hazard scoring is considered immaterial.
3) Approximately 9% of the lands that drain directly into Caine Creek via small order streams. Unit C also occupies less 3% of this same watershed. Caine Creek is a 5th order stream in the mid-lower part of the drainage basin. The interim Stream Flow Hazard Score is moderate and the interim Sediment Hazard Score is low. It is also important to recognize that Unit D along with a small portion of Unit C occupy nearly all the mid to upper lands which drain into the stream identified in Figure D-1.

Expected Watershed Impacts

Unit D does have a notable influence on the area of the 3rd order watershed that forms the headwaters of Caine Creek. This watershed has high interim hazard scoring for Stream Flow Hazard. Due to widespread spruce beetle attack, a high harvest level is expected within the next five years. Accordingly, operations within Unit D, in combination with future beetle mortality and existing land modifications, may have the potential to negatively impact downstream conditions within the 3rd order watershed and within the lower Caine Creek watershed. When considering individual small order stream networks, there is also potential for negative impacts to the 2nd order stream within Unit D that flows into the Caine Creek headwaters.

Unit E – Chuchinka Creek Watershed

The northern part of Unit E drains to the north into the northern branch of Chuchinka Creek while the southern part drains southward into the southern branch of Chuchinka Creek.

Unit E occupies the following areas within two distinct watersheds:

1) Approximately 10% of the lands that drain directly into the northern branch of Chuchinka Creek, which is a 5th order stream in the lower-mid section of the northern drainage basin. The interim Stream Flow Hazard Score is very low and the interim Sediment Hazard Score is very low.
2) Approximately 9% of the lands that drain directly into the mid and lower section of the southern branch of Chuchinka Creek, which is a 6th order stream. Combined with Unit F, the Research Forest occupies approximately 23% of this watershed, therefore the combined influence of both units must be considered. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is low.

Unit E does have a notable influence on the area of the watersheds over which it lies, but considering the expected harvest level and current condition of the watersheds, notable watershed impacts from Unit E operations are not expected.

Unit F – Chuchinka Creek and Angusmac Creek Watersheds

The northern majority of Unit F drains into the southern branch of Chuchinka creek via three separate stream networks. The southern portion of Unit F drains via one primary stream pathway into Angusmac Creek.

Unit F occupies the following areas within two distinct watersheds:

1) Approximately 14% of the lands that drain directly into the mid and lower section of the southern branch of Chuchinka Creek, which is a 6th order stream. Combined with Unit E, the Research Forest occupies approximately 23% of this watershed, therefore the combined influence of both units must be considered. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is low.
2) Approximately 6% of the lands that drain directly into the mid and lower section of Angusmac Creek which is a 4th order stream prior to its confluence with Chuchinka Creek. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is low.

Unit F, in combination with Unit E, does have a notable influence on the watershed that encompasses the lower section of the southern branch of Chuchinka Creek, but considering the expected harvest level and current condition of the watersheds, notable watershed impacts from Unit F operations are not expected.

Unit G - Angusmac Creek and Crooked River Watershed

The western quarter of Unit G drains via two streams into a large unnamed stream network that flows north into the Crooked River. The majority of Unit G drains via the internal Lakes and wetland system into the mid portion of Angusmac Creek.

Unit G occupies the following areas within four distinct watersheds:

1) Approximately 21% of the lands that drain directly into the mid-section of Angusmac Creek, which is 4th order stream. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is very low.
2) Less than 1% of the lands that drain directly into the mid and lower section of Angusmac Creek which is a 4th order stream prior to its confluence with Chuchinka Creek. Due to the minimal influence on this watershed the interim hazard scoring is considered immaterial.
3) Approximately 8% of the lands that drain directly into a large unnamed 4th order stream system that flows northward into the Crooked River. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is low
4) Approximately 2% of the lands that drain into a large 4th order stream system that ultimately drains into the Crooked River. Due to the minimal influence on this watershed the interim hazard scoring is considered immaterial.

Unit G does have a notable influence on the area of lands that drain directly into the mid-section of Angusmac Creek; however only a moderate level of harvest is expected in that watershed area. As such, notable watershed impacts from Unit G operations are not expected.

Unit H – Bowron River Watershed

The western majority of Unit H drains into two primary streams that flow directly into the Bowron River. The eastern end of Unit H drains to the east into a separate watershed that drains north towards the Bowron River.

Unit H occupies the following areas within two distinct watersheds:

1) Approximately 6% of the lands that drain directly into the lower Bowron River via small order streams. The interim Stream Flow Hazard Score is very low and the interim Sediment Hazard Score is very low.
2) Approximately 3% of the lands that drain directly into a large, unnamed 3rd order stream system that drains northward into the lower Bowron River. The interim Stream Flow Hazard Score is very low and the interim Sediment Hazard Score is very low.

Unit H does not have a notable influence on the area of the watersheds, over which it lies, and a low to moderate harvest level is expected. Therefore, notable watershed impacts from Unit H operations are not expected.

Unit I – Hungary Creek and Fraser River Watersheds

The southeast corner of Unit I drains into one stream that flows directly into the Fraser River. The rest of Unit I drains via two streams into Hungary Creek.

Unit I occupies the following areas within two distinct watersheds:

1) Approximately 7% of the lands that drain directly into the south side of the Fraser River from small order streams. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is high.
2) Approximately 7% of the lands that drain directly into Hungary creek via small order streams. The lower section of Hungary Creek is a 4th order stream. The interim Stream

Flow Hazard Score is low and the interim Sediment Hazard Score is moderate. It is also important to recognize that Unit I occupies nearly all the land that drains into the stream, identified in Figure D-2. This stream is a direct tributary to Hungary Creek.

Unit I does not have a notable influence on the area of the watersheds, over which it lies. Depending of future harvest patterns within Unit I, there is the potential to have a notable influence on the conditions within the drainage basin of the aforementioned 2nd order stream; however, a low to moderate harvest level is expected within Unit I and within the 2nd order drainage basin, therefore notable watershed impacts from Unit I operations are not expected.

Unit J - Fraser River Watershed

Except for the southern end of Unit J, all of the unit drains into one mapped stream tributary that flows along the north edge of Unit J and directly into the Fraser River across from Naver Creek. The southern end drains into Porter Creek, which flows directly into the Fraser River, across from Naver Creek.

Unit J occupies the following areas within two distinct watersheds:

1) Approximately 27% of the lands that drain directly into the unnamed, 4th order stream that flows along the boundaries of unit J directly into the Fraser River. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is moderate.
2) Approximately 12% of the lands that drain directly into the west side of the Fraser River from small order streams. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is very high. It is also important to recognize that Unit J contains virtually all the land that drains into Porter Creek, which is identified in Figure D-3.

Unit J does have a notable influence on the area of the watersheds over which it lies. Depending of future harvest patterns within Unit J, there is also the potential to have a notable influence on the conditions within the Porter Creek drainage basin (2nd order basin), however a low to moderate harvest level is expected within Unit J and within the Porter Creek drainage basin, therefore notable watershed impacts from Unit J operations are not expected.

Unit K – Pitoney Creek and Willow River Watersheds

The eastern side of Unit K drains via two streams into Pitoney Creek. The western part of Unit K drains via two streams directly into the Willow River.

Unit K occupies the following areas within two distinct watersheds:

1) Approximately 2% of the lands that drain directly into the east side of the Willow River from small order streams. Combined with Unit L, the total area occupied is approximately 4% of this watershed. The interim Stream Flow Hazard Score is high and the interim Sediment Hazard Score is moderate.
2) Approximately 6% of all the lands that drain into Pitoney Creek, which is a 5th order stream at its confluence with the Willow River. The interim Stream Flow Hazard Score is low and the interim Sediment Hazard Score is very low.

Unit K does not have a notable influence on the area of the watersheds, over which it lies, furthermore harvesting within 1/3 of Unit K is restricted by a retention visual quality objective. In consideration of the overall, low level of harvesting and the small area influence, notable watershed impacts from Unit K operations are not expected.

Unit L – Willow River Watershed

Unit L has limited terrain and only one principle stream, which flows to the northwest and drains directly into the Willow River.

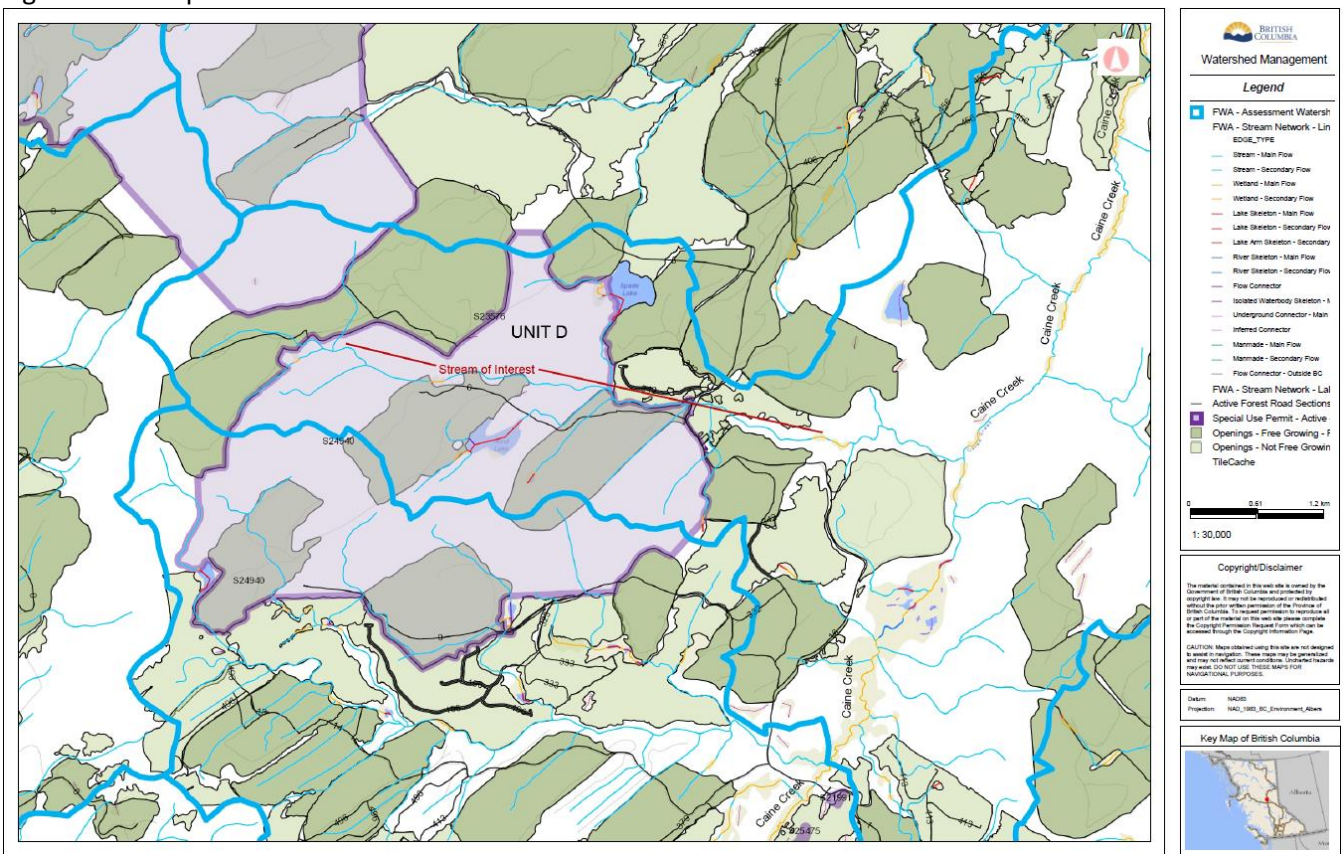
Unit L occupies the following areas within one distinct watershed:

1) Approximately 2% of the lands that drain directly into the east side of the Willow River from small order streams. Combined with Unit K, the total area occupied is approximately 4% of this watershed. The interim Stream Flow Hazard Score is high and the interim Sediment Hazard Score is moderate.

Unit L does not have a notable influence on the area of the watershed, over which it lies, and a low to moderate harvest level is expected. Therefore, notable watershed impacts from Unit L operations are not expected.

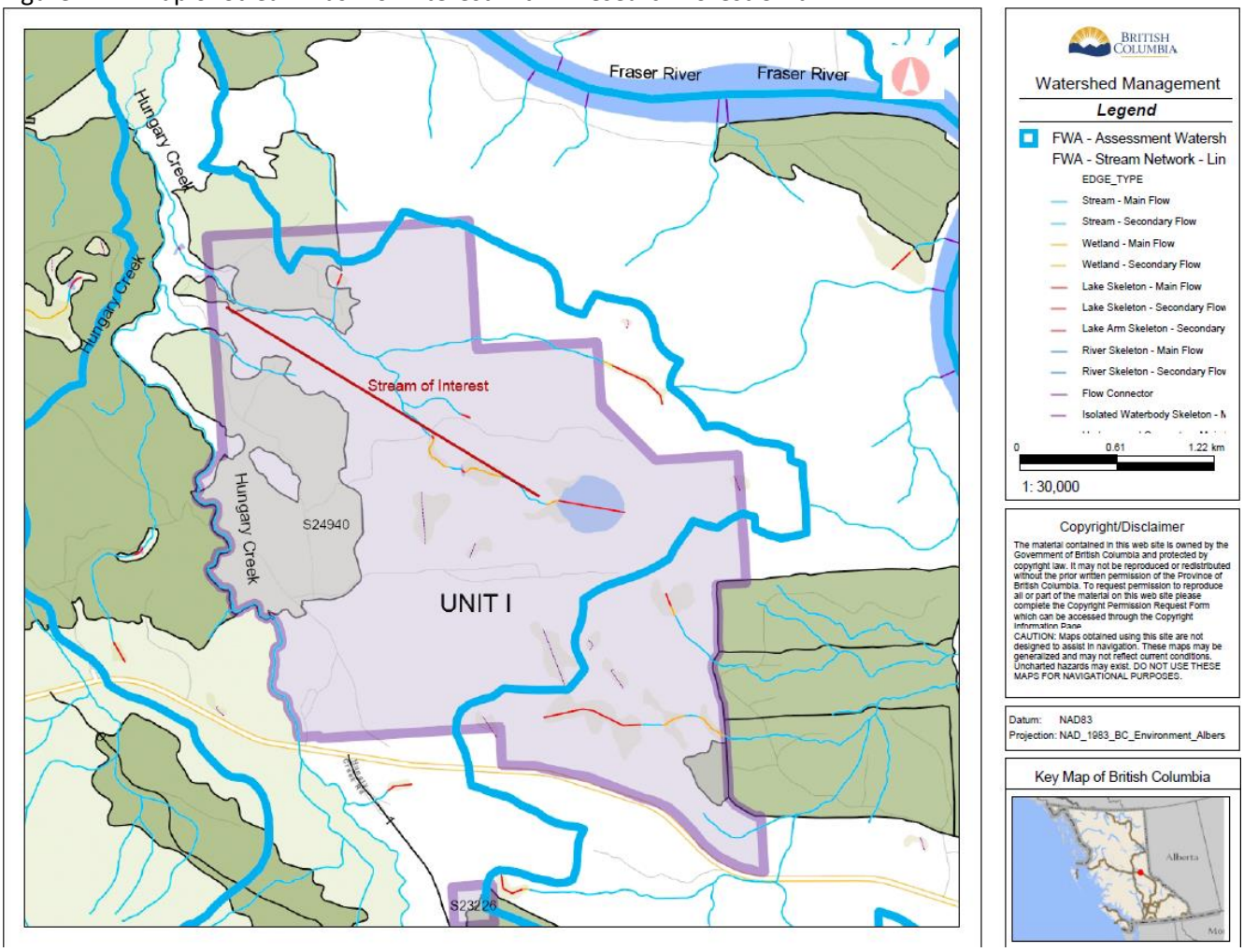
The following maps identify the stream basins that are largely contained with the Research Forest area, and may be highly influenced by the level of harvesting and road building undertaken.

Figure D-1: Map of Stream Basin of Interest within Research Forest Unit D[28]



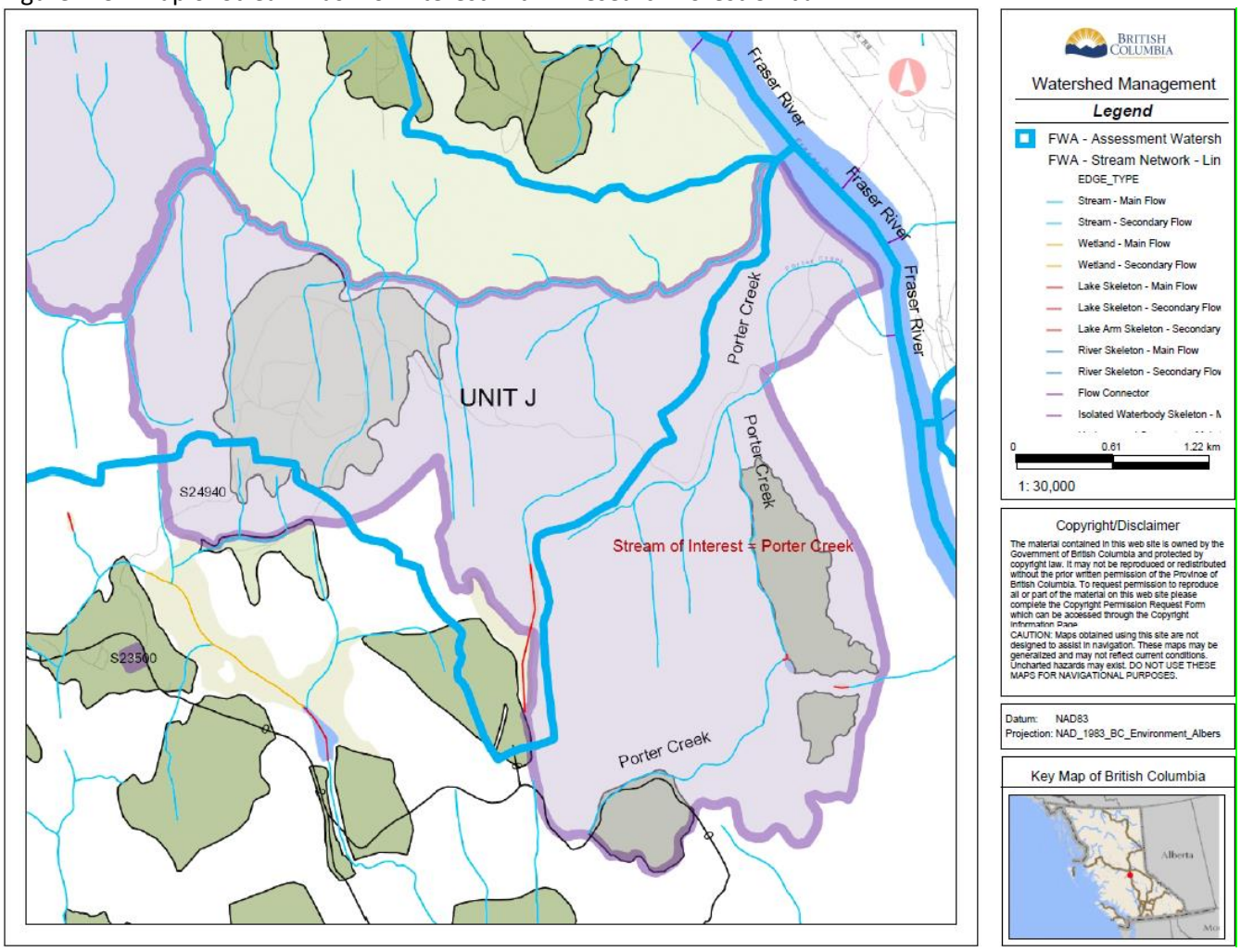
[28] GeoBC, Province of British Columbia. 2016. Freshwater Atlas Dataset. http://geobc.gov.bc.ca/base-mapping/atlas/fwa/fwa_data.html

Figure D-2: Map of Stream Basin of Interest within Research Forest Unit I[29]



[29] GeoBC, Province of British Columbia. 2016. Freshwater Atlas Dataset. http://geobc.gov.bc.ca/base-mapping/atlas/fwa/fwa_data.html

Figure D-3: Map of Stream Basin of Interest within Research Forest Unit J[30]



The following three maps show the interim hazard rating for Stream Flow (Peak Flow), Sediment (Surface Erosion), and Riparian conditions within the watersheds, over which the Research Forest is situated. These hazards were calculated by the Omineca Region of the Ministry of Forests, Lands and Natural Resources.[31]

[30] GeoBC, Province of British Columbia. 2016. Freshwater Atlas Dataset. http://geobc.gov.bc.ca/base-mapping/atlas/fwa/fwa_data.html

[31] Ministry of Forests, Lands and Natural Resource Operations, Omineca Regional Office. 2016. Interim Watershed Hazard Ratings for the Omineca Natural Resource Region.

Figure D-4: Interim Stream (Peak) Flow Hazard Rating for Watersheds within Research Forest

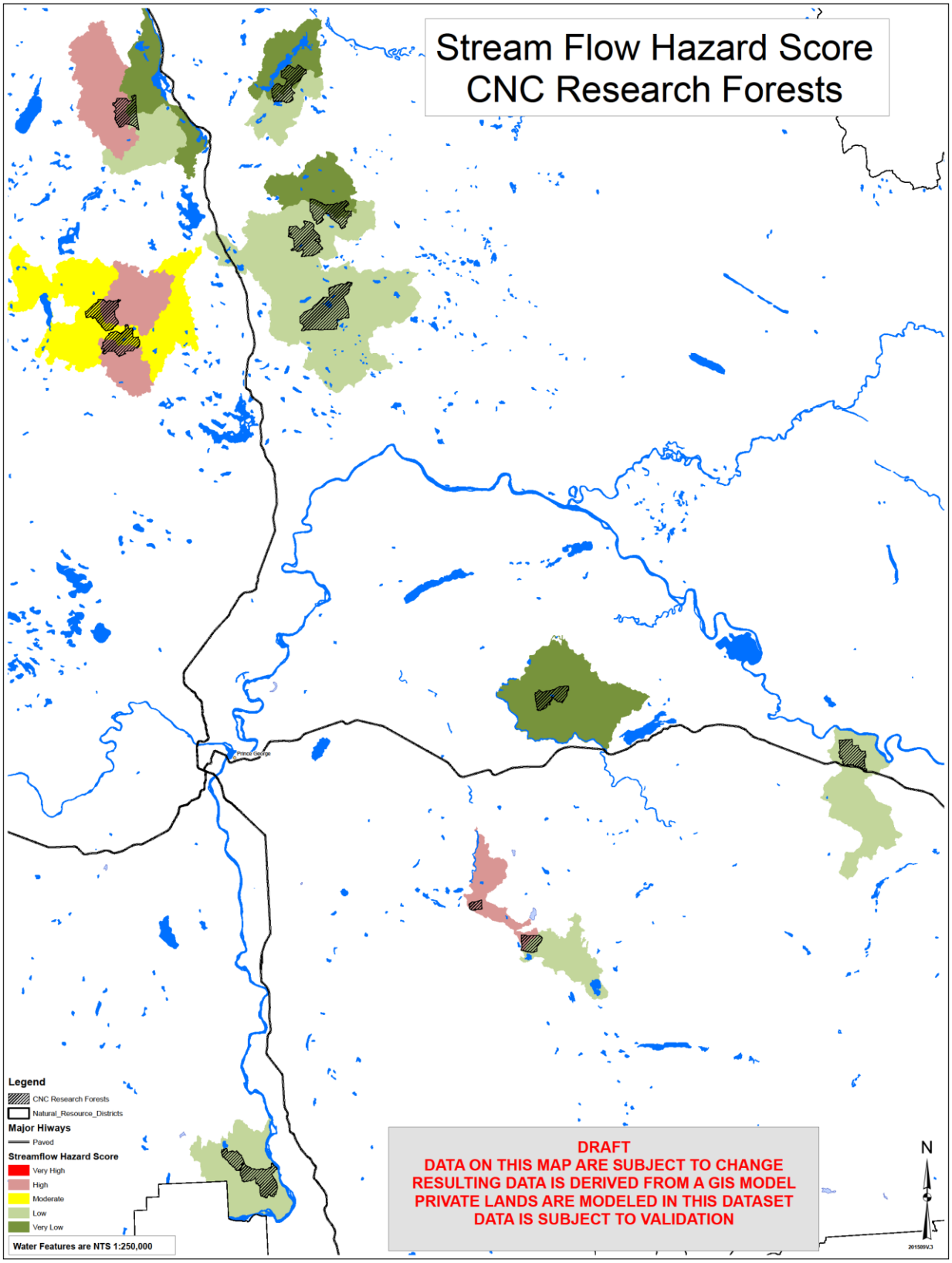


Figure D-5: Interim Sediment (Surface Erosion) Hazard Rating for Watersheds within Research Forest

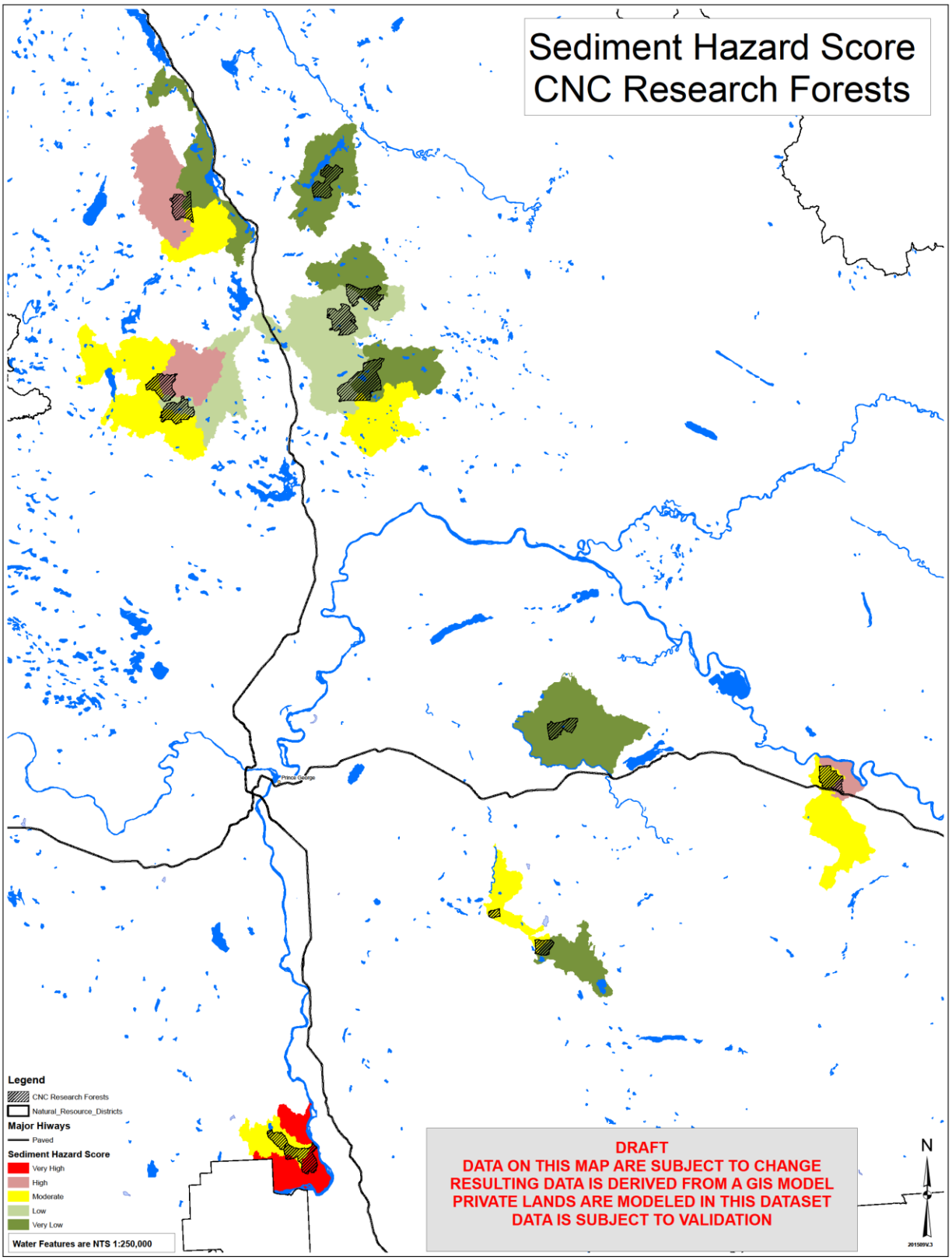
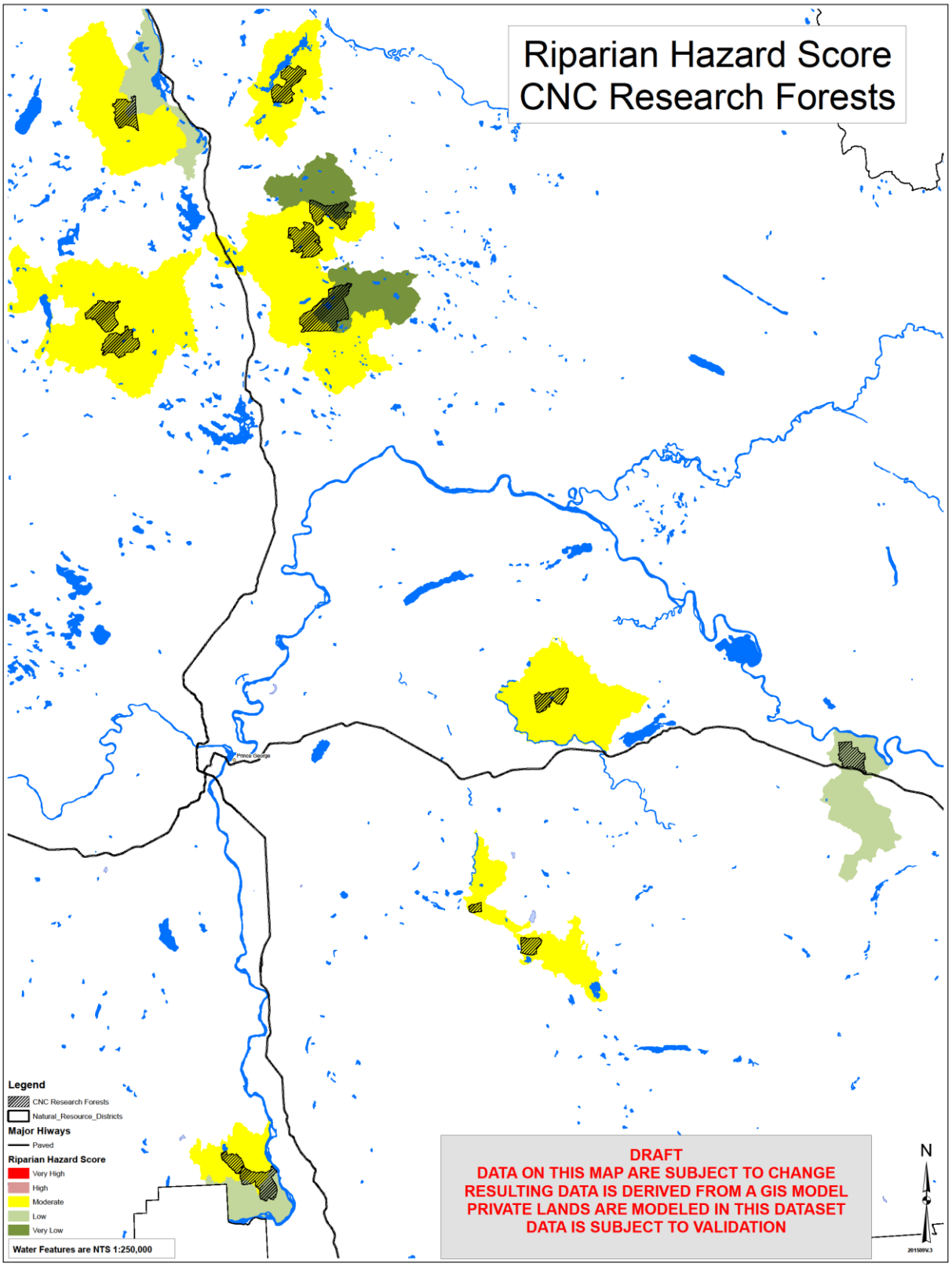


