

Little Bobtail Wildfire Ecosystem Restoration Plan

SOCIETY FOR ECOSYSTEM RESTORATION IN NORTHERN BRITISH COLUMBIA

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PROJECT [1230-7]

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Executive Summary

The Society for Ecosystem Restoration in the Northern British Columbia (SERNBC) was established in 2013 to manage the structure and function of vulnerable and degraded ecosystems to achieve a desired future condition that will sustain ecological services and human socio-economic needs. SERNBC achieves this mission by coordinating ecosystem restoration activities in northern BC and fostering collaboration amongst stakeholders.

Wildfire Ecosystem Restoration as a project concept was initiated as a result of a SERNBC Ecosystem Restoration Project Selection Process Workshop held in 2016. The Little Bobtail wildfire was selected because it is a relatively new fire (2015) which can be compared to the same process being explored in the older Kenney Dam fire (2004). Ecosystem restoration in the context of this project is defined as assisting with the recovery of a particular ecosystem that has been degraded, damaged or destroyed by re-establishing its characteristics, species composition and ecological processes. Projects are selected from the mosaic of burned sites that will be augmented, treated, or nudged in their natural development trajectory to become the types of ecosystems identified through SERNBC's strategic planning as being of importance and requiring restoration activities.

The project was designed as an open and flexible approach to restoration planning, looking to combine a general understanding of the impacted landscape with input from the consulting specialists, government specialists, stakeholders and First Nations. The project could also be seen as a "pilot" that reflects an innovative, collaborative and integrated approach to wildfire restoration that goes beyond the restoration of fireguards, soil disturbance and timber to include all biophysical values that the province is responsible for managing.

Through a series of steps involving land base analysis and engagement with stakeholders and First Nations, values were identified within the fire area that would benefit from restoration or rehabilitation related activities. In response to these needs, the following assessments and treatments were recommended:

- **Riparian restoration** assessments be completed on six prioritized sites (371 ha) across the wildfire area;
- **Road rehabilitation** in association with other planned restoration activities within the immediate vicinity of those activities; and
- Further assessments and analysis of **climate change-related ecosystem vulnerabilities**.

Following the completion of the planning process a few key "lessons learned" were identified that would help subsequent wildfire restoration planning.

- **Prompt Restoration Planning** – Prompt implementation of an integrated wildfire restoration plan provides the greatest opportunity to ensure a holistic and ecological approach to all activities within the burned area. The benefits of such planning can be more readily realized if completed soon after a wildfire.
- **Forest Ecosystem Networks** – In concert with prompt response to wildfires, the development of Forest Ecosystem Networks (FENs) or ecosystem corridors can be a tool in the implementation of restoration planning processes to provide overall guidance to both industrial scale response to fires (e.g. salvage harvesting) as well as ecological restoration activities.

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List of Acronyms

BEC	Biogeoclimatic Ecosystem Classification
CAD	Consultative Areas Database
CBS	Closed Bottom Structure
DRA	Digital Road Atlas
ER	Ecosystem Restoration
FEN	Forest Ecosystem Network
FFT	Forest for Tomorrow
FMLB	Forest Management Land Base
FPB	Forest Practices Board
FPTWG	Fish Passage Technical Working Group
FREP	Forest and Range Evaluation Program
FRPA	Forest and Range Practices Act
FSR	Forest Service Roads
FTA	Forest Tenure Application
FTEN	Forest Tenure
FWA	Freshwater Atlas
LWD	Large Woody Debris
MFLNRORD	Ministry of Forests, Lands, Natural Resource Operations and Rural Development
MPB	Mountain Pine Beetle
NDT	Natural Disturbance Type
OBM	Open Bottom Structure
OGMA	Old Growth Management Area
PCIC	Pacific Climate Impacts Consortium
PSCIS	Provincial Stream Crossing Inventory System
PEM	Predictive Ecosystem Modelling
RAPP	Riparian Assessment Prescription Procedure
RAU	Riparian Assessment Unit
RESULTS	Reporting Silviculture Updates and Land Status Tracking System
RMA	Riparian Management Area
RRZ	Riparian Reserve Zone
RVT	Riparian Vegetation Types
SBSdk	Sub-Boreal Spruce BEC zone, dry cool subzone
SERNbc	Society for Ecosystem Restoration in Northern BC
TSA	Timber Supply Area
TSST	Tree Species Selection Tool
UWR	Ungulate Winter Range
VRI	Vegetation Resources Inventory
WHA	Wildlife Habitat Area
WRP	Watershed Restoration Program
WSEP	Watershed Status Evaluation Protocol
WTRA	Wildlife Tree Retention Area

1 Introduction

The Society for Ecosystem Restoration in the Northern British Columbia (SERNbc) was established in 2013 in support of expanding ecosystem restoration efforts in the Omineca Region. Since that time, the activities of SERNbc have been expanded to include all of Northern BC to include the Skeena, Omineca and Northeast (Peace) Regions. Members of SERNbc represent governmental agencies, academic institutions, organizations such as the BC Trappers Association and the Guide Outfitters Association, as well as private citizens. The mission of SERNbc is to manage the structure and function of vulnerable and degraded ecosystems to achieve a desired future condition that will sustain ecological services and human socio-economic needs. SERNbc achieves this mission by coordinating ecosystem restoration activities in northern BC and fostering collaboration amongst stakeholders.

Wildfire Ecosystem Restoration as a project concept was initiated as a result of a SERNbc Ecosystem Restoration Project Selection Process Development Workshop held on March 8th, 2016, with participants from government, academia and environmental consulting. The objective of the workshop was to bring together ecologists, practitioners, and wildlife habitat specialists to an open forum to discuss current and potential projects, priorities, and project selection methods in line with SERNbc's objectives and mission. An outcome of this workshop was the concept of wildfire-based ecosystem restoration projects that would be considered for areas burned in recent wildfires.

The Little Bobtail wildfire was selected because it is a more recent wildfire (2015) which can be compared to the same process explored in the nearby but older wildfire: the 2004 Kenney Dam wildfire. Ecosystem restoration in the context of this project is defined as assisting with the recovery of a particular ecosystem that has been 'degraded, damaged or destroyed by re-establishing its characteristics, species composition and ecological processes' (Neal and Anderson, 2009). Projects would be selected from the mosaic of burned sites that may be augmented, treated, or nudged in their natural development trajectory to become the types of ecosystems identified through SERNbc's strategic planning as being of importance and requiring restoration activities.

1.1 PROJECT OBJECTIVES

The objective of the Little Bobtail Wildfire Ecosystem Restoration Project was to carry out an assessment of the area impacted by the 2015 Little Bobtail wildfire to identify and recommend ecosystem restoration (ER) treatments on degraded ecosystems. It is anticipated that this project will add to the broader knowledge of treatment potential on a wildfire-impacted land base. To ensure a holistic approach to ER and support SERNbc's mission to manage for multiple ecological services, a wide range of resource values were included to identify vulnerable ecosystems.

This work was funded through the Forest Enhancement Society of BC (FESBC) to deliver this Ecosystem Restoration Plan (ERP) identifying resource values, assessing possible treatments, and providing recommendations and direction for treatment activities. The ERP includes a map identifying treatment areas (see Figure 9 in Section 4). A temporary webmap tool was used for communication and information sharing with First Nations, government, stakeholders and resource professionals. Under subsequent phases of the project, treatment prescriptions will be finalized based on values identified, tender packages will be developed for completion of works, and funding applications prepared to implement the ERP.

The project was designed as an open and flexible approach to restoration planning, looking to combine a general understanding of the impacted landscape with input from the consulting specialists, government specialists, stakeholders and First Nations. The project could also be seen as a "pilot" that reflects an

innovative, collaborative and integrated approach to wildfire restoration that goes beyond the restoration of fireguards, soil disturbance and timber, to include all biophysical values that the province is responsible for managing.

1.1.1 LOCATION

This project focuses on the land base affected by the 2015 Little Bobtail wildfire located approximately 60 km southeast of Vanderhoof, BC (Figure 1). The fire started on May 8th and burned approximately 25,533 ha of primarily Mountain Pine Beetle (MPB) killed stands. The wildfire area (hereafter referred to as the study area) is in the southeastern portion of the Stuart-Nechako Natural Resource District (the District) and the western portion of the Prince George Natural Resource District within the Prince George Timber Supply Area (TSA).

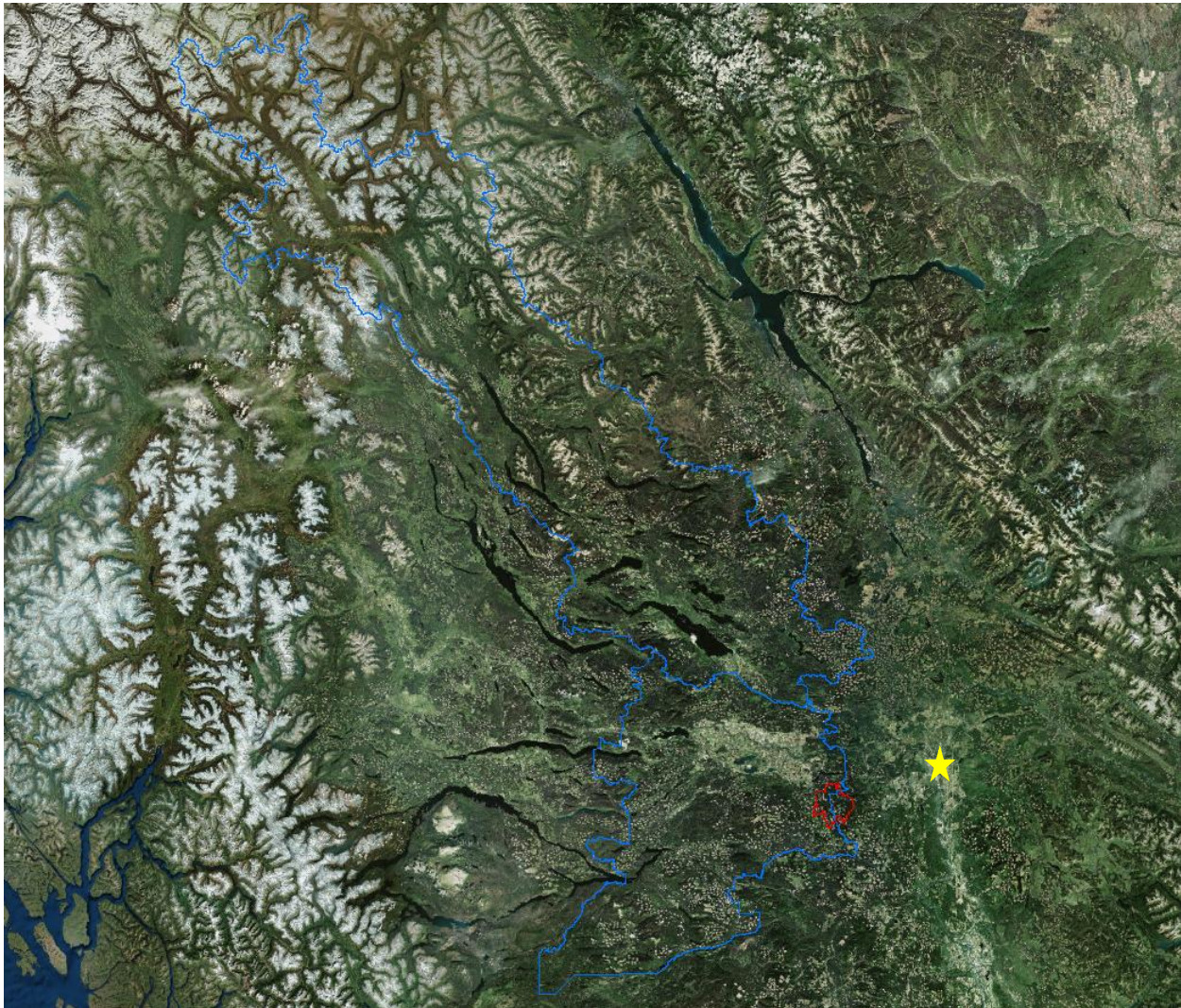


Figure 1 Location of Little Bobtail Wildfire (red) in the Stuart Nechako Resource District (blue) in relation to Prince George (star)

