Kenney Dam Wildfire Ecosystem Restoration Plan

SOCIETY FOR ECOSYSTEM RESTORATION IN NORTHERN BRITISH COLUMBIA

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PROJECT [1230-6]

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FESBC Forest Enhancement Society of British Columbia

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Acknowledgements

This project was initiated by the Society for Ecosystem Restoration in Northern BC (SERNbc) with significant guidance and contributions from John DeGagne, the Executive Director of SERNbc and Stewardship Forester with the Ministry of Forests, Lands, Natural Resource Operations and Rural Development in Vanderhoof, BC. Funding was provided by the Forest Enhancement Society of BC.

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The project also involved contributions and input from a range of First Nations, stakeholders and resource professionals through engagement during the project.

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 Kenney Dam wildfire was selected as a project area because it is a relatively old fire (2004) which can be compared to the same process being explored in the more recent Little Bobtail fire (2015). 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 areas that would benefit from restoration or rehabilitation related activities. In response to these needs, the following assessments and treatments were recommended:

- **Fish passage restoration** assessments and planning be implemented in the Twin Creek Drainage;
- **Riparian restoration** assessments be completed on six prioritized sites (143 ha) across the wildfire area;
- **Road rehabilitation** in association with other planned restoration activities within the immediate vicinity of those activities;
- Further assessments and analysis of **climate change-related ecosystem vulnerabilities**; and
- Field review and investigation of the **grassland ecosystems** in the Kenney Dam wildfire area to understand conditions and 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
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
PEM	Predictive Ecosystem Modelling
PSCIS	Provincial Stream Crossing Inventory System
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 consider for areas burned in recent wildfires.

The Kenney Dam wildfire was selected because it is a relatively old fire (2004) which can be compared to the same process being explored in a nearby but more recent wildfire: the 2015 Little Bobtail 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 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.

1.1 PROJECT OBJECTIVES

The objective of the Kenney Dam Wildfire Ecosystem Restoration Project was to carry out an assessment of the area impacted by the 2004 Kenney Dam 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 8 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 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 2004 Kenney Dam wildfire located approximately 70 km southwest of Vanderhoof, BC (Figure 1). The fire started on June 28th and burned approximately 10,465 ha of primarily Mountain Pine Beetle (MPB) killed stands northeast of the Kenney Dam (Egger, 2009). The wildfire area (hereafter referred to as the study area) is in the southwest portion of the Stuart-Nechako Natural Resource District (the District) within the Prince George Timber Supply Area (TSA).

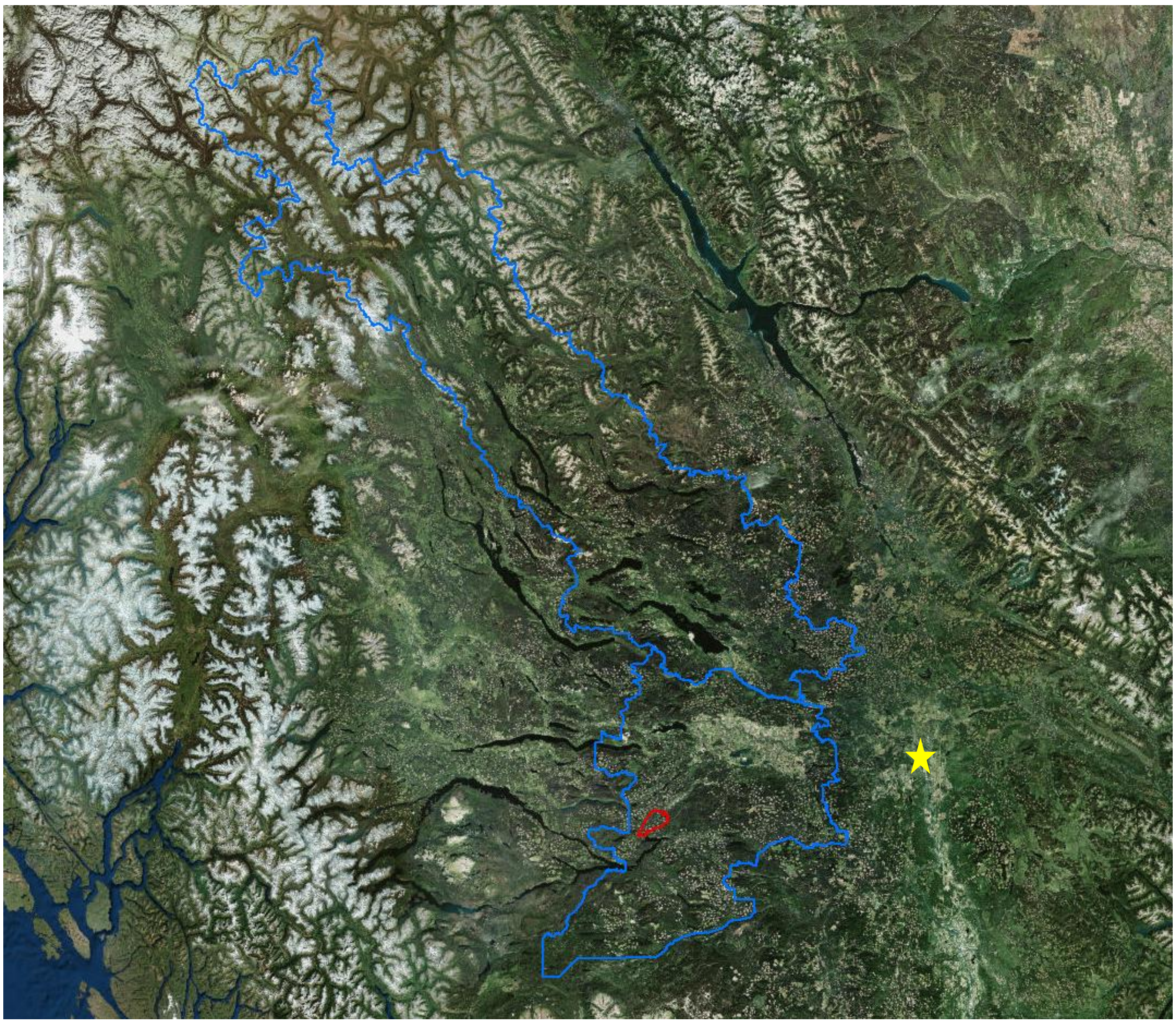

Figure 1 Location of Kenney Dam Wildfire (red) in the Stuart Nechako Resource District (blue) in relation to Prince George (star)

1.1.2 BIOGEOCLIMATIC CLASSIFICATION

The study area is located within the Fraser Plateau Ecoregion and Bulkley Basin Ecosection. The climate here is sub-continental with cold winters and warm summers (Demarchi, 2010). The majority of the study area is within the Sub-Boreal Spruce (SBS) Biogeoclimatic zone (BEC) in the dry cool (dk) subzone, which is one of the driest subzones in the SBS with a mean annual precipitation of 509 mm and a mean annual temperature of 2.3 °C (Chourmouzis, C. Yanchuk, A.D., Hamann, A., Smets, P. and S.N. Aitken, 2009). Elevations range from 740 m to 960 m, and soil parent materials consist primarily of lacustrine and moraine associated with gray luvisols (DeLong, Jull and Tanner, 1993, p.31). Topography of the study area is dominated by the Nechako Canyon running from the Kenney Dam in the south to the north east of the study area. Two smaller drainages, Twin Creek and Cutoff Creek, parallel the Nechako River and eventually join it near the north end of the study area.

Climax forests in the SBSdk consist mainly of hybrid white spruce, however as a result of the natural disturbance regime the landscape is dominated by lodgepole pine and trembling aspen. Subalpine fir is mostly absent. On drier sites and especially on bedrock sites Douglas-fir will occur, while black spruce will occupy wet sites associated with wetlands (DeLong).