Figure D-6: Interim Riparian Hazard Rating for Watersheds within Research Forest



Appendix E: Visual Quality Objectives: Definition of altered forest landscape under The *Forest Planning and Practices Regulation*

"altered forest landscape" means forest landscape that
(a) is viewable from a significant public viewpoint,
(b) contains cutblocks or roads, and
(c) is in one of the categories prescribed under section 1.1;

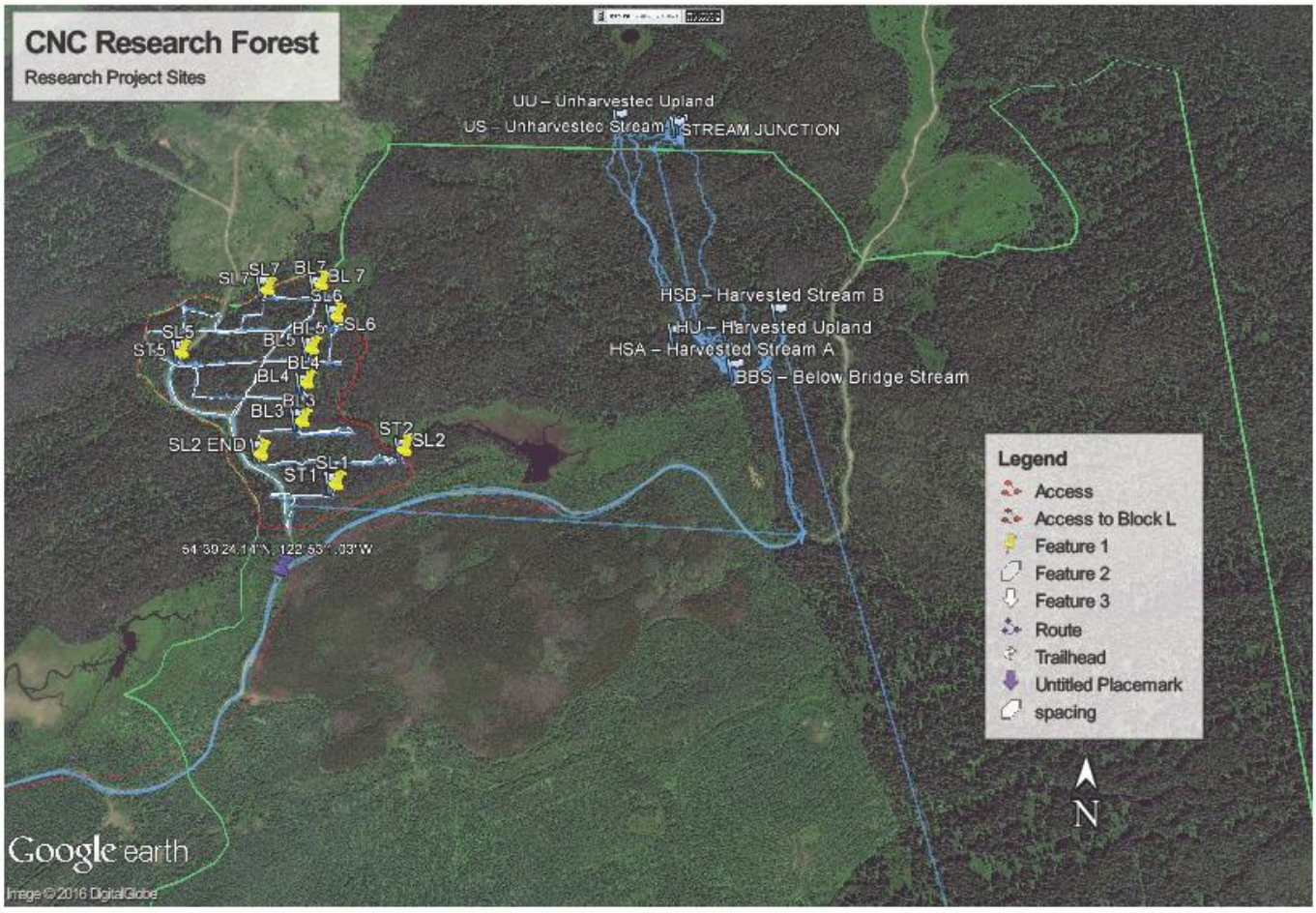
1.1) For the purposes of paragraph (c) of the definition of "altered forest landscape" in section 1, the following categories are prescribed, each according to the extent of alteration resulting from the size, shape and location of cutblocks and roads:
(a) preservation: consisting of an altered forest landscape in which the alteration, when assessed from a significant public viewpoint, is
(i) very small in scale, and
(ii) not easily distinguishable from the pre-harvest landscape;
(b) retention: consisting of an altered forest landscape in which the alteration, when assessed from a significant public viewpoint, is
(i) difficult to see,
(ii) small in scale, and
(iii) natural in appearance;
(c) partial retention: consisting of an altered forest landscape in which the alteration, when assessed from a significant public viewpoint, is
(i) easy to see,
(ii) small to medium in scale, and
(iii) natural and not rectilinear or geometric in shape;
(d) modification: consisting of an altered forest landscape in which the alteration, when assessed from a significant public viewpoint,
(i) is very easy to see, and
(ii) is (A) large in scale and natural in its appearance, or (B) small to medium in scale but with some angular characteristics;
(e) maximum modification: consisting of an altered forest landscape in which the alteration, when assessed from a significant public viewpoint,
(i) is very easy to see, and
(ii) is (A) very large in scale, (B) rectilinear and geometric in shape, or (C) both.[32]

[32] Ministry of Forests, Lands and Natural Resource Operations, 2016. Statutes and Regulations Webpages. http://www.bclaws.ca/Recon/document/ID/freeside/14_2004

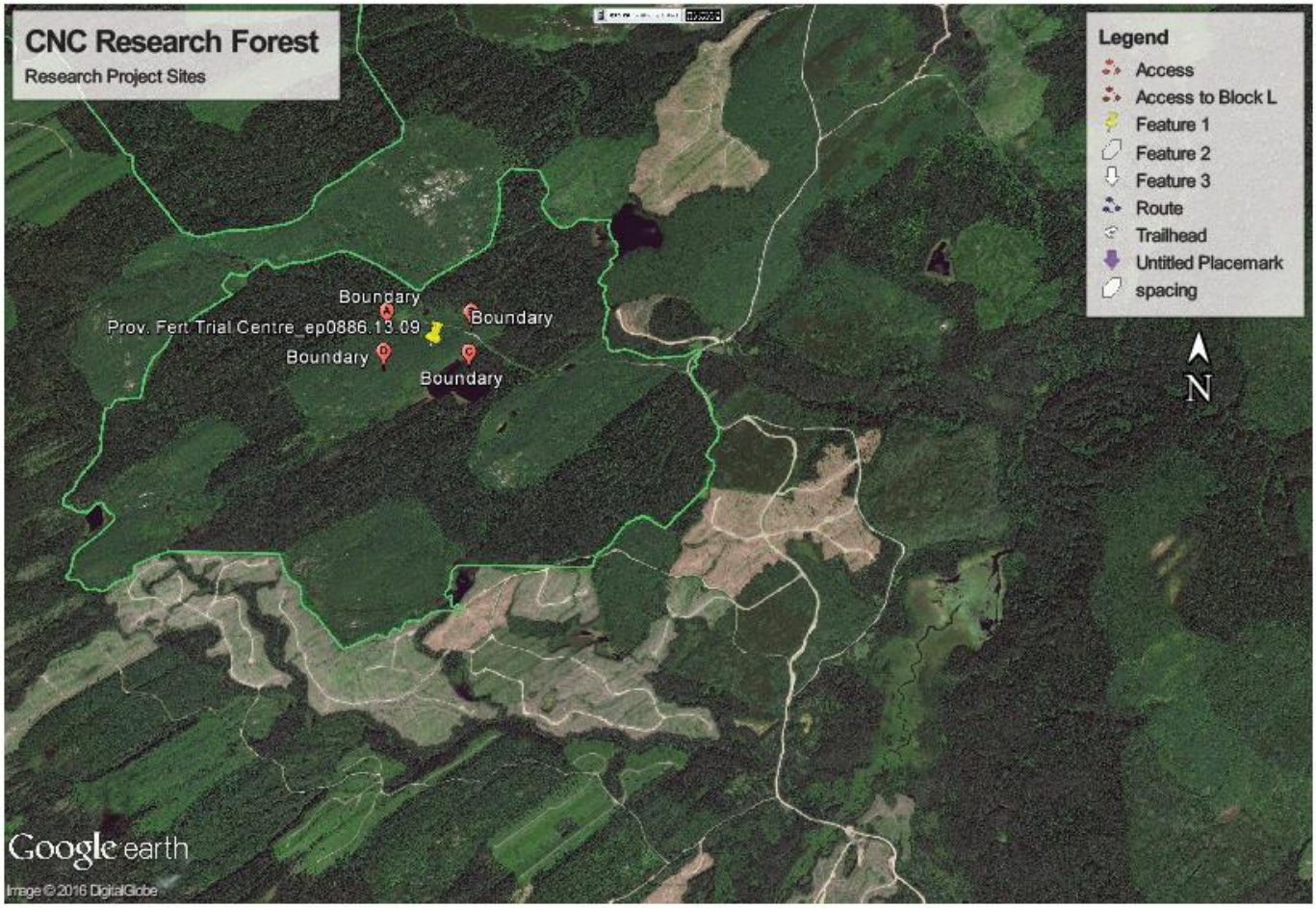
Appendix F: Research Site Locations

The following maps identify the location of all current research sites within and adjacent to the Research Forest.

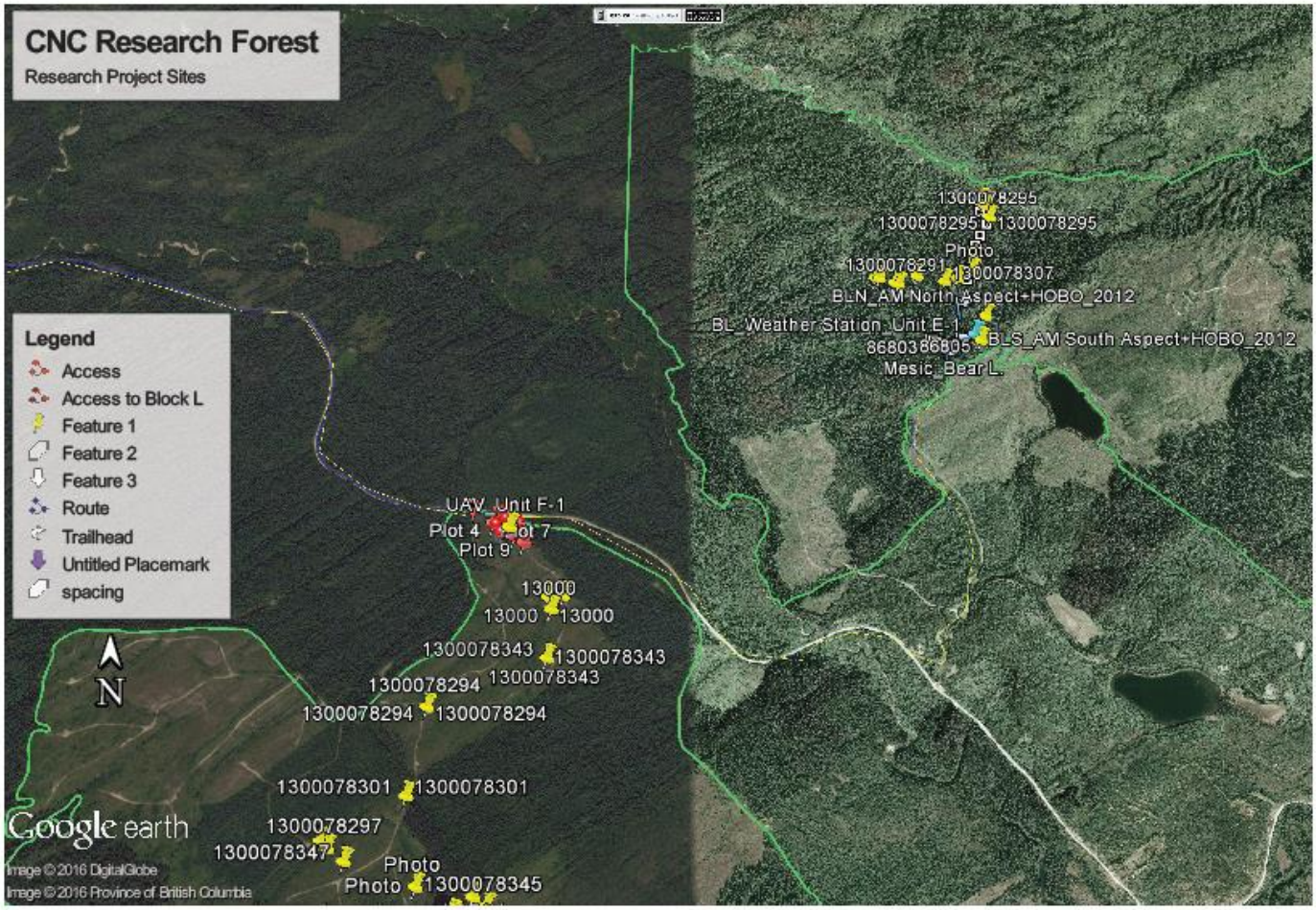
Map of Research Sites within and Adjacent to Unit A.



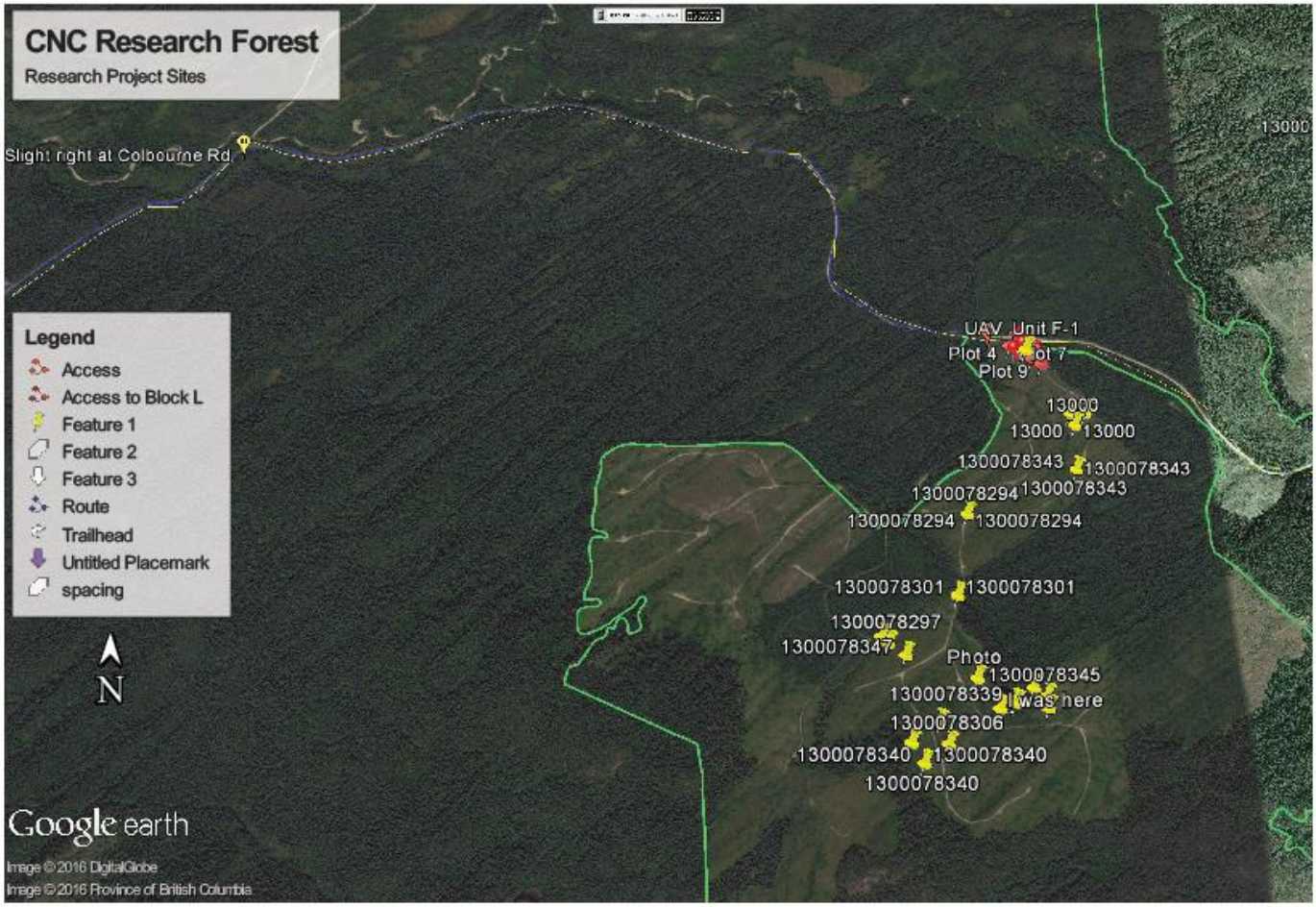
Map of Research Sites within and Adjacent to Unit D.



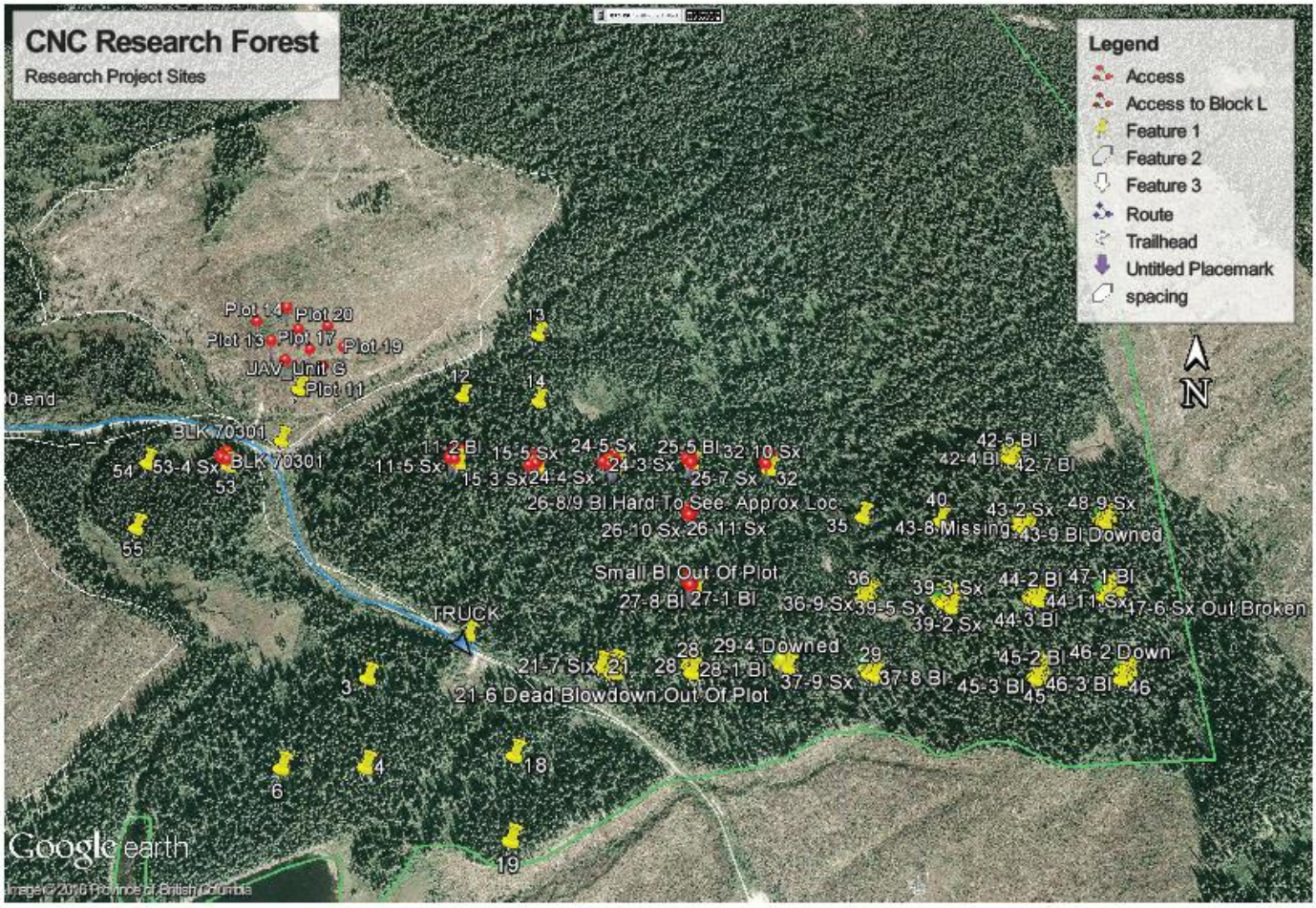
Map of Research Sites within and Adjacent to Unit E.



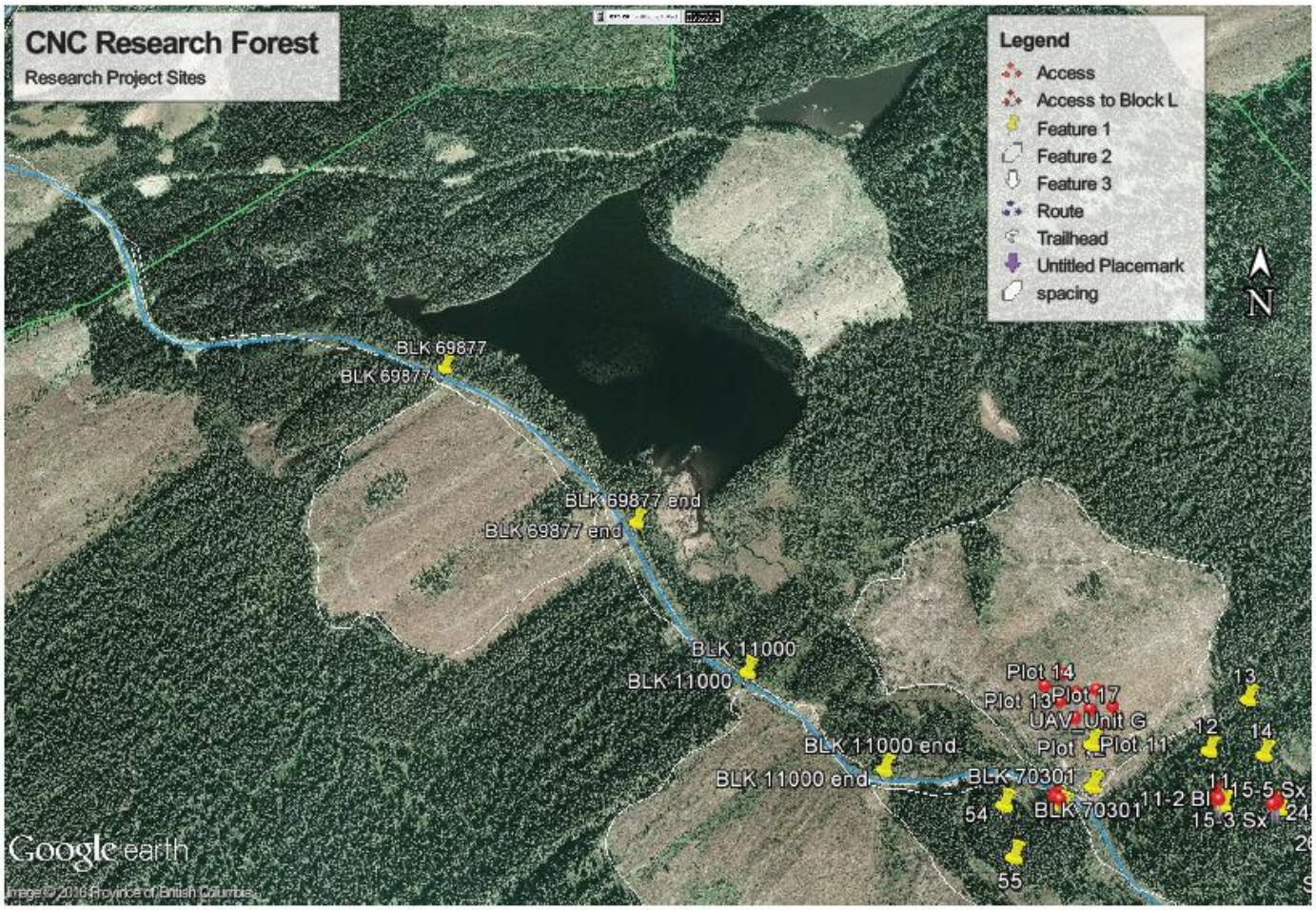
Map of Research Sites within and Adjacent to Unit F.



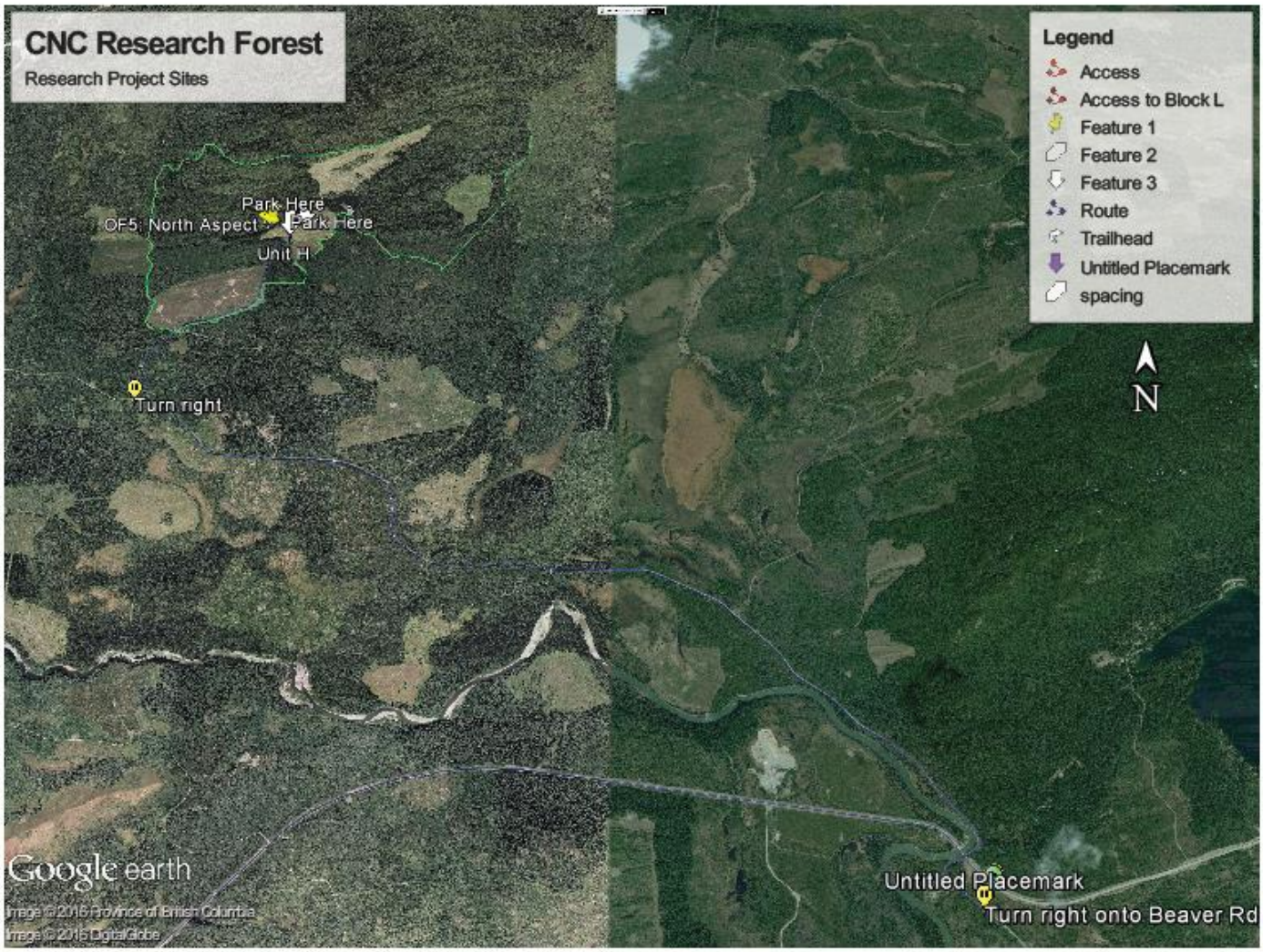
Map of Research Sites within and Adjacent to Unit G.



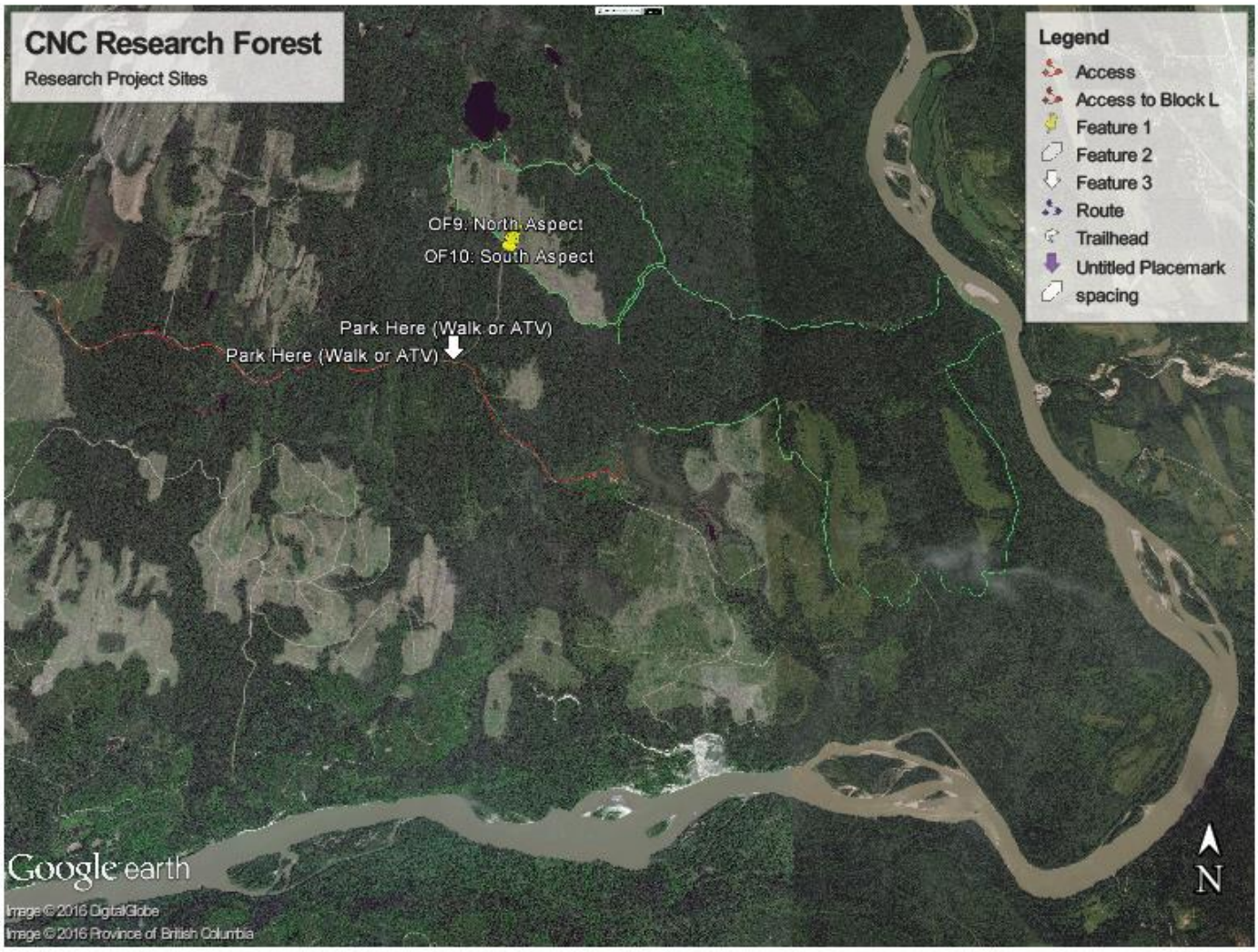
Map of Research Sites within and Adjacent to Unit G.