1.1.2 BIOGEOCLIMATIC CLASSIFICATION

The study area is located mainly within the Fraser Basin Ecoregion with the south east edge of the wildfire extending about 1.5 km into the Fraser Plateau Ecoregion. The majority of the fire is in the Nechako Lowlands Ecoregion with the same southeast edge overlapping the Nazko Upland Ecoregion. The climate is sub-continental with an even amount of precipitation year round (Demarchi, 2010), and is comparatively warmer than the other ecoregions in the ecoprovince. The study area is primarily within the Sub-Boreal Spruce (SBS) Biogeoclimatic zone (BEC) in the dry warm (dw3) subzone, which is a relatively warm subzone compared to others in the region, with a mean annual precipitation of 610 mm and a mean annual temperature of 2.2 °C (Chourmouzis, C. Yanchuk, A.D., Hamann, A., Smets, P. and S.N. Aitken, 2009). A small portion in the southeast of the study area overlaps the SBSmw (moist warm subzone) as elevations climb up to Bobtail Mountain. Elevations in the study area range from 800 m to about 1,000 m, and soil parent materials consist primarily of morainal and lacustrine associated with gray and brunisolic gray luvisols (DeLong, Jull and Tanner, 1993, p.31). Topography of the study area is gently rolling plateau divided by wide drainages including the Cluculz, Norman and Little Bobtail drainages. Two lakes, the Eutatazella and Little Bobtail, are within the study area as well as a number of smaller unnamed lakes. Norman Lake lies to the northeast of the study area and Nalesby Lake to the south. Bobtail Mountain borders the study area to the southeast.

The SBSdw3 subzone consists mainly of upland coniferous forests comprised of hybrid white spruce and subalpine fir with trembling aspen. As a result of frequent fires, over time the landscape became dominated by lodgepole pine and trembling aspen. Douglas fir can be found on drier, rich sites in the southern portions of the subzone, while black spruce and poplar tend to dominate wet and alluvial sites (DeLong, 1993). The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD) Tree Species Selection Tool (TSST) website for the SBSdw3 subzone indicates that prior to the recent MPB outbreak, stands in this subzone were historically dominated by fire-origin seral forests of lodgepole pine and hybrid white spruce, with subalpine fir making up the understory (DeLong, 2011).

1.1.3 NATURAL DISTURBANCE REGIME

According to the Biodiversity Guidebook (Parminter, 1995), the SBSdw3 is considered to be a natural disturbance type 3 (NDT3) which historically experienced frequent wildfires of variable size, from small spot fires to very large 10 to 20 thousand hectares in size. Natural fires in this NDT type typically contain a patchwork of unburned and burned areas, creating a mosaic of even-aged stands (Parminter). Douglas-fir presence in the stand plays a role in the post-fire structure but does not influence disturbance frequency (Parminter). The average fire return interval in the NDT 3 is about 125 years (Parminter). The NDT3 also experiences defoliating insects and bark beetles as well as root diseases and wind events.

Current Stand Characteristics

Figure 2 shows the distribution of the forested area by age class. The most current (2017) Vegetation Resource Inventory (VRI) shows that of the 21,107 ha of forested stands, about 19% is under 20 years, 14% is between 21 and 40 years, less than 7 % is between 41 and 80 years, and 28% is between 80 and 100 years old. Of the mature stands, approximately 12% is between 101 and 120 years, 20% is between 121 and 250 years, and less than 1% is over 250 years old.

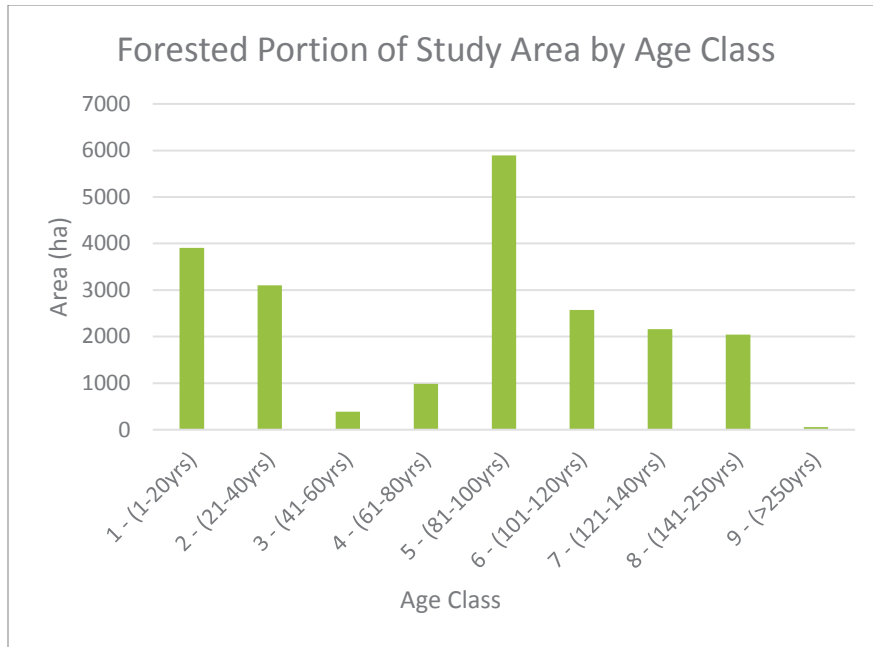


Figure 2 Age Class Distribution of Forested Stands in the Study Area

Prior to the fire, the dominant tree species was lodgepole pine. According to the VRI, pine-leading stands currently constitutes 66% of the forested land base, aspen-leading stands 20%, with the remainder consisting of spruce-leading stands (Figure 3). A few small black spruce and black cottonwood stands exist within the study area, however they occupy less than 2% of the study area.



Figure 3 Forested Study Area by Leading Tree Species

1.1.4 WILDFIRE IMPACT

Wildfires in this NDT type have a tendency to create a mosaic of burned and unburned stands. VRI polygons listed as having an earliest non-logging disturbance of ‘B’ (burned) and dates within or close to

the Little Bobtail fire dates (May 2015) were assumed to be part of the Little Bobtail fire. While 25,533 ha is the total extent of the fire from available spatial data, based on a Burn Severity Layer¹ provided by MFLNRORD, the VRI and an orthophoto review, it is estimated that about 90% of the study area burned to some extent.

1.2 BACKGROUND

1.2.1 OWNERSHIP

Within the study area, land designated for the Crown forest managed land base accounts for 92% of the study area. The majority of this consists of treed upland (73% or 18,666 ha). Approximately 3% percent (869 ha) of the study area is private land, and an additional 2% (571 ha) is within a woodlot, of which 126 ha is a Schedule A woodlot (private land portion).

1.2.2 TENURES AND OBLIGATIONS

Land use impacts within the study area are primarily forestry activities; however there are several range tenures, guide outfitters and trapline tenures that overlap. Three major forest licensees operate within the study area: Canadian Forest Products (Canfor), Sinclair Group Forest Products Ltd. (Sinclar), and BC Timber Sales (BCTS). Figure 4 shows the area harvested by year for the study area. Since 1978, the total area harvested 101,130 ha with the majority of this occurring the decade prior to the wildfire.

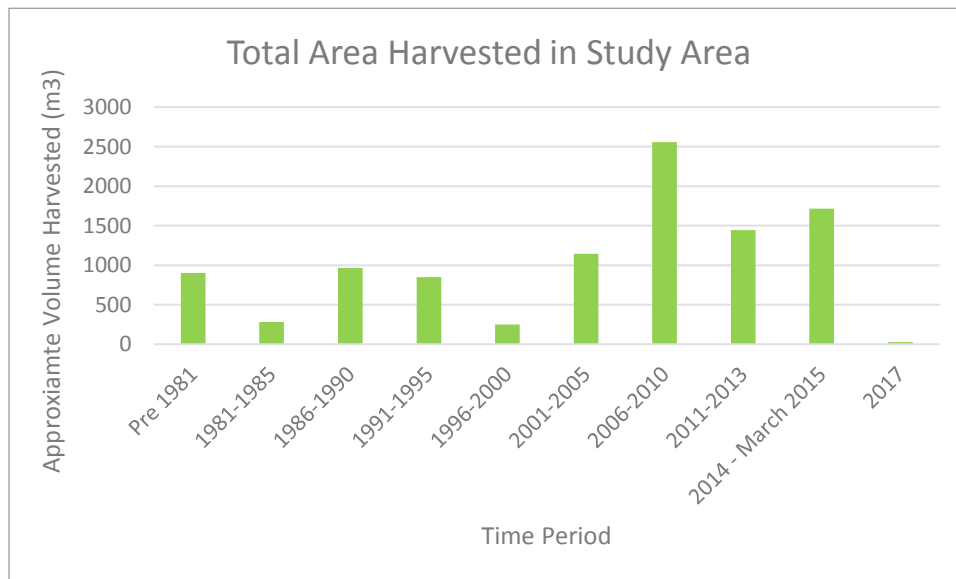


Figure 4 Harvested Area by Year in the Study Area

1.2.3 RECREATION AND PROTECTED AREAS

The study area does not contain any Parks or Protected Areas, although two recreation reserves and one recreation site are found within it totaling approximately 180 ha. In addition, the study area contains

¹ See appendix for methodology to generate the Burn Severity layer.

several types of crown leases making up no more than 305 ha. These include environmental, conservation and other recreation reserves, as well as First Nations tenures and standard residential leases. In addition, there is a small overlap with a windpower investigative lease.

One Indian Reserve, the Umlisile Indian Reserve No. 4, is located within the study area at the north end of Eutataleza Lake. The MFLNRORD Consultative Areas Database (CAD) was used to identify First Nations with overlapping traditional territories in the study area. The results of this search included Carrier Chilcotin Tribal Council, Lheidli-T'enneh Band, Nazko First Nation, and Saik'uz First Nation.

1.2.4 WILDLIFE AREAS & CONNECTIVITY

While there are no Ungulate Winter Ranges (UWR), Wildlife Habitat Areas (WHA) or Old Growth Management Areas (OGMA) established in the study area, stand characteristics, particularly those with Douglas-fir, can be important habitat for mule deer, black bear, wolves and coyotes. The steep shrub- and aspen-dominated southern aspect slopes in the subzone are considered good habitat for sharp-tailed grouse and mule deer, as well as other common wildlife in the area such as moose, grizzly bear, and ruffed grouse (DeLong, p32). Wetlands and riparian areas in this subzone are commonly used by beaver and muskrat as well as amphibians such as the Long-toed Salamander, wood frogs and Columbia spotted frogs (BC MOE, Habitat Wizard, 2018) and is considered good overwintering habitat for moose (DeLong). Elk have also been known to be present in the area.

Connectivity in the SBSdw3 typically consists of wetland complexes and riparian corridors (Parminter). The study area's ability to provide wildlife habitat may be variable as a result of the wildfire. Some species may benefit from the disturbance while others will find their habitat degraded. While wildlife specific habitat treatments would be challenging to assess and treat, landscape level attributes such as interior habitat and connectivity may be more easily gauged and remediated.