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (MFLNRORD) Tree Species Selection Tool (TSST) website for the SBSdk subzone indicates that prior to the recent MPB outbreak stands in this subzone were historically 42% mature and 45% immature, primarily in age classes 4 to 6 (61 to 120 years) (Banner, 2011). Lodgepole pine made up 52% of the mature and 44% of immature stands. However, stands in the SBSdk in general are now dominated more by spruce and aspen with Douglas-fir occurring on south facing sites (Banner, 2011). Plantation and natural regeneration was found to be composed primarily of lodgepole pine with smaller components of spruce and deciduous.

1.1.3 NATURAL DISTURBANCE REGIME

According to the Biodiversity Guidebook (Parminter, 1995), the SBSdk 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.

1.1.4 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 the majority (65% or 6,835 ha) of the study area is less than 21 years old, with the remainder fairly equally distributed amongst the older age classes. Based on recorded RESULTS denudation code for disturbance, of this 6,835 ha approximately 38% (4,042 ha) was from the wildfire (burned) and 12.5% (1,314 ha) was from logging. The remaining 13% (1,479 ha) in the dataset had no attributes assigned.

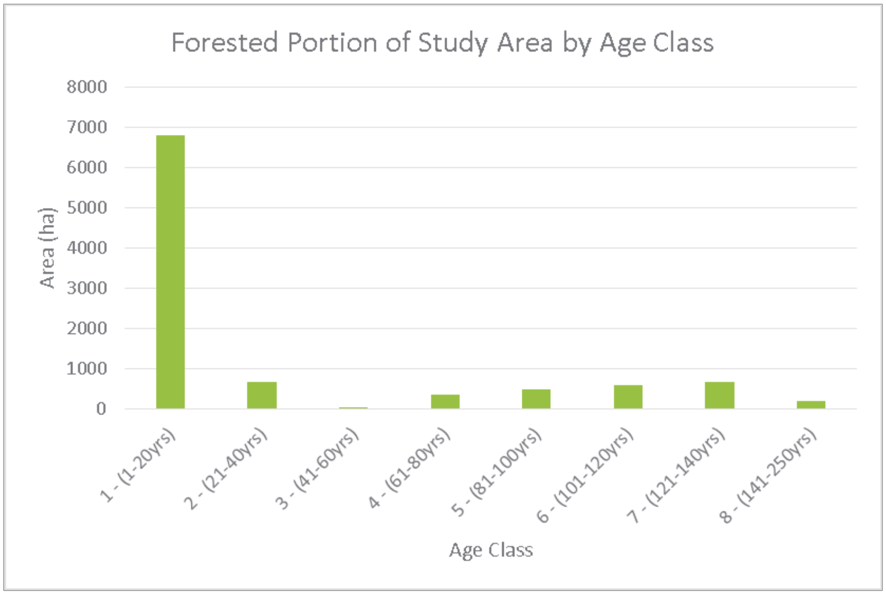

Figure 2 Age Class Distribution of Forested Stands in the Study Area

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, however they occupy less than 2% of the land base.

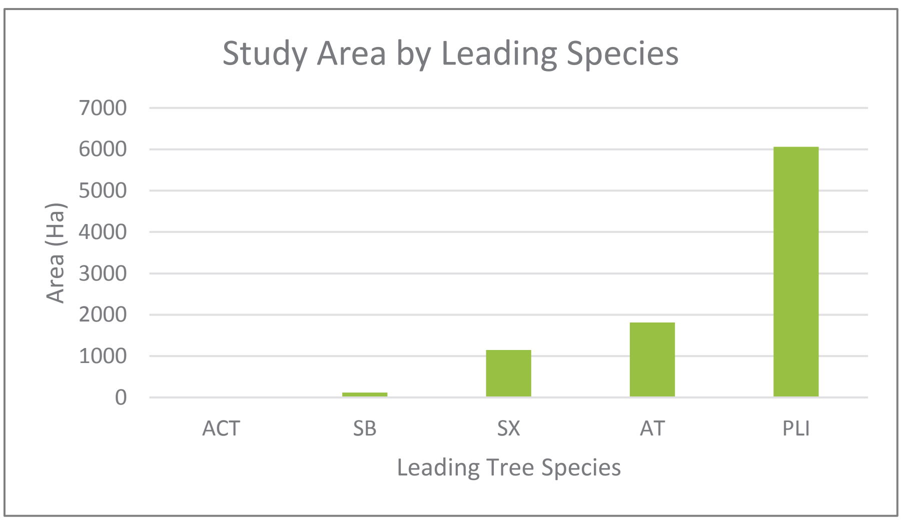

Figure 3 Forested Study Area by Leading Species

1.1.5 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 Kenney Dam dates (June 2004) were assumed to be part of the Kenney Dam fire. While 10,465 ha is the total extent of the fire, based on the VRI and an orthophoto review it is estimated that only 44% (4,230 ha) of the study area burned. Of the remaining 4,679 ha of vegetated and treed land base, 59% is in age class 1, 5% in age class 2, 17% is in age classes 3 to 6, and about 10% is older than 120 years. The majority of the burned area occurred in the crown forest management area, however a significant portion of the Nechako Canyon Protected Area appears to have burned as well. Although VRI disturbance attribute data for the park classifies only 333 ha as having been burned during the wildfire event, based on an orthophoto review it appears as if this number is closer to 1,000 ha. In addition, of the 299 ha of private land within the study area approximately 80 ha is listed as having been burned.

1.2 BACKGROUND

1.2.1 OWNERSHIP

Within the study area, land designated for the Crown forest managed land base accounts for 85% of the land base. The vast majority of this consists of treed upland (92% or 8,263 ha) while the remaining is either non-treed upland or wetland. Approximately 3% percent (299 ha) of the study area is private land, 140 ha of which is a Schedule A woodlot (the private land portion of a woodlot). Of the remaining crown land, 11% (1,203 ha) is classified as protected within the Nechako Canyon Protected Area or flood protection land associated with the Kenney Dam, and about 28 ha (less than 1%) is in miscellaneous reserves such as recreation or wildlife.

1.2.2 TENURES AND OBLIGATIONS

Land use impacts within the study area are primarily forestry activities; however there are several range tenures, one guide outfitter and one trapline tenure that overlap. Two major forest licensees operate within the study area: Canadian Forest Products (Canfor) and West Fraser Ltd. Figure 4 shows the area harvested by year in the study area. Since 1978, the total area harvested was 2,241 ha with the majority occurring the few years prior to the wildfire.