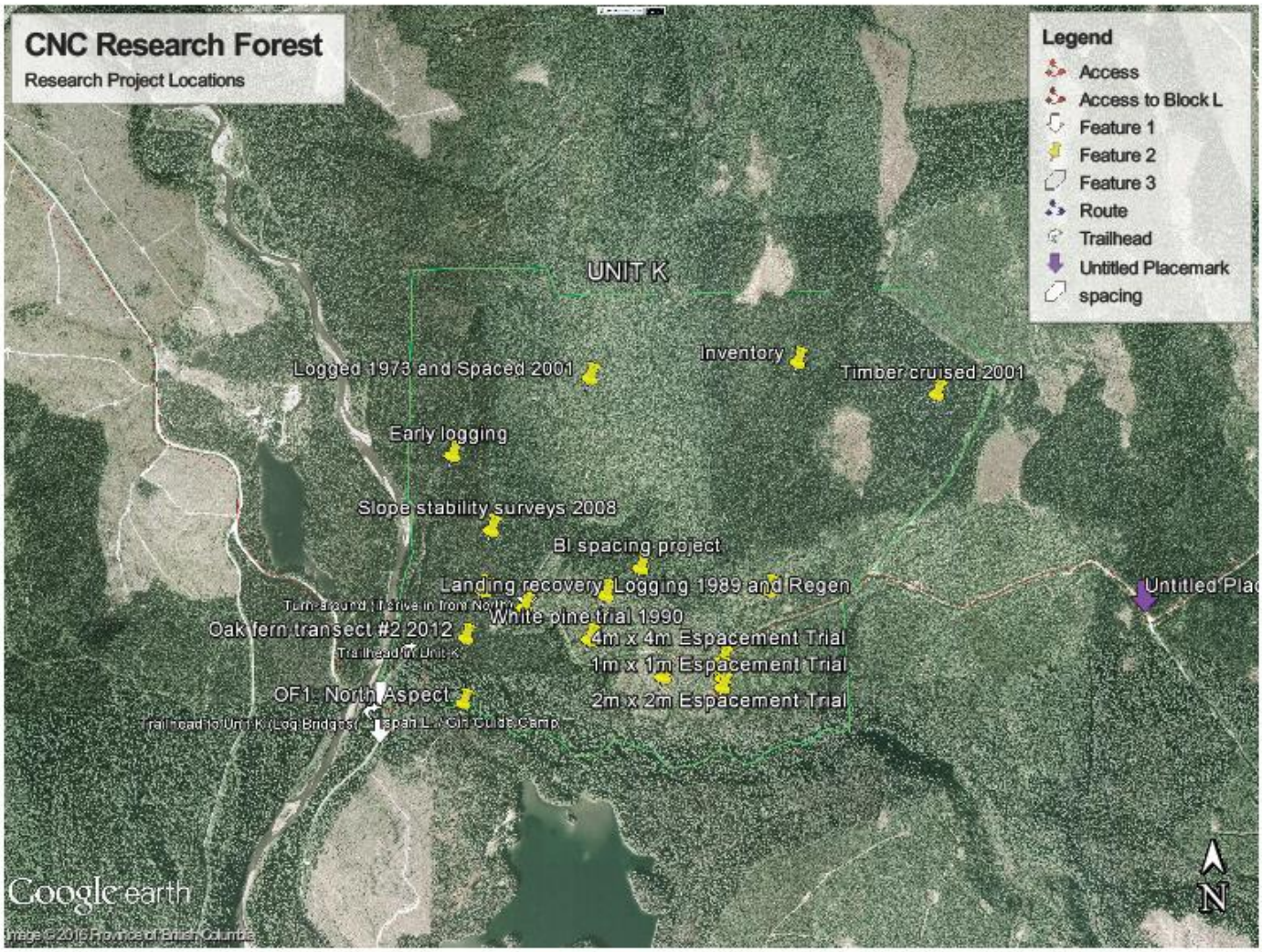
Map of Research Sites within and Adjacent to Unit H.



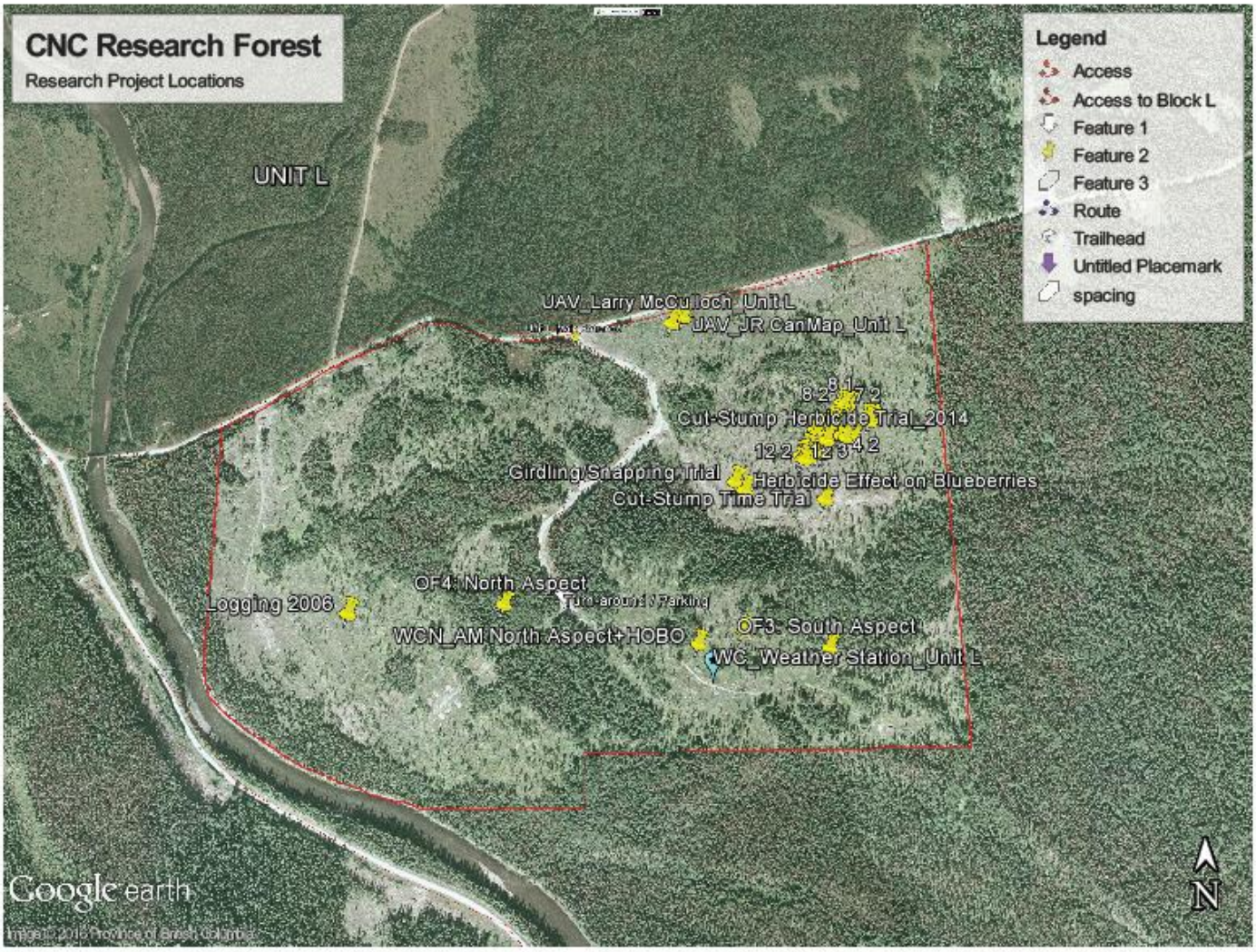
Map of Research Sites within and Adjacent to Unit J.



Map of Research Sites within and Adjacent to Unit K.



Map of Research Sites within and Adjacent to Unit L.



Summary of Research Site Locations within and Adjacent to the Research Forest.

CNC Research Forest Unit	General Location Description	Direction from Prince George	Research Category	Summarized Project Title	Project Description	Location			Active, Inactive, Complete?
						UTM Zone	Easting	Northing	
A-1	Bear Lake	North-West	Forest Operations	Riparian	UU – Unharvested Upland	10 U	508348.3	6058038.2	Active
A-1	Bear Lake	North-West	Forest Operations	Riparian	US – Unharvested Stream	10 U	508521.83	6058011.8	Active
A-1	Bear Lake	North-West	Forest Operations	Riparian	HU – Harvested Upland	10 U	508521.38	6057293.3	Active
A-1	Bear Lake	North-West	Forest Operations	Riparian	HSA – Harvested Stream A	10 U	508667.32	6057309.1	Active

A-1	Bear Lake	North-West	Forest Operations	Riparian	HSB – Harvested Stream B	10 U	508808.93	6057363.1	Active
A-1	Bear Lake	North-West	Forest Operations	Riparian	BBS – Below Bridge Stream	10 U	508683.88	6057186.4	Active
A-1	Bear Lake	North-West	Forest Operations	Stub Tree	Transects	10 U	507446.79	6057029.7	Active
D	Bear Lake	North	Silviculture	Provincial Research Trial: E.P.886.13, Installation 9 – Hand Lake	Fertilizer Trial, 3 replications of 6 treatments: NB, NSB, ON1, ONM2, Complete & Control	10U	506986	6027572	Unknown
E-1	Bear Lake	North-East	Silviculture & Climate Change	Microclimate Measurement	Climate data for assisted migration	10 U	533586	6042328	Active
E-1	Bear Lake	North-East	Silviculture & Climate Change	Assisted Migration: Influence of Aspect	BLN Seedling Trial: North Aspect	10 U	533655	6042443	Active, msmts in ~2021
E-1	Bear Lake	North-East	Silviculture & Climate Change	Assisted Migration: Influence of Aspect	BLS Seedling Trial: South Aspect	10 U	533612	6042305	Active, msmts in ~2021
E-1	Bear Lake	North-East	Silviculture & Climate Change	Assisted Migration: Soil Moisture Limitations	Seedling Trial: Sub-Mesic	10 U	533537.78	6042275.1	Active
E-1	Bear Lake	North-East	Silviculture & Climate Change	Assisted Migration: Soil Moisture Limitations	Seedling Trial: Mesic	10 U	533470.44	6042236.1	Active
E-1	Bear Lake	North-East	Silviculture & Climate Change	Assisted Migration: Soil Moisture Limitations	Seedling Trial: Sub-Hygric	10 U	533552.1	6042475.5	Active

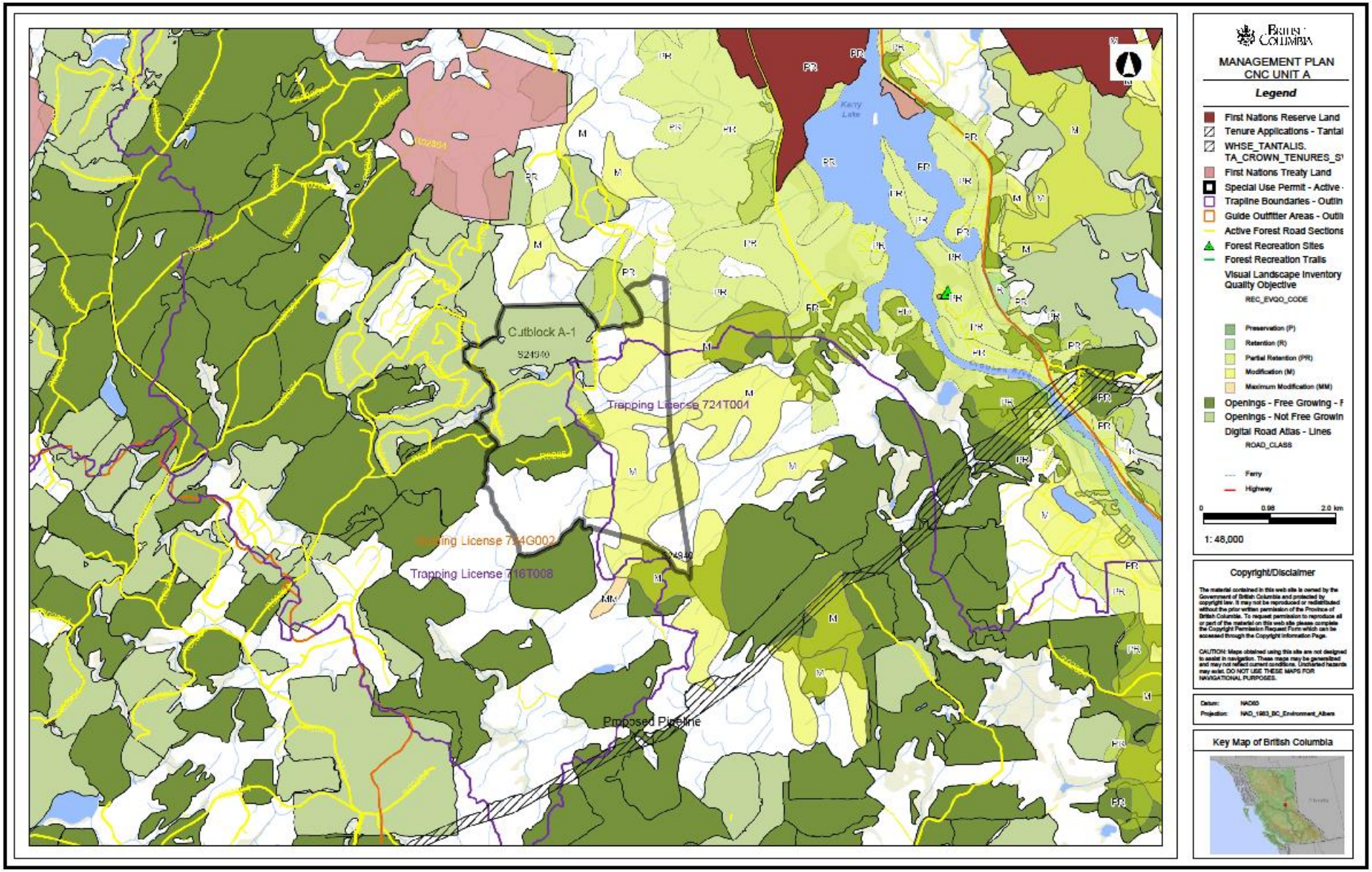
E-1	Bear Lake	North	Silviculture & Climate Change	Frost Project	2012=16 Sensors 203=10 Sensors	10U	533443.84	6042641.54	Complete
F-1	Bear Lake	North-East	Geomatics	UAV Applications in Forestry: Larry McCulloch	CNC: Unit F	10 U	531153.42	6041249.2	Complete
F-1	Bear Lake	North	Silviculture & Climate Change	Frost Project	2013=10 Sensors	10U	530721.7	6039930.4	Complete
G-2	Bear Lake	North-East	Geomatics	UAV/ Photogrammetry: JR CanMap	Unit G Stem Mapping	10 U	534996.24	6029029.7	Active
G	Bear Lake	North-East	Geomatics	UAV Applications in Forestry: Larry McCulloch	CNC: Unit G	10 U	534675.25	6029462.9	Complete
H	Beaver FSR (Mount Bowron)	East	Silviculture & Climate Change	Oak Fern Transects	OF5: North Aspect	10 U	559232	5979345	Active
H	Beaver FSR (Mount Bowron)	East	Silviculture & Climate Change	Oak Fern Transects	OF6: South Aspect	10 U	559179	5979378	Active
J	Blackwater Rd/ Woodpecker FSR	South	Silviculture & Climate Change	Oak Fern Transects	OF9: North Aspect	10 U	516119	5922166	Active
J	Blackwater Rd/ Woodpecker FSR	South	Silviculture & Climate Change	Oak Fern Transects	OF10: South Aspect	10 U	516150	5922285	Active
K	Willow-Cale/ Willow-100 FSR	South-East	Silviculture & Climate Change	Assisted Migration	White Pine Trial	10 U	555576	5947761	Inactive
K	Willow-Cale/ Willow-100 FSR	South-East	Forest Operations	Espacement Trial	1m x 1m Spacing	10 U	556151	5947550	Inactive
K	Willow-Cale/ Willow-100 FSR	South-East	Forest Operations	Espacement Trial	2m x 2m Spacing	10 U	556155	5947588	Inactive
K	Willow-Cale/ Willow-100 FSR	South-East	Forest Operations	Espacement Trial	3m x 3m Spacing	10 U	556153	5947625	Inactive

K	Willow-Cale/ Willow-100 FSR	South-East	Forest Operations	Espacement Trial	4m x 4m Spacing	10 U	556153	5947664	Inactive
K	Willow-Cale/ Willow-100 FSR	South-East	Silviculture & Climate Change	Oak Fern Transects	OF1: North Aspect	10 U	555034	5947495	Active
K	Willow-Cale/ Willow-100 FSR	South-East	Silviculture & Climate Change	Oak Fern Transects	OF2: South Aspect	10 U	555384	5947601	Active
L	Willow-Coalmine FSR	South-East	Silviculture & Climate Change	Microclimate Measurements	Climate data for assisted migration	10 U	549377	5953210	Active
L	Willow-Coalmine FSR	South-East	Silviculture & Climate Change	Assisted Migration: Influence of Aspect	WCN Seedling Trial: North Aspect	10 U	549330	5953258	Active, msmts in ~2021
L	Willow-Coalmine FSR	South-East	Silviculture & Climate Change	Assisted Migration: Influence of Aspect	WCS Seedling Trial: South Aspect	10 U	549426	5953298	Active, msmts in ~2021
L	Willow-Coalmine FSR	South-East	Silviculture & Climate Change	Oak Fern Transects	OF3: South Aspect	10 U	549608	5953252	Active
L	Willow-Coalmine FSR	South-East	Silviculture & Climate Change	Oak Fern Transects	OF4: North Aspect	10 U	548919	5953348	Active
L	Willow-Coalmine FSR	South-East	Forest Operations	Comparison of Forestry Brushing Methods	Biologic, Chemical, Mechanical Trial	10 U	549623.52	5953728.3	Active
L	Willow-Coalmine FSR	South-East	Forest Operations	Comparison of Forestry Brushing Methods	Cut-Stump Time Trial	10 U	549613.05	5953574.5	Inactive
L	Willow-Coalmine FSR	South-East	Forest Operations	Comparison of Forestry Brushing Methods	Seasonal Girdling/ Snapping Trial	10 U	549418.34	5953615.8	Active
L	Willow-Coalmine FSR	South-East	Forest Operations	Herbicide Treatment Impacts on Blueberry Plants	NRET Student Research Project	10 U	549439.1	5953595.9	Active

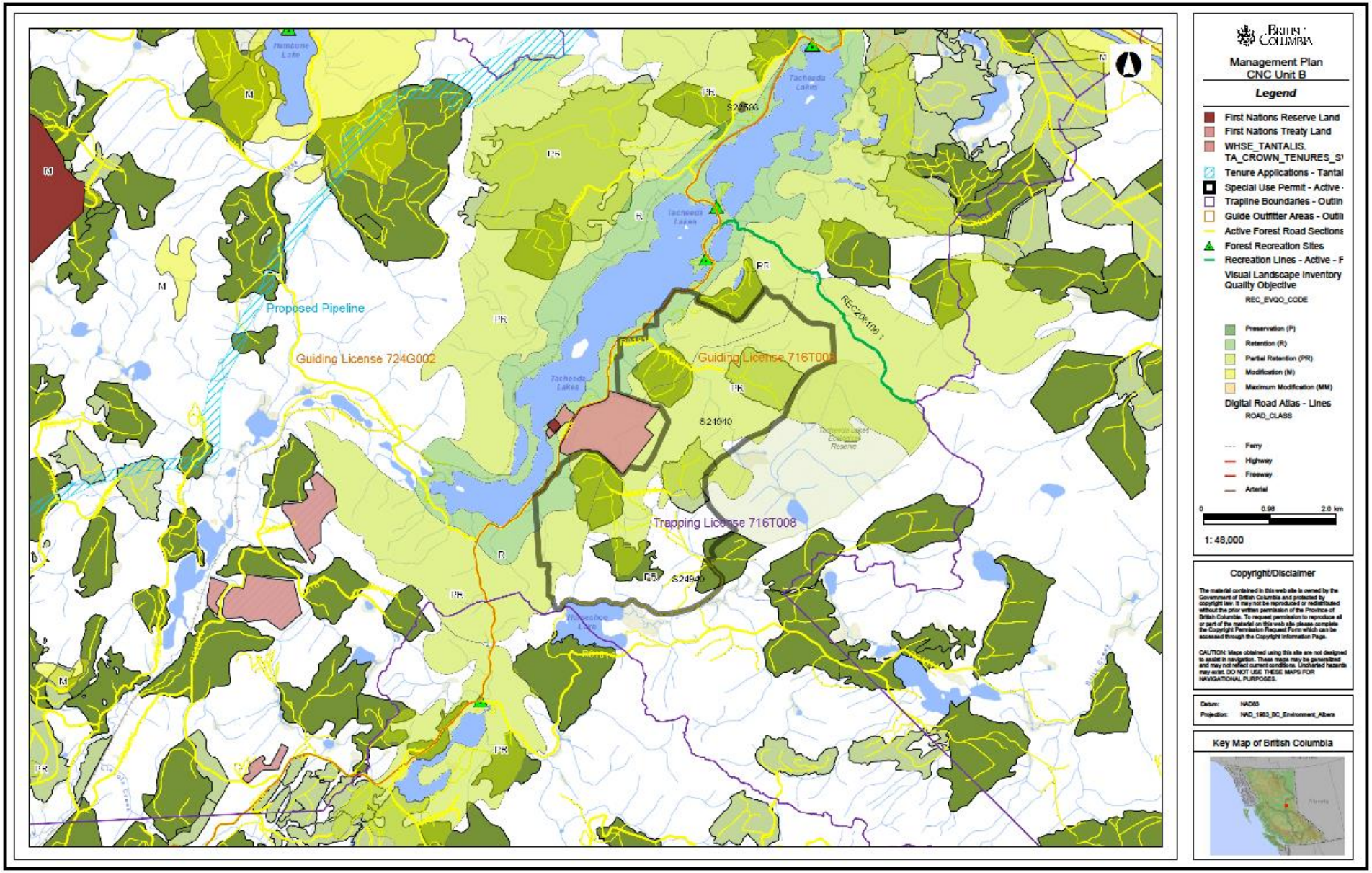
L	Willow-Coalmine FSR	South-East	Geomatics	UAV/ Photogrammetry: JR CanMap	Unit L Data Collection	10 U	549312.1	5954007.2	Complete
L	Willow-Coalmine FSR	South-East	Geomatics	UAV Applications in Forestry: Larry McCulloch	CNC: Unit L	10 U	549285	5953991.1	Complete

Appendix G: Management Plan Content Map

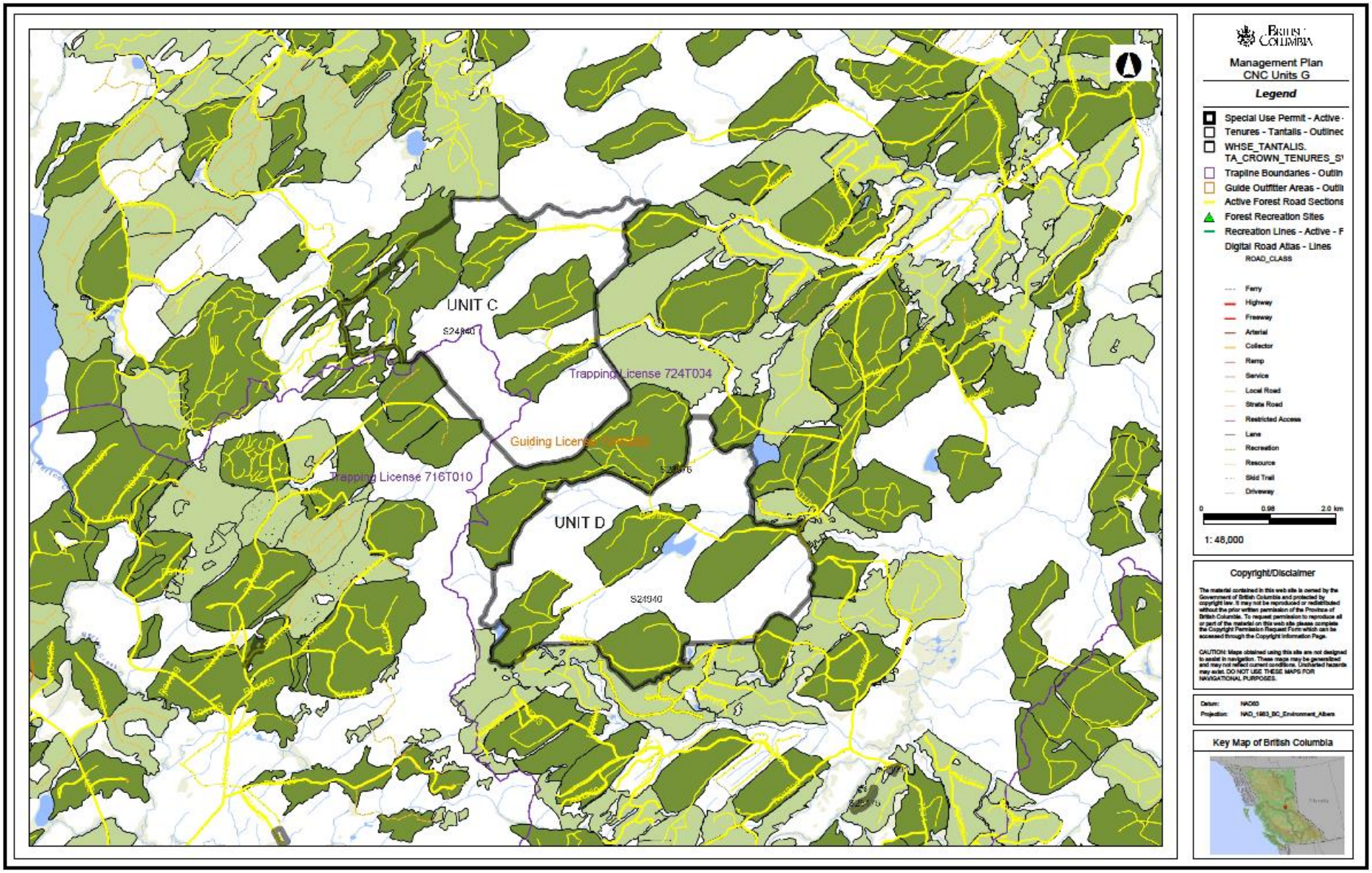
Research Forest Management Plan Map - Unit A.



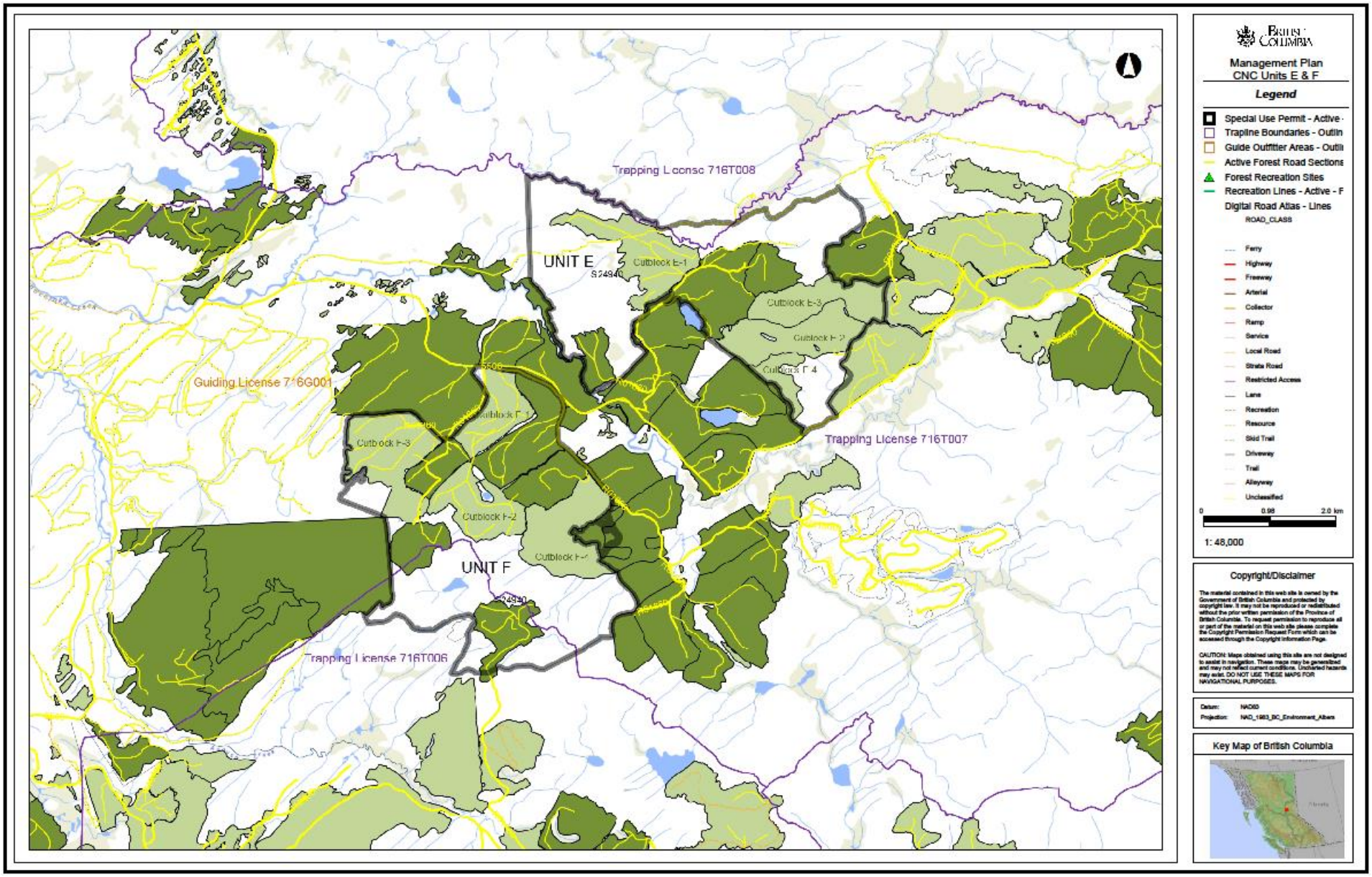
Research Forest Management Plan Map - Unit B.