1.2.5 RIPARIAN AREAS

Many of the key components of basic riparian function rely on mature forest, such as large woody debris (LWD), small organic debris, and stream temperature, which may be lost as a result of wildfire. For example, shade will be reduced and small organic debris typically increases post-fire but is reduced over the long-term (Barkley, 2013). Stream bank stability may also be compromised as a result of dead or burned root systems, and sedimentation can increase filling in pore spaces in stream beds where fish lay eggs. Wildfires may also contribute to an increase in LWD to the stream over the short-term, however the potential for LWD recruitment tends to be very low for at least one timber rotation (Barkley), possibly longer, over which time the land base will be faced with other climate related changes.

With climate change, storm frequency and intensity is expected to increase, leading to more wind events and increased erosion and channel destabilization (Pike, R.G., et al 2008). Projected temperature increases will result in less snow accumulation and faster snowmelt, and hydrologic regimes that have historically been snow-dominated may transition to display characteristics of mixed or hybrid (rain and snow) regimes which may lead to increased frequency of winter peak flows and changes in the timing of flows including earlier spring flows (Pike, 2008). Due to the increased moisture and topographically sheltered nature of riparian areas, some areas can experience protection from wildfire impacts, however many end up being burned due to topography or fire behavior.

Within the study area there are a variety of stream sizes, orders and classes. Forestry stream classes were not available for the study area; instead stream order was used as a way of classifying streams and estimating their effective riparian management area (RMA). GeoBC's Freshwater Atlas (FWA) Stream

Network (2017) shows approximately 624 km of streams within the study area. Of these, 90% are first to third order or ‘headwater streams’, 6% are fourth order streams, about 1% are fifth order and about 3% are sixth order. The main drainage is Cluculz Creek, but portions of Norman Creek, Dahl Creek, and Little Bobtail creek are also within the study area. Cluculz Creek drains into Eutataleza Lake, then north into Cluculz Lake, and finally into the Nechako River. Norman Creek drains north into Norman Lake and the Nechako River, and Dahl Creek drains eastward into the Chilako River.

The Nechako River watershed is home to several listed fish species and key fish species of commercial and First Nations value, including White Sturgeon and important salmon populations of Coho and Chinook, as well as Sockeye Salmon, Mountain Whitefish and Rainbow Trout. The Cluculz drainage also has historical observations of Rainbow Trout and Kokanee.

Lakes comprise about 950 ha of the study area. Twelve lakes are over 5 ha in size with two of these, Eutataleza Lake and Little Bobtail Lake, being over 200 ha. Numerous smaller lakes are scattered throughout the study area. The study area also contains approximately 1,750 ha of wetlands and wetland complexes², and many smaller classified and un-classified wetlands.

1.2.6 CLIMATE CHANGE

Climate adaptation and future forest resiliency has been broadly identified as a value by stakeholders in the province. Due to expected changes in climate (BC MOE, 2016), efforts could be made to improve the resiliency of the existing and future stands through silviculture treatments (Campbell, E.M., et al. 2009). Planting mixed or more climate adapted species would align with other potential ER treatments, such as road rehabilitation, riparian function and wildlife habitat enhancements.

Climate change projections will have an effect on tree species as a result of changes in moisture deficits, percent precipitation as snow, spring thaw, peak flows, and extreme events. In addition, increased average temperatures are expected to increase the prevalence of forest health issues such as fungal, insect and abiotic factors. To buffer against these changes, diversity in ecosystems is seen as an important component of future stands (Campbell, 2009). Deciding if a stand may be susceptible to changes in climate and how to add variability will depend on site specific factors and risks. As seen by the recent massive outbreak of MPB, the ongoing spruce beetle outbreak, and numerous other insect and disease incidences, changes from climatic norms impact tree stress which makes them more susceptible to pests and pathogens, leading to more degraded ecosystems. While increasing species diversity may be desirable, ensuring species survival is critical to long-term success.

2 Approach

The planning process is driven by common ER principles and is consistent with the BC Government’s ER strategic vision to restore forest and grassland ecosystems “to an ecologically appropriate condition creating a resilient landscape that supports the economic, social, and cultural interests of British Columbians” (Neal, A. and G.C. Anderson. 2009). The scope of potential treatment activities is limited in a number of ways. Based on the BC Government’s ER strategic plan (Neal), activities should include restoration, rehabilitation, habitat enhancement or improvement, reclamation, mitigation and maintenance of ecosystems, habitats or degraded sites.

² See the BC Forest Planning and Practices Regulation (FPPR) s. 48 for a definition of wetland complexes.

Projects driven by SERNbc will need to meet the organization’s mission and purpose, and are limited to portions of the land base where the chance of success would not be negated by other land users’ activities and rights. SERNbc’s mission is to manage the structure and function of degraded ecosystems to achieve a desired future condition which includes identifying, treating and monitoring degraded and vulnerable ecosystems, coordinating restoration activities, and acquiring and distributing technical information on ER. As such, the initial scope for the project with regards to ER was quite broad while also being limited by the area that could be treated without negative interference to others.

The study area has a number of competing interests and values from an economic, social and environmental perspective. Due to the impact of the wildfire on the amount of standing mature timber, the ability of the study area to meet many of the objectives may be compromised or delayed. The wildfire resulted in a patchwork of burned and unburned sites, however due to the age of the remaining forested stands there is now a limited amount of live mature standing timber on the land base, resulting in fragmented and potentially degraded aquatic and terrestrial habitat.

Faced with all of these overlapping interests, the first step was to engage stakeholders, government experts and SERNbc to determine the best approach to ER in the study area that considers and manages for identified ER values in addition to future climate projections. The general approach for this project included:

- Data Gathering and Preparation
- Collaboration and Engagement – with subject matter experts and stakeholders
- Land Base Analysis – to examine the study area through the lens of values brought forward during engagement
- Restoration Planning – identification of restoration treatments

2.1 DATA PREPARATION

All relevant existing information on the study area was obtained, including but not limited to current silviculture obligations, other investments, and rehabilitation plans. Spatial data included the VRI, FWA riparian layers (streams, rivers, wetlands, and lakes), Forest Tenure (FTEN) cutblocks and roads, ownership, a MFLNROD provided burn severity layer, and predictive ecosystem modelling (PEM). These spatial layers were used in conjunction with current imagery, known development planning and local knowledge to support planning and development of restoration recommendations.

A project webmap was set-up as a tool to facilitate discussions and support engagement with the District, major forest licensees, First Nations and additional stakeholders. The webmapping environment allowed users the ability to review ecosystems with potential for treatments in light of existing land base data and other pertinent information.

2.1.1 BURN SEVERITY

Burn severity tool data was made available for the study area by the BC Government. Landsat8 2014 and 2015 were used in conjunction with eCognition³ image recognition software to classify post-fire areas by

³ eCognition is a Trimble software product. For further information visit <http://www.ecognition.com/>

photosynthetic activity⁴ into four burn severity categories: High (~70% of trees burnt), Moderate (~30 to 70% of trees burnt), Low (~<30% of trees burnt) and not burned.

Within the study area, there was a total of 4,780 ha (19%) classified as ‘low’ burn severity, 6,052 ha (23%) classified as ‘medium’ burn severity, and an additional 11,719 ha (45%) classified as ‘high’ burn severity, leaving approximately 2,982 ha (12%) of the forested land base as unburned.

2.2 COLLABORATION AND ENGAGEMENT

Engagement with First Nations and stakeholders, tenured and otherwise, with interests in the study area was identified as a priority step at project initiation. Stakeholder and First Nation discussions helped focus project objectives and identify areas or potential treatments considered highest value. The engagement approach was broad in scope in order to consider differing and possibly conflicting direction on the importance of restoration activities.

The SERNbc Board of Directors were first engaged to confirm broad project objectives and set the framework for the project. A stakeholder list for engagement was developed with assistance from the District and included the major forest licensees, other tenure holders including trappers, range, and guide outfitters, and the Upper Nechako Wilderness Council (UNWC) representing resorts and lodges in the area. First Nations with potential interests in the study area were identified using the BC Government’s CAD with results verified by District staff. Engagement with identified First Nations with traditional territory in the study area and the range of stakeholders occurred simultaneously in order to understand their specific perspectives and values on the land base.

Governmental agencies and regional staff, such as the MFLNRORD, BC Wildfire Service, pertinent Wildlife Biologists and Recreation Officers, were contacted to discuss project objectives and solicit their input on the study area and potential treatments. Ministry staff were also contacted to ensure an understanding of Provincial goals and objectives for ER planning, current and proposed activities, and communicate a respect for their roles and responsibilities within the study area.

Emails were initially distributed to the First Nations and stakeholders introducing them to the project, describing SERNbc’s objectives for restoration, and providing the opportunity for discussion to better understand their interests and knowledge of the land base. A link to the webmapping tool was provided to familiarize stakeholders with the study area. Most conversations took place over the phone to discuss the project and solicit stakeholder feedback. Where no email or phone number was available, an informative letter was mailed out to the remaining stakeholders describing the project objective, providing a link to the webmap, and options to provide feedback. Results of this engagement were used as an aid to inform planning and treatment prescription development (see Appendix 6.1).

2.3 LAND BASE ANALYSIS

The land base analysis was carried out to determine the extent of opportunity and feasibility of each restoration treatment activity brought forward during engagement and initial information gathering. The following land base values were investigated for the study area:

- Timber values and recovery,

⁴ For further information on Burn Severity Mapping, refer to “Differenced Normalized Burn Ratio Burn Area Reflectance Classification” process described by Will Burt in a FNLORD document at: https://www.for.gov.bc.ca/ftp/rsi/external/!publish/Forest%20Health/Forest%20Health%20Presentations/Fire%20mitigation/2_Will%20Burt_Burn%20Severity%20Mapping_FH-2015_Nelson.pdf

- Riparian function,
- Fish passage,
- Road rehabilitation,
- Biodiversity, wildlife habitat and connectivity,
- Climate change adaptation,
- Grassland ecosystems, and
- Berry production.

Each of these values or areas of focus was examined during the project with varying levels of land base analysis. Overall planning budgets limited the ability of the planning team to fully implement land base analysis and planning for each value or restoration treatment option. See discussions in Section 4 regarding additional steps that could be taken to further flush out restoration needs and opportunities regarding these values.

2.4 RESTORATION PLANNING

Following the completion of the land base analysis, restoration planning was undertaken to identify:

1. Key areas that should be the focus of subsequent assessments or restoration prescriptions, or
2. Additional analysis that may be needed to further understand the need for restoration activities.

This report represents the completion of the first phase of this restoration planning effort. Additional assessment, planning and prescription work is recommended to further restoration activities within the study area.

3 Results

The following sections describe the outcome of the land base analysis for each identified ER value and potential treatment.

In general, the following treatments were identified and planned out during this process:

- Riparian Function
- Road Rehabilitation

A number of additional planning steps and treatment types were identified for further consideration by SERNbc and/or the province, funding permitting:

- Biodiversity, Wildlife Habitat and Connectivity
- Climate Change Adaptation
- Berry Production

3.1 TIMBER RECOVERY

Timber values and specifically the removal of fibre for processing, to both generate economic activity and help fund treatments, was a specific goal of the wildfire ER project – i.e. is there timber associated with a given treatment that could be removed during the treatment, the value of which can be used to offset

the treatment cost. Of the treatments that have been identified below, including riparian restoration and road rehabilitation, a number of treatments may generate useable fibre that has the potential to be removed and help offset treatment costs. The specific opportunity for timber recovery is mostly related to the riparian restoration or road rehabilitation activities, where fibre could be removed or may need to be addressed to respond to worker safety, for example.

The utilization of timber associated with restoration treatments will continue to be a consideration, specifically considered during prescription development phases, however the magnitude of this opportunity is limited in comparison to what was initially anticipated. This is due to a number of factors, including:

- The significant pre-fire (operational harvesting) and post-fire (salvage and FFT) activities across the study area;
- Uncertainty regarding the potential impacts of machine-based harvesting within riparian zones;
- Ecological benefits associated with retaining fire impacted stands; and
- Overhead hazards associated with remaining standing dead timber and other considerations for worker safety.