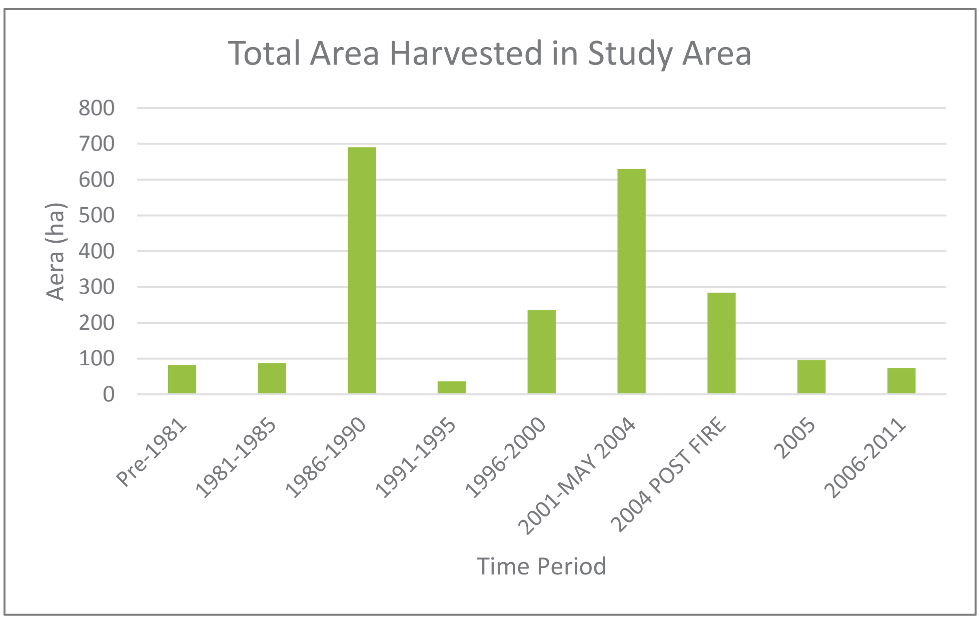

Figure 4 Harvested Area by Year in the Study Area

1.2.3 RECREATION AND PROTECTED AREAS

The Nechako Canyon Protected Area stretches along the Nechako River from the Kenney Dam in the south to approximately 4.5 km downstream of the confluence of the Nechako and Cheslatta Rivers. The Nechako Canyon is a geologically unique gorge through which the Nechako River flowed prior to the construction of the Kenney Dam in 1952. The river was dried through the construction of the Dam and the Protected Area supports significant recreational opportunities in an area containing rich archaeological sites (BC MFLNRO, 1997). Two small flood reserves are located near the Dam and adjacent to the Cheslatta spillway.

Two small recreation reserves are located partially within the study area. The Cheslatta River Recreation Site is located at the mouth of the Cheslatta River, and Fish Lake South Recreation Site is located at the west end of Fish Lake.

No Indian Reserves are located within the study area. 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 Cheslatta Carrier Nation, Nadleh Whut'en Band, Saik'uz First Nation, Stellat'en First Nation and Ulkatcho 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 of the SBSdk 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 ruffled 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 SBSdk 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 is 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 209 km of streams within the study area. Of these, 82% are first to third order or 'headwater streams', 10% are fourth order streams which are the main sub-drainages within the study area (includes Twin Creek, Cutoff Creek and Cicuta Creek), and the remaining 8% are the Cheslatta and Nechako Rivers.

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 Twin Creek drainage has historical observations of Rainbow Trout, Coho and Chinook salmon at the mouth of the stream. Cutoff Creek, on the east side of the study area, has historical observations of Chinook salmon. A reconnaissance of Fish Lake in 1971, which flows into Cutoff Creek, identified Rainbow Trout, Redside Shiner, and Northern Pikeminnow, but no other listed species or species at risk. Cicuta Creek drainage had a reconnaissance carried out in 1977 which identified some potential spawning and rearing habitat for Rainbow Trout. In addition, a stocking assessment was completed in 2009 and found that Cicuta Lake had a self-reproducing population of Rainbow Trout. While the lake itself is outside the study area to the west of the Nechako River, it drains eastward into the study area. The connecting stream network has several Rainbow Trout fish observation points but no species at risk.

There are six lakes over 5 ha in size in the study area as well as numerous smaller lakes. The study area also contains approximately 400 ha of wetlands and wetland complexes[1] over 5 ha, and many smaller classified and un-classified wetlands. As a result, there are approximately 1,380 ha of stream RMA in the study area and an additional 460 ha of wetland and lake RMA. In total, approximately 17% of the study area is adjacent to a riparian feature. According to the VRI attributes, approximately 30% of these riparian areas were burned, resulting in the potential for more than 500 ha of riparian areas with potentially degraded function.

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,

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

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.

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 from an economic, social and environmental perspective. 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 challenges, 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, 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.

2.2 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,
- 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 identified. 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:

- Fish Passage
- 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 fish passage, riparian restoration, road rehabilitation, and grassland ecosystems, 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 relatively long time since the wildfire in the Kenney Dam study area limits the opportunity for viable fibre removal;
- 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 study 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 and their proximity to the Nechako River indicated they may be high value watersheds. The office-based assessment and planning prioritization stages of this FPTWG process was 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 currently lacking a coordinated restoration plan (MOF & MWLAP, 1999).

The Nechako River was too large of a system to undertake a fish passage assessment on through this project. The Twin Creek drainage, located in the northwest end of the study area, was a 14 km^2 drainage that flows into the Nechako River approximately 9.3 km downstream of the confluence of the Nechako and Cheslatta Rivers. It is identified as the main stream that flows out of a series of small lakes and wetlands, with an additional number of smaller tributaries flowing into Twin Creek as well. Twin Creek has one listed species at risk and three key species (including anadromous salmon), as well as a previous investment of an arch culvert upstream of suspected fish barriers.

Due to high value species presence and potential for significant habitat gain, the Twin Creek drainage was selected for implementing the FPTWG Fish Passage Assessments (see Appendix 6.2 for detailed procedures and discussion). While assessments had been carried out before, they did not appear to be comprehensive or include the mainstem of Twin Creek where the suspected fish barriers are located. It is possible that these assessments were done on a site by site basis to inform harvesting and road building, and may have been completed prior to the FPTWG protocol development. While the existing fish observation points are localized at the mouth of the creek, a 2007 assessment suggested that the stream was suspected to support numerous salmonid species as well as spawning habitat (Schwindt, 2007).

Figure 5 shows the identified crossings categorized by 1 km habitat gain increments within the study area. The pink circles with black dots represent the crossing with the highest habitat gained (greater than 7 km). In the study area, this crossing occurs once in the Twin Creek Drainage.