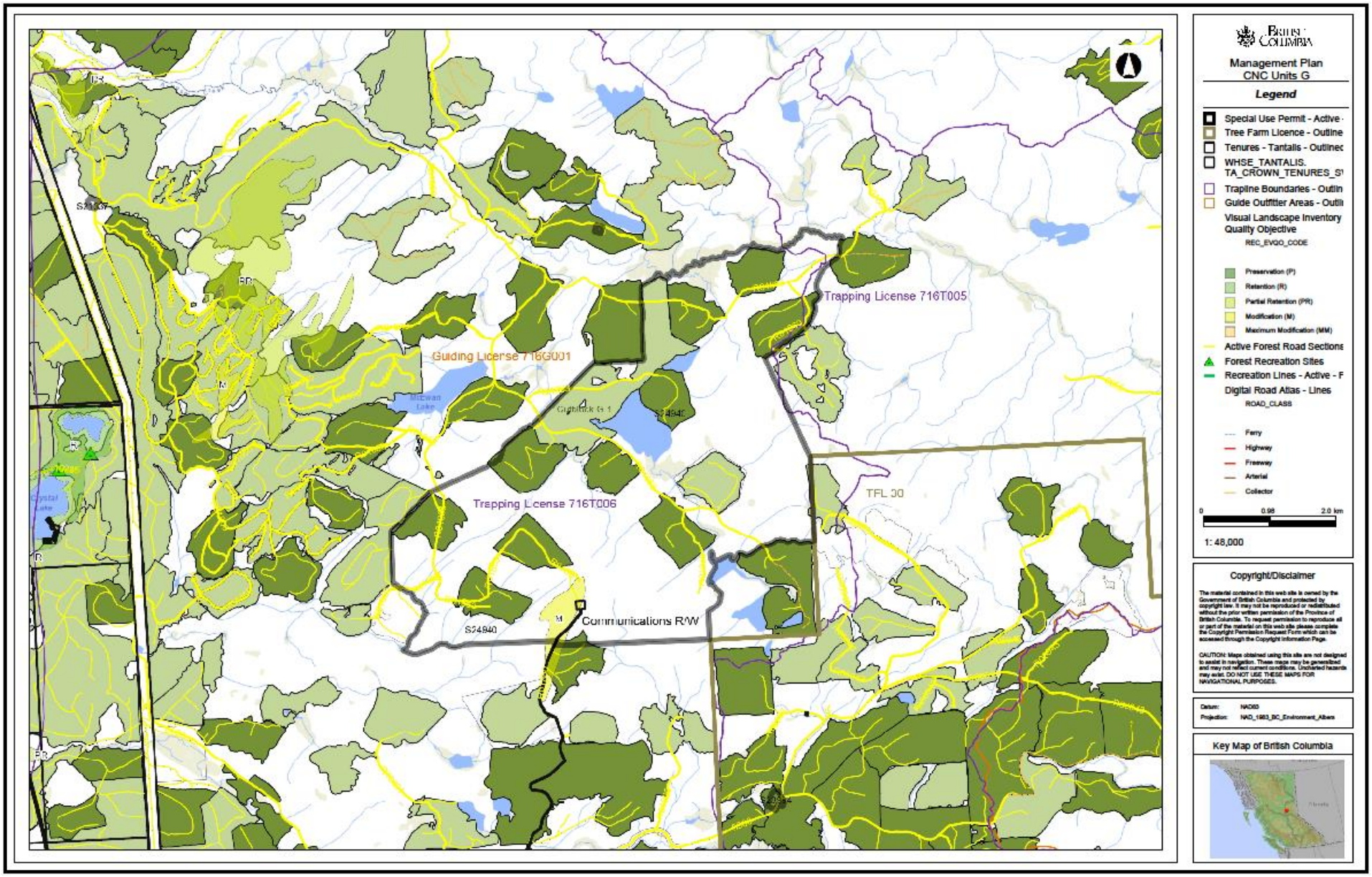
Research Forest Management Plan Map - Unit C and D.



Research Forest Management Plan Map - Unit E and F

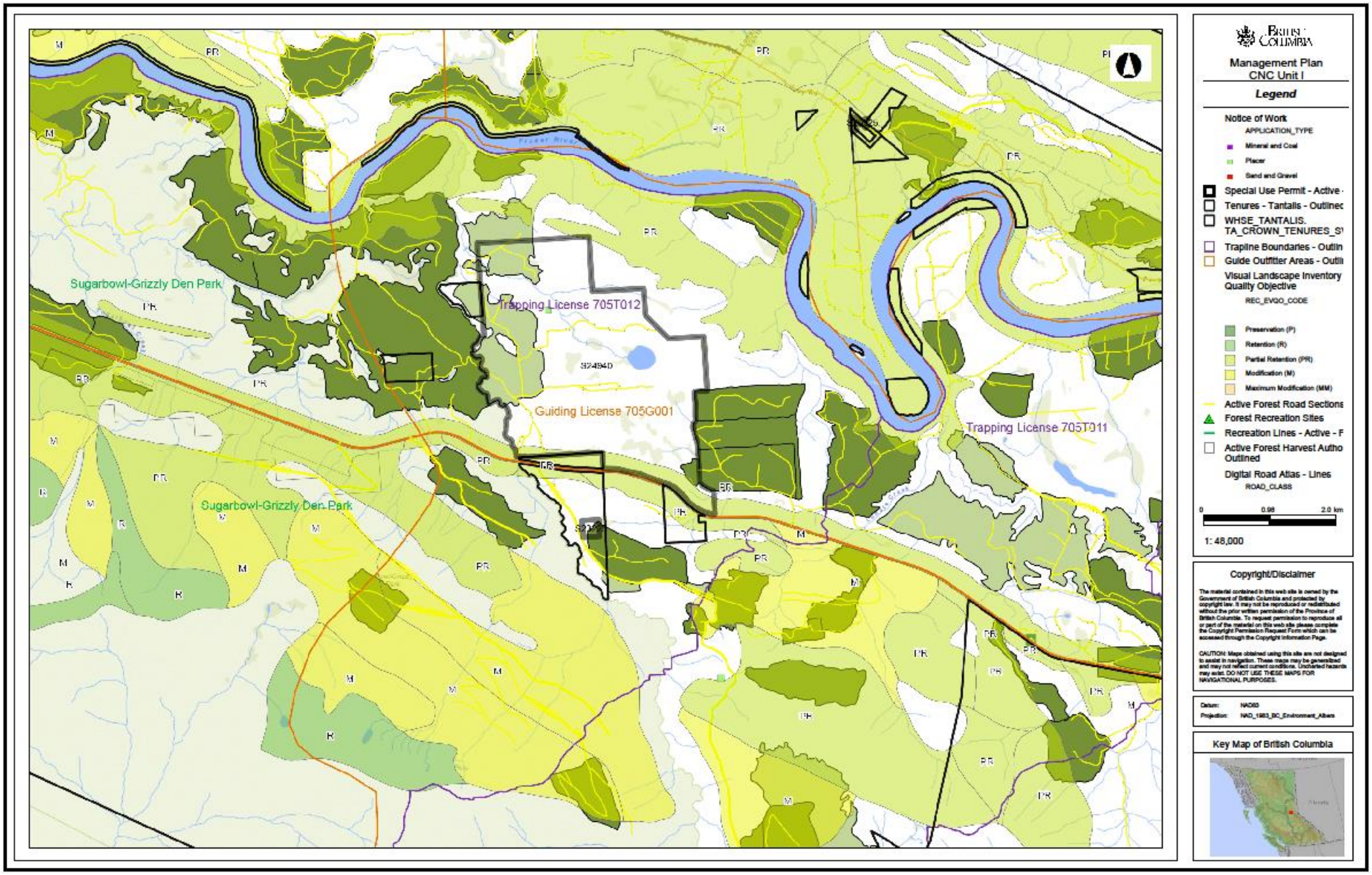


Research Forest Management Plan Map - Unit G.

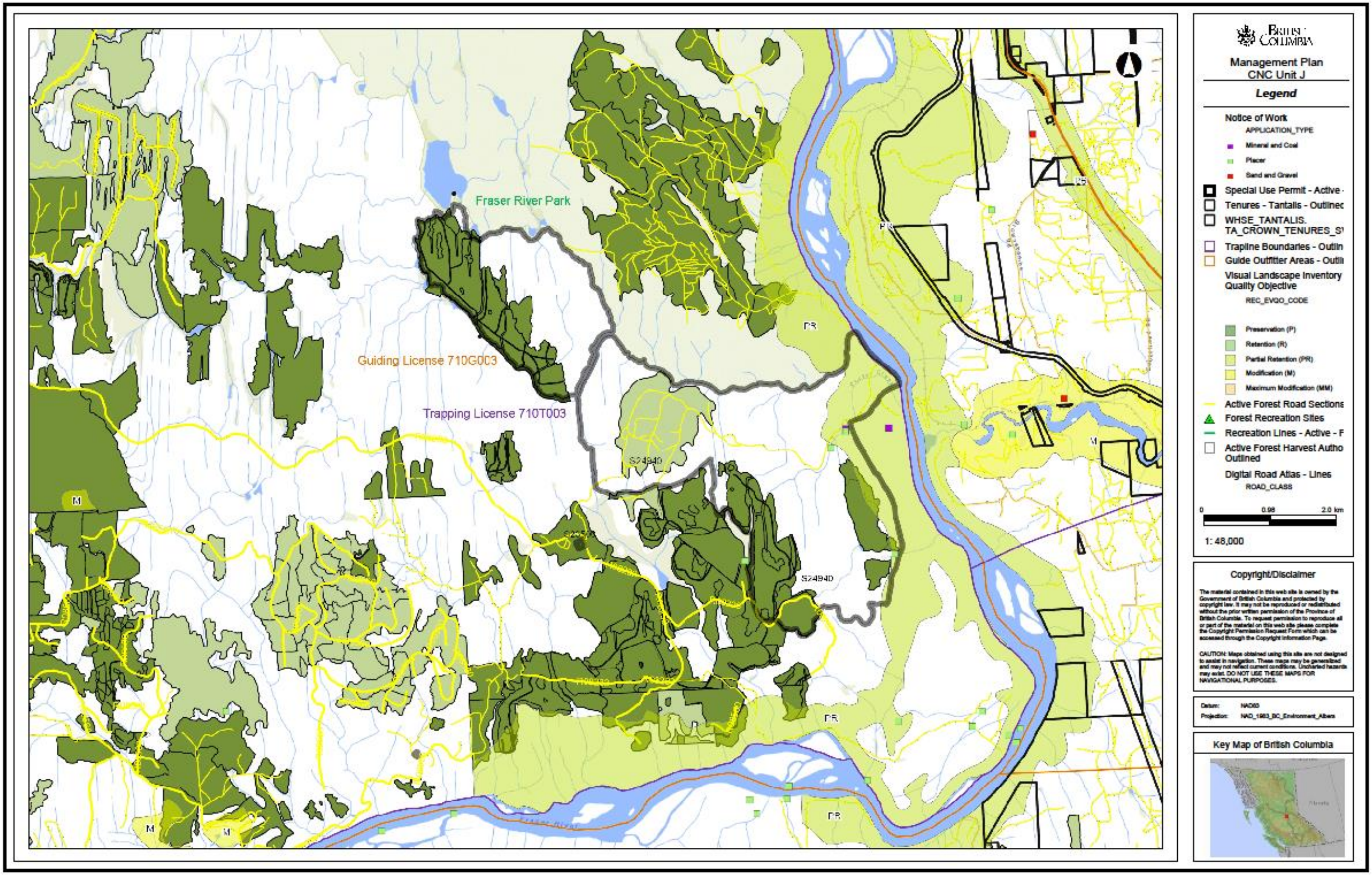


Research Forest Management Plan Map - Unit H.

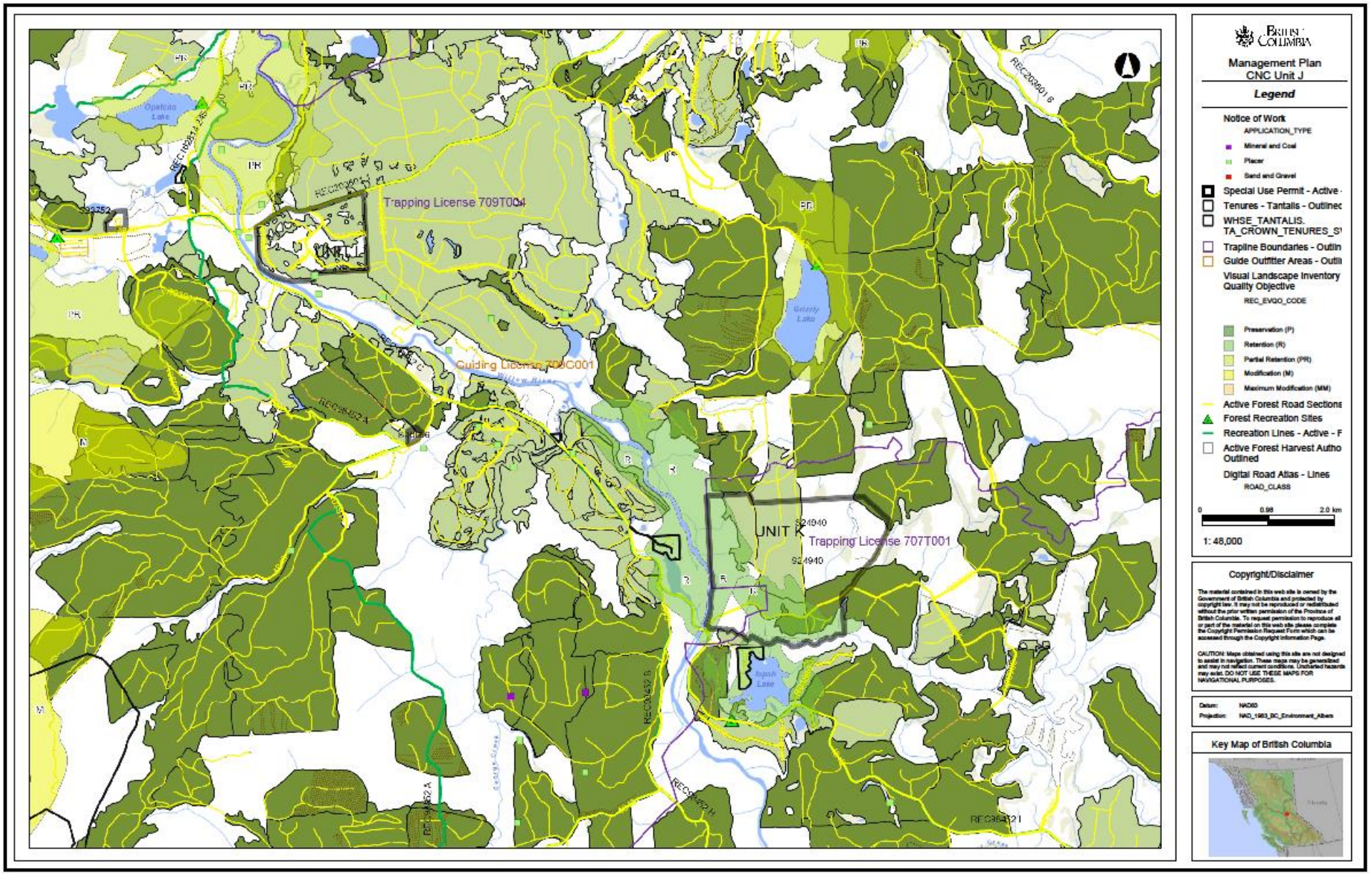
Research Forest Management Plan Map - Unit I.



Research Forest Management Plan Map - Unit J.



Research Forest Management Plan Map - Unit K and L.



Appendix H: Timber Supply Analysis and Review

2017 TIMBER SUPPLY ANALYSIS AND DATA PACKAGE FOR THE COLLEGE OF NEW CALEDONIA RESEARCH FOREST

ANALYSIS AND REPORT COMPLETED BY FORSITE CONSULTANTS

College of New Caledonia CNC Research Forest

Analysis Report

Version 1.1

September 2017

Project 679-1

Prepared by:

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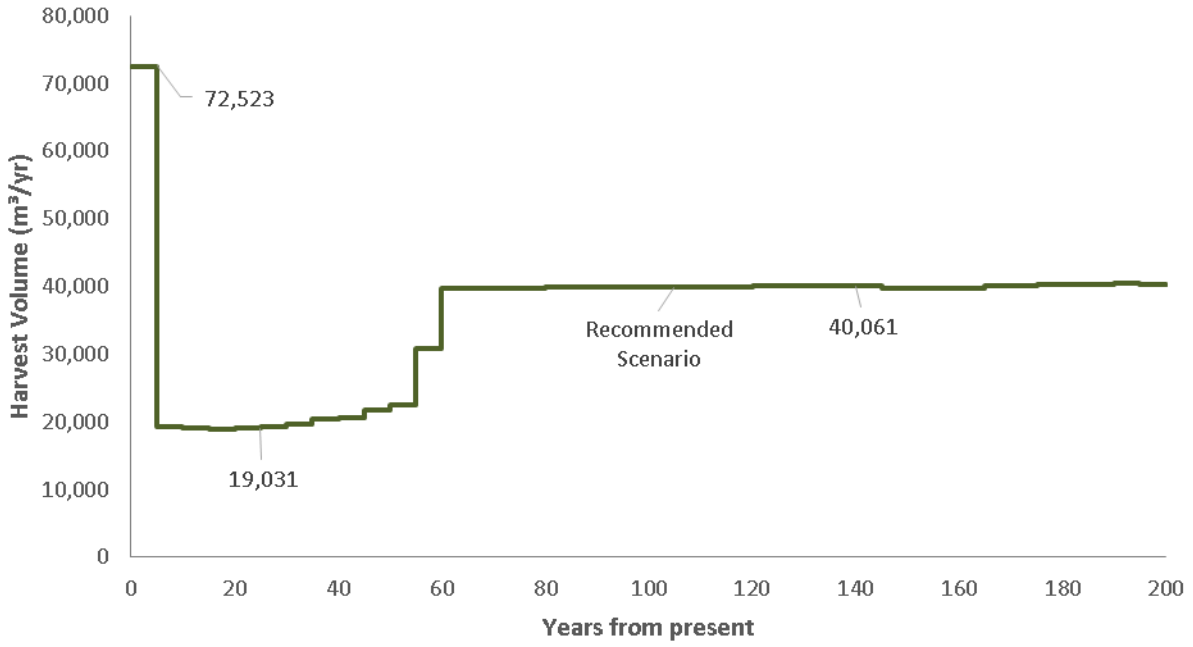
Executive Summary

The College of New Caledonia (CNC) is preparing to complete a Timber Supply Review (TSR) for its Research Forest. Although CNC recently completed a TSR in 2016, spruce beetle is at epidemic levels within and around the Northern Research Forest units and is continuing to cause new spruce mortality. This document summarizes timber supply modeling carried out using the Research Forest's new Vegetation Resources Inventory and updated spruce mortality assumptions.

The total growing stock for the timber harvesting land base (THLB) was compared between the CNC's new inventory and the provincially maintained inventory and when compared across all age classes, there was very little difference in overall volume (CNC VRI volume predicts -1.27% smaller than provincial VRI) but when filtered to older stands (>150 years), the difference grew substantially (CNC VRI volume predicts -16.8% smaller than provincial VRI). This suggests that CNC's new inventory predicts more volume for younger stands and less volume for older stands relative to the provincial inventory. Cruise volumes compiled for recent blocks also showed much higher volumes than CNC's new VRI (49% higher).

Modeling shows that an initial harvest rate of approximately 72,500 m³/yr is required to salvage timber assumed to be killed by the spruce beetle. The 2016 analysis showed a much higher initial harvest rate, however much of that volume was already harvested in winter 2016/2017 in a large salvage operation.



The harvest profile for the next 20 years is characterized as largely spruce/balsam stands older than 150 years, the same population that saw significant differences with both the provincially maintained VRI as well as the cruise complications for recent harvest openings. This implies that if the areas selected for harvest in the final recommended scenario are indeed harvested in reality, it is likely the realized volume coming from these stands will equate to much higher volume totals than forecasted by this analysis.

Several sensitivities were examined to test the sensitivity of the harvest flow to various input assumptions. The table below summarizes the percent change in harvest flow relative to the salvage base case as a result of changing input assumptions.

Sensitivity Description	Harvest Rate (m^3/yr)			Percent Change Relative to Salvage Base Case		
	Initial Rate	Mid-Term	Long-Term	Initial Rate	Mid-Term	Long-Term
Salvage Base Case	76,318	19,569	40,422	-	-	-
Higher Spruce Mortality	91,281	16,396	40,265	20%	-16%	0%
Shelf-Life	71,977	17,723	40,359	-6%	-9%	0%
Hemlock	76,721	16,131	39,013	1%	-18%	-3%
No corridor	89,729	20,107	42,206	18%	3%	4%
Revised Corridor	80,746	18,978	41,538	6%	-3%	3%
1st Period salvage only	86,907	17,608	40,515	14%	-10%	0%
Final Recommended	72,523	18,992	39,721	-5%	-3%	-2%

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1 Introduction

The College of New Caledonia (CNC) is preparing to complete a Timber Supply Review (TSR) for its Research Forest. Although CNC recently completed a TSR in 2016, spruce beetle is at epidemic levels within and around the Northern Research Forest units and is continuing to cause new spruce mortality. This document summarizes timber supply modeling carried out using the Research Forest's new Vegetation Resources Inventory and updated spruce mortality assumptions. Inputs and assumptions used for this analysis are documented in the data package attached as Appendix A.

2 Study Area

2.1 Location

The CNC Research Forest is located in 12 separate management unit parcels spread around Prince George, BC (Figure 1).

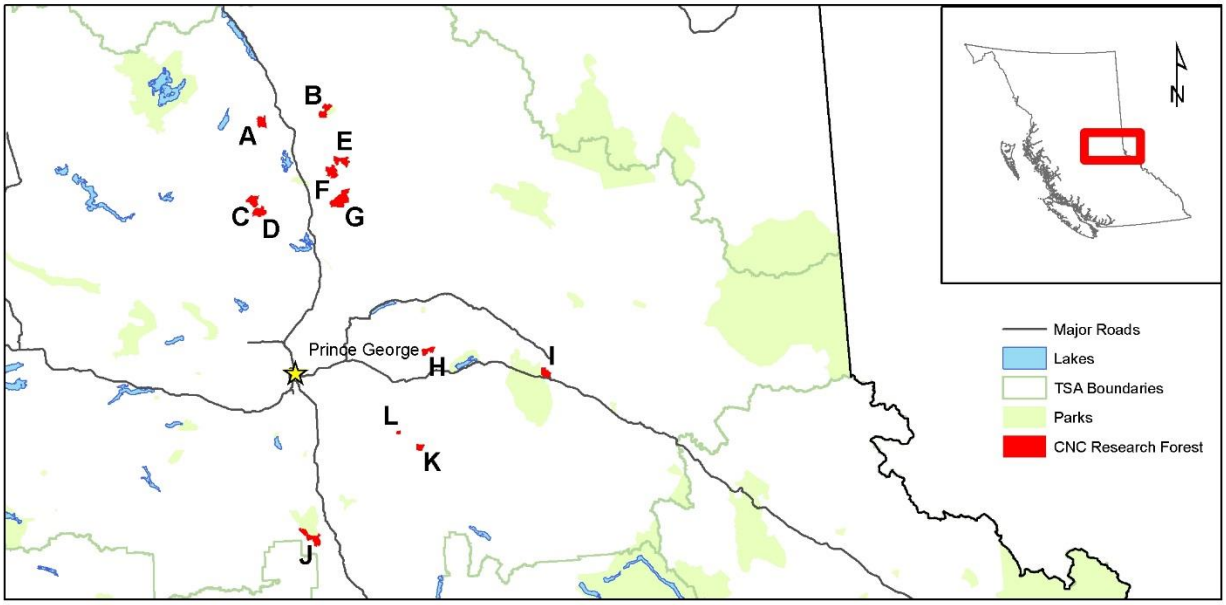

Figure 1 Location Map of CNC Research Forest Management Units A through L

2.2 Land Base Definition

Land base assumptions are used to define the contributing forest landbase (CFLB) and the timber harvesting land base (THLB) in the Research Forest. The THLB is designated to support timber harvesting while the CFLB is identified as the broader productive forest that can contribute towards meeting non-timber objectives (e.g. biodiversity). The land base area summary is provided in Table 1.

Table 1 Area Land Base Assignments

Land Base Assignment Category	Gross Area (ha)	Effective Area (ha)	% Total Area	% of CFLB
Total Area	**12,567**	**12,567**	**100%**	
Less:				
Non-Forest / Non-Productive	221	221	2%	
Existing Roads	83	80	1%	
Crown Forested Land Base (CFLB)		**12,266**		**100%**
Less**:**				
Physically Inoperable / Steep Slopes	776	664		
Low Productivity (SI <8 or never reaches 140 m³/ha)	1,522	979	5%	5%
Problem Forest Types:				
Black Spruce	154	0	0%	0%
Deciduous	354	5	0%	0%
Hemlock & Cedar Leading	117	105	1%	1%
Riparian Reserve Zones	779	402	3%	3%
Timber Harvesting Land Base (THLB)		**10,111**		**82%**
Less Aspatial Netdowns**:				
Stand Level Retention (9%)		910		7%
Net Effective Harvestable Land Base		**9,201**		**75%**

*Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, lake buffers netdown does not include non-forested area.

**Aspatial netdowns are applied in the model or yield curves and are not reflected in the GIS dataset areas.

2.3 Current Attributes of the Study Area

The Research Forest is currently dominated by spruce and balsam (Figure 2), with much of the pine killed by the Mountain Pine Beetle between 2005 and 2008. Other species include hemlock, Douglas-fir, trembling aspen, black spruce, and trace amounts of western cedar.

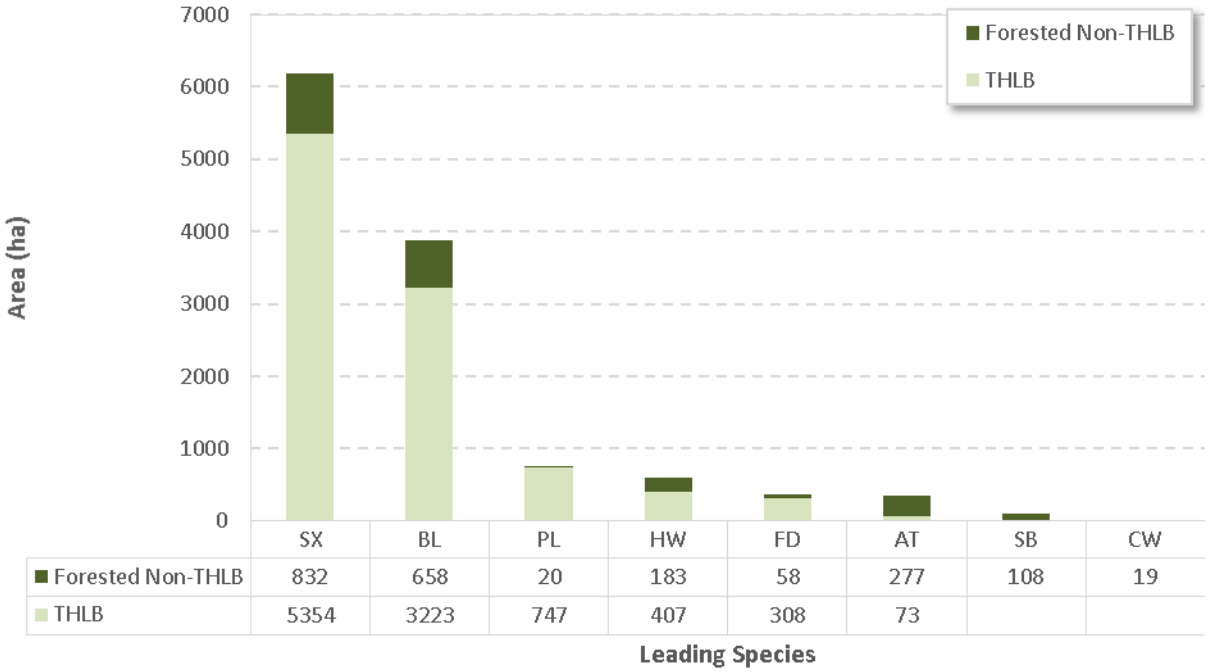

Figure 2 Area by Leading Species

Due to recent salvage harvesting for pine and the ongoing salvage harvesting of spruce, a large portion of the THLB is less than 10 years old (Figure 3). However, there is still a significant proportion of susceptible older spruce and balsam stands on the landbase, leaving relatively little area between 50 and 100 years old.

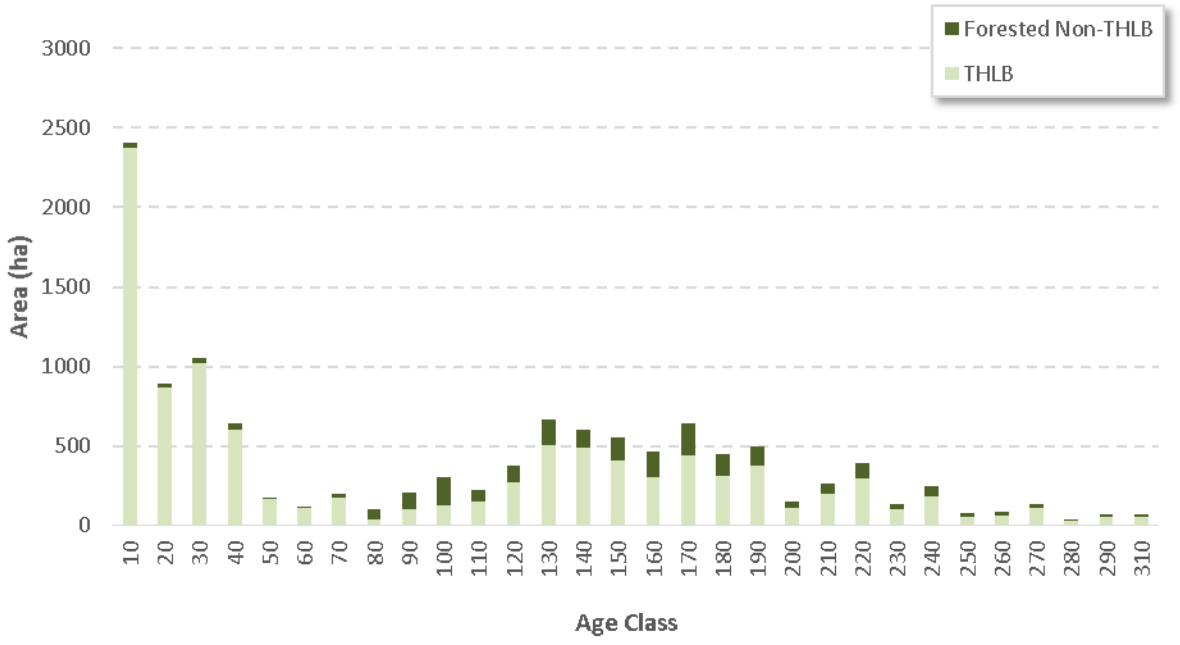

Figure 3 Area by Age Class and Contributing Classification

Site index refers to the potential productive capacity of a stand. The inventory site index was used as the site productivity input to develop yield curves for existing natural stands while the managed site index was used for existing and future managed stands.