3.2 FISH PASSAGE

Fish passage improvement was identified as a potential treatment activity due to the value fisheries have to many stakeholders, First Nations, and society. A Forest Practices Board (FPB) special investigation into fish passage determined that upwards of 70% of crossings provincially are likely to be barriers to fish (FPB, 2009). As a result, the BC Government formed the Fish Passage Technical Working Group (FPTWG) to develop a strategic approach to streamline fish passage remediation efforts (Adelaide, 2011).

A standard protocol was developed by the FPTWG that outlined four phases of any fish passage remediation project. The purpose of the protocol is to ensure a systematic process to identify the most cost effective structures to replace, and avoids wasting limited dollars on structures that will have little or no gain in habitat (FPTWG). The protocol consists of four phases:

- Phase 1: Assessments – typically carried out at a third order or larger watershed scale (completed once watersheds are prioritized);
- Phase 2: Habitat Confirmation – confirm the quantity and quality of habitat to be gained at selected high-priority sites (identified through Phase 1);
- Phase 3: Design – barriers are chosen and a replacement or remediation design is proposed; and
- Phase 4: Rehabilitation – where the design is implemented.

Certain challenges arise when applying the FPTWG protocol to a wildfire area. Firstly, the study area does not coincide with a single watershed; instead the impacted land base may overlap a section of several watersheds. To apply the protocol to the Little Bobtail wildfire area would require an inventory of a much larger area than the wildfire itself. Once the initial analysis is complete, situations may also arise where significant habitat within the study area can only be gained by engaging in works outside of the watershed area, therefore outside of the study area.

To increase efficiency across the province, funding for fish passage works must follow the FPTWG protocol. Pursuing this process in the study area was seen as worthwhile because there are a number of third and fourth order watersheds in the study area and a general lack of assessment data for the area.

Also, Cluculz Creek, Eutataleza Lake and Cluculz Lake are fish bearing waterbodies that also have value for recreational and First Nations fishing purposes. The office-based assessment and planning prioritization stages of this FPTWG process were carried out for the study area. Further details for this approach are described in Appendix 6.2.

The Nechako River watershed was listed as a having a very high regional priority for fish, containing several fish species at risk, and having significant impacts from land use but lacking a coordinated restoration plan (MOF & MWLAP, 1999). Other than Rainbow trout and Kokanee, no other key fish species or species at risk were found to be present in existing assessment data in the Provincial Stream Crossing Inventory System (PSCIS).

Of species listed as key commercial or recreation, or species at risk, the Little Bobtail wildfire area appears to contain only Kokanee and Rainbow Trout. There are 10 third to sixth order watersheds overlapping the study area. Because of the moderate terrain in the area, a large number of the streams will be modelled as inferred fish-bearing (defined as <25% fish breaks). Habitat gained is more challenging to estimate because of large lakes, wetlands and high order streams flowing through the area. Watersheds with crossings classified as 'observed' should be the first focus of any further work. Once this field information knowledge gap is filled, it will be easier to assess which watersheds and crossings could offer the most habitat gained.

Also, due to the gentle terrain and number of riparian areas, habitat quality may play a larger role in these watersheds than habitat quantity (linear length of habitat gained). There are Kokanee observations in Eulataleza Lake and its tributaries, however no rare or endangered fish are shown in the available data. To follow the FPTWG protocol, significant areas outside the study area would also need to be assessed. The most logical watershed units to assess were those tied to the Cluculz and Norman drainages as these watersheds overlapped the study area more so than the Dahl and Butcherflats drainages. The Norman Creek drainage is a fairly small drainage and all the crossings appeared to have very low potential for habitat gained (i.e. they were at the upper ends of streams and had little upstream habitat that could be made available by making crossings passable to fish).

The Cluculz drainage is a large drainage and therefore was split up into an upper and lower portion for these preliminary assessments. The upper portion consisted of all water flow draining from Cluculz Creek itself into Eulataleza Lake, and the lower portion included all remaining drainage into Eulataleza and down to Cluculz Lake.

Figure 5 shows the identified crossings categorized by 1 km habitat gain increments within the study area. Crossings with less than 100 km habitat gained are not shown on the map. The pink circles with black dots represent the crossing with the highest habitat gained (greater than 7 km). In the upper Cluculz watershed unit, there are two crossings that are modelled to have a habitat gained index of over 10 km. The first is an existing arch culvert and the second is an unknown crossing structure type with approximately 15 km of modelled upstream habitat. In addition, there is one site with approximately 4.5 km, one with 3.3 km, and 10 others with over 1 km habitat gained index each. In total, there are 95 crossings on inferred or observed fish bearing streams. In the remaining area of the Cluculz drainage, the Lower Cluculz watershed unit, there are 274 crossings on inferred or observed fish streams. Four of these are modelled to have more than 10 km of habitat potential upstream and 5 of these highest crossings are located with the study area. It is likely that the crossings with the highest habitat gained potential are already fish friendly crossings. An additional 7 crossings show as having between 5 and 10 km of potential habitat gained, while 29 more have between 1 and 5 km of potential habitat to be gained upstream. Because a watershed assessment has not been completed on these drainages, a systematic assessment according to the FPTWG protocol is recommended on one or both of these drainage units.

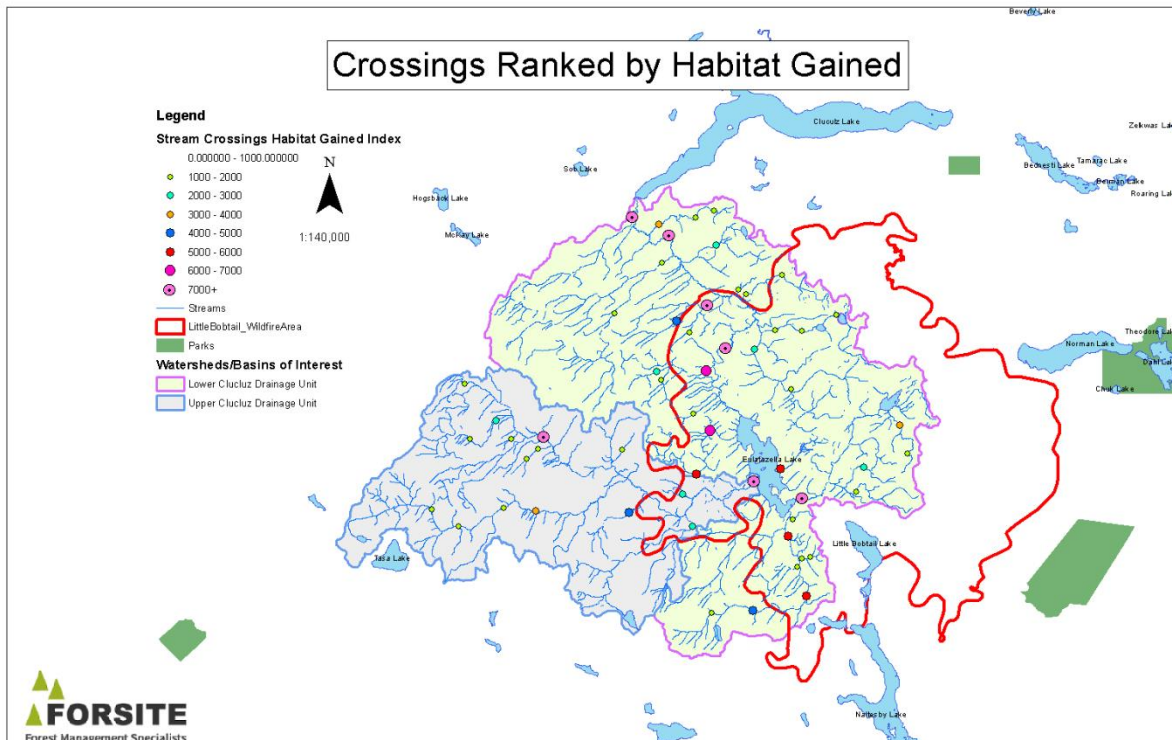


Figure 5 Crossings Categorized by 1 km Habitat Gain Increments within the Study Area

3.3 RIPARIAN FUNCTION

Riparian areas were identified for potential treatment due to the key roles they play in ecosystem function (Tripp, D. et al., 2017) as well as the additional value placed on water quality and quantity by First Nations and stakeholders. Degraded riparian areas have been a focus of many ER treatments in the past (Triton, 2011 and Poulin, V.A., 2005), and common treatments such as planting and LWD recruitment align well with the scope and objectives of this project.

The focus of the riparian analysis was to determine if riparian functions have been impaired by the wildfire and to what extent they are recovering since the fire 3 years ago. The objective of riparian assessments is to identify where the most severe impacts to riparian function have occurred within the study area and which impaired areas may be treated through ER prescriptions. Although wildfires are a natural process, and the patchwork of vegetation left behind has value in the form of environmental heterogeneity (Klinkenberg, 2017), the attributes of a functioning riparian system, particularly with regards to LWD, will play a significant role in maintaining stream function (Hogan, D.L., Bird, S.A., and M.A. Hassan. 1998a) and in moderating the effects of climate change within riparian and adjacent areas by contributing to slope and soil surface stability, prevention of erosion, and moderation of storm surface runoff (Stevens, V. 1997).

The Riparian Assessment and Prescription Procedures (RAPP) was chosen to evaluate the RMAs within the study area to identify any deficiencies in riparian function. These assessments lead to the development of silviculture treatments in support of riparian function recovery, including development of shade, bank stability, small organic debris, or coniferous LWD. A RAPP Overview Assessment was completed as part

of the planning phase to identify areas for potential ER treatment. A detailed description of the planning steps undertaken to identify potentially impaired riparian areas can be found in Appendix 6.3.

Based on the RAPP Overview Assessment, the following 10 groupings of riparian areas (Riparian Assessment Units or RAUs) were flagged as potentially being impaired as a result of the wildfire (Table 1). Figure 6 below shows the initial estimate of stand structure for these riparian areas, which appear to be a mix of all types with stand initiation and shrub/herb stages comprising approximately 50% of the riparian areas. Riparian Vegetation Types (RVT) occurring within the study area were also estimated and appear to be about 51% RVT 1 (understocked with conifers and brush sites), about 23% RVT 3 (conifers overtopped by deciduous) and 12% RVT 4 (deciduous stands with no conifers). Mature stands are also fairly well represented with pockets of standing mature timber within riparian areas that were not burned (Figure 7 Riparian Vegetation Types in Figure 7). These were included in the possible impacted riparian areas because they were initially not filtered out of the GIS analysis but were identified as treed areas through an orthophoto review. Because these RVT types were classified with orthophotos and burn severity layers, they are only a first iteration and further field assessments are required.