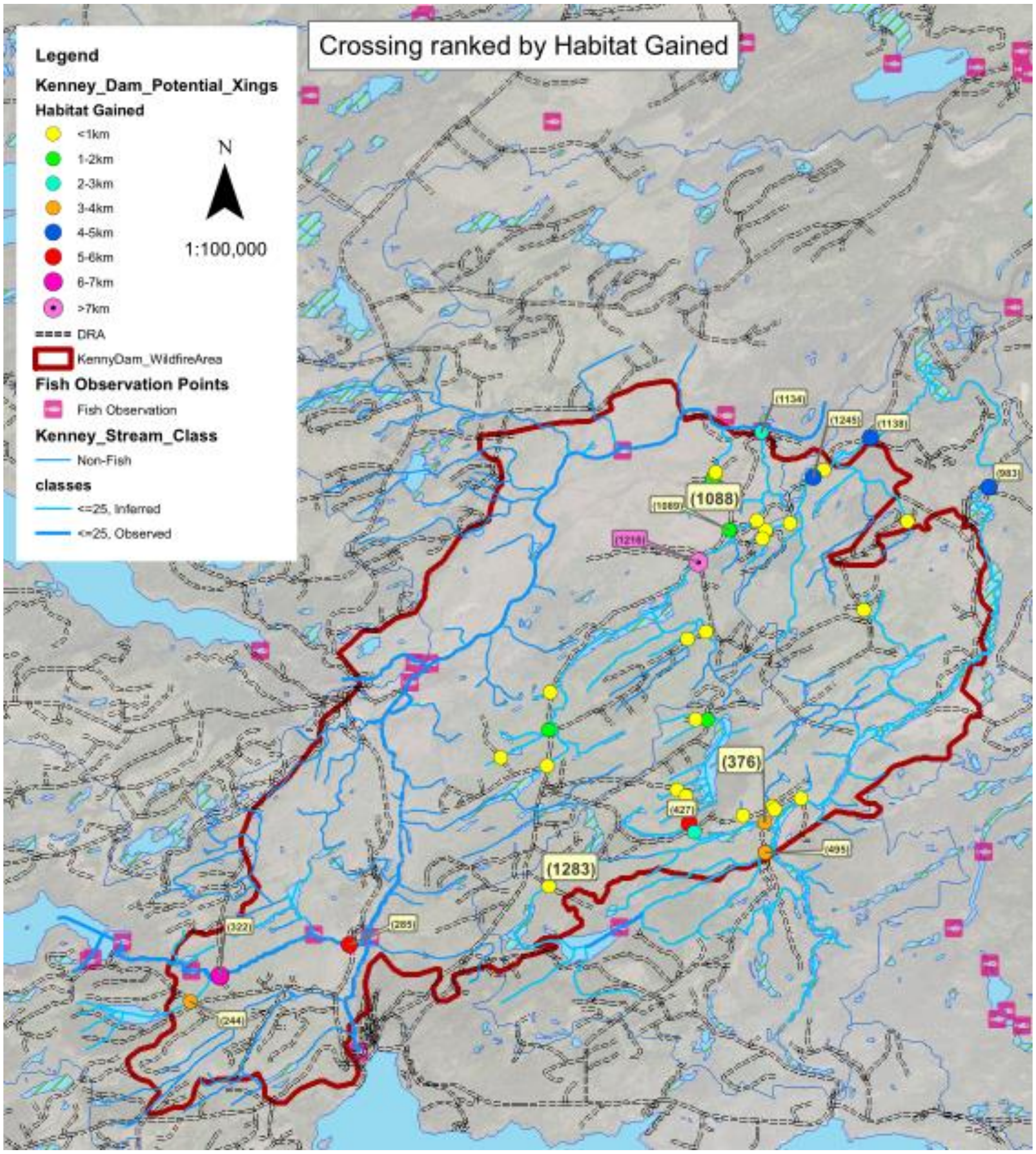

Figure 5 Crossings Categorized by 1 km Habitat Gain Increments within the Study Area

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 14 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 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. They are primarily in the shrub/herb, pole/sapling, and initiation stages. Riparian Vegetation Types (RVT) occurring within the study area are predominately RVT 3 (conifers overtopped by deciduous) with a few small areas in RVT 4 (deciduous dominated stands lacking conifers) and minor component of RVT 5 (mature stands or unimpaired).

Table 1 Potential Sites for Riparian Function Restoration

Riparian Assessment Unit (RAU)	Description	Estimated Area (ha)
1	Nechako River east bank	19.9
2	Nechako River west bank	20.2
3	Twin Creek lower	16.8
4	Twin Creek upper	37.0
5	Cutoff Creek sub-basins	12.2
6	Fish Lake wetland	17.2
7	Cutoff Creek	23.1
8	Cicuta drainage	36.6
	Total	**183**

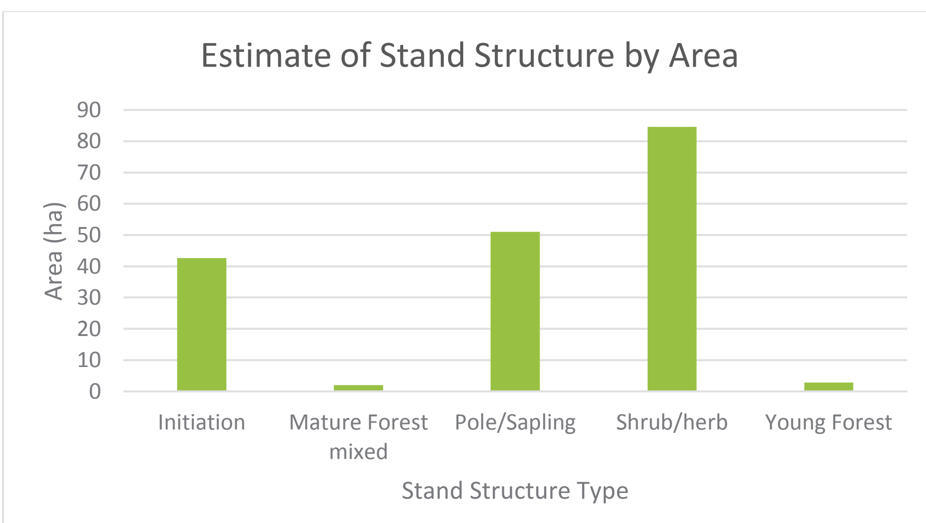

Figure 6 Estimate of Stand Structure within Riparian Areas Recommended for Assessment

3.4 ROAD REHABILITATION

The provincial government has launched several planning initiatives for road rehabilitation as a result of the significant timber harvesting that has 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/km^2, and the density of crossings that would indicate high risk to habitat is 0.38 crossings/km^2 (p.6). Within the study area, all of the fourth order watersheds have a road density exceeding Porter's high risk threshold for road density, and all watersheds exceed the high risk threshold for stream crossing density. This indicates that road rehabilitation may be a worthwhile restoration activity.

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 165 km of road, which equates to a road density of 1.57 km/km^2. Based on an average road width of 5 metres (from observations elsewhere in the District) this is approximately 80 ha of road. Of this total, approximately 79 km, or 37 ha, were identified as potential road rehabilitation candidates.

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 4,800 ha (47%) of the vegetated land base went unburned by the fire. These remaining unburned stands consist of a mixture of different age classes which would be categorized into different qualities of habitat and connectivity suitability.

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 licensee, government, resource professionals, First Nations and stakeholders 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. Given the time since the Kenney Dam wildfire, this FEN delineation is a lower priority for implementation when compared to other more recent fires in the vicinity, e.g. the Little Bobtail Fire.

3.6 CLIMATE CHANGE ADAPTATION

The Pacific Climate Impacts Consortium (PCIC) Plan2Adapt tool was designed to help 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 will 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 days[2] 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).

[2] 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).

As a result of modelled[3] 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 GRASSLAND ECOSYSTEMS

Grasslands ecosystems within the study area were identified using the PEM dataset, excluding the Protected Area in the northwest. There are 10 ha of SBSdk 81 site series (Saskatoon/slender wheatgrass) red-listed plant community, and an additional 18 ha of SBSdk 82 site series (bluegrass/slender wheatgrass) red-listed plant community (Figure 7).

The SBSdk 81 commonly has limited shallow soils over bedrock on warm south-facing slopes greater than 25%. These sites occupy dry and rocky ridges as well as colluvial slopes or base-rich morainal areas below dry rocky ridges and are lacking in tree cover with a well-developed shrub cover of Saskatoon berry, common snowberry, prickly rose and juniper (Banner et al. 1993 and Delong et al. 1993. p.42). The SBSdk 82 is commonly a non-treed plant community restricted to south and southwest aspects on moderately sloped to level terrain. Soils are typically well-drained fine textured 'blankets' of morainal or lacustrine parent material (CDC, 2018). While the shrub layer in this grassland community is minimal, the herb layer is well-developed and dominated by several grass species. As a result of the abundant insolation and low snowpacks in these grassland ecosystems, they function as critical habitat for numerous animals and support specialized plant and invertebrates that are not found elsewhere (Haeussler, S., 1998).

These grasslands are thought to have been historically common in the SBS (Hauessler, 1998), however due to agricultural conversion as well as urban and industrial uses they are now limited to rare, restricted sites and it is not possible to distinguish the difference between original natural and agricultural openings. While these grasslands may have recovered historically on their own, they rely on a combination of fire and animal disturbance such as beavers and ungulates to limit aspen taking over the sites (Haeussler). As

[3] 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 higher (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.

a result of fire suppression, fragmentation and other human and climate alterations, they are considered more at risk and of specific note through this planning process.

Grassland ecosystems within the study area were small in size (less than 30 ha total) and will be challenging to access for preliminary assessments. Further field assessment of these areas is needed to understand their current status and future vulnerability. One step could be to identify existing un-grazed sites as benchmark examples and develop prescribed burn plans to limit aspen encroachment.