For this analysis, an area-weighted average site index for managed stands was calculated for each leading species type using the Provincial Site Productivity Layer estimates. Site indices are sourced from the Provincial Site Productivity Layer[1]. The distribution of both the natural and managed stand site indexes are shown in Figure 4.

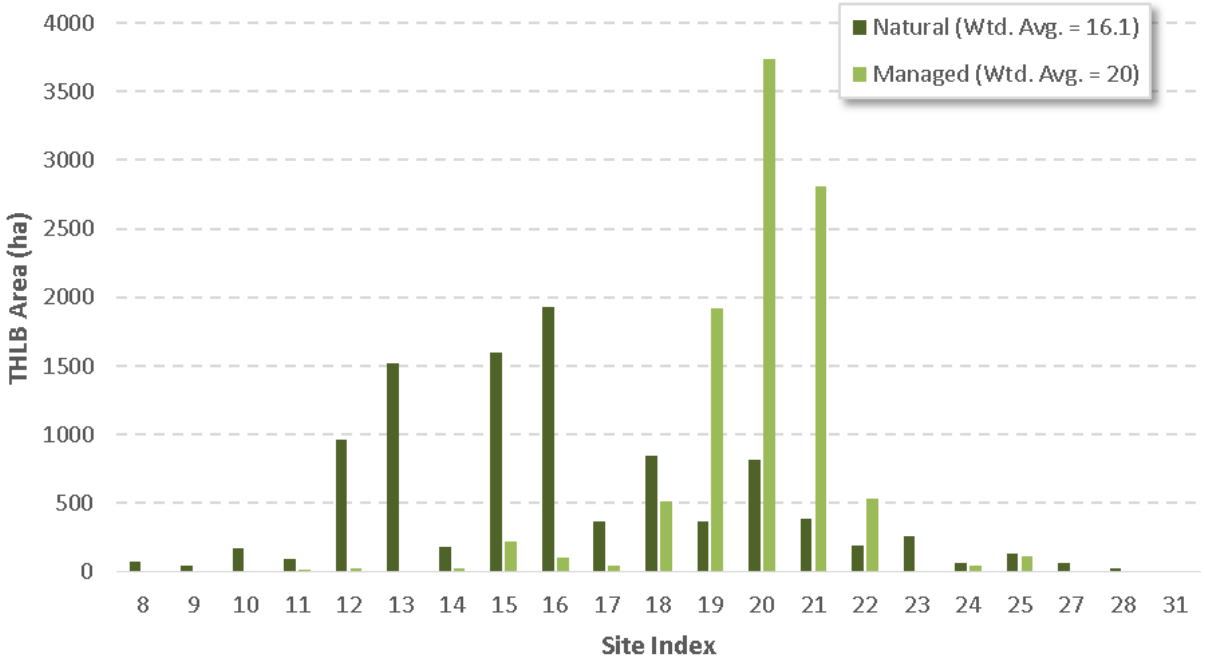

Figure 4 Distribution of Natural and managed Stand Site Index over the THLB

3 Inventory Volume Comparison

This analysis utilized newly acquired inventory and as well as used a recent build of the Ministries of Forest's Variable density yield projection program (VDYP 7.30a). To provide context and attempt to quantify some differences between the provincially maintained inventory and CNC's new inventory, cruise volume compilations for recent harvest blocks were compared with provincially maintained inventory (Table 2), and CNC's new inventory volume projections (Table 3). Additionally, CNC's new inventory volume projections for the same harvest blocks were compared with the provincially maintained inventory (Table 4).

These comparisons show that the provincial VRI volume predictions overall were within 1% of the cruise volume estimates and that CNC's new inventory volume estimates were estimating ~67% of cruise volumes. When the two inventory volume predictions were compared, the CNC volume predictions were 68% of provincial VRI volume predictions.

[1] https://www.for.gov.bc.ca/hts/siteprod/provlayer.html

The total growing stock for the THLB was also compared between the two inventories (not shown) and when compared across all age classes, there was very little difference in overall volume (CNC VRI volume predicts -1.27% smaller than provincial VRI) but when filtered to older stands (>150 years), the difference grew substantially (CNC VRI volume predicts -16.8% smaller than provincial VRI). This suggests that CNC's new inventory predicts more volume for younger stands and less volume for older stands relative to the provincial inventory.

Table 2 Cruise Volume predictions vs. Provincial VRI volume predictions for recently cruised harvest blocks

Block	Conifer Volume (m^3/ha)		Area (ha)	Difference (m^3/ha)	% Difference
	Provincial Inventory	Cruise			
A-2	282.6	462.0	76.4	179.4	63%
A-8	305.9	368.0	36.1	62.1	20%
B-1	420.0	375.0	110.1	-45.0	-11%
C-1	259.2	345.0	174.4	85.8	33%
C-2	298.0	306.0	319.2	8.0	3%
C-3	290.4	337.0	31.5	46.6	16%
D-1	414.2	347.0	314.2	-67.2	-16%
D-2	434.0	367.0	105.0	-67.0	-15%
D-3	403.8	358.0	87.9	-45.8	-11%
D-4	301.2	283.0	22.2	-18.2	-6%
E-2	344.7	316.0	97.5	-28.7	-8%
E-3	281.6	359.0	60.0	77.4	27%
E-4	391.0	301.0	11.5	-90.0	-23%
F-4	345.5	305.0	106.9	-40.5	-12%
G-2	300.5	332.0	76.0	31.5	10%
G-3	357.9	383.0	188.7	25.1	7%
G-4	295.9	322.0	117.1	26.1	9%
weighted avg.	**342.8**	**344.9**		**-2.1**	**1%**

Table 3 Cruise Volume predictions vs. College of New Caledonia's VRI volume predictions for recently cruised harvest blocks

Block	Conifer Volume (m^3/ha)		Area (ha)	Difference (m^3/ha)	% Difference
	CNC	Cruise			
A-2	312.5	462.0	76.4	149.5	48%
A-8	249.1	368.0	36.1	118.9	48%
B-1	250.6	375.0	110.1	124.4	50%
C-1	207.5	345.0	174.4	137.5	66%
C-2	228.2	306.0	319.2	77.8	34%
C-3	214.2	337.0	31.5	122.8	57%
D-1	238.1	347.0	314.2	108.9	46%
D-2	236.7	367.0	105.0	130.3	55%
D-3	245.4	358.0	87.9	112.6	46%
D-4	227.5	283.0	22.2	55.5	24%
E-2	214.5	316.0	97.5	101.5	47%
E-3	240.9	359.0	60.0	118.1	49%

E-4	218.4	301.0	11.5	82.6	38%
F-4	209.2	305.0	106.9	95.8	46%
G-2	221.9	332.0	76.0	110.1	50%
G-3	215.5	383.0	188.7	167.5	78%
G-4	233.3	322.0	117.1	88.7	38%
weighted avg.	**231.4**	**344.9**		**-113.5**	**49%**

Table 4 College of New Caledonia's VRI volume predictions vs. provincial VRI volume predictions for recently cruised harvest blocks

Block	Conifer Volume (m^3/ha)		Area (ha)	Difference (m^3/ha)	% Difference
	Provincial	CNC			
A-2	282.6	312.5	76.4	29.9	11%
A-8	305.9	249.1	36.1	-56.8	-19%
B-1	420.0	250.6	110.1	-169.4	-40%
C-1	259.2	207.5	174.4	-51.7	-20%
C-2	298.0	228.2	319.2	-69.8	-23%
C-3	290.4	214.2	31.5	-76.2	-26%
D-1	414.2	238.1	314.2	-176.1	-43%
D-2	434.0	236.7	105.0	-197.3	-45%
D-3	403.8	245.4	87.9	-158.4	-39%
D-4	301.2	227.5	22.2	-73.6	-24%
E-2	344.7	214.5	97.5	-130.2	-38%
E-3	281.6	240.9	60.0	-40.6	-14%
E-4	391.0	218.4	11.5	-172.6	-44%
F-4	345.5	209.2	106.9	-136.3	-39%
G-2	300.5	221.9	76.0	-78.6	-26%
G-3	357.9	215.5	188.7	-142.4	-40%
G-4	295.9	233.3	117.1	-62.6	-21%
weighted avg.	**342.8**	**231.4**		**111.4**	**-33%**

4 Long Run Sustainable Yield Calculation

The Long Run Sustainable Yield (LRSY) is the largest theoretical yield that can be harvested from a forest over an indefinite period. It assumes that stands are harvested when they reach their maximum or culmination mean annual increment (CMAI) and that there is an equal amount of each in each age class and analysis unit (AU; i.e. fully regulated forest). It also assumes there are no non-timber constraints applied. For this analysis, the LRSY was calculated by determining the maximum CMAI of each future managed AU and multiplying the THLB area within each AU.

Table 5 Long-Run Sustained Yield Calculation

AU	CMAI Age	CMAI (m^3/ha/yr)	Net THLB Area (ha)	LRSY (m^3/yr)
BL-VG	85	4.341	202	876
BL-G	75	5.347	2,429	12,989
BL-M	80	4.738	302	1,429
FDI-VG	110	2.584	48	123
FDI-G	70	5.629	233	1,312
HW-G	85	4.945	370	1,829
PLI-VG	75	4.079	102	416
PLI-G	65	5.529	577	3,193
SX-VG	65	6.005	275	1,653
SX-G	75	4.821	4,561	21,990
SX-M	115	3.049	90	275
SX-P	145	2.349	12	27
	Wtd. Avg	**5.012**	**9,201**	**46,113**

This LRSY calculation suggests that the theoretical maximum long term harvest level for this landbase would be 46,113 m^3/yr. These harvest levels would only be achieved if no constraints are applied in the model and stands could all be harvested at exactly the assumed age. Short-term harvest levels can vary substantially from these levels depending on the age of the forest being harvested.

5 Base Case Analysis

5.1 Timber Supply

Modeling results are presented for two candidate base case scenarios: an even-flow timber supply scenario, and a scenario where even-flow constraints are relaxed in order to capture and salvage timber damaged by spruce beetle. The even-flow base case scenario was used as a benchmark for the salvage scenario to ensure harvest levels did not go below what can be achieved in even-flow scenario. This ensured that salvage harvest scheduling did not deplete or liquidate green timber that can be harvested in subsequent periods where timber supply is forecast is low. The results of these two base case scenarios are shown in Figure 5. The 2016 base case is also shown for reference (the one year difference between these scenarios is not reflected in the figure).

Modeling shows that under an even-flow scenario, approximately 18,775 m^3/yr can be maintained. When even-flow constraints are relaxed for the salvage scenario, modeling shows that an initial harvest rate of approximately 76,000 m^3/yr is required to salvage timber assumed to be killed by the spruce beetle. The 2016 analysis showed a much higher initial harvest rate, however much of that volume was already harvested in winter 2016/2017 in a large salvage operation (reflected in the inventory as shown in Figure 3 above). Relaxation of even-flow constraints also results in significant increase in the long-term harvest level. This increase is largely due to the adoption of managed site indexes for future managed stands (detailed in Section 5.5 of the data package).

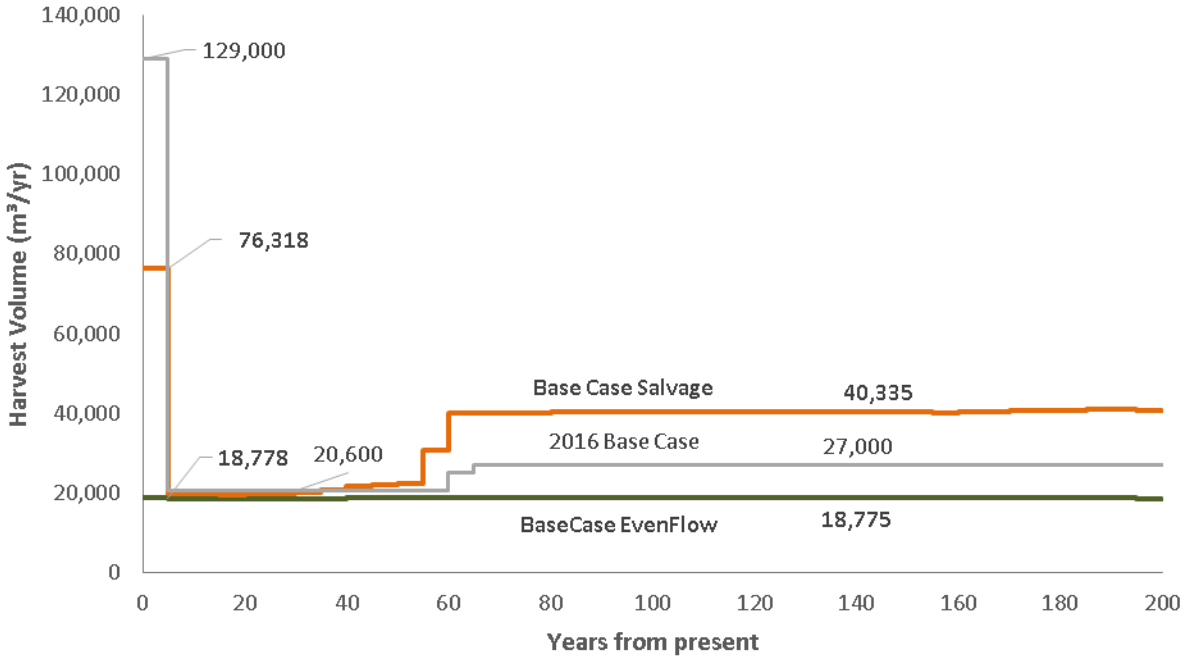

Figure 5 Harvest over Time for Base Case Scenarios relative to the 2016 Base Case

Harvest by product and condition for the salvage base case is shown in Figure 6. Dead fiber is dead material that is not considered to be merchantable as sawlog. In total, this scenario is able to salvage 372,200 m³ of which 77% (284,800 m³) is considered sawlog and the remainder is not considered to be merchantable as sawlog (pulp and other fiber).

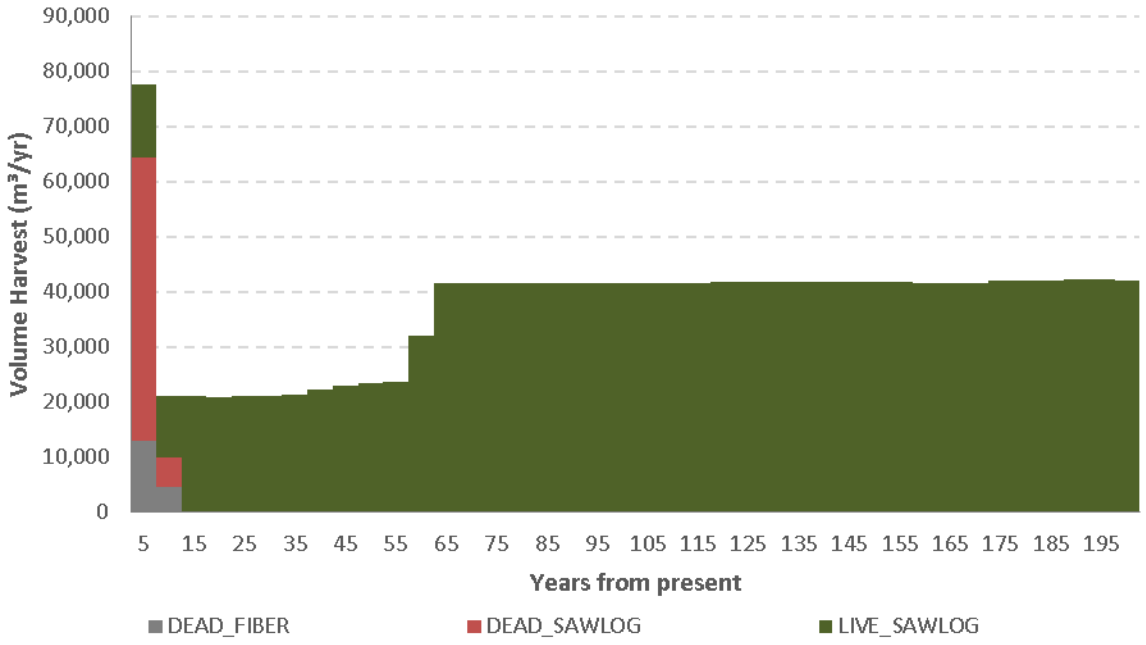

Figure 6 Harvest over Time by Product Condition for the Salvage Base Case

The amount of untreated area assumed to be killed by the spruce beetle over time is shown in Figure 7. This shows that the even-flow scenario salvages approximately 760 ha of the 2880 ha (26%)

killed by the spruce beetle while the salvage scenario is able to salvage 61% (1770 ha). Area not salvage harvested is due to being locked up in wildlife tree patches or is reserved by the model to satisfy seral constraints.

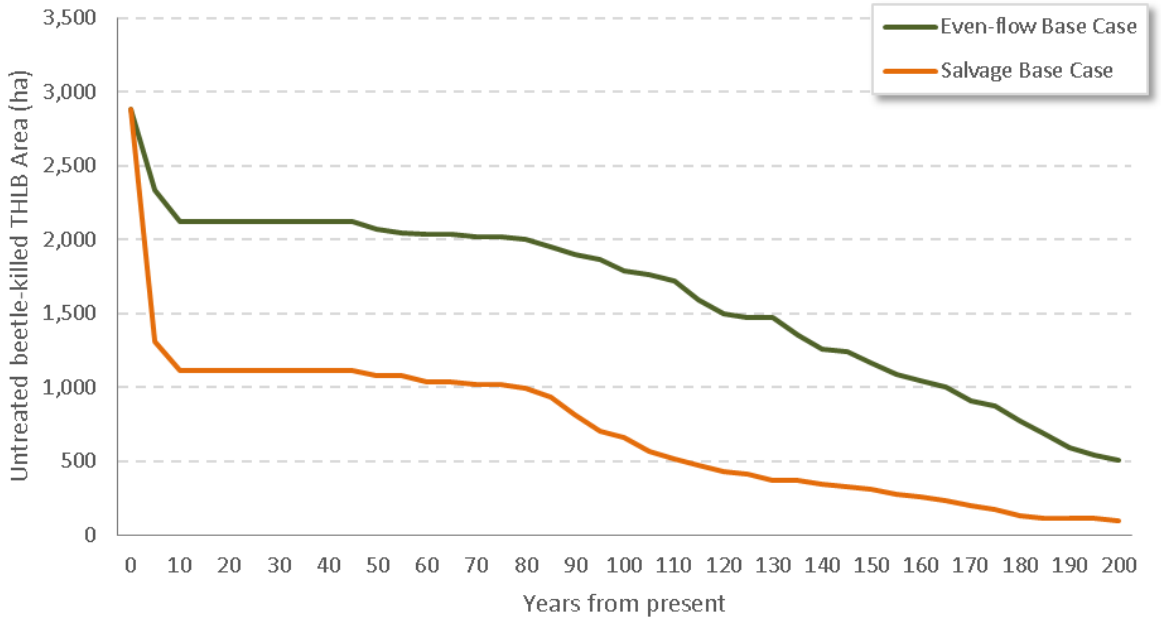

Figure 7 Untreated area killed by the spruce beetle over time for the base case scenarios

5.2 Growing Stock

The total and merchantable growing stock over time for the even-flow and salvage scenarios is shown in Figure 8. Salvage harvesting depletes the growing stock faster than the assumed shelf-life for attacked spruce but also serves to get these stands off delayed regeneration curves resulting in faster overall volume recovery relative to the even-flow scenario. The elevated harvest in the long-term results a lower amount of growing stock in the future, however the stabilized growing stock associated with this scenario demonstrates the sustainability of this harvest level.

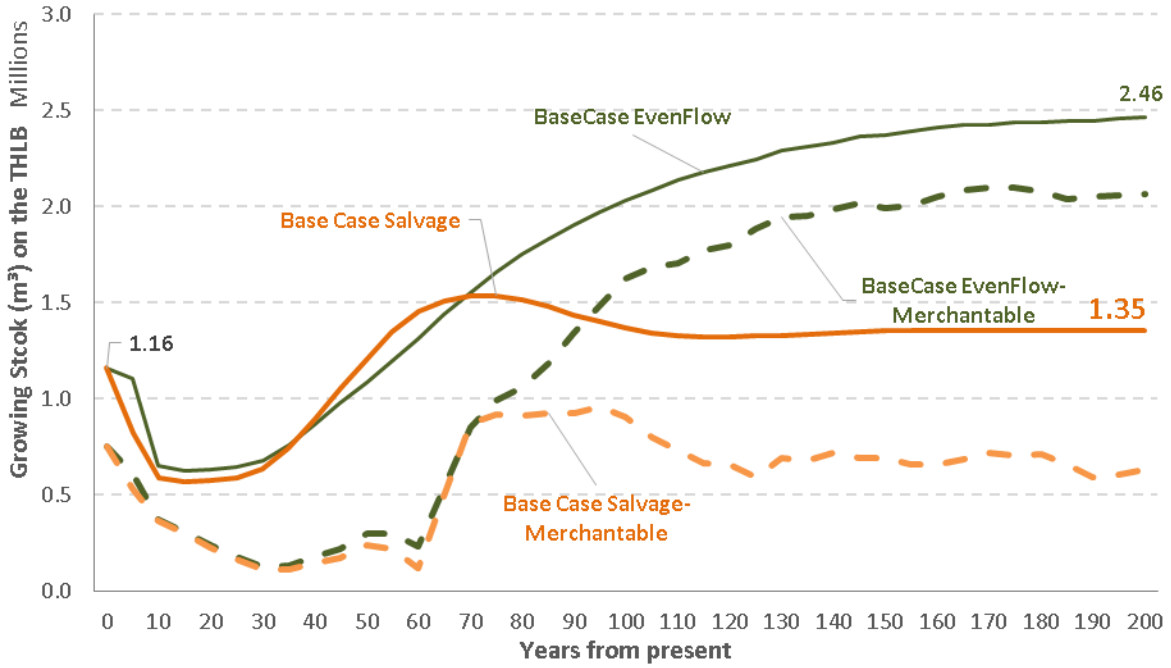

Figure 8 Total THLB Growing stock and merchantable growing stock over time for base case scenarios

Initially, 50% of the growing stock is considered dead (Figure 9). After the first 10 years, salvage harvesting and the shelf-life assumptions work to deplete this dead volume completely.

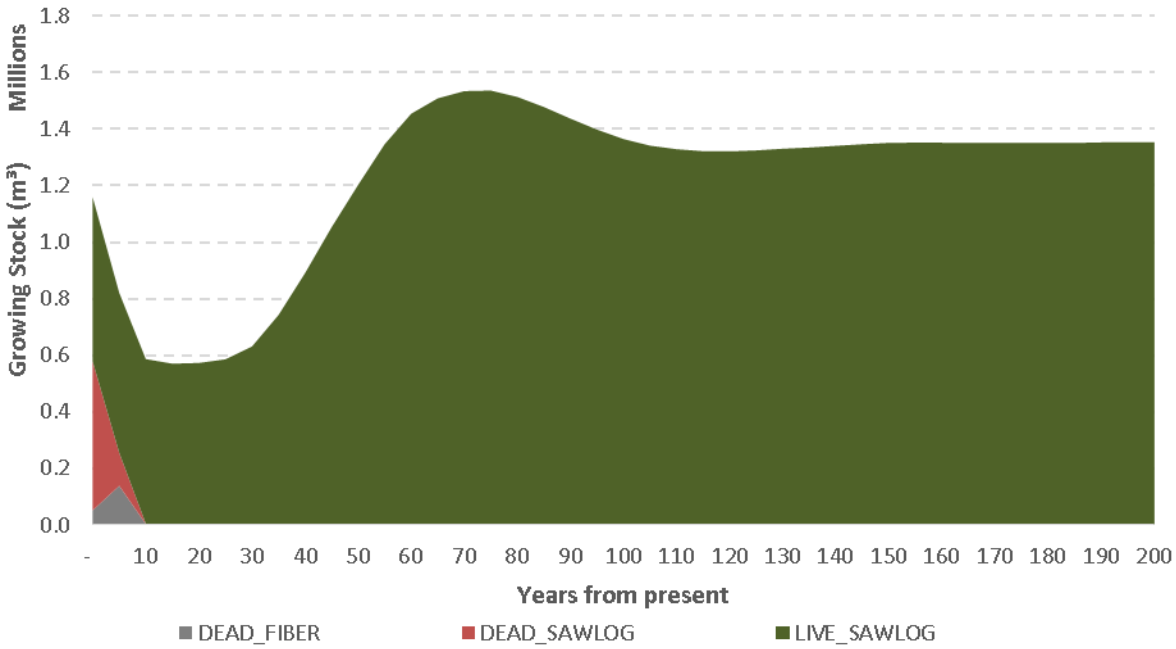

Figure 9 Growing Stock over time by condition and product for the selected base case scenario

5.3 Harvest Attributes

The average harvest age over time for the salvage scenario is shown in Figure 10. This indicates that harvest age for the next 20 years is in relatively old stands (170 years) but that the harvest 20 to 80 years from now will be supported by much younger stands (~75 years on average). These younger stands have significantly different product distributions associated with them relative to the older stands currently being harvested.

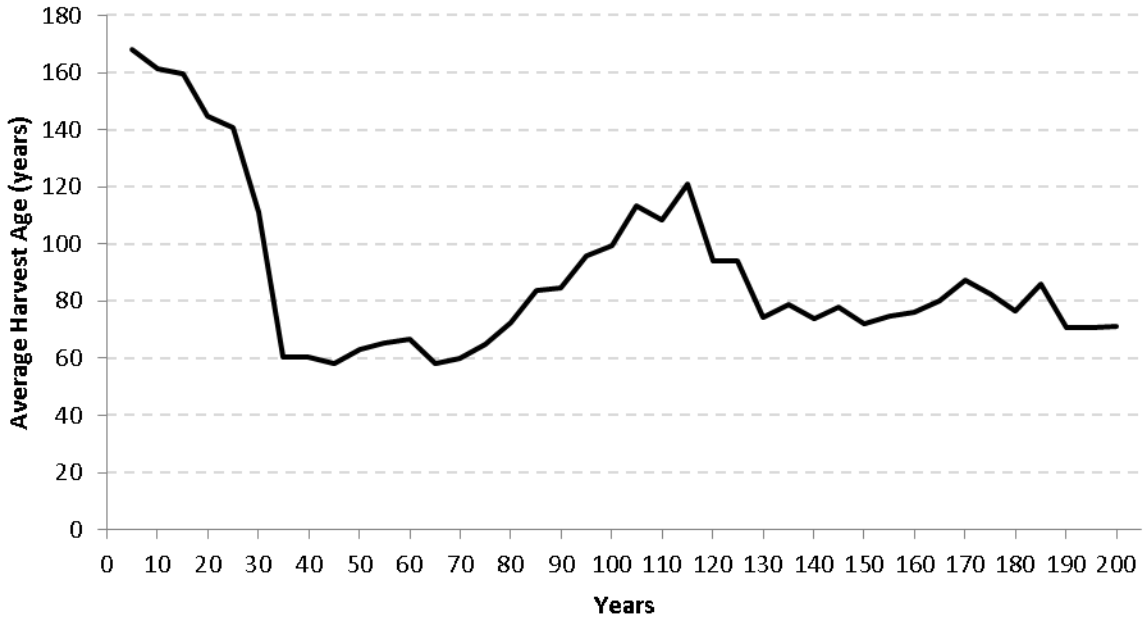

Figure 10 Average harvest age over time for the salvage base case scenario

In addition to the average shown in Figure 10, Figure 11 shows the harvest area over time by age class.

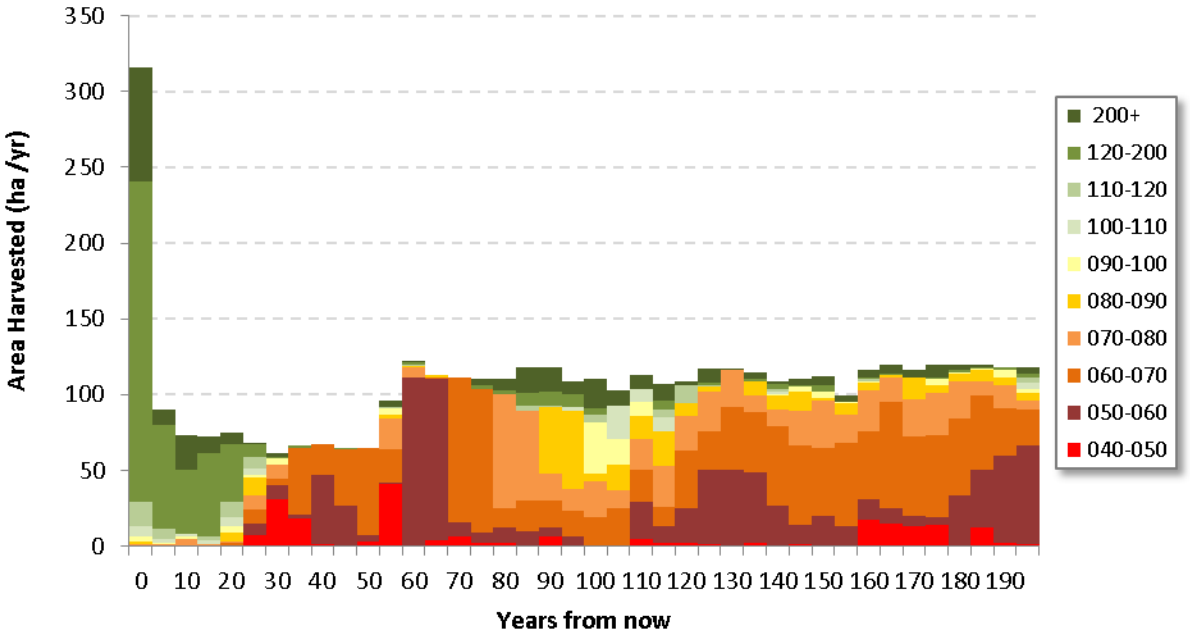

Figure 11 Harvest area (ha/yr) by age class for the salvage base case scenario

Average harvest yield over time increases for the first 80 years as harvests transition from older stands to younger, faster growing stands (Figure 12) associated with gains from managed site indexes that are stabilised long-term at around 360 m³/ha.

Figure 12 Average harvest yield (m³/ha) over time for the salvage base case scenario

Harvest area over time for the salvage base case scenario is shown in Figure 13. Harvest area in the next five years will drop drastically from over 300 ha/yr to around 70 ha/yr as the salvage period ends. The harvest area will stabilize after about 65 years at around 115 ha/yr.