Table 1 Potential Sites for Riparian Function Restoration

Riparian Assessment Unit (RAU)	Description	Estimated Area (ha)
1	Upper Norman/Dahl	16.7
2	Upper Eulatazella East	28.2
3	Lower Norman Lake Trib	27.6
4	Eulatazella Trib West	50.3
5	Norman Creek	52.9
6	Eulatazella Trib East	22.0
7	Norman Trib West	23.9
8	Norman Trib East	78.4
9	Upper Norman Lake Trib	34.5
10	Mid Norman Lake Trib	36.2
Total		370

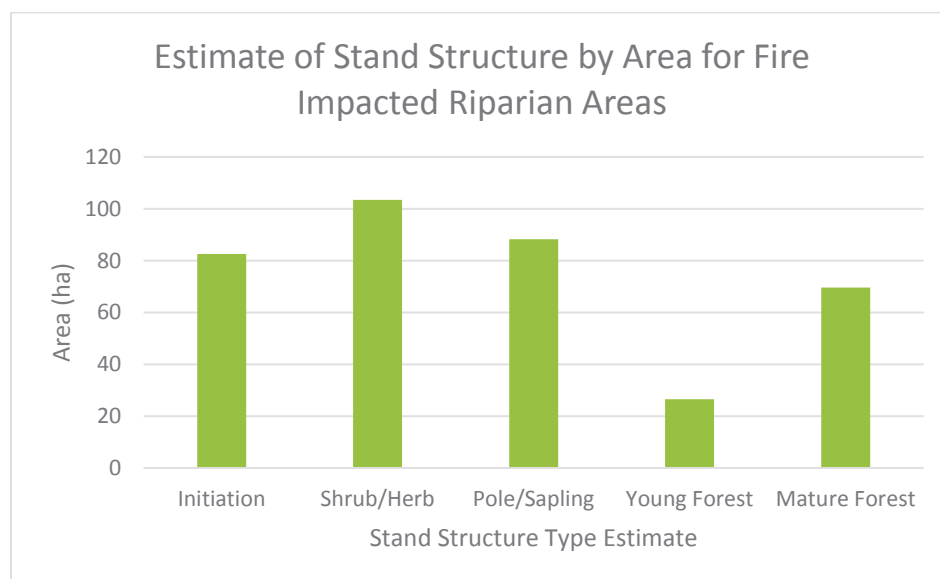


Figure 6 Estimate of Stand Structure within Recommended Riparian Assessment Units

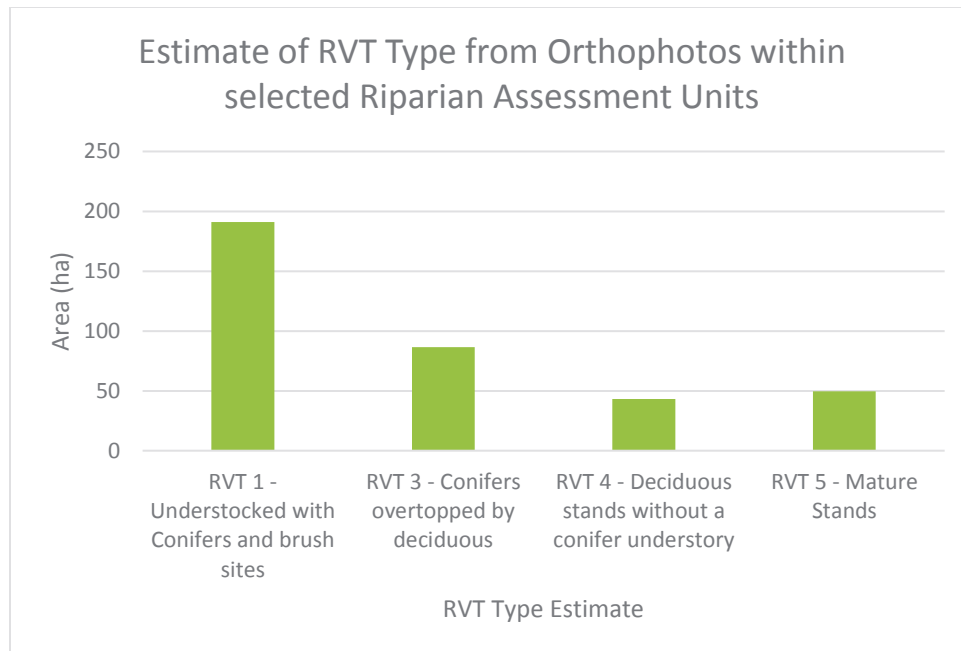


Figure 7 Riparian Vegetation Types in Recommended Riparian Assessment Units

3.4 ROAD REHABILITATION

The provincial government has launched several planning initiatives for road rehabilitation as a result of the significant timber harvesting that occurred much in response to MPB. A larger, multi-phase process is currently being developed and implemented by SERNbc in the District to identify and rehabilitate temporary access roads. An outcome of this work is the development of road rehabilitation standards for treatment prescriptions that will inform other road rehabilitation efforts within the District, and ultimately elsewhere in the Province.

Road density plays a role in the health of watersheds. Roads cause fragmentation of habitat, create barriers to movement for both aquatic and terrestrial organisms, and allow predators to more easily hunt prey. According to Porter (2015) in a Forest and Range Evaluation Program (FREP) report on watershed evaluation criteria, there are certain thresholds beyond which watersheds are at moderate or high risk of habitat degradation. The habitat indicator benchmark for road density is listed as 1.2 km/km², and the density of crossings that would indicate high risk to habitat is 0.32 crossings/km² (Porter, p.6).

The primary objective of road rehabilitation is to identify temporary access structures within the study area that are suitable candidates for reforestation, while ensuring minimal impacts to other users on the land base. This will assist in meeting a number of objectives, including improving timber supply, ameliorating hydrological impacts, improving water flow and fish passage, managing access, and improving forage thereby improving wildlife habitat. A description of the approach taken for this analysis is provided in Appendix 6.4.

Within the study area there are approximately 526 km of road. Based on an average road width of 5 meters (from observations elsewhere in the District) this is approximately 236 ha of road. Of this total, approximately 72 km, or 36 ha, were identified as potential road rehabilitation candidates. Using just the provincial digital road atlas data, the road densities for the five overlapping watersheds average about 1.3 km/km², with Dahl Creek watershed being the lowest at 0.78 and Cluculz Creek watershed being the highest, at 1.6 km/km².

3.5 BIODIVERSITY, WILDLIFE HABITAT & CONNECTIVITY

Designing a forest ecosystem network (FEN) that meets landscape old-growth and connectivity objectives is described in the Biodiversity Guidebook (Parminter, 1995). A FEN is a connected network of representative old-growth and mature forests delineated in a managed landscape. The purpose of a FEN is to maintain or rehabilitate ecosystem connectivity across a landscape. Typically composed of riparian areas, protected areas and wildlife habitat areas, FENs usually include other types of landscapes not ordinarily disturbed, such as inoperable or non-productive land and areas with visual quality objectives.

FENs reduce habitat fragmentation, support representation of the full spectrum of ecosystems within a particular land base, provide a component of interior forest habitat and refuge areas, and can allow for wildlife security cover and movement across the landscape (Parminter, 1995). FEN design should include permanent reserves, riparian habitats, and all types of ecosystems on the landscape including upland and cooler habitats, topographic linkages, habitat linkages, and interior habitats (Parminter, 1995).

When designing a FEN, Parminter (1995) lists some general steps to follow, including:

- Identifying and mapping representative and rare ecosystems, and assessing if they provide interior stand characteristics;
- Identifying and mapping areas that will not be harvested, such as riparian reserve zones (RRZ), wildlife tree retention areas (WTRA), protected areas, recreation areas, inoperable stands and unstable slopes;
- Assessing the complex of all these areas and listing areas not protected, or identifying gaps due to disturbances on the land base such as wildfires or roads;
- Identifying stands with old-growth characteristics;
- Assessing if connectivity objectives have been achieved, and if not, attempt to use mature and old forest stands to connect areas;
- Review above assessment outcomes with established biodiversity objectives; and
- Assess if all objectives are met (such as old growth, mix of seral stages, rare ecosystems, forest interior, and connectivity).

Designing a FEN across burned landscapes, and specifically within the study area, would provide specific guidance in retaining limited remaining standing timber post-fire. Identifying landscape linkages and gaps in connectivity, and the quality of linkage habitat, may help identify sites that could be remediated with some form of silvicultural treatment. Approximately 2,055 ha (8%) of the vegetated land base went unburned, with additional large portions of the study area burned to a lesser severity. Approximately 4,717 ha of the vegetated land base is modelled to have low severity burn, while 5,961 ha is shown to have moderate severity. Within the unburned land base, Figure 8 shows the remaining age class distribution with the majority of the area in age classes 1 and 2 (1,477 ha). In the low severity burn areas, there is potentially more structure remaining that could provide habitat values. While no stands greater than 250 years fall in the low severity burn category, about 474 ha of age class 8 (141-250 years) potentially remains minimally impacted by the fire, as does 361 ha of age class 7 and 255 ha of age class 6. The moderately severe burn category shows a similar trend, however has approximately 10 ha of greater than 250 year old stands.

By merging the pre-fire VRI with the burn severity layer, it is possible to estimate the age classes of stands impacted by the fire. The fire destroyed approximately 44 ha of stands greater than 250 years old, 964 ha of 141-250 year old stands, and over 2,700 ha of 100-141 year old stands. While many of these stands

were killed by MPB prior to the wildfire event, the remaining structure can still serve numerous habitat functions. This basic understanding of where remaining stands of timber lie will feed into the FEN process by providing a starting point in identifying possible connectivity corridors.

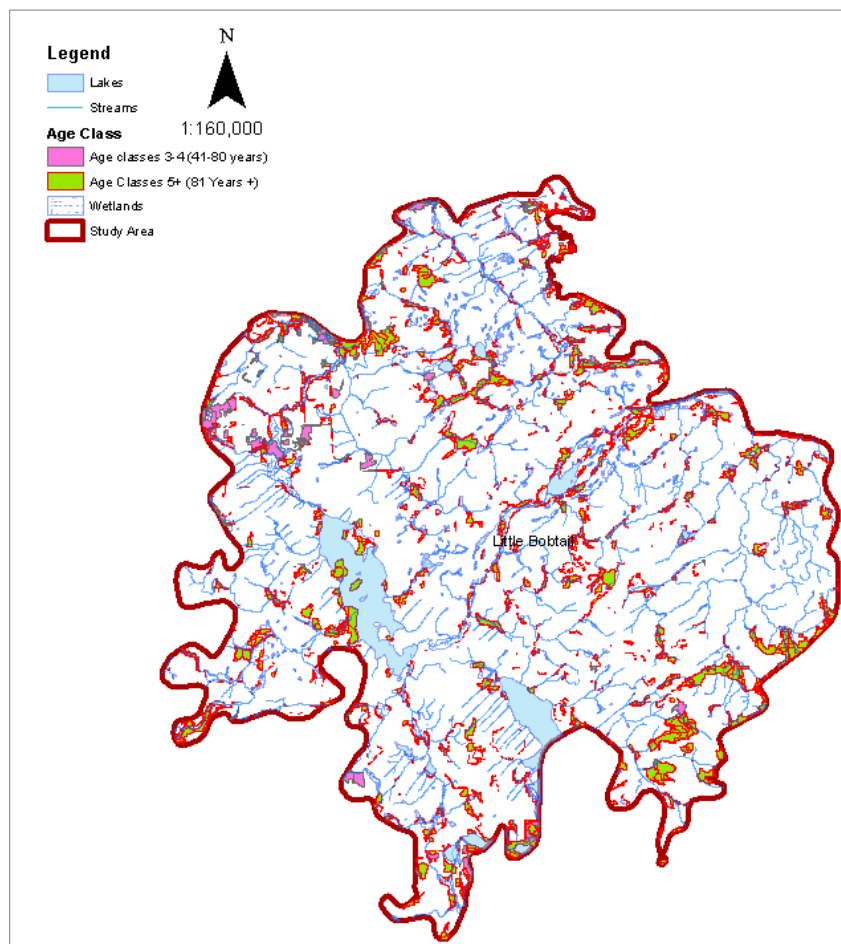


Figure 8 Remaining Unburned or Low Severity Burn Vegetated and Treed Stands by Age Class

The challenge with designing a FEN in the study area is that the resulting corridor network may not be protected from further disturbance, whether natural or human, without specific legal designation. Regardless, the benefit of designing a FEN would then be the ability to communicate this knowledge to licensees, government, resource professionals and First Nations with interests in the area, to facilitate a coordinated approach to structured fire restoration into the future.