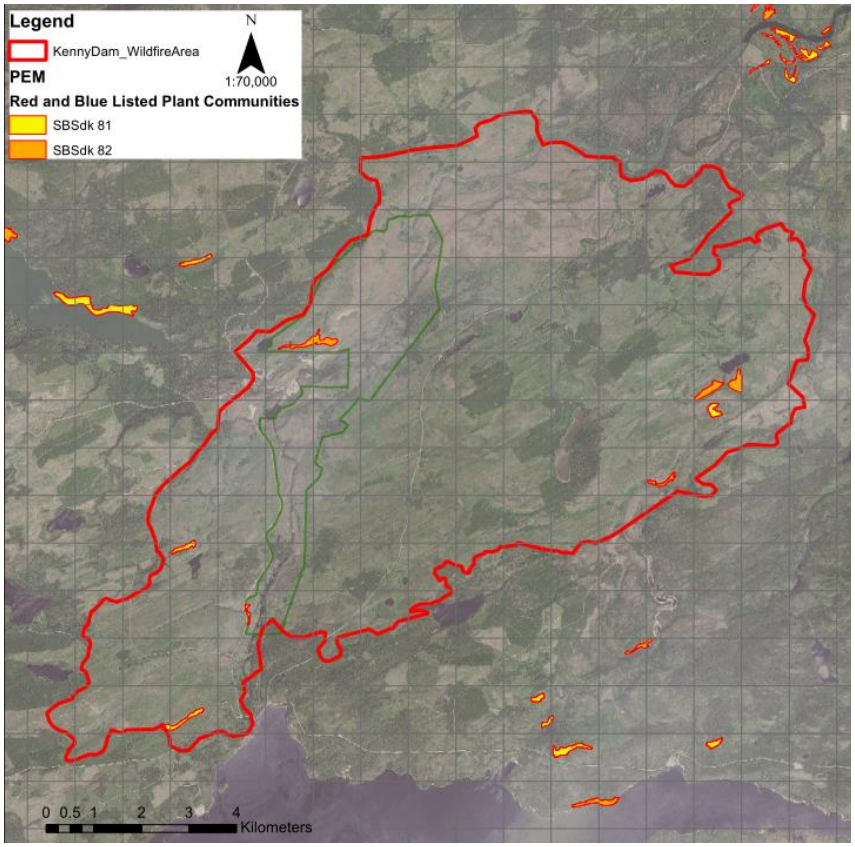

Figure 7 Grassland Communities Present (based on PEM) in the Study Area

3.8 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 membrabaceum), oval-leaved blueberry (Vaccinium ovalifolium), highbush cranberry (Viburnum edule) and soopalalie (Sheperdia 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 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 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 this engagement and analysis of the land base, a series of ER-related assessment and treatments are recommended (Figure 8).

4.1 FISH PASSAGE FIELD ASSESSMENTS AND HABITAT CONFIRMATION

It is recommend that ***fish passage restoration assessments and planning be implemented in the Twin Creek Drainage***. There is a clear process in place for assessments and remediation associated with the work of the FPTWG. Sites were identified within the study area that had high habitat value for important fish species. The intention of a fish passage assessment will be to determine whether any of the 10 identified crossings are blockages to fish passage, and if so, to confirm fish habitat and fish presence associated with these sites. Four of the identified crossings are on the mainstem of Twin Creek, and two are in the upper reaches upstream of the last small lake on that stream network. Four additional crossings of inferred fish habitat are on its tributaries. Data and reporting should be submitted to the FPTWG's system PSCIS. Subsequent steps would be driven by the results of the recommended assessment.

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 ***assessments be completed on six prioritized sites*** (Table 2) to identify areas where silvicultural treatments such as fill planting, thinning, or deciduous removal could be implemented. Previously identified sites along the Nechako River (east and west banks) were not included in this recommendation because access to these areas was challenging and potentially unsafe when implementing treatments. In addition, these sites were seen as having minimal potential for riparian restoration to impact the mainstem supply of LWD or most other riparian function components such as stream shading and small organic debris.

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. Sites listed in Table 2, totaling approximately 143 ha, were found to have been impacted by the wildfire which also contained 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 Units (RAU)	Description	Estimated Area (ha)
1	Twin Creek lower	16.8
2	Twin Creek upper	37.0
3	Cutoff Creek sub-basins	12.2
4	Fish Lake wetland	17.2
5	Cutoff Creek	23.1
6	Cicuta drainage	36.6

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 defendable 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 activities have 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 37 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 or fish passage, 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 tool for restoration planning on any given wildfire area, with value maximized if completed soon after the wildfire event. Given this, ***the development of a FEN for the project area is generally not recommended*** as priority should be given to more recent wildfire areas.

Despite this, and in response to other planning pressures, a FEN design can still be used 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, having 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 ER activities going forward (i.e. road rehabilitation, fish passage). In addition, given the relatively small size of the Kenney Dam wildfire area, there is value in evaluating the land base at a larger scale and incorporating adjacent existing or potential habitats within the design.

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 and/or ecosystem 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 changes. Immediate implementation of climate change-informed tree species selection and adaptation decisions goals should be implemented in all restoration work completed under this project within the study area.

4.6 GRASSLAND ECOSYSTEM ASSESSMENTS

Further investigation of the grassland ecosystems in the Kenney Dam study area is recommended. Focus should be given to the following:

- To understand if restoration treatments are necessary to support the persistence and resilience of these ecosystems, and
- To understand if additional areas across the study area should be restored to grassland or supported on such a trajectory.

These ecosystems are extremely unique within the landscapes in and around the study area. Understanding these ecosystems, the values they provide, and their sustainability over the long-term would provide guidance to future restoration efforts, if needed.