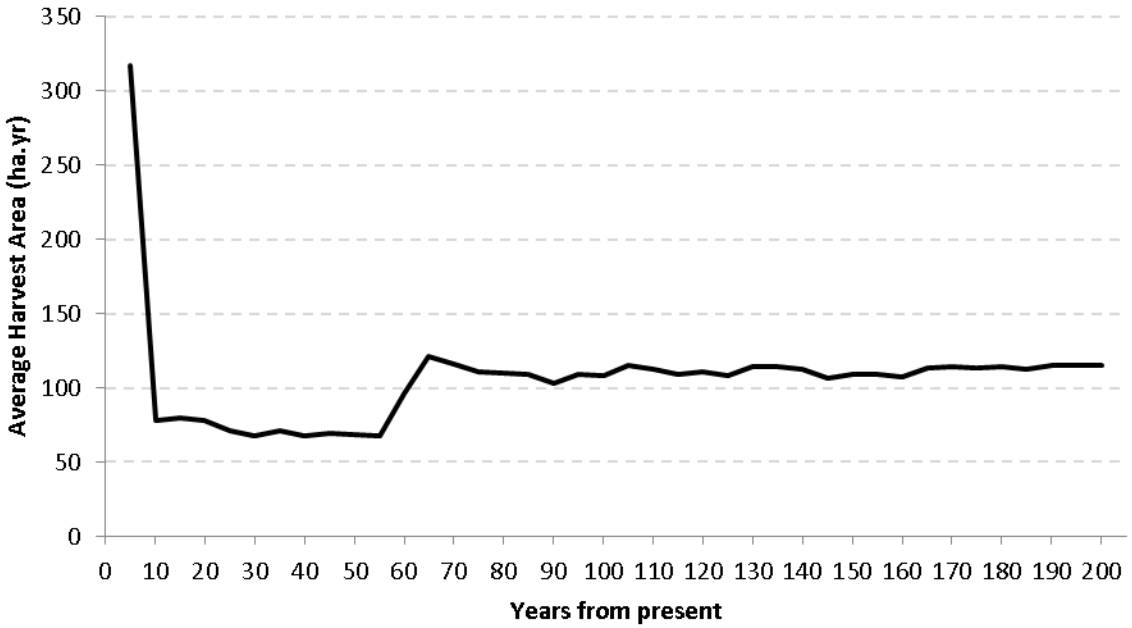

Figure 13 Average harvest area over time for the salvage base case scenario

5.4 Age Class Profile

The age class distributions for the THLB at 0, 50, 100, and 200 years in the future for the salvage base case scenario are shown in Figure 14. The large spike of age class 50, 50 years from now reflects the salvage of both pine and spruce over the past 5 and next 5 years. Over time, the flow regime ultimately converts the forest into a 'regulated' state, with similar area in age class below the rotation ages (70-90 years). The buildup of area in the 200+ age class represents area being reserved to satisfy old seral constraints.

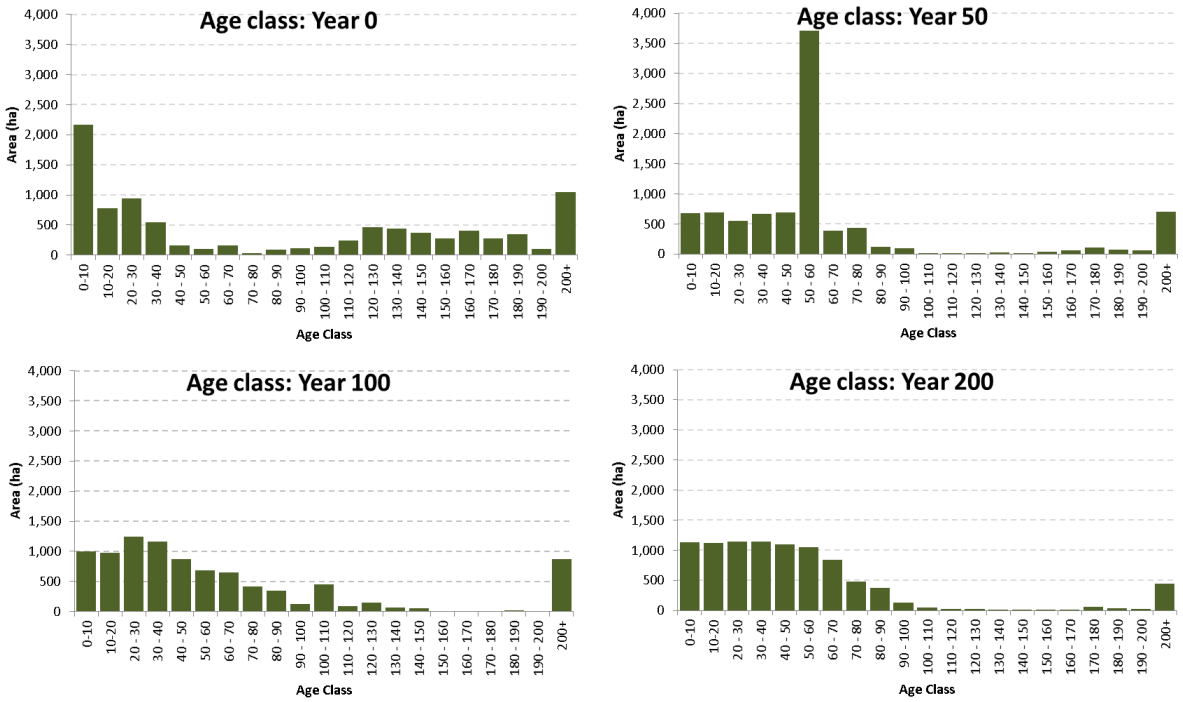

Figure 14 Age Class distribution on the THLB at 0, 0, 100, and 200 years from now for the salvage base case scenario

5.5 Old Seral Requirements

The percent of each parcel in an "Old" condition (>120 years old) relative to modeled requirements is shown in Figure 15. The black line represent the proportion of the parcel considered old while the red column represents the required minimum level. This shows that for the most part, modeled seral requirements did not limit harvest availability with the exception of unit D, H, and K.

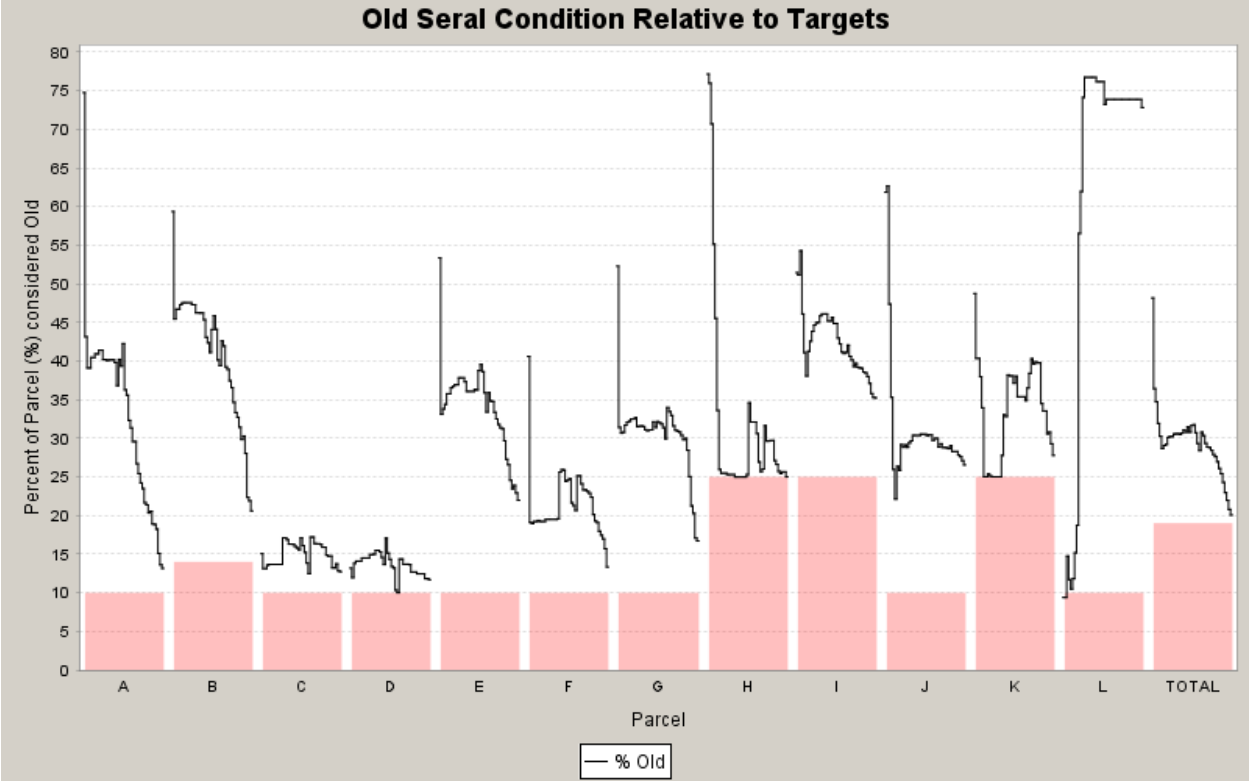

Figure 15 Old seral condition over time relative to modeled requirements for the salvage base case scenario

6 Sensitivities to the Base Case

The sensitivity analyses presented in this section use the Salvage base case as the baseline for comparison.

6.1 Higher Spruce Beetle Mortality

The assumption for beetle mortality for parcels H to L in the base assumptions is that 33% of the total spruce-leading volume will be killed by the beetle. This sensitivity investigates the impact on the harvest flow if the damage from beetle is higher than expected in these units; if 66% of the total spruce leading volume is killed. This increased mortality assumption resulted in a 15% increase in the volume considered dead relative to the base case (663,000 m^3 vs. 578,000 m^3 for the base case). Figure 16 shows the resulting on harvest flow of this increased mortality relative to the base case. In order to salvage the increased amount of dead timber before the shelf-life expires, the initial harvest rate increases 20% to 91,280 m^3/yr which has implications in the mid-term (year 5 to year 35) when it is approximately 16% lower relative to the base case.

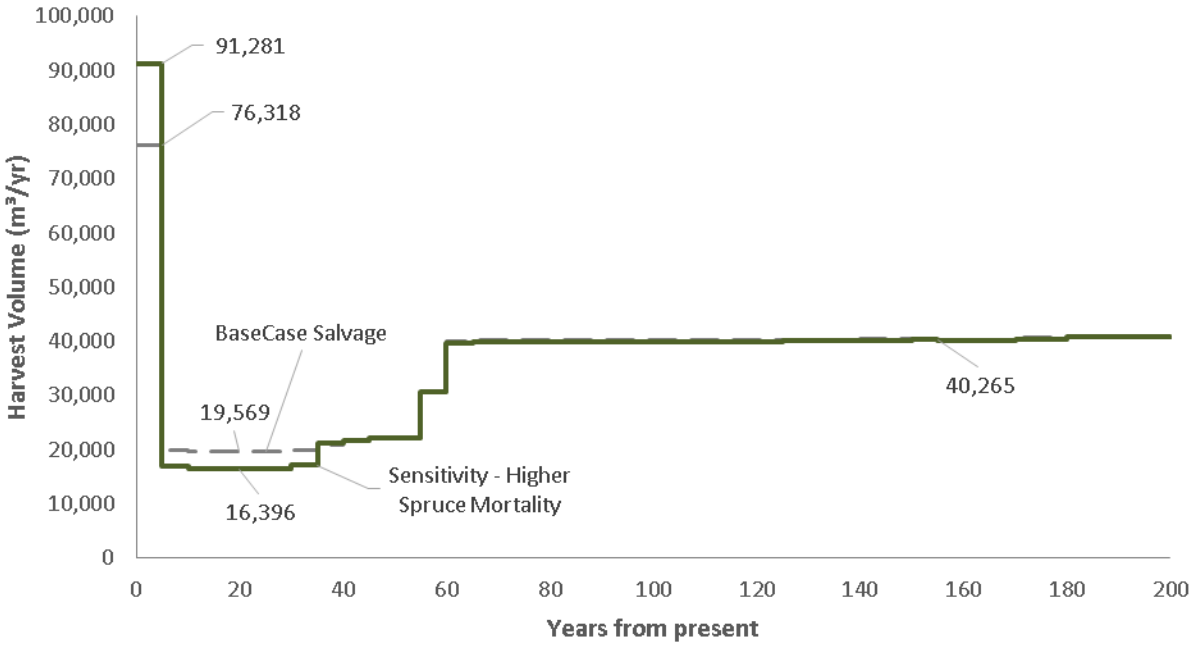

Figure 16 Harvest flow comparison - Salvage Base case Vs. Spruce Mortality Sensitivity

6.2 Shelf-Life

Shelf-life for volume useable as sawlogs for the base case is 1 year at 100% then decreases in 10% steps for a total shelf-life of 11 years (Figure 17). This sensitivity examines the timber supply implications if the shelf-life is shorter than expected by 5 years (0% at year 6 vs. year 11). Figure 18 shows the timber supply implications under the shortened shelf-life assumptions. Because useable sawlog volume diminishes much faster under these assumptions, the growing stock is depleted much faster and stands fall out of operablitiy much quicker which results in a significant reduction in short-term salvage harvest, mid-term harvest, and a delay in the attainment of the long-term harvest level relative to the salvage base case. The delay in the rise to the long-term harvest level occurs because more green volume has to be harvested in the first 10 years to attain the requested harvest, thereby depleting the green growing stock that the model was relying on to harvest in later periods under the base assumptions.

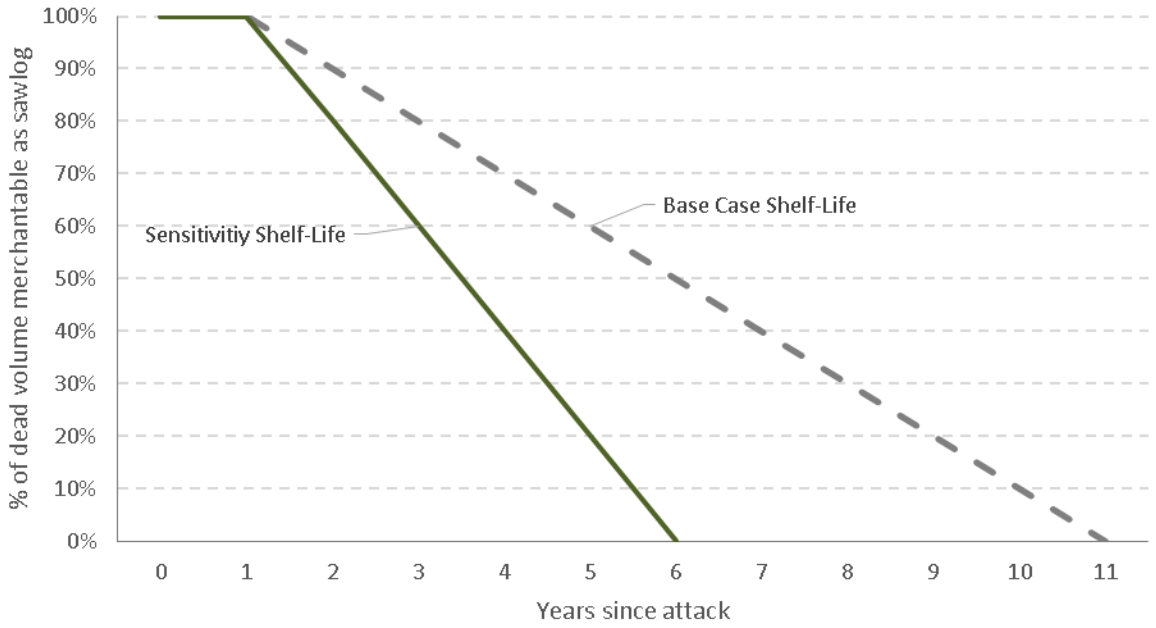

Figure 17 Comparison of shelf-life for volume within stands attacked by the spruce beetle in the shelf-life sensitivity vs. the base case assumptions

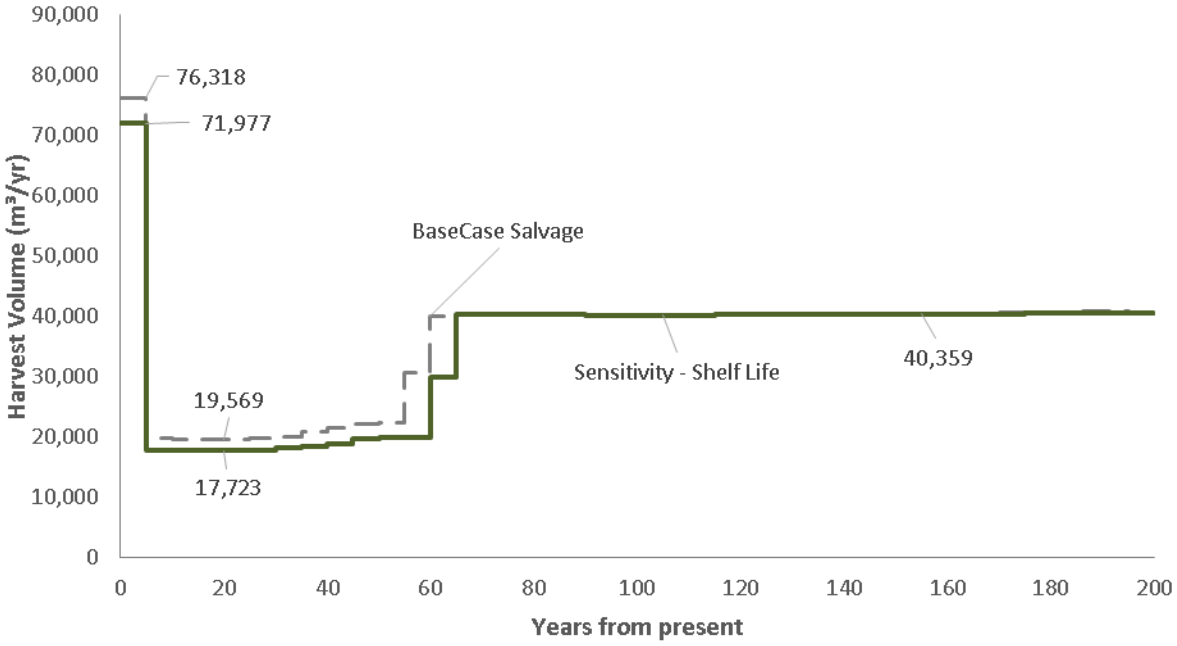

Figure 18 Harvest flow comparison - Salvage Base case Vs. Shelf-Life Sensitivity

6.3 Hemlock

Under the salvage base case scenario, the harvest flow from year 5 to 35 relies relatively heavily on hemlock volume. The economic viability of hemlock volume in parcel H is speculative so this sensitivity examines the timber supply implications if hemlock-leading stands are considered a problem type and are removed from the THLB. The result of this assumption change decrease the THLB by 371 ha, a 4% reduction in THLB relative to the base case assumptions. Figure 19 shows the timber supply result of this change. Mid- and long-term timber supply are reduced but the mid-term is affected more severely (~18%) than the long-term (~3%) because hemlock volume contributes significantly to the harvest during this period under the base assumptions.

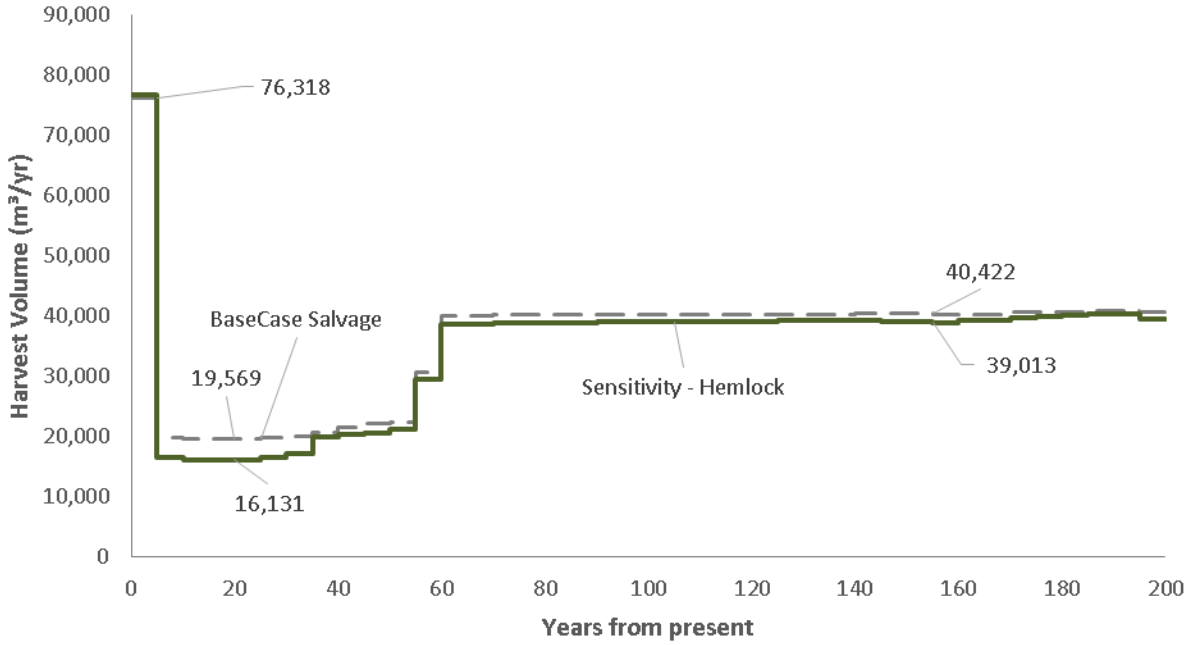

Figure 19 Harvest flow comparison - Salvage Base case Vs. Hemlock Sensitivity

6.4 Biodiversity Corridors Removed

Constraints were placed on spatial long-term wildlife and connectivity corridors in the base assumptions. Stand within these corridors could be harvested if they were over 119 years old and met other merchantability criteria (> 140 m³/ha) and the disturbance within corridors for each parcel was limited to a maximum of 34% less than 60 years old to ensure corridors were dominated by stands >60 years old. This management limits access to stands killed by the spruce beetle in the base case assumptions due to the applied disturbance limits within the corridors. This sensitivity was designed to examine the implications of removing corridor management on timber supply.

When corridor management was removed, disturbance rates (harvest rates) within corridors were allowed to increase thereby allowing the model to salvage 16% more volume killed by the spruce beetle (430,600 m³ vs. 372,300 m³ in the salvage base case) and also resulted in a 4% increase to long-term harvest levels.

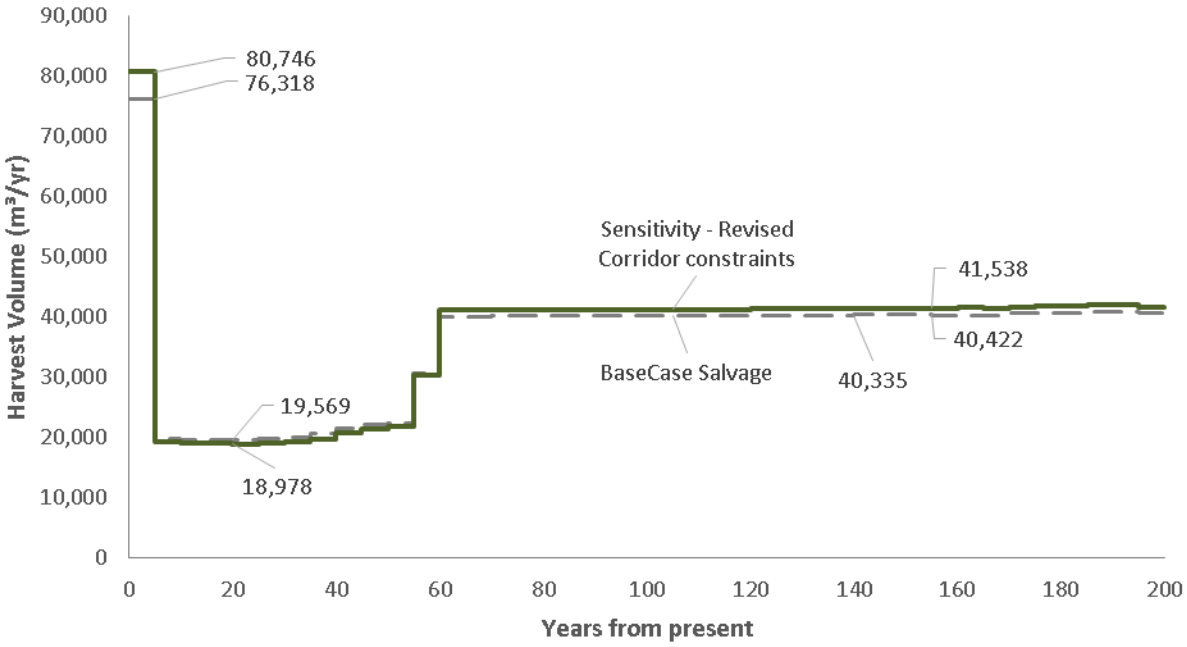

Figure 20 Harvest flow comparison - Salvage Base case Vs. No Corridor Sensitivity

6.5 Biodiversity Corridors Revised Constraints

This sensitivity explored timber supply implications if constraints within corridors are relaxed but not eliminated relative to the base assumptions. Rather than maintaining a maximum of 34% less than 60 years old, this sensitivity assumes a maximum disturbance rate of 34% less than 30 years. Similarly to the previous sensitivity, the relaxed corridor constraints allowed 3% more volume to be salvaged (384,322 m³ vs. 372,300 m³ in the salvage base case) in the short-term as well as a 3% increase in long-term harvest levels (Figure 21 & Figure 22).

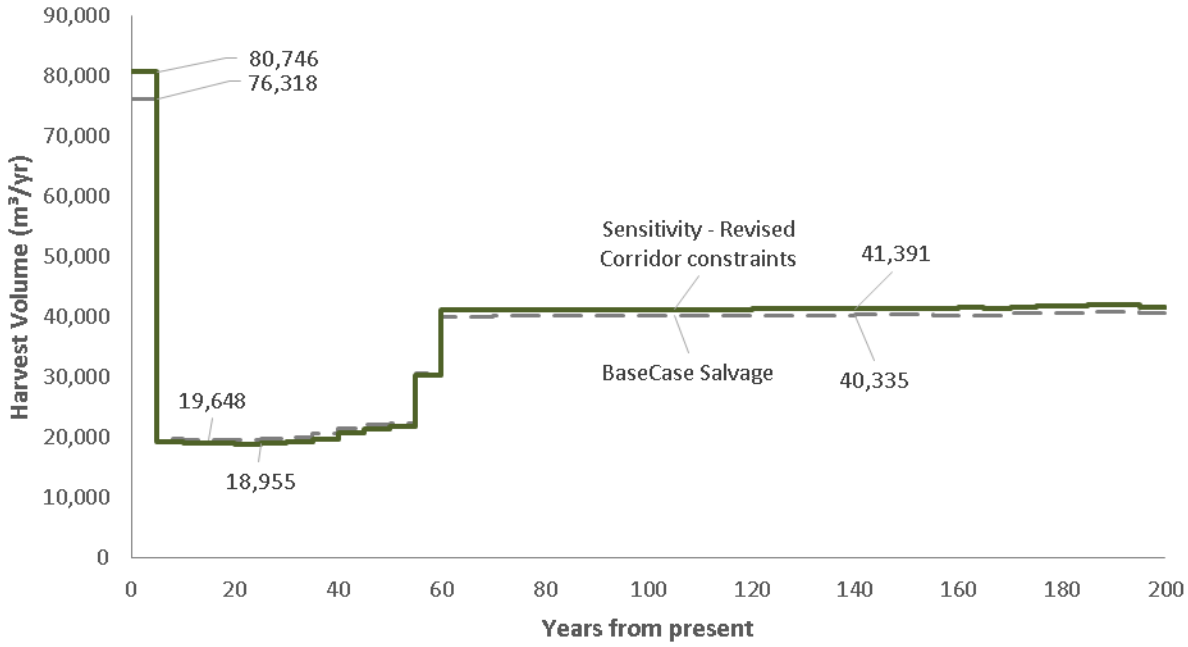

Figure 21 Harvest flow comparison - Salvage Base case Vs. Revised Corridor Sensitivity

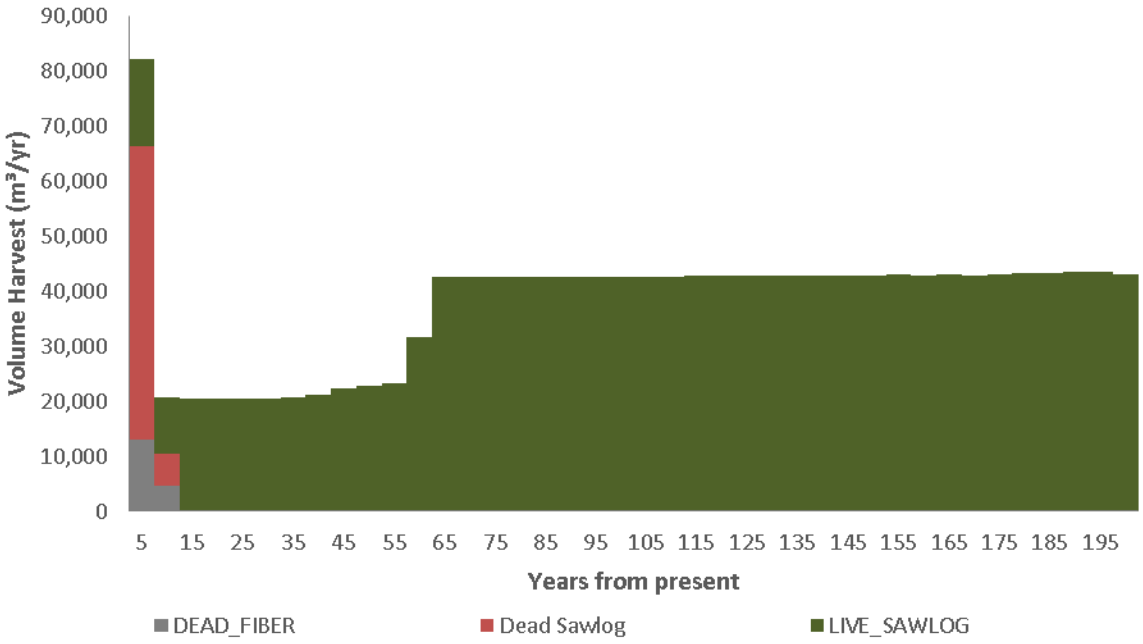

Figure 22 Harvest over Time by Product Condition for the Revised Corridor Sensitivity

6.6 Salvage 1st Period only

The base salvage scenario allowed harvesting in the second period. This scenario forced salvage harvesting to occur in the first period only. Due to the restriction, this scenario salvages more dead material as sawlog (301,249 m³ total), but less dead volume overall (365,795 m³ for this scenario vs. 372,255 m³ for the base salvage scenario). Additionally, more live volume is harvested in the first two

periods relative to the base salvage scenario, which causes mid-term harvest levels to be slightly lower (Figure 23).