Due to overall project limitations, a FEN was not designed through this project but is recommended as a subsequent planning step that can be considered by SERNbc to support future restoration planning efforts. Having said that, the benefits of establishing such a network would be maximized where this approach is given specific attention soon after the wildfire had occurred, in support of all harvesting and restoration works being planned across an area.

3.6 CLIMATE CHANGE ADAPTATION

The Pacific Climate Impacts Consortium (PCIC) Plan2Adapt tool was designed to help practitioners assess climate change by region based on a set of standard climate model projections. Predictions for the Bulkley-Nechako Region in 2050 indicates that the mean annual temperature is modelled to increase from

the 1961-1990 baseline by 1.2 to 2.6 °C. Annual precipitation percent is modelled to increase by an average of 7% (with a range of 2 to 14%) while summer precipitation will decrease by 2% and winter precipitation will increase by 8%. Growing degree days⁵ are modelled to increase by 255 degree days and heating degree days will decrease by 627. The median increase in frost free days is 21 days (PCIC).

As a result of modelled⁶ changes to climate, adaptation treatments could be considered for the study area, including:

- Increasing tree species variability in support of general ecosystem resilience,
- Tree species adaptation, and
- Improvement of stand or ecosystem resiliency in light of anticipated climate changes.

Further assessment of the ecosystems in the study area, and the susceptibility of these ecosystems, specifically the tree species within, to climate related changes is needed. Albeit related to the assumed climate scenario and associated changes, the ecosystem related changes can be considered either 1) incremental, with current species surviving or 2) more catastrophic, with the changes resulting in whole scale species or vegetation community changes. Understanding which ecosystems will experience this heightened level of “stress” would provide further guidance to restoration planning.

Although the scope of the project did not allow for this information to be investigated further, additional work to identify these “at risk” ecosystems would support both:

- Species selection decisions in association with other restoration activities, and
- Identification of sites where active management can be used to improve resilience or support the species changes that are expected.

For further context around climate adaptation tools refer to Appendix 6.5.

3.7 BERRY PRODUCTION

Berry production on the land base was viewed as an important value through preliminary research and discussions with stakeholders. Wild berry species are used by First Nations as a food source and as a part of their cultural practices, by the public as a recreational activity, and by wildlife as a major food resource (Burton, P. Burton, C. and McCulloch, L. 2000). Wildlife use numerous berry species, while species commonly sought by humans include black huckleberry (*Vaccinium membranaceum*), oval-leaved blueberry (*Vaccinium ovalifolium*), highbush cranberry (*Viburnum edule*) and soopalalie (*Shepherdia canadensis*) (Burnton, 2000). Of these species, soopalalie and highbush cranberry are the most common in the SBS dk (DeLong, 1993). Because the study area is predominantly early successional, berry species were considered to be relatively abundant in the study area and no specific treatments were investigated to increase the prevalence of berry species.

While no individual treatments to foster or support berry production were identified, opportunities will be identified for incorporating these values into other treatment types, such as riparian restoration and

⁵ Growing degree days: a derived variable indicating the amount of heat energy available for plant growth. Calculated by multiplying the number of days that the mean daily temperature exceeded 5 °C by the number of degrees above that threshold (PCIC, 2012).

⁶ The Plan2Adapt tool projections are modelled from a set of 30 GSM projections which are based on the results from 15 separate Global Climate Models. Each of these uses one ‘run’ of a high (A2) and a lower (B1) greenhouse gas emission scenario (PCIC). For further information, refer to: <http://www.plan2adapt.ca/tools/planners?pr=2&ts=8&toy=16>.

road rehabilitation where possible. Ongoing discussions with First Nations are needed to further identify opportunities for restoration works to support berry production, as both the restoration of the wildfire area continues and the vegetation cover develops, with goals to monitor conditions and support long-term sustainability of this value.

4 Recommendations

A number of possible treatment activities were initially discussed, however the list of recommended ER treatments was limited to those that met identified ER principles and SERNbc's project criteria, and where values that are currently being managed for in the study area would benefit from additional planning and treatment activities. These values were then discussed with SERNbc, MFLNRORD specialists, natural resource practitioners, stakeholders and First Nations, and treatment possibilities were selected that had been prioritized by multiple stakeholders. Based on the results of engagement and analysis of the land base, a series of ER-related assessment and treatments are recommended (Figure 9).

4.1 FISH PASSAGE FIELD ASSESSMENTS AND HABITAT CONFIRMATION

It is ***not recommended fish passage restoration assessments and planning be carried out in the Upper and Lower Cluculz Watershed Units***. While assessments have been done sparingly in these watersheds and appear to have been done in a manner other than recommended by the FPTWG Protocol (e.g. for forestry road building), there is too much area external to the study area to justify fish passage assessments to be within the scope of this project. There were 370 sites identified within the Cluculz watershed that had high habitat value for important fish species. A fish passage assessment would need to determine whether any of these identified crossings are blockages to fish passage, which should be carried out at a watershed level and not based on the study area alone. This process and subsequent data collection would be submitted to PSCIS to update their database. However, there are too many sites both within and external to the study area to rationalize an assessment of this type for this particular project.

4.2 RIPARIAN FUNCTION FIELD ASSESSMENTS AND PRESCRIPTIONS

Based on the RAPP Overview Assessment of the riparian conditions across the study area, it is recommended that ***riparian assessments be completed on ten prioritized sites*** (Table 2) to identify areas where silvicultural treatments such as fill planting, thinning, or deciduous removal could be implemented. The most appropriate field-level assessment that will result in easily implementable treatment prescriptions is the RAPP Level 1 Assessments which are tailor made for silviculture activities within riparian areas. These sites, totaling approximately 370 ha, were found to have been impacted by the wildfire that also contain fisheries values. Riparian function assessments on these areas will result in possible silvicultural prescriptions that will act to improve overall riparian function.

Table 2 Sites for Riparian Restoration Assessments

Riparian Assessment Unit (RAU)	Description	Estimated Area (ha)
1	Upper Norman/Dahl	16.7
2	Upper Eulatazella East	28.2
3	Lower Norman Lake Trib	27.6
4	Eulatazella Trib West	50.3
5	Norman Creek	52.9
6	Eulatazella Trib East	22.0
7	Norman Trib West	23.9
8	Norman Trib East	78.4
9	Upper Norman Lake Trib	34.5
10	Mid Norman Lake Trib	36.2
Total		370

The RAPP was originally designed to assess impacts of logging practices, therefore to use it effectively for wildfire impacted riparian areas requires some adjustments to assumptions and methodologies. In the past, RAPP surveys were conducted as a result of riparian areas being identified as having higher value through an Interior Watershed Assessment Procedure (IWAP) or similar review. Within the study area, no IWAP or similar prioritization has been carried out, however there is an interest in developing restoration options for riparian areas within burned landscapes, therefore this project used the pre-existing and defensible RAPP process to gather sufficient information to assess riparian function.

Riparian assessment and prescription development should not be conducted without knowledge of upslope or upstream conditions and risks that may affect the project. Utilization of a professional qualified in the full spectrum of riparian and aquatic health is recommended.

4.3 ROAD REHABILITATION PLANNING

The density of roads within the study area are relatively high, and road rehabilitation has significant value to wildlife and biodiversity. Regardless, **a road rehabilitation treatment specific project is not recommended** due to the relatively small area identified for treatment (approximately 36 ha). In order for this treatment to be economically and operationally feasible on its own requires more area to assess and treat. As a result, this ER treatment is not recommended as a stand-alone treatment option, however it should be explored in conjunction with other ER activities taking place on the adjacent land base. Road locations associated spatially with other potential ER treatments, such as riparian assessments, could add value and make other treatments more cost effective while producing more holistic results. Several areas were identified in the study area as having potential for enhanced multi-value treatments, these should be explored with the potential for road rehabilitation activities.

It is recommended if this treatment option is pursued to utilize the standards and procedures for field assessments and treatment prescriptions previously developed by SERNbc (under separate project).

4.4 BIODIVERSITY, WILDLIFE HABITAT & ECOSYSTEM CONNECTIVITY

A FEN design process can be used as an effective support for restoration planning on any given wildfire area, with value maximized if completed soon after the wildfire event. It is recommended that the **FEN process be explored in further detail to facilitate long-term planning and restoration in the study area.**

Subsequent activities on the land base would then be used to improve or enhance ecosystem connectivity, resulting in positive impacts on wildlife habitats and other ecosystem goals.

The FEN design process is fairly straightforward. In addition to the value gained from planning and designing connected ecosystems, it would add value by furthering our understanding and prioritization of other ER treatments. It would be useful in identifying and remedying deficiencies in connectivity across the study area, and help focus road rehabilitation and riparian activities going forward. In addition, given availability of burn severity modelling data, there is value in evaluating the land base at a larger scale and incorporating adjacent existing or potential habitats.

4.5 CLIMATE CHANGE ADAPTATION

Climate change adaptation was raised by a number of stakeholders and First Nations as a factor that should be considered in wildfire restoration planning. Broad investigation of opportunities to incorporate climate change-related risks into restoration planning have been undertaken. ***Further assessment and analysis of climate change-related ecosystem vulnerabilities in the study area is recommended.*** Such investigations should focus on the identification of ecosystems and tree species that are vulnerable and will be “at risk” or “stressed” in light of climate change versus those that will see more gradual or manageable change.

Immediate implementation of climate change-informed tree species selection and adaptation decisions goals should be implemented in all restoration work in the project area.

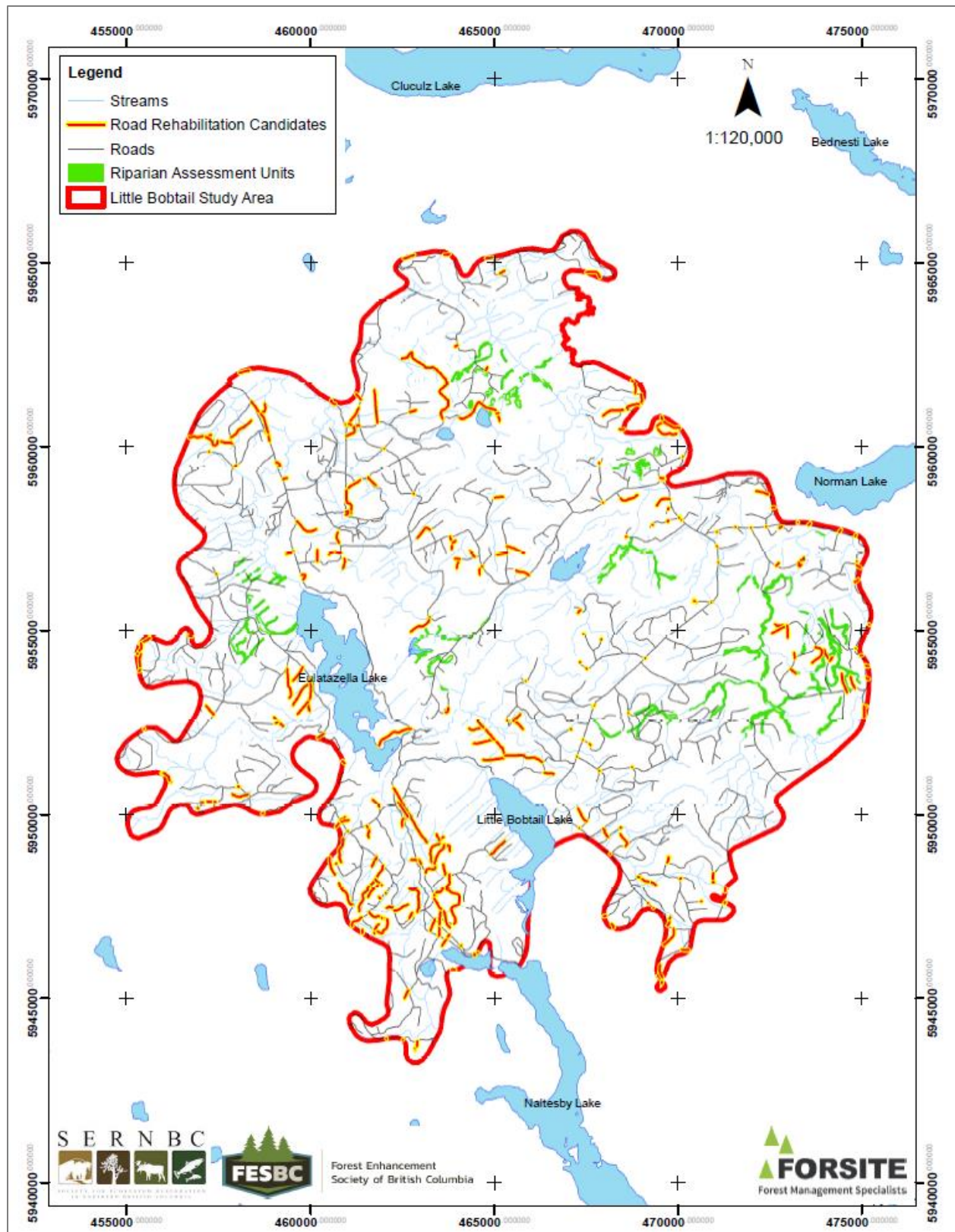


Figure 9 All Recommended Ecosystem Restoration Treatments for the Little Bobtail Study Area