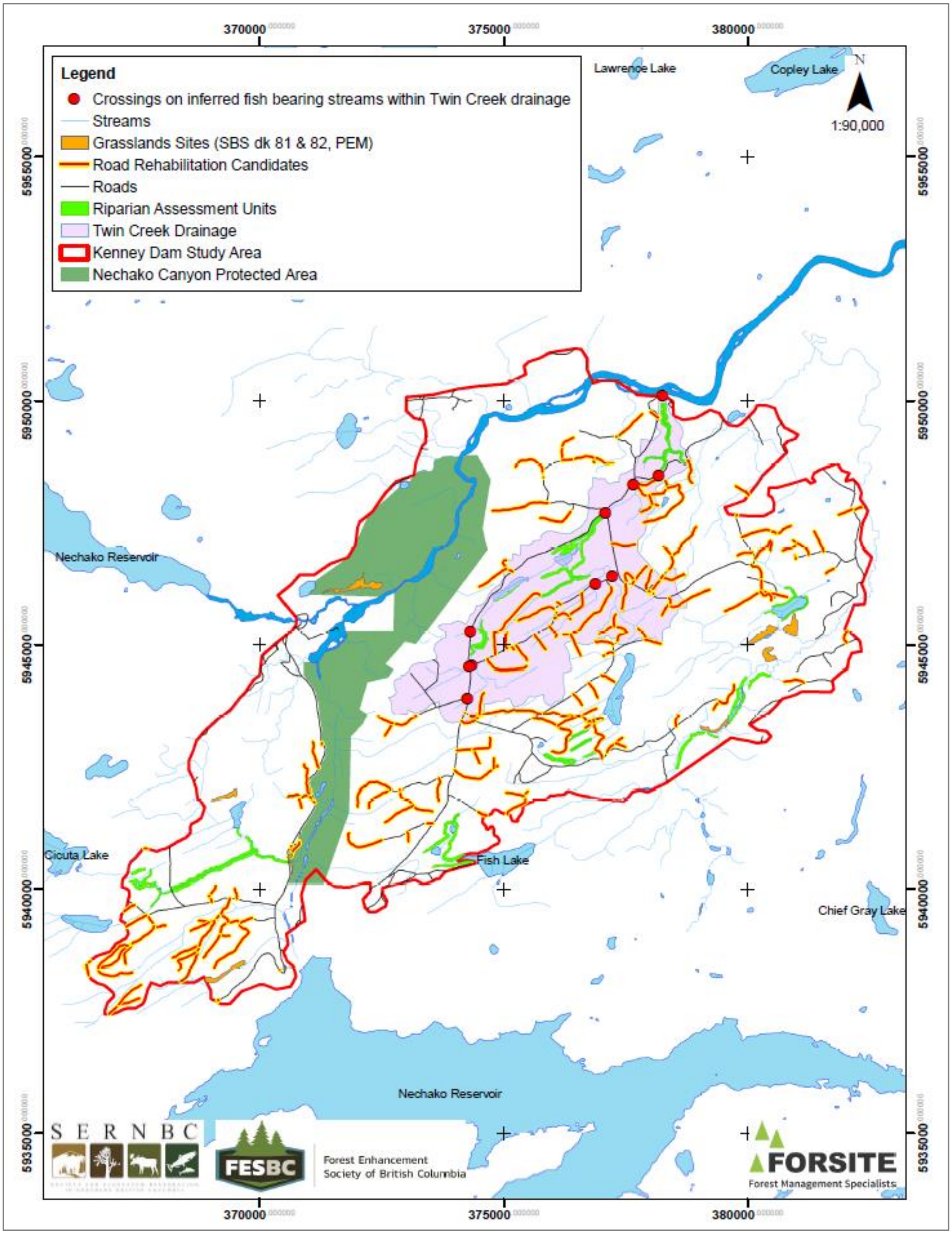

Figure 8 All Recommended Ecosystem Restoration Treatments for the Kenney Dam Study Area

5 Lessons Learned

Through the implementation of the restoration planning process for the Kenney Dam 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 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 73 crossings total identified within the study area. Of these, 18 were located within the Twin Creek drainage, 28 in the Cutoff Creek drainage, 3 in the Cicuta drainage, and 24 crossings within residual sub-basins of the Nechako River.

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 (Loktеff, 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.

Figure 9 shows an example of fish presence being inferred by gradient breaks. The stream on the left side of the image is classified as Non-Fish Bearing above a 25% gradient break. The stream below this point is classified as Fish Observed due to the fish observation point on that stream feature (in this case the Nechako River). The stream feature on the right side of the image is classified as Fish Inferred. It is a separate stream than the Nechako River, however there are no gradient or other natural barriers between it and the fish observation point shown below on the Nechako River.

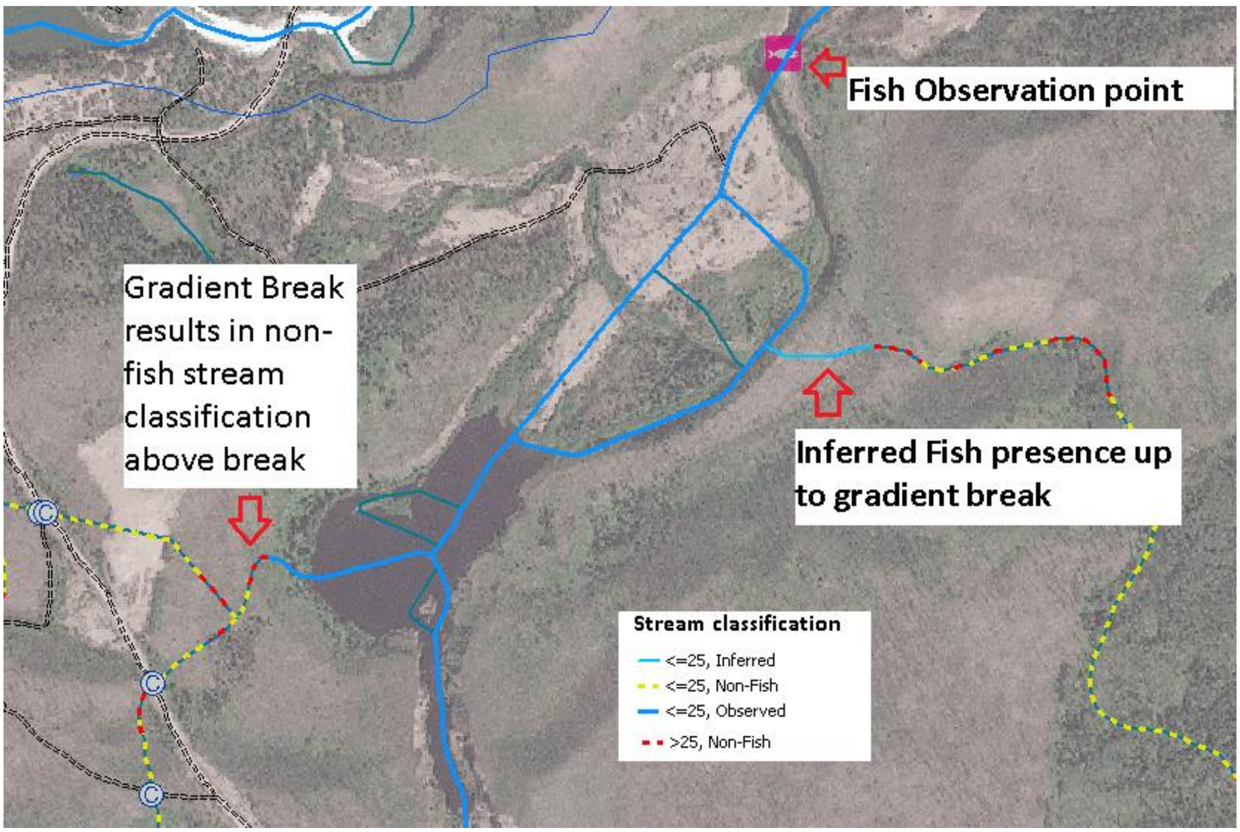

Figure 9 Example of Inferring Fish Presence (Phase II)

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)[4].

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,

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

2011). To make this index work, crossing numbers were increased by 1 to ensure the first crossing was not divided by 0.

Figure 10 shows a stream network with two crossings. Crossing A is the first crossing in the network and if it is an open bottom structure (OBS) it will gain the upstream habitat to the next crossing. In this case the total habitat gained is 2.5 km. The habitat gained by replacing Crossing B would be 259 m. In order to gain the habitat above Crossing B you would also need to replace all downstream barriers, in this case Crossing A. Factoring this in reduces the relative value of replacing Crossing B. Refer to Mount (2011) for more discussion on habitat gained indices.