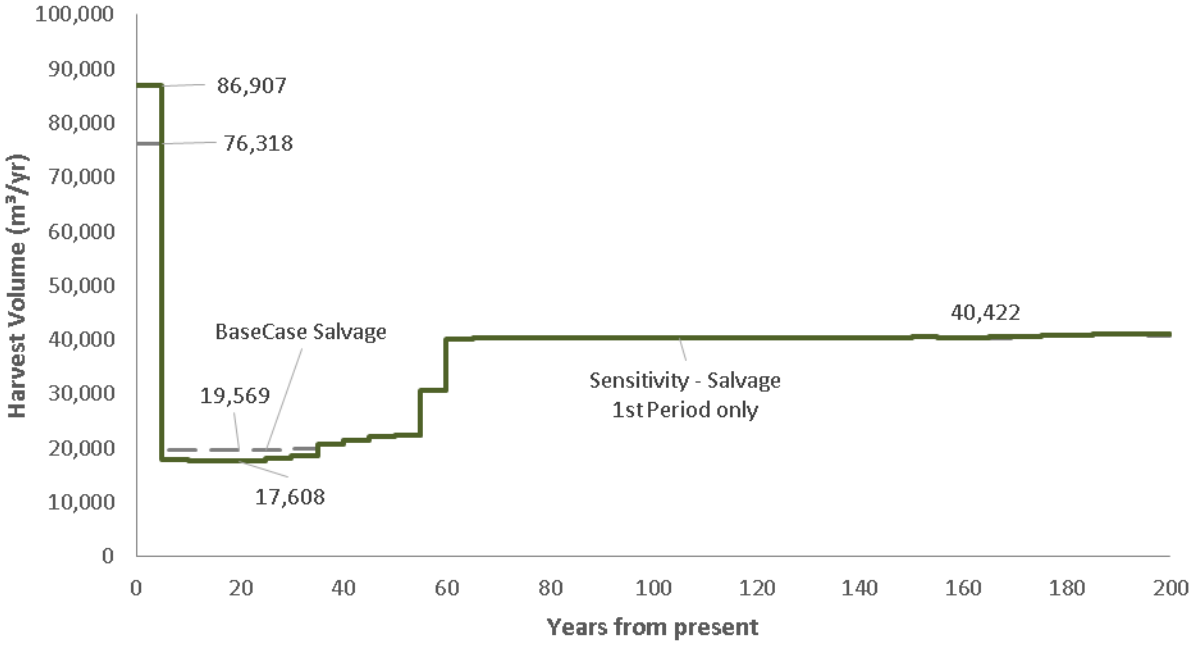

Figure 23 Harvest flow comparison - Salvage base case vs. Salvage 1st period only

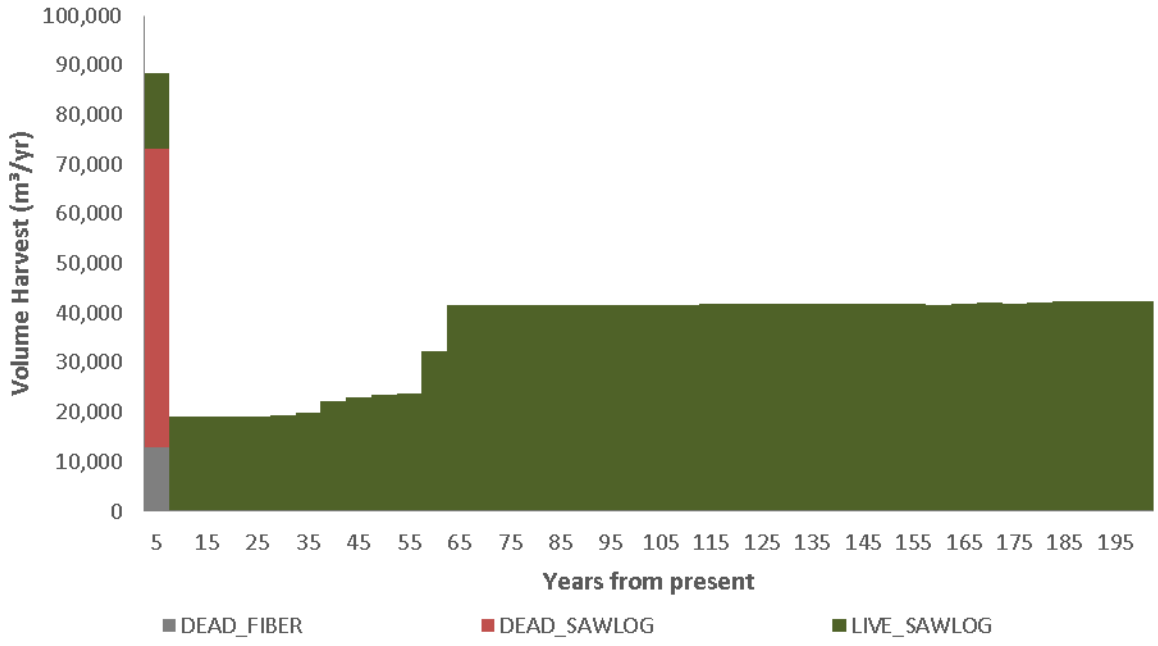

Figure 24 Harvest over Time by Product Condition for the 1st period Salvage only Sensitivity

7 Recommended Scenario

Upon reviewing the base case and its sensitivities, it was realized that spruce beetle mortality assumptions had been applied erroneously and all tree species in spruce stands had been "killed" rather than just the spruce. For this scenario, the model yields were revised so that only the spruce volume was affected and the implications to timber supply were assessed. This change in mortality assumptions resulted in a reduction in the amount of estimated timber killed by the spruce beetle from ~578,000 m^3 to ~324,200 m^3 within the THLB. Although substantially less volume was considered dead, the resulting impact to timber supply relative to previous scenario formulations was relatively small because in order to salvage the dead spruce material, the whole stand is harvested.

This final recommended scenario also recognizes the sensitivity around Hemlock volume coming from parcel H. However, this scenario removed all stands found within unit H where the combined composition of Hemlock and Cedar proportion is > 60%. Applying this assumption reduced the effective THLB area by 2.9% (from 9,201 ha to 8,934 ha).

7.1 Timber Supply

Correcting spruce mortality assumptions and removing HwCw stands >60% reduced the 1 period harvest by 5%, the mid-term by 3% and the long-term by 2% relative to the salvage base case (Figure 25). Reducing the THLB had a downward pressure on mid- and long-term timber supply while correcting salvage assumptions reduced the need to salvage as much wood in the 1st period, which provided more timber available during the mid-term thereby exerting an upward pressure on timber supply during this period. Based on the relatively small difference in timber supply under the revised mortality assumptions, the salvage base case and sensitivities were not updated.

Figure 26 shows the harvest profile by live sawlog, dead sawlog, and dead fiber over time after the spruce mortality assumptions were corrected and updated. This shows significantly less dead material being harvested in the first period relative to the salvage base case. However, the dead material cannot economically be salvaged without also harvesting green timber in the spruce stands.

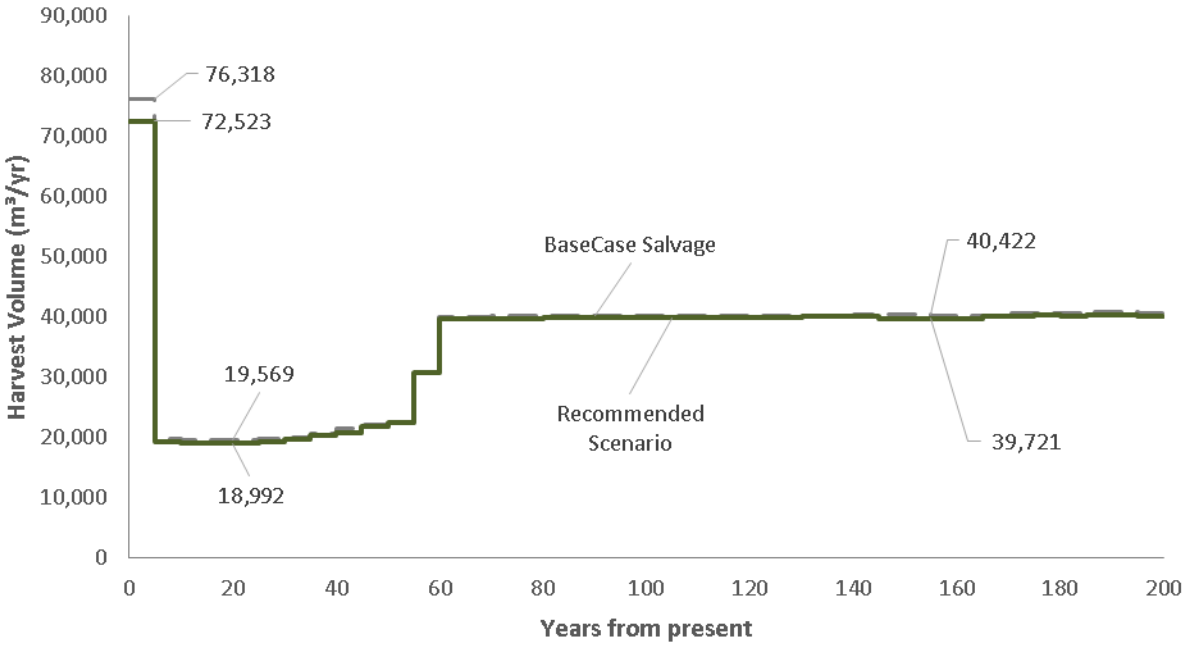

Figure 25 Harvest flow comparison - Salvage Base case Vs. Final Recommended Scenario

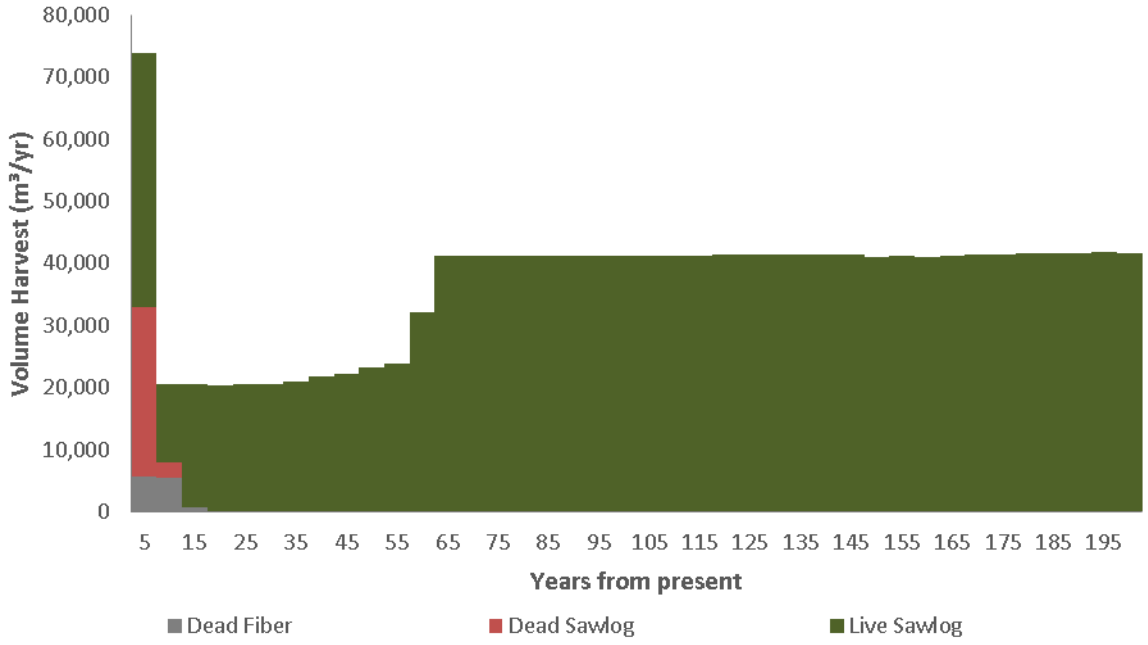

Figure 26 Harvest over Time by Product Condition for the final recommended Scenario

7.2 Growing Stock

Removing stands with HwCw >60% from the THLB had the effect of reducing the initial growing stock relative to the salvage base case (Figure 27). Correcting mortility assumptions had no effect on

initial total growing stock because the same amount of volume was still there, just less of it was considered dead (Figure 28).

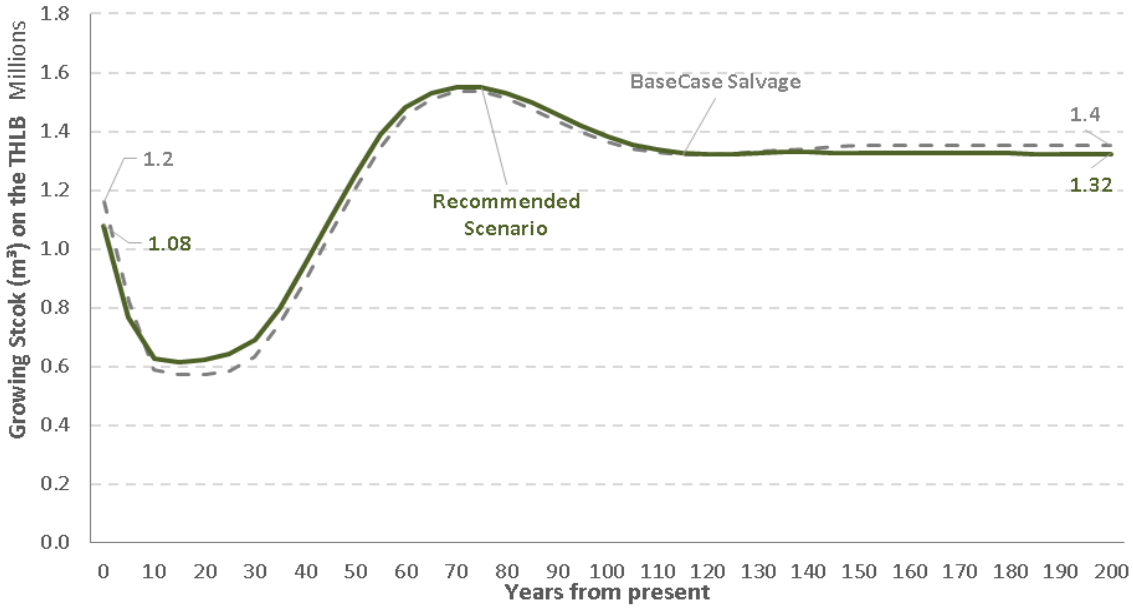

Figure 27 Growing Stock Comparison - Salvage Base case Vs. Final Recommended Scenario

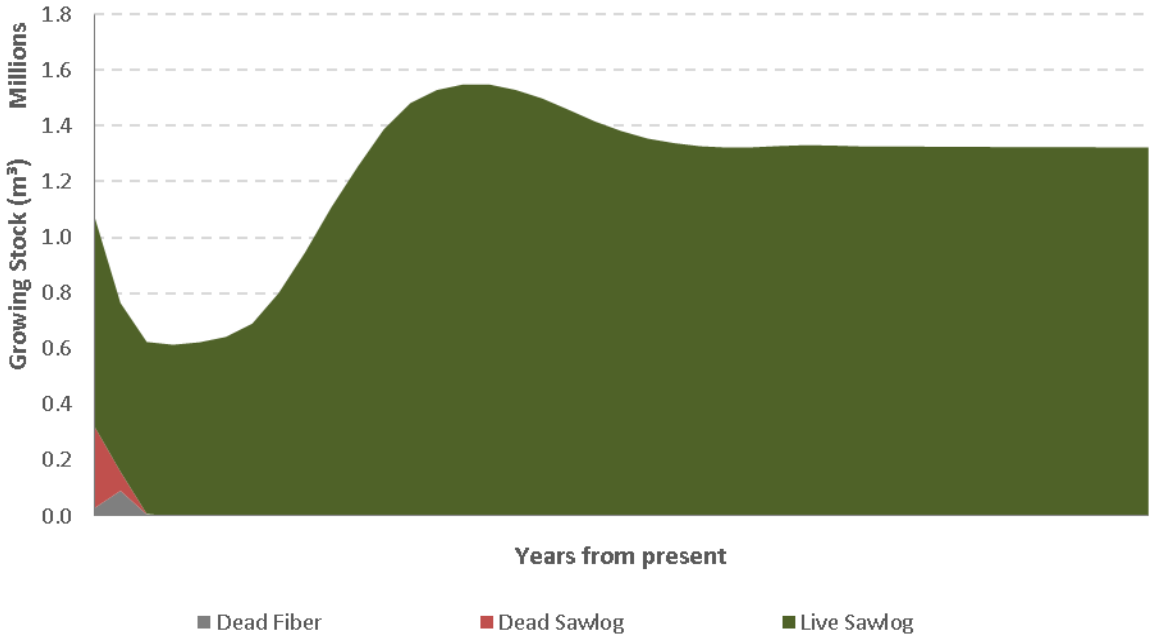

Figure 28 Growing Stock over time by condition and product for the final recommended scenario

7.3 Harvest Attributes

The effect of removing HwCw >60% stands and revising spruce mortality assumptions on average harvest age, average harvest volume yield, and harvest area can be seen in Figure 29, Figure 30, Figure 31, respectively.

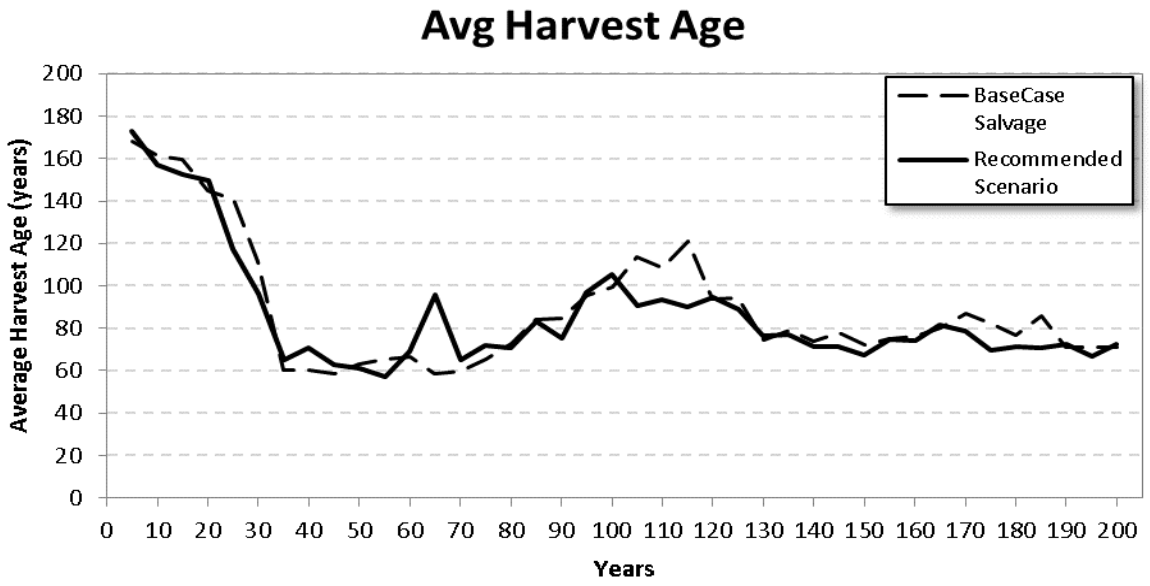

Figure 29 Average harvest age comparison - Salvage Base case Vs. Final Recommended Scenario

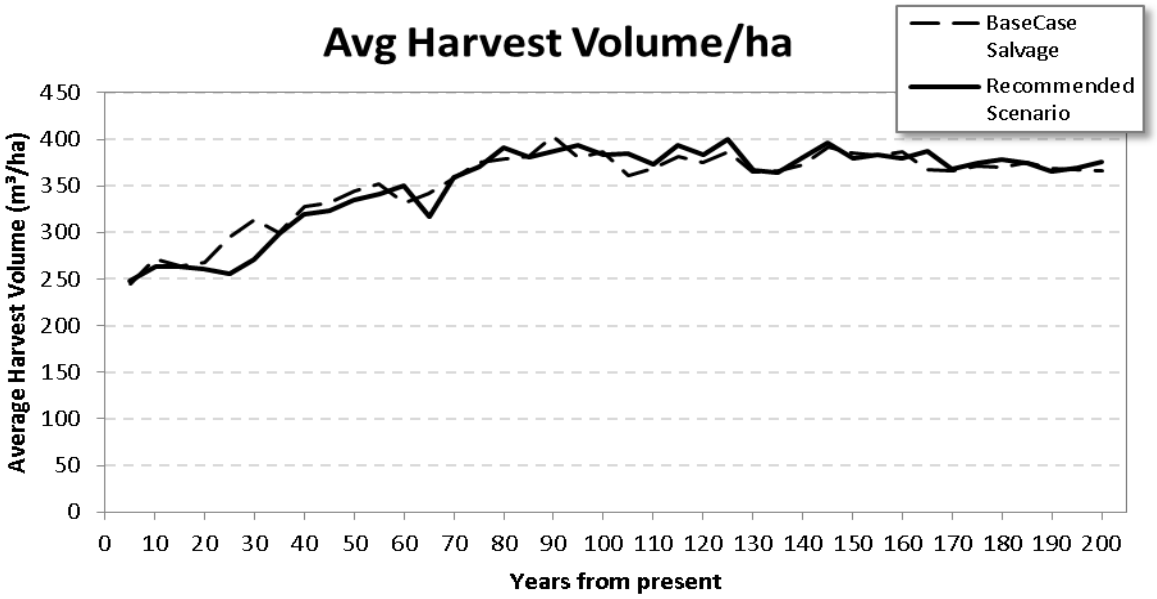

Figure 30 Average harvest yield (m³/ha) Comparison - Salvage Base case Vs. Final Recommended Scenario

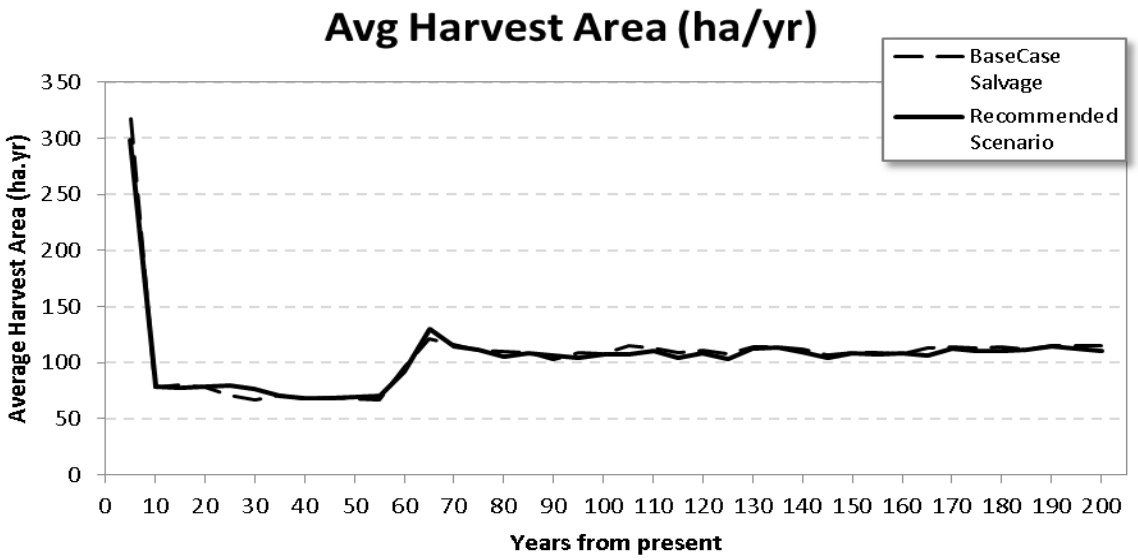

Figure 31 Average harvest area (ha/yr) Comparison - Salvage Base case Vs. Final Recommended Scenario

7.4 Age Class Profile

The age class distributions for the THLB at 0, 50, 100, and 200 years in the future for the salvage base case scenario are shown in Figure 32. The forest dynamics under this scenario are still very similar to the salvage base case scenario. By then end of the planning horizon, the forest age class distribution is fairly evenly distributed across age class below 70 years, with some old forest reserved to meet old seral requirements.

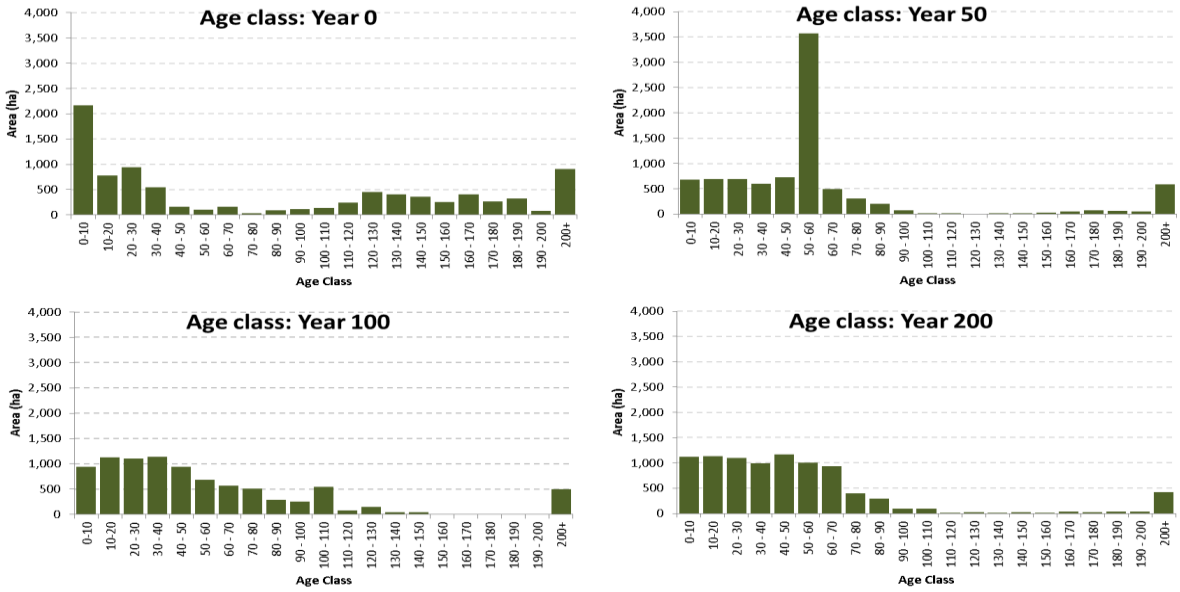

Figure 32 Age Class distribution on the THLB at 0, 0, 100, and 200 years from now for the final recommended scenario

7.5 Old Seral Requirements

The percent of each parcel in an "Old" condition for the final recommended scenario (>120 years old) relative to modeled requirements is shown in Figure 33. As with the salvage base case, the modeled old seral requirements have limited impacts to timber supply. Since stands with HwCw >60% in Unit H were removed from the THLB under this scenario, the rapid early depletion of old seral area that occurred in the salvage base case does not occur under this scenario.

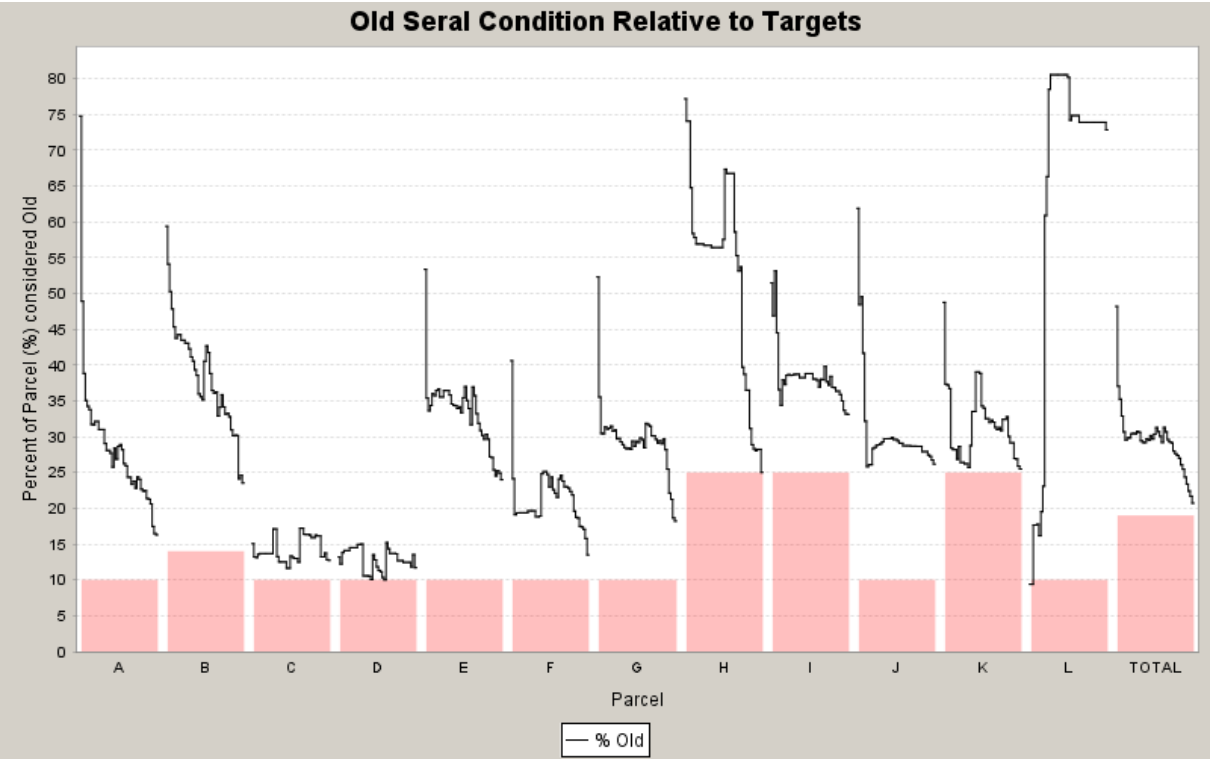

Figure 33 Old seral condition over time relative to modeled requirements for the final recommended scenario

8 Scenario Summary / Discussion

8.1 Harvest flow Summary

Table 6 shows a summary of harvest flows for the scenarios modeled for this analysis.

Table 6 Harvest flow summary for modeled scenarios

Sensitivity Description	Harvest Rate (m³/yr)			Percent Change Relative to Salvage Base Case		
	Initial Rate	Mid-Term	Long-Term	Initial Rate	Mid-Term	Long-Term
Salvage Base Case	76,318	19,569	40,422	-	-	-
Higher Spruce Mortality	91,281	16,396	40,207	20%	-16%	-1%
Shelf-Life	71,977	17,723	40,359	-6%	-9%	0%
Hemlock	76,721	16,131	39,013	1%	-18%	-3%
No corridor	89,729	20,137	42,185	18%	3%	4%
Revised Corridor	80,746	18,955	41,468	6%	-3%	3%
1st Period salvage only	86,907	17,679	40,473	14%	-10%	0%
Final Recommended	72,523	18,992	39,721	-5%	-3%	-2%

8.2 Salvage "Efficiency" Comparison

Each scenario's salvage "efficiency" can be measured by comparing the initial growing stock considered killed to the total dead volume harvested (Figure 34). The scenario able to salvage the most dead volume was the No Corridor sensitivity. Conversely, the scenario least able to salvage dead volume was the shelf-life sensitivity. Correcting the spruce mortality assumptions for the final recommended scenario had little bearing in the ability to salvage timber killed by the spruce beetle relative to the salvage base case.