5 Lessons Learned

Through the implementation of the restoration planning process for the Little Bobtail study area, the following lessons were identified by the planning team for consideration in future restoration planning efforts:

- **Forest Ecosystem Networks** – Development of FENs or ecosystem corridors can be used as a step early on in the implementation of a restoration planning process to provide overall guidance to other activities. For this effort to provide meaningful and robust guidance to all forest and land management activities, it would need to consider any applicable legal and/or regulatory structures, timber supply review impacts, and licensee involvement.
- **Prompt Restoration Planning** – Prompt implementation of an integrated wildfire restoration plan provides the greatest opportunity to ensure a holistic and ecological approach to all activities within the burned area. Such a planning process could also be used to provide direction to industrial activities, but would certainly be beneficial as a coordinating effort for all government or NGO investments in restoration or rehabilitation. Currently program specific planning for restoration/rehabilitation takes place (e.g. Forests For Tomorrow, Forest Carbon Initiative., independent NGOs) but there would be benefits from a coordinated and holistic restoration plan to provide ecological and landscape-level context for these activities.

6 Appendices

6.1 OUTCOME OF STAKEHOLDER, FIRST NATIONS AND GOVERNMENT ENGAGEMENT

Response and level of input varied by stakeholder, often as a result of their specific interests or resource use. Stakeholders, such as trappers, guide outfitters, local resorts and First Nations, were in support of the project and objectives for ER. This was especially true for treating and mitigating impacts of past human activities, such as road density, which has had negative consequences for numerous resources including declining wildlife populations. Ideally, prescriptions would manage for all resources and values and find a balanced and holistic approach while considering potential impacts from a changing climate. Many stakeholders described themselves as stewards of the land with an objective that emphasized sustainable resource and land management in order to return the land back to historical conditions without a sole focus on timber supply.

There were stakeholders skeptical of ER projects within a naturally disturbed area. The primary reason provided was that wildfires are a natural disturbance that creates a mosaic of forested stands and valuable habitats which otherwise do not occur, and that these ecosystems tend to be self-maintaining. Discussions focused on what ER meant from an ecological and scientific perspective versus implementing treatments post-fire to supplement natural succession.

There were some common themes or concerns raised across stakeholder groups, including:

- Concern for sustainability and healthy ecosystems for future generations.
- Desire to create a future forest that is more resilient to natural and human-caused disturbances, including future impacts from climate change.
- Prescriptions and treatments should be considered in the context of adjacent land use plans and higher level landscape level plans.
- Fires create natural openings and a mosaic of age classes, which provide for several values that are often not created through forestry activities.
- Avoid “plantations” as these are not representative of natural forest stands and natural habitats, and are often viewed as harmful to ecosystems and biodiversity. What lives within these plantations is not representative of what would occur under natural conditions. These stands often have little age class diversity and contain a single species which reduces resiliency to disturbances. The lack of prescribed fires historically has also contributed to the monoculture-type stands by reducing variability and mosaic of forest stand types, ages and species that would prevent future large fires from occurring.
- Planting could serve multiple benefits. Vegetation would come “online” sooner than if left for natural regeneration, and allows for the ability to manipulate species composition to increase diversity and provided resiliency to projected climate shifts.
- Water quality is an important value where management of this resource can be improved. Important to protect water quality, fish-bearing tributaries, and the riparian ecosystems which provide for these values.

- Overall support for road rehabilitation activities to minimize and control motorized access. Rehabilitation activities are seen to have a positive impact on water management by minimizing erosion and subsequently protecting water quality. Reduced road density would also benefit wildlife populations, particularly moose, through improved habitat and reduced access for hunting and prey species.
- Natural regeneration has occurred in several areas of the wildfire which has provided for some quality habitat. Seek to find a balance in providing additional habitat or focusing restoration efforts on severely degraded sites to compliment those already created from the wildfire.

Stakeholder input was categorized into general themes in order to identify feasible treatment activities that addressed multiple identified values where possible.

6.2 FISH PASSAGE

6.2.1 FPTWG PROTOCOL

The FPTWG strategic approach involves determining which watersheds have the highest value, then within those watersheds determining priorities for restoration of fish habitat (FPTWG, 2014). According to this, watersheds are selected by size, where typically those of third order or greater are used as an assessment unit. Watersheds are then ranked by the number of listed species at risk, then by number of key species, and finally whether it is a fisheries sensitive watershed or not. This process prioritizes watersheds for potential remediation efforts. Once a watershed is selected, a systematic process is undertaken to determine where the fish passage barriers may exist, confirming the habitat that could be gained by removing a barrier, and ranking barriers by the amount of habitat gained.

Within selected watersheds, prioritizing sites for restoration involves following the FPTWG protocol for determining habitat gained (Mount, C., Norris, S., Thompson, R., and D. Tesch, 2011). Streams are classified into the following fish presence categories: Fish Observed, Fish Inferred, or Non-Fish Bearing. Crossings of streams by roads are then assumed to be crossing structures and are ranked based on the amount of habitat upstream they would provide if they were passable to fish up to the next crossing structure. Crossings have a higher habitat gained the more habitat they have available upstream to the next crossing. Crossings with higher habitat gained and least number of crossings downstream should be prioritized.

6.2.2 WATERSHED PRIORITY

In an effort to focus limited funding for fish passage work, the FPTWG protocol indicates that fish passage assessments should be undertaken only on priority watersheds (FPTWG, 2014). The priority watershed selection criteria is outlined in the FPTWG strategic approach document (2014) which includes a revised method based on species at risk and the Province's mandate to maintain biodiversity. Through this process, priority watersheds will include the following:

1. Watersheds with known presence of species at risk or key species,
2. Watersheds with little or no previous fish passage assessments conducted, and
3. Fisheries sensitive watersheds.

6.2.2.1 Sub-Basin Prioritization

To prioritize the sub-basins in the study area, the first section of a process outlined in the BC Ministry of Environment's Watershed Restoration Program (WRP) planning document "Watershed Restoration Planning and Priority Setting, and Emphasis on Fish Habitat" (2004) was roughly followed where:

- Sub-basins within the study area were identified,
- Information was gathered on each sub-basin,
- Limiting factors for fish for each sub-basin were flagged,
- The potential for restoration success for each sub-basin was analyzed, and
- A target sub-basin for detailed assessment and further work was selected.

To assist with this process, the BC Government's mapping tool Habitat Wizard was used. Stream and lake reports as well as fish assessments and observations were queried to find which fish species had been observed in the study area and whether any previous assessments had been completed. In addition, a previous report on watershed priorities in the Prince George Forest Region provided a broader scale background on the condition of the Nechako River watershed and Chilako River watershed in terms of fish habitat and water quality. This report used a six step 'regional benchmark process' where step 5 prioritized watersheds according to their fisheries resource values and step 6 estimated the status of impact and potential for restoration for the prioritized watersheds (BC MOE & MFLNRO, 1999).

The Prince George report ranked the Nechako River watershed as having a very high regional priority for both domestic water supply and fish, with several fish species of concern, however it was not listed as a priority key watershed for the region or listed as a target watershed for enhancing environmental values (BC MOE & MFLNRO, 1999). While this status is over 17 years old, it provided additional rationale for pursuing further assessments within Nechako River sub-basins.

6.2.2.2 Sub-Basin Analysis

In order to conduct any field assessments it is necessary to determine where and how many crossings there are in the selected watershed, infer the fish-presence in streams, and calculate habitat gained by each incremental crossing. This process is explained in detail by Mount (2011) in the FPTWG Protocol. Their recommended process was followed in this analysis with the phases briefly described below.

6.2.2.2.1 Phase I: Determining Number of Potential Crossings

Using the spatial road layers and the FWA stream network data within the boundary of the wildfire, points were generated at the intersection of streams and roads and labelled as "potential crossings". There were 370 crossings on streams with inferred or observed fish presence identified within the study area.

6.2.2.2.2 Phase II: Inferring Fish Habitat

Using the FWA stream network and modelled stream gradient from TRIM contours, streams were categorized into gradient groups of less than 25% and greater than 25%. Then, using these gradient barriers and provincial fish observation points, each FWA stream feature was categorized into three categories: Fish Observed, Fish Inferred, or Non Fish-Bearing.

Barriers assumed to block fish passage were gradients greater than 25% or non-beaver dam obstructions as identified in the provincial 'Obstructions to Fish' data. Beaver dams, while included in the provincial layer as obstructions, have been found in many cases not to be a barrier to trout or salmon migration (Lokteff, R. L., Roper, B. B., & Wheaton, J. M. 2013). Fish observation points in the study area were often

recorded on both upstream and downstream sides of mapped beaver dams and as a result not considered barriers in this project.

This process was completed for all mapped streams within the study area. After streams were classified, all non-fish stream culverts were removed from consideration and a habitat-gained index was then calculated on the remaining streams (Phase III)⁷.

6.2.2.2.3 Phase III: Calculate Habitat Gained

The habitat gained was calculated by measuring the linear distance upstream of a crossing to the next barrier. The result was then divided by the number of downstream crossings to get a 'habitat gained index' which is a method of prioritizing crossings based on the best available return on investment (Mount, 2011). To make this index work, crossing numbers were increased by 1 to ensure the first crossing was not divided by 0.

6.2.3 RESULTS OF GIS ANALYSIS

The habitat gained calculation process was repeated for all the crossings in the study area. There were 420 crossings in total. Fifty three were on crossings that were inferred (based on slope gradients or downstream barriers) to be non-fish bearing. Of the remaining 367 crossings, 15 were on streams with observed fish presence (based on fish observation points above the crossing) and 353 were on streams with inferred fish presence (no barriers between fish observation points and the crossing). One crossing has a habitat gained index of 45 km, however there is an existing open bottom structure in place. Another site, crossing number CL 1257 with a large round pipe, has a habitat gained index of 33 km. A third site with significant modelled habitat gained index was site CL1243, an existing bridge, with over 28 km of habitat upstream of the crossing. Three other sites have over 10 km of habitat gained, 7 crossings have between 5 and 10 km, and 43 additional sites have between 1 and 5 km of potential habitat gained. The potential for significant gains to fish habitat exists in the Cluculz watershed and the first step is a watershed based assessment as per the FPTWG protocol.