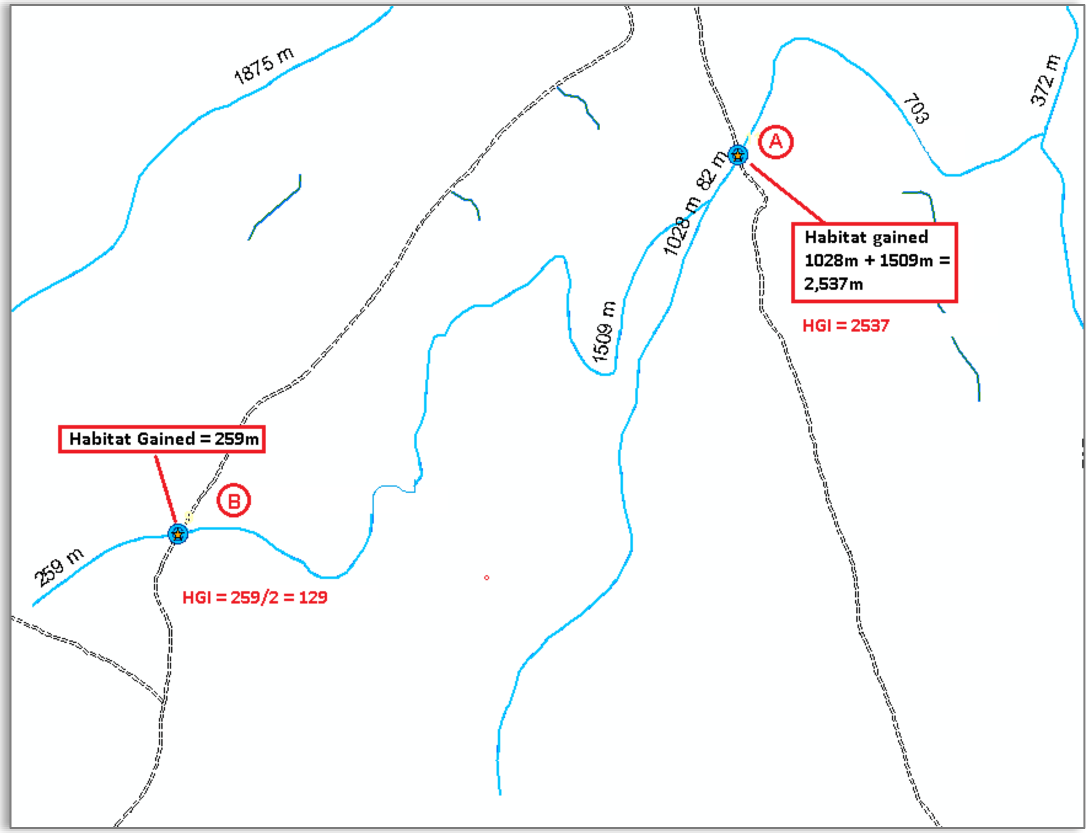

Figure 10 Example of Habitat Gained Calculation (Phase III)

6.2.3 RESULTS OF GIS ANALYSIS

The habitat gained calculation process was repeated for all the crossings in the study area. Figure 11 shows the number of crossings grouped into 1 km categories. There were 73 crossings total, 27 of which were Non-Fish Bearing. Of the remaining 46 crossings on inferred or observed fish stream crossings, 27 of these crossings, if assumed to be barriers and replaced with open bottom structures, would only result in less than 1 km of habitat gained. One crossing would garner over 7km of habitat, while 4 crossings would gain 5 to 7 km.

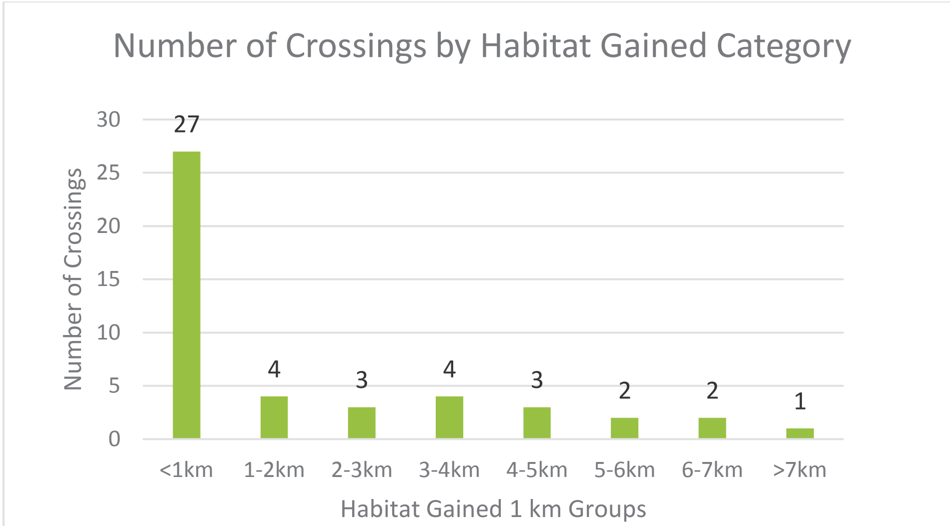

Figure 11 Number of Crossings on Assumed Fish-Bearing Streams by Habitat Gained

The six highest priority sites as a result of the habitat gain calculation are described in Table 3.

Table 3 Highest Priority Sites for Fish Passage Assessments

Sub-Basin	Crossing ID	Habitat Gained (km)
Twin Creek	1216	9.7
Cicuta mainstem	322	6.7
Cicuta mainstem	285	5.9
Cutoff Creek tributary	427	5.3
Cutoff Creek tributary	1245	4.7
Cutoff Creek tributary	1138	4.3

The remaining sites were not included in the grouping that would facilitate inclusion in the FPTWG protocol for a watershed-based fish passage assessment. These sites were lower in habitat value and scattered throughout several sub-basins. Individually, these other sites could be good candidates for rehabilitation, however the watersheds within which they are located would need to be fully assessed prior to moving on to the habitat confirmation, design and remediation phases of the RAPP.

6.2.3.1 Ground Truthing High Value Sites

To confirm these six sites were worth including in a fish passage assessment tender package, a field visit was conducted. Sites with the highest potential for habitat gained were targeted for a field check on August 8th 2017. These field assessments complete the sub-basin analysis to confirm sites available for further assessments and prescriptions.

6.2.3.1.1 Twin Creek Sites

The highest habitat gained site (1216) on Twin Creek turned out to be an engineered arch culvert. It was the fourth crossing on Twin Creek. To realize the habitat gained for this installed arch, three other crossings would need to be assessed and potentially replaced: sites 1134, 1088, and 1089. The total habitat gained for the three crossings up to the arch equals 4.6 km. With the habitat gain realized above the arch, this drainage would result in a total of over 14 km.


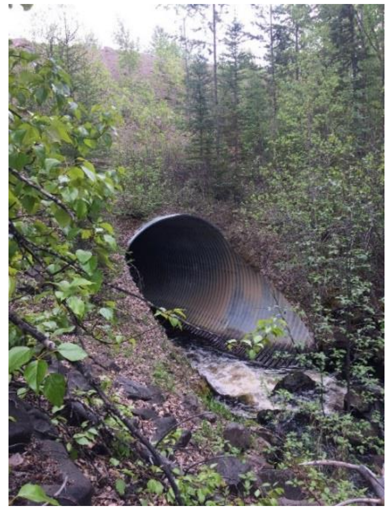

Figure 12 Crossing 1216: Arch Culvert Situated Upstream of Possible Fish Barriers (Right). Crossing 285: Closed Bottom Structure (Left).

6.2.3.1.2 Cicuta Sites

The second and third highest sites on the mainstem draining Cicuta Lake were complex sites (sites 285 and 322). The crossing with the highest habitat gained (285) was ground-truthed and found to be an engineered 2 to 3m diameter CBS. Slopes up and down stream of the site were found to be over 25% in some locations. Connectivity to the Nechako River was therefore questionable, however Cicuta Lake upstream of these sites has been stocked with Rainbow Trout in the past. Fish may gain habitat from upstream of these culverts by swimming downstream out of one lake and back up into another lake. To do this they would need to pass through crossing 244 which is on a tributary. Fish were also observed on both sides of crossing 322 which may indicate it is passable to fish.

6.2.3.1.3 Cutoff Creek Sites

The fourth site on a tributary to Cutoff Creek was not able to be ground-truthed due to a road deactivation, however a site about 1 km upstream of the site (crossing 427) was visited and found to be dry, vegetated and deactivated.