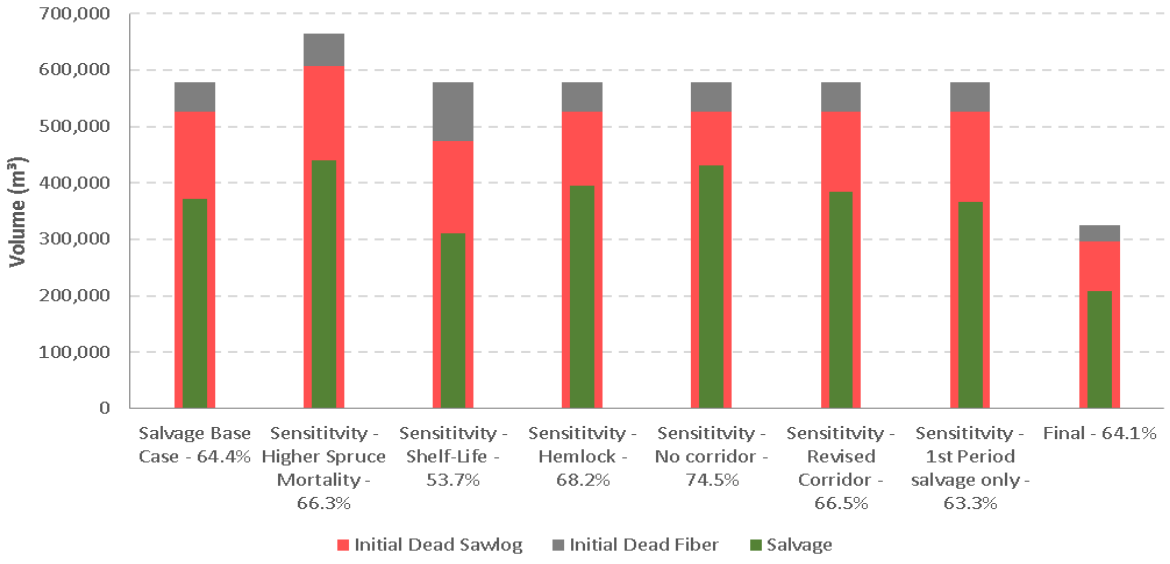

Figure 34 Salvage "efficiency" for each modeled scenario (Initial growing stock vs. salvaged volume)

8.3 Implications of Inventory Volume Predictions

The inventory volume comparison in Section 3 showed that CNC's new inventory may be significantly underestimating volume in older spruce/balsam stands. It is important to recognize that the vast majority of stands harvested in the first few periods are in these very stands. If the areas selected for harvest in the final recommended scenario are indeed harvested in reality, it is likely the realized volume coming from these stands will equate to much higher volume totals than forecasted by this analysis.

Appendix A – Data Package

College of New Caledonia CNC Research Forest

Data Package

Version 1.1

September 2017

Project 679-1

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1 Introduction

The College of New Caledonia (CNC) is preparing to a complete timber supply review for its Research Forest. Although CNC just recently completed a timber supply review in 2016, spruce beetle is at epidemic levels within and around the Northern Research Forest units and is continuing to cause new spruce mortality. This document outlines the information and assumptions that are proposed to be used in forest estate modelling to support a review of the timber supply within the forest.

1.1 Study Area

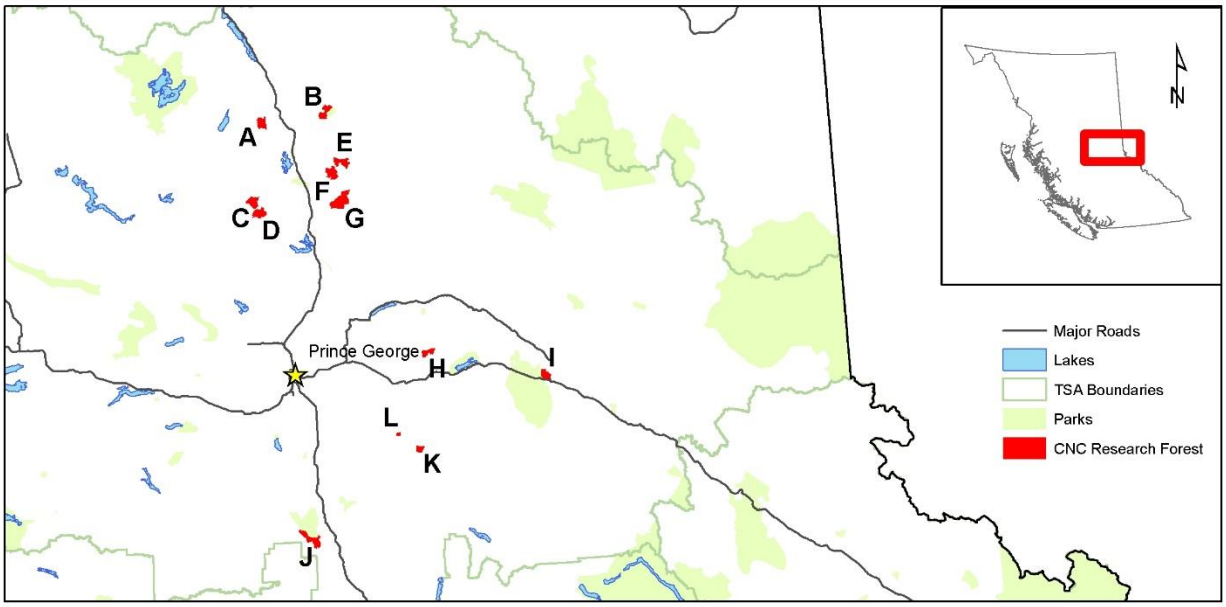

Figure 1 Location Map of CNC Research Forest Management Units A through L

1.2 Data Sources

Many different spatial data layers were compiled to provide input into the forest estate modeling. The final planning inventory was developed by Forsite using the ESRI ArcGIS software suite and Python programming language. The use of these data layers is described in more detail in subsequent sections.

Table 1 Input Data Sources

Spatial Data	Source(s)	Feature Name	Effective
Wetlands	WHSE_BASEMAPPING_FWA_WETLANDS_POLY	Wetlands	2017
Riparian Buffers	Forsite Generated from: Classified streams provided by CNC, WHSE_BASEMAPPING_FWA_LAKES_POLY_polygon, WHSE_BASEMAPPING_FWA_WETLANDS_POLY_polygon,WHSE_BASEMAPPING_FWA_RIVERS_POLY_polygon	RiparianBuffers	2017
Road Buffers	Buffered roads provided by CNC	RoadBuffers	2017
Vegetation Resources Inventory Rank 1	Inventory captured and typed by Ecora, processed into VRI rank 1 format by MoFLNRO	vri_rank1	2016

Spatial Data	Source(s)	Feature Name	Effective
Recent Harvest Blocks	CNC_Harvested_Blocks_Mar2017.shp provided by CNC	CNC_Harvest_Blocks	2017
Wildlife Tree Patches	CNC_Prescribed_WTP_Mar2017.shp provided by CNC	CNC_Prescribed_WTP	2017
Visuals	REC_VLND_polygon.shp	REC_VLND_polygon	2017
CNC Boundary	CNC_S24940 provided by CNC	CNC_S24940_ms	2017
Steep slopes	Surface generated from LiDAR 1m contours	Steep	2017
Wildlife Corridors	Bio_Corridors_Merge.shp provided by CNC	Bio_Corridors	2017

1.3 Inventory

Newly acquired Vegetation Resources Inventory (VRI) current to 2017 was used for this analysis. Inventory attributes (Age) attributed to 2016 were projected forward 1 year to 2017 and depletions were reflected using harvest blocks and roads current to March 2017.

2 Land Base Assumptions

Land base assumptions are used to define the contributing forest landbase (CFLB) and the timber harvesting land base (THLB) in the research forest. The THLB is designated to support timber harvesting while the CFLB is identified as the broader productive forest that can contribute toward meeting non-timber objectives (e.g. biodiversity). The land base area summary is provided in Table 2.

Table 2 Area Land Base Assignments

Land Base Assignment Category	Gross Area (ha)	Effective Area (ha)	% Total Area	% of CFLB
Total Area	**12,567**	**12,567**	**100%**	
Less:				
Non-Forest / Non-Productive	221	221	2%	
Existing Roads	83	80	1%	
Crown Forested Land Base (CFLB)		**12,266**		**100%**
Less:				
Physically Inoperable / Steep Slopes	776	664		
Low Productivity (SI <8 or never reaches 140 m³/ha)	1,522	979	5%	5%
Problem Forest Types:				
Black Spruce	154	0	0%	0%
Deciduous	354	5	0%	0%
Hemlock & Cedar Leading	117	105	1%	1%
Riparian Reserve Zones	779	402	3%	3%
Timber Harvesting Land Base (THLB)		**10,111**		**82%**
Less Aspatial Netdowns**:				
Stand Level Retention (9%)		910		7%
Net Effective Harvestable Land Base		**9,201**		**75%**

*Effective netdown area represents the area that was actually removed as a result of a given factor. Removals are applied in the order shown above, thus areas removed lower on the list do not contain areas that overlap with factors that occur higher on the list. For example, lake buffers netdown does not include non-forested area.

**Aspatial netdowns are applied in the model or yield curves and are not reflected in the GIS dataset areas.

2.1 Non-Vegetated / Non-Forested

British Columbia Land Cover Classification (BCLC) fields were not populated in the VRI rank 1 delivery so a combination of other VRI fields plus the Freshwater Wetlands feature were used to determine Non-vegetated / Non-Forest. All VRI polygons with LAND_COVER_CLASS_CD_1 attributes of "LA" (Lakes) and "RI" rivers **or** if SPECIES_CD_1 was NULL and no harvest history **or** WETLAND_RIPCD was not NULL and did not have a treed LAND_COVER_CLASS_CD_1 ('TB', 'TC', 'TM).

2.2 Existing Roads

An existing road inventory (line feature class) was provided by CNC that had road widths attributed. This feature was buffered on each side by half the attributed road widths to determine netdowns for roads.

2.3 Operability Restrictions – Steep Slopes

Slopes over 45% were identified using a digital elevation model (DEM) generated from liDAR-derived contours. Polygons of >45% slopes were generated and some processing of the steep feature was done to aggregate steep areas that were close together (arcpy.AggregatePolyons_Cartography) and eliminate small 'donut' holes (arcpy.EliminatePolygonPart_managment) up to 2ha in size. This process identified approximately 51 ha of which 47 ha were effectively removed from the land base.

2.4 Low Productivity

Low productivity sites (< 8 SI) have natural yields that never achieve 140 m³/ha conifer volume and were therefore removed from the THLB. To assess the 140 m³/ha cutoff, the balsam component was reduced by 30%. Areas that had previous harvesting history were not excluded even if they met this criteria.

2.5 Problem Forest Types & Deciduous

Problem forest types are stands which are physically operable and meet the low site criteria but are not currently utilized or have marginal merchantability. For this analysis, the following stands are considered problem forest types and were excluded from the THLB. Any of these stand types with previous logging history (managed) were not excluded from the THLB.

2.5.1 Black Spruce

Areas with black spruce as the leading species were removed from the THLB. Although approximately 150 ha exist within the CNC research forest, all were removed for other reasons (e.g. low productivity).

2.5.2 Deciduous

Deciduous leading stands (SPECIES_CD_1 in ["ACB", "ACT", "AT", "EP"]) were removed from the THLB. Since most deciduous stands never reach 140 m³/ha conifer volume, most of these areas were removed during the low productivity netdown.

2.5.3 Hemlock and Cedar Leading

Cedar or Hemlock leading stands outside of Parcel H were removed from the THLB.

2.6 Riparian

Classified stream line work was provided by CNC while freshwater atlas rivers, Lakes, and Wetlands were obtained from DataBC. These riparian features were buffered according to their riparian class by the effective riparian buffers identified in Table 3. These buffers identified approximately 778 ha of which 485 ha were removed for this netdown reason.

Table 3 Riparian Buffers Applied

Riparian Class	Qualities that Define Riparian Class	Riparian Management Area (m)	Riparian Reserve Zone (m)	Riparian Management Zone (m)	Effective Riparian Buffer (m)
S1 – B	Fish Bearing & > 20m Wide	70	50	20	54
S2	Fish Bearing & 5m to 20m wide	50	30	20	34
S3	Fish Bearing & 1.5m to 5m wide	40	20	20	44
S4	Fish Bearing & < 1.5 m wide	30	0	30	5
S5	Non-Fish Bearing & >3m wide	30	0	30	5
S6	Non-Fish Bearing & <3m wide	20	0	20	5
W1 or W5	>5 ha	50	10	40	26
W3	1 to 5 ha	30	0	30	12
L1-B	>5 Ha to 1000ha	10	10	0	26
L3	1 ha to 5 ha	30	0	30	12

3 Non-Timber Management Assumptions

3.1 Long-Term Wildlife & Connectivity Corridors

CNC provided a spatial feature representing long-term and wildlife connectivity corridors. This feature was incorporated into the modeling planning file. Stands within this these corridors are eligible for harvest if they are over 119 years old however, only 34% of the corridor area within each parcel can be younger than 60 years old.

3.2 Prescribed Wildlife Tree Patches & Stand-Level Biodiversity

CNC provided a spatial feature identifying prescribed Wildlife Tree Patches (WTPs). These areas are not available for harvest until 59 years post-regeneration/planting of their associated cutblocks. Each WTP is to be locked from harvest eligibility for 59 years from the WTP established date.

3.3 Landscape-Level Biodiversity

Old seral requirements were incorporated into the modeling so that over all the units, at least 19% must be retained as old forest (>120 years) at all times. Since the research forest is composed of several geographically separate parcels, a specific minimum threshold has been assigned to each parcel.

Table 4 Landscape Level Biodiversity Old Seral Retention Targets

Research Forest Unit	Projected Old Non-Pine Percentage
A – Kerry Lake	10%
B – Tacheeda Lakes	14%

Research Forest Unit	Projected Old Non-Pine Percentage
C – Caine Creek	10%
D – Caine Creek	10%
E – Chuchinka Creek	10%
F – Chuchinka Creek	10%
G – Angusmac Creek	10%
H – Purden Mountain	25%
I – Hungary Creek	25%
J – Fraser River	10%
K – Willow River	25%
L – Willow River	10%
Total for All Units	19%

3.4 Visual Quality Objectives

Visual quality objectives (VQOs) will be addressed in the model using Plan to Perspective (P2P) ratios and Visually Effective Green-up (VEG) heights determined for 5% slope class increments, as well as VQO by percent alterations. The P2P ratios and VEG heights by slope class, as well as the allowable VQO percent alterations are detailed in Table 5 and Table 6 respectively.

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

Table 5 P2P Ratios and VEG Heights by Slope Class

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

Table 6 VQO by Percent Alterations

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

4 Harvesting Assumptions

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

4.1 Tree Utilization

Tree utilization standards used to determine merchantable volumes for this analysis are shown in Table 7.

Table 7 Utilization Standards

Species	Minimum Diameter at Breast Height (DBH) cm	Maximum Stump Height (cm)	Minimum Top Diameter (cm)
Lodgepole Pine	12.5	30.0	10.0
Other Conifer	17.5	30.0	10.0
Deciduous	17.5	30.0	10.0

4.2 Minimum Harvest Criteria

In order for a stand to be considered economic and eligible for harvest within the model it must meet the minimum volume per hectare (MVH) of 140 m³/ha and or when the stand achieves 95% of the culmination mean annual increment (CMAI), whichever is more constraining. Stands that never meet the MVH are removed from the THLB, as described in Section 2.4.

Balsam stands: When assessing stands against the 140 m³/ha minimum, the volume of all natural balsam was reduced by 30%. Recent harvesting in old, natural balsam stands has demonstrated that well over 30% of the balsam volume is note recovered or usuable.

4.3 Harvest Priority

Based on the new inventory data, none of the remaining dead pine killed by the Mountain Pine Beetle are salvageable because they are economically inoperable (low stand volume), or the protection of the future potential yield of the live component is a higher priority, or the stand has a high biodiversity value. Therefore, no harvest priority will be placed on dead pine salvage. Stands with dead pine may still be selected for harvest in any period as long the remaining live portion of the stand meets the minimum harvest criteria (after applying shelf-life assumptions).

The current and ongoing spruce beetle epidemic is the driving harvest priority. For units A through G, it is assumed that all stands >99 years old (regardless of the percent spruce composition) will experience about 83% damage from spruce beetle and/or windthrow by post-attack year 1. In units H, I, J, K, and L, it is assumed that spruce-leading stands will experience 33% mortality by post-attack year 1, starting with the oldest spruce-leading stands. Therefore, operationally and in the modelling environment the priority is to harvest stands already attached, or where attack is anticipated, by spruce beetle.

4.4 Silvicultural Systems

The dominant silviculture system used in the CNCRF is clearcut with reserves (WTPs, riparian reserves, etc.) and this is how treatments will be recognized in the model.

5 Growth and Yield Assumptions

5.1 Analysis Unit Characteristics

Often natural stands are stratified into analysis units to produce weighted average yield curves for modelling. However in this analysis a yield curve was generated for each individual VRI polygon. In contrast, the yield curves (both existing and future) for managed stands were generated by stratifying the AVI into analysis units based on Leading species and site productivity class. Table 8 shows a summary of the analysis units for future managed yield curves and their associated area distribution.

Table 8 Analysis Unit Stratification Characteristics

Leading Species	Site index Range (managed Site Index)	AU Name	THLB Area (ha)
Balsam fir	>=22	BL-VG	228
Balsam fir	>=18 and <22	BL-G	3,086
Balsam fir	>=12 and <18	BL-M	365
Douglas-fir	>=22	FDI-VG	65
Douglas-fir	>=18 and <22	FDI-G	284
Hemlock	>=18 and <22	HW-G	444
Lodgepole pine	>=22	PLI-VG	114
Lodgepole pine	>=18 and <22	PLI-G	636
Black spruce	>=8 and <12	SB-P	1
White spruce	>=22	SX-VG	312
White spruce	>=18 and <22	SX-G	5,399
White spruce	>=12 and <18	SX-M	112
White spruce	>=8 and <12	SX-P	13
Total			**11,059**

5.2 Stand Projection Models

Yield curves developed for existing natural stands were prepared using the Variable Density Yield Prediction (VDYP) 7 for each forest cover polygon. Existing and future managed stand yield curves were generated using the Table Interpolation Program for Stand Yields (TIPSY) 4.3, for each AU.

5.3 Decay, Waste, and Breakage

For natural stands, reductions to stand volume for decay, waste and breakage factors were set to the default provincial stand loss factors. These factors were applied in the development of the VDYP7 yield curves.

For managed stands, operational adjustment factors (OAF) are utilized in the TIPSY model. An OAF1 of 20% was applied for pine-leading stands and 15% for all other species, while OAF2 increases from 0% to 5% by the time the stands reach 100 years of age.

5.4 Managed and Natural Stand Definitions

To project stand growth and yield, stands are classified as natural or managed stands based on their year of establishment. Natural stands are considered to be stands established prior to 1987. Natural stand yields are generated using VDYP. Managed stands are considered to be stands established post-1987. Existing and future managed stand yields are generated using TIPSY.

Stands that are disturbed through harvesting regenerate to a managed stand, whereas stands that are disturbed by a natural agent (and not salvaged) regenerate to a natural stand.

5.5 Site Index Assignments

Site index reflects the potential productive capacity of a stand. The inventory site index was used as the site productivity input to develop yield curves for existing natural stands while the managed site index was used for existing managed and future managed stands.

For this analysis, an area-weighted average site index for managed stands was calculated for each leading species type using the Provincial Site Productivity Layer estimates. Site indices are sourced from the Provincial Site Productivity Layer. The distribution of both the natural and managed stand site indexes are shown in Figure 2.

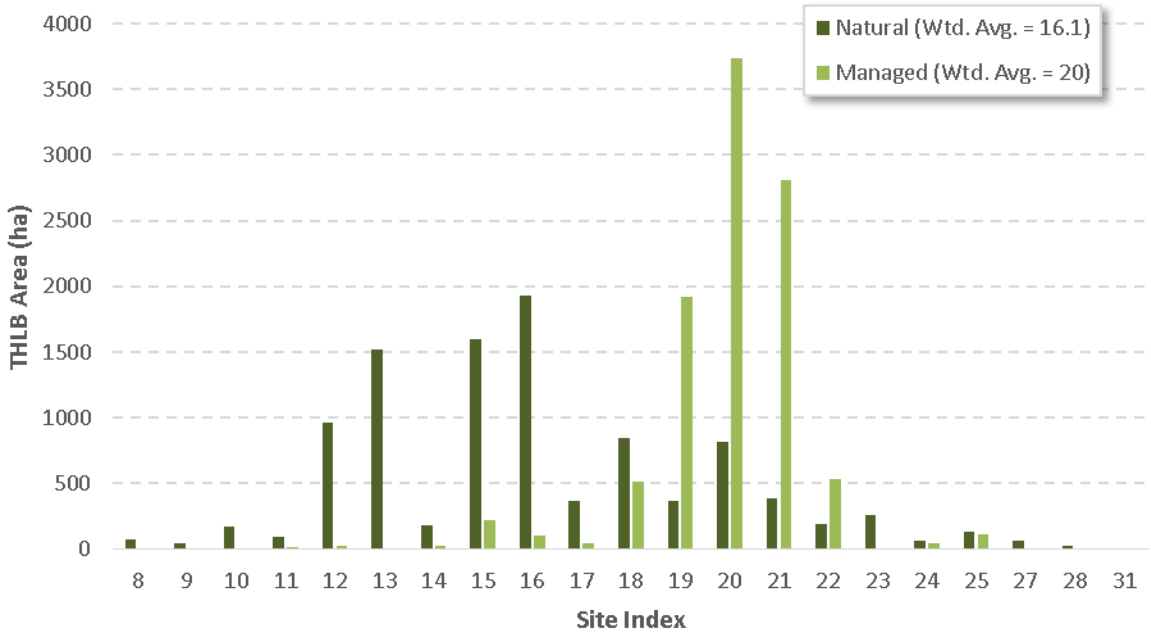

Figure 2 Distribution of Natural and managed Stand Site Index over the THLB

5.6 Regeneration

Regeneration assumptions (TISPY inputs) for existing and future managed stands are summarized in Table 9.

Table 9 Regeneration Assumptions for Existing and Managed Stands

Current Leading Species	Planted Species Composition	Regen Delay (yr)	OAFs		Method		Initial Density
			1	2	Type	%	
Balsam	Sx6Bl4	1	15	5	Plant	100	1600
Cedar	Sx3Cw3Hw3Bl1	1	15	5	Plant	100	1600
Douglas Fir	Fd5Sx3Pl2	1	15	5	Plant	100	1600
Hemlock	Hw5Sx3Bl10Cw10	1	15	5	Plant	100	1600
Pine	Pl7Sx3	1	20	5	Plant	100	1600
Black Spruce	SB5SX5	1	15	5	Plant	100	1600
Spruce	Sx7Bl3PL1	1	15	5	Plant	100	1600

5.7 Mountain Pine Beetle

The mountain pine beetle (MPB) peaked in the CNCRF between 2005 and 2008 and has since leveled off. Unsalvaged losses due to MPB are dependent on the shelf life and amount of merchantable volume attributed to the affected land base. This analysis assumes that the MPB outbreak has ended and there will be no further MPB mortality

In the CNCRF the estimated level of pine mortality in affected mature stands is 92%, which equates to a median stand-level mortality of 46%. In the CNCRF, the area-weighted average time-since-death in MPB-impacted stands is 11 years. Merchantable pine volume within an attacked stand decreases over time as dead stems degrade. For the purpose of this analysis, the remaining standing dead pine volume was ignored.

5.8 Spruce Beetle

For Units A to G, the assumption is that all stands >99 years old with a component of spruce (regardless of the percentage of spruce) will experience approximately 83% damage from spruce beetle and/or windthrow by year 1.

For Units H, I, J, K, and L, the assumption is that spruce beetle management may be more effective, but the mortality results will be similar where beetle attack is successful. Any spruce-leading stands may have 83% mortality applied in year 1, starting with the oldest spruce-leading stands. The accumulation of spruce beetle mortality will be stopped when 33% of the total spruce-leading volume within a unit has been selected for mortality.

The shelf life assumptions used for this analysis area a simple 10% loss of spruce volume for every year starting 1 year post-attack (Table 4).

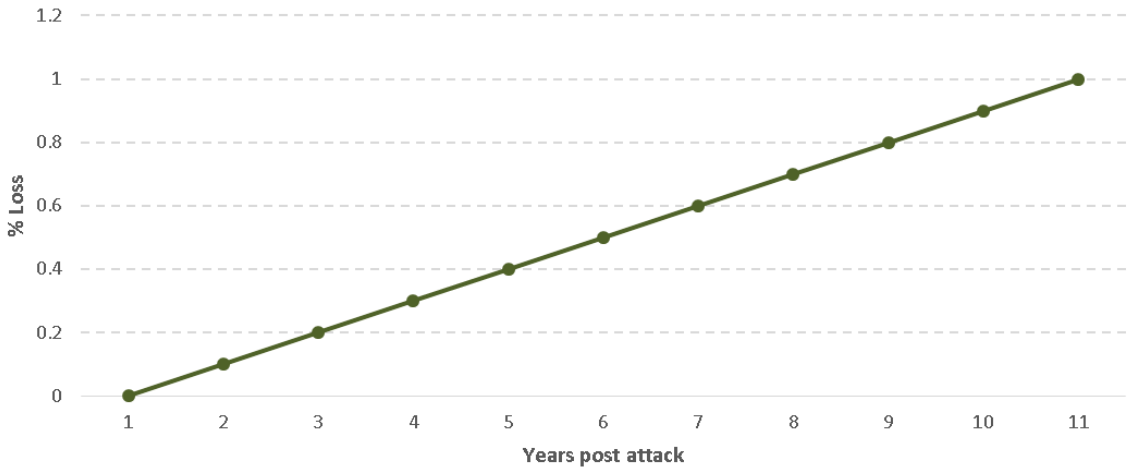

Figure 3 Shelf-life assumptions for Spruce post-Spruce Beetle Attack

Update: The base case scenarios and the sensitivities performed incorporated mortality to all species volumes within identified spruce stands affected by the spruce beetle. The final recommended scenario applied mortality assumptions to spruce volumes only.

6 Natural Disturbance Assumptions

6.1 Natural Disturbance within the THLB

Disturbances within the THLB are modeled as unsalvaged, or non-recoverable losses (NRL). This analysis adopted the NRL used for the Prince George TSR V, which were pro-rated to the CNCRF based on the area of THLB relative to the Prince George TSA. This came to 1420 m^3/yr. This amount was subtracted from modelled outputs prior to reporting.

6.2 Natural Disturbance within the NHLB

Stands on the entire land base were modeled using a 350 lifespan.

7 Modelling Assumptions

7.1 Patchworks™ Model Description

For forecasting and analysis, the PATCHWORKS™ modeling software was used. This suite of tools is sold / maintained by Spatial Planning Systems Inc. of Deep River, Ontario (www.spatial.ca).

Patchworks is a fully spatial forest estate model that can incorporate real world operational considerations into a strategic planning framework. It is unique in its ability to dynamically assess spatial relationships during modeling and adapt solutions to achieve spatial objectives. It utilizes a goal seeking approach and an optimization heuristic to schedule activities across time and space in order to find a solution that best balances the targets/goals defined by the user. Targets can be applied to any aspect of the problem formulation. For example, the solution can be influenced by issues such as mature/old forest retention levels, young seral disturbance levels, patch size distributions, conifer harvest volume, growing stock levels, snag densities, CWD levels, ECA's, specific mill volumes by species, road building/hauling costs, delivered wood costs, net present values, etc. Patchworks continually generates alternative solutions until the user decides a stable solution has been found. Solutions with attributes that fall outside of specified ranges (targets) are penalized and the goal seeking algorithm works to minimize these penalties – resulting in a solution that reflects the user's objectives and priorities.

Patchworks' flexible interactive approach is unique in several respects:

- Patchworks' interface allows for highly interactive analysis of trade-offs between competing sustainability goals.
- Patchworks integrates operational-scale decision-making within a strategic-analysis environment: realistic spatial harvest allocations can be optimized over long-term planning horizons. Patchworks can simultaneously evaluate forest operations and log transportation problems using a multiple-product to multiple-destination formulation. The model can identify in precise detail how wood will flow to mills over a complex set of road construction and transportation alternatives.
- Allocation decisions can be made considering one or many objectives simultaneously and objectives can be weighted for importance relative to each other. (softer vs. harder constraints)
- Allocation decisions can include choices between stand treatment types (Clearcut vs. partial cut, fertilization, rehabilitation, etc.).

- Unlimited capacity to represent a problem – only solution times limit model size.
- Fully customizable reporting on economic, social, and environmental conditions over time. Reports are built web-ready for easy sharing of analysis results – even comparisons of multiple indicators across multiple scenarios.

7.2 Blocking

Table 10 Blocking Assumptions

Criteria	Factor Applied
Blocking	Polygons were grouped into blocks using the built-in patchworks blocking tool (group fragments). Multi-part blocks were created with a target block size of 25 ha. A 20 m distance threshold was used meaning that polygons up to 20 m apart could be considered part of the same block. Blocks were stratified on the following attributes: Yield Groups (AU), Operational Planned Year (OPPLANYEAR), and Contributing Classification (i.e. Net land base vs. net harvest land base) and were not allowed to contain polygons with more than a 10 year age gap.
Target Block Size	A target block size of 20 ha was used. The blocking tool will attempt to group polygons into 20 ha blocks as long as they meet the specified stratification criteria.
Minimum Block Size	Efforts were made to minimize the incidence of very small blocks (Blocks > 0.1 ha). This is not dependant on the patchworks blocking tool but rather through a GIS eliminate process conducted on the input spatial modeling file.

7.3 Harvest Priorities and Target Weightings

The concept of harvest priorities (e.g. oldest first) is not relevant in an optimization/heuristic model. However, within Patchworks, it is necessary to weight various targets or objectives relative to each other so that solutions reflect management priorities. . In this analysis, the harvest volume target was weighted substantially lower than all other targets to insure that non timber objectives were not sacrificed to deliver volume. Using this approach harvest volume is attractive to the model only when all other issues have been addressed (e.g. old seral objectives). Weighting takes into account the scale of different units associated with targets (ha vs m^3 vs %'s) when setting weightings.

Patchworks generates millions of alternative solutions and ranks them depending on how well they achieve the user's objectives. For this reason the user must decide when terminate the search for a better solution. A search is terminated when a specific defined criterion for a 'stable' solution has been achieved. This helps ensure that differences between scenario results occur because of model input differences and not from extra effort spent finding a better solution. For the purpose of this project, Patchwork results were accepted once the objective function improved by less than 0.001% over 250,000 iterations.

8 Long Run Sustainable Yield Calculation

The Long Run Sustainable Yield (LRSY) is theoretically the largest yield that can be harvested from a forest over an indefinite period. It assumes that stands are harvested when they reach their maximum or culmination mean annual increment (CMAI) and that there is an equal amount of each in each age class and AU (i.e. fully regulated forest). It also assumes there are no non-timber constraints applied. For this analysis, it was calculated by determining the maximum Mean Annual Increment of each future managed AU and multiplying the THLB area within each AU.

Table 11 Long-Run Sustained Yield Calculation

AU	CMAI Age	CMAI (m^3/ha/yr)	Net THLB Area (ha)	LRSY (m^3/yr)
BL-VG	85	4.341	202	876
BL-G	75	5.347	2,429	12,989
BL-M	80	4.738	302	1,429
FDI-VG	110	2.584	48	123
FDI-G	70	5.629	233	1,312
HW-G	85	4.945	370	1,829
PLI-VG	75	4.079	102	416
PLI-G	65	5.529	577	3,193
SX-VG	65	6.005	275	1,653
SX-G	75	4.821	4,561	21,990
SX-M	115	3.049	90	275
SX-P	145	2.349	12	27
	Wtd. Avg	**5.012**	**9,201**	**46,113**