6.2.4 RESTORATION POTENTIAL

Restoration potential is a key factor in ranking watersheds. If one watershed has higher fisheries values but no real opportunity for remediation due to costs of either the assessments themselves or the crossing design and replacement, it would be logical to select a different watershed for assessment. In the case of the study area, limitations to restoration include the cost of doing an assessment and the scope of the project. Investing in remediation of fish passage must follow the FPTWG protocol. If there are no sites listed in the Provincial Stream Crossing Inventory System (PSCIS) with designs, or if barriers are identified, it requires taking a step back and completing habitat assessments. If there are more than one watershed to choose from, additional research is required to better understand which has the highest fish values and the most sites that would offer the greatest amount of habitat gained. Because Cluculz watershed overlaps a large portion of the Little Bobtail study area, and has a large number of unassessed crossings with high habitat gained indices, it is the recommended unit for fish passage assessment.

⁷ A GIS model has been created by the FPTWG to automate this process, however it was not available for this project (Mount, C. 2018).

6.3 RIPARIAN IMPAIRMENT ASSESSMENT

There are two common methods for determining the impairment of riparian function:

1. The Watershed Status Evaluation Protocol, and
2. The Riparian Assessment and Prescription Procedure.

6.3.1.1 Watershed Status Evaluation Protocol

The Watershed Status Evaluation Protocol (WSEP) is an assessment process designed to be a repeatable and quick biological assessment tool for watersheds in the 50 to 500 km² size range (Pickard et al. 2014). The protocol is carried out in two steps: Tier I is a GIS-based evaluation, and Tier II is done in the field on a subset of the area.

Since the study area overlaps partial sections of several drainages, including large mainstems and several headwater streams and residual drainages, it was determined that it was not suited to a watershed level evaluation such as the WSEP. Also, it was assumed that, based on the area having been burned by a high intensity wildfire and the resulting age class distribution being predominantly early seral, the overlapping portions of the watersheds were likely degraded and so a Tier I Evaluation was not needed.

An evaluation tool more directly applicable to silvicultural treatments is the Riparian Assessment and Prescription Procedure described below.

6.3.1.2 Riparian Assessment and Prescription Procedure

The Riparian Assessment and Prescription Procedure (RAPP) is a process designed to assess the level of impairment of a riparian area. It was originally designed for coastal forests, however it was used in the Prince George area as recently as 2010 for assessing the impact of MPB on riparian function (Triton). Due to its design, the RAPP can be carried out anywhere and results in a list of potential treatment options to be further investigated in the field.

The RAPP Level 1 Field Assessment addresses the following questions:

1. What riparian function is impaired, where is it, and to what extent is it impaired?
2. What are possible restorations scenarios?
3. Which of the degraded riparian sites are the highest priorities for restoration?

Riparian function is described in terms of its aquatic and terrestrial functions. With regards to the terrestrial component, healthy riparian function is characterized by variations in stand structure (i.e. canopy layers, vertical and horizontal structure) and tree species. Aquatic riparian function can be described in terms of large woody debris (LWD), small organic debris, stream shading, surface sediment filtering, and maintenance of bank stability. Koning (1999) describes riparian vegetation as serving a number of purposes, including:

- Geomorphological regulation of stream channel through LWD which assists in moderating flow and sediment movement as well as contributing to the creation of fish habitat
- Channel and bank stability through rooting and ground cover
- Providing shade, which regulates temperature and reduces algal production
- Providing small organic debris as a nutrient source
- Providing characteristics of wildlife habitat

A stream with non-impaired function is characterized as being unable to provide any of these services, rendering a stream susceptible to soil loss or channel and bank instability as a result of peak flow events and/or movement of the channel or bank (Tripp, D.B., Tschaplinski, S.A. Bird and D.L Hogan, 2009). It may also be unable to adequately filter run-off, store and safely release water, or provide shade to moderate stream temperatures and microclimate changes. In particular, LWD loss through wildfire will reduce the riparian area's long term ability to provide rooting strength to the channel, resulting in loss of the ability to store sediment and moderate flow, and reduce the prevalence of habitat conditions typically created by LWD (Tripp, 2009).

In order to gather the necessary data to facilitate treatment activities, the most appropriate method of data collection for riparian areas was determined to be the methodology outlined by Koning (1999) in the Watershed Restoration Program (WRP) Technical Circular No. 6, Riparian Assessment and Prescription Procedures (RAPP). The purpose of the RAPP is to determine riparian area impairment and classify the riparian areas into distinct Riparian Vegetation Types (RVT) to assist in developing riparian silvicultural prescriptions.

There are three stages within the RAPP:

1. Office-based overview assessment,
2. Reconnaissance "level 1" field-based assessment, and
3. Detailed "level 2" field-based assessment where required, and prescription development.

Treatments resulting from RAPP surveys typically include silviculture activities in order to support restored riparian function. This may include, but is not limited to, the promotion of uneven aged stands, creating canopy gaps, under planting with shade tolerant species, combining tree planting with native understory shrubs to improve vegetation diversity, selective use of fertilizers which will assist preferred trees to gain a competitive advantage, thinning dense conifer stands, girdling deciduous within mixed stands to open up the stand while providing for wildlife trees, or planting climate adapted conifers.

6.3.1.2.1 Stage I: Office-Based Overview Assessment

The RAPP process was primarily developed focused on degradation by harvesting, which was used as a surrogate for areas degraded by wildfire. The first step in the process is to identify 'harvested' (burned) riparian areas within the study area, assuming that riparian function has been impaired by fire. Priority locations for treatment were identified in areas within the modelled RMA of fish observed or fish inferred streams, the RMAs of classified lakes and wetlands, or areas greater than 25 m from unburned stands. These locations were then classified into groups by proximity to access roads:

1. Less than 300 m to the riparian site,
2. Between 300 and 1,000 m to the site, and
3. Greater than 1,000 m to the site.

Once priority areas were identified they were further prioritized for field visits by grouping them into logical and cost effective units. Stands in close geographical proximity (walkable) to one another were grouped into assessment areas, called a Riparian Assessment Unit (RAU), while outlier stands were dropped due to increased costs for site visits resulting in limited treatment value.

6.3.1.2.2 Stage II: Level 1 Assessment

Once riparian areas were grouped into an initial priority based on the GIS analysis, the RAPP Form 1 process was completed whereby a tentative or initial estimate at stand structure and RVTs is made

through a desktop review of satellite imagery. Stand structure types listed by Koning (1999) were used in this riparian assessment process⁸. The stand structure types include:

- INIT (initial succession) – 0 and 1 years
- SH (shrub herb) – 1 and 20 years
- PS (pole sapling) – trees more than 10 m tall, typically densely stocked depending on species, and may be 10 to 40 years old for conifer and 10 to 15 years for deciduous.
- YF (young forest) – 30 to 80 years
- MF (mature forest) – 80 to 250 years
- OF (old forest) – older than 250 years

Although the satellite imagery was of good quality it was not sufficient to distinguish between INIT and SH. Therefore, if the ground appeared bare, it was classed as INIT.

6.3.1.2.2.1 Riparian Vegetation Types

There are several ways to classify riparian vegetation. Koning (1999) describes a method that incorporates the stand structure and overstory species with composition and layers. For example, SHIs/HwCw(Dr) would be: a low (ls) shrub (SH) regeneration stand between 1 and 20 years old where red alder (Dr) is a minor component (<20%) and western hemlock (Hw) and western redcedar (Cw) are dominant (p.31).

Another simpler method that appears to be more geared toward specific silvicultural treatments is described by B. Bancroft and K. Zielke in a document prepared for the Ministry of Forests titled “Guidelines for Riparian Restoration in British Columbia: Recommended Riparian Zone Silviculture treatments” (2002). They list 5 RVTs:

- RVT 1: Understocked with conifer and brush sites
- RVT 2: Overstocked conifer stands
- RVT 3: Conifer overtopped by deciduous trees
- RVT 4: Deciduous dominated stands lacking conifers
- RVT 5: Mature, unimpaired

This method was decided to be the most effective for assessing riparian impairment as a result of a wildfire and recommending possible silvicultural treatments.

6.4 ROAD REHABILITATION

A classified road dataset was provided by the District from a previously developed GIS algorithm which classified existing access structures as temporary or permanent as defined in the Forest Planning and Practices Regulation (FPPR). The algorithm was applied to a consolidated road database compiled from multiple sources, including RESULTS, Digital Road Atlas (DRA) and Forest Tenure Application (FTA). The District completed a preliminary clean-up of the dataset, which was further refined to remove duplicate records and eliminate apparent classification errors resulting from the multiple data sources.

⁸ See the glossary in Koning, (1999), for a more thorough description of these stand structure types.

Additional spatial data sources included FTA cut blocks, RESULTS free growing blocks, historical fires, recreation sites and trails, private lands, various tenured areas (i.e. trappers, ranchers, guides), wildlife habitat areas, modelled Caribou winter habitat (including higher risk areas), and additional modelling outputs from the GIS algorithm (i.e. local opportunities, constraints). Data was used in conjunction with satellite imagery, known development planning, and local knowledge to further refine road classification to be reflective of current practices and better ensure recommendations are operationally realistic.

In-block roads, spur roads, and general access roads that had no future opportunities or ongoing silviculture obligations were identified as potential candidates for rehabilitation and labelled as temporary access structures (TAS) in the dataset. All other roads that represented main access routes or Forest Service Roads (FSRs) were labelled as permanent access structures (PAS). This in-depth review was completed for the study area and a list of candidate roads for rehabilitation were developed and mapped.

The refined classified roads dataset established the referral package that was then delivered to Canfor, Sinclair and BCTS, the major forest licensees with operating area in the study area, and staff with the provincial Forest for Tomorrow (FFT) program. The classified road dataset was presented to further refine the candidate roads selected for on-ground assessments. Engagement at the onset of the project allowed for integration of future operational plans and ongoing silviculture obligations into the classification of roads. This information was also provided to Saik'uz First Nation who expressed interest in road rehabilitation within their traditional territory.

6.5 CLIMATE ADAPTATION

6.5.1 TREE SPECIES SELECTION TOOLS

The MFLNRORD developed a web-based Tree Species Selection Tool (TSST) to assist forestry professionals in adapting strategies to maintain and improve species and ecosystem resilience, adaptability, and overall productivity in the face of expected climate changes. In addition, the provincial stocking standards were recently updated to address modelled changes in climate (Peterson, D. and T. Ethier, 2012) and better equip forest professionals with tree species selection when planning for an uncertain future climate.

One of the tools available is the Stand Level Drought Risk Assessment Tool (DeLong, S. C., H. Griesbauer, and C.R. Nitschke, 2011). By entering a specific BEC subzone and relative moisture regime the tool will show drought risk for tree species in the chosen site series for four time periods: current, 2020, 2050 and 2080. When set up to show drought risk for the SBSdw3 and a relative moisture regime of 4 (Figure 10), it shows that for all time periods the majority of tree species will see increasing levels of stress as a result of projected moisture deficits. In fact, even lodgepole pine and trembling aspen will experience moderate to high amounts of drought stress by 2080 compared to current levels of stress related to drought. The only two tree species with low drought stress over this same modelled time period are Douglas-fir and ponderosa pine. This suggests that practitioners should be planning to include more drought resistance species in the SBSdw3. In addition, the PEM shows the majority of the study area as estimated to be SBSdw3 01 site series, indicating that drought may be a significant future issue in the study area. Pine is estimated to be at low risk for drought by 2020, but at moderate risk for drought by 2050, and high risk by 2080. Spruce is shown to be at moderate risk by 2020 and 2050 and high risk for drought by 2080. Douglas fir and Ponderosa pine appear to be the least at to be impacted by drought in this subzone and moisture regime, however there may be additional factors that would limit these species suitability to the sites within the study area.



Figure 10 Species Selection Drought Risk Tool Showing Drought Risk by Tree Species for SBSdw3 Relative Soil Moisture Regime of 4 (Mesic)

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