Figure 13 Crossing 427: Deactivated Culvert

The sixth site (crossing 1138) was also found to be a dry, vegetated channel with no flow. The fifth site (crossing 1245), located upstream of this dry channel was found to not connect across the Kenney Dam road, resulting in most of the calculated habitat gained to be cancelled out.

Figure 14 Crossing 1138: Dry, Vegetated Channel

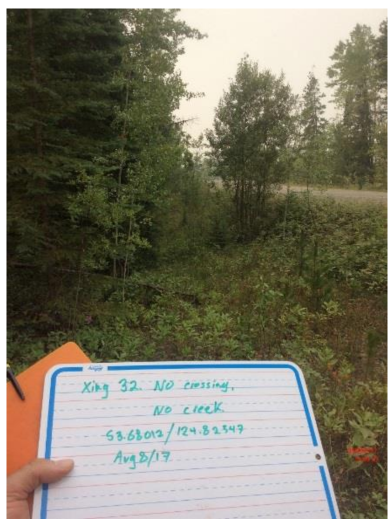

Figure 15 Crossing 1245: No Creek Visible

The remaining crossings in the study area had a low combination of habitat gained and fish species of concern. As a result of this GIS analysis, field assessment and historical records indicating that the creek may contain salmon species, it was decided that the Twin Creek drainage has the highest amount of potential habitat gained for species of concern. The Twin Creek drainage is shown below in Figure 16.

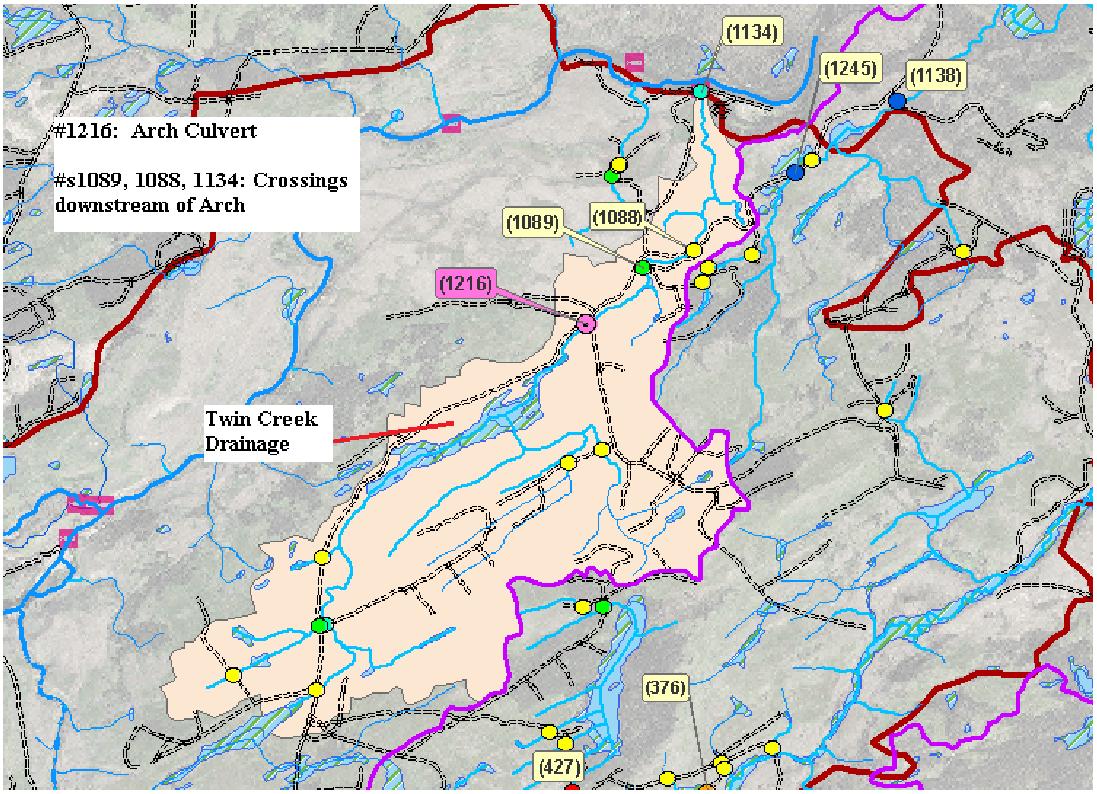

Figure 16 Twin Creek Crossings with High Habitat Gained

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. Of the numerous small sub-basins in the study area, Twin Creek, Cutoff Creek, and the Cicuta drainage have the most potential for habitat gain by carrying out a fish assessment.

6.2.4.1 Twin Creek

Twin Creek is in a fourth order watershed entirely within the study area, with the last known observation of Coho and Chinook salmon listed as in 1994. No red or blue-listed species were identified however the watershed appears to meet the priority for high value watersheds by having important salmonid populations (Sockeye, Coho, and Chinook) at least at the mouth of the drainage.

It has 10 inferred fish stream crossings, one of which appears to be a non-fish friendly closed bottom structure (CBS) (crossing 1088) downstream of an OBS (crossing 1216). This OBS was likely installed as part of a forestry road system and not as a result of a Phase 1 Watershed Assessment. If crossing 1216 were to pass fish, it would gain 9.7 km of upstream habitat including lakes. Unfortunately it is unlikely that the 2006 investment of the existing arch culvert passes fish due to the suspected barriers to fish downstream (crossings 1088, 1134, and 1089).

The first crossing on Twin Creek occurs on private property. SERNbc as a non-governmental organization is in a unique position to work with private landowners. The replacement of the sites downstream of the arch (crossing 1216) could gain a total of approximately 13 km of habitat. Therefore, implications of remediation at this crossing are significant.

6.2.4.2 Cutoff Creek

The Cutoff Creek drainage is only partially within the study area, however most of the eastern half of the study area, including several lakes, drains into Cutoff creek. A report by Arc Environmental Ltd. (1998, March) determined that the only rearing habitat in Cutoff Creek is in reach 3. Reaches 1 and 2 have poor channel definition as a result of human-caused changes to the flow direction. The author lists four options for restoration opportunities on Cutoff Creek, however cautions that overall benefit would be limited and labour would be intensive and costly. The critical site listed in the report is outside the wildfire area.

While the Cutoff Creek drainage has recorded observations of salmon, there is little habitat to be gained by undertaking Fish Passage Assessment within the study area. To carry out a Fish Passage Assessment, either small sub-basins of Cutoff would need to be completed which would include numerous low quality sites and probably deactivated crossings, or the entire 80 km^2 watershed would need to be assessed, of which 59% is outside the study area and therefore out of the scope of this project.

6.2.4.3 Cicuta Drainage

The Cicuta drainage is a unique stream network. Habitat Wizard indicates that Cicuta Lake was at one time stocked with Rainbow Trout, though success of stock may be questionable (BC Habitat Wizard). A large diameter (2+ meter) engineered CBS is located at the lower end of this drainage (crossing 285) upstream of the Nechako River. Slopes up and down stream of this crossing are modelled as being over 25%. Despite this, fish observations are shown to be upstream of this site, likely as a result of fish stocking. If fish travel downstream from the stocked Cicuta Lake, they may gain more habitat through deactivation of some crossings on this network (i.e. crossings 322 and 244), however minimal habitat will be gained and no salmon are present in the drainage above the Nechako River. In addition, most of this drainage is external to the study area, therefore it is mostly out of scope for this project and not a priority for assessment.

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 km^2 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 meters 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 process[5]. 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

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

- 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, SHls/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.

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 and West Fraser, 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

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 SBSdk and a relative moisture regime of 4 (Figure 17), 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 SBSdk. In addition, the PEM shows 55% of the study area being SBSdk01 site series, indicating that drought may be a significant future issue in the study area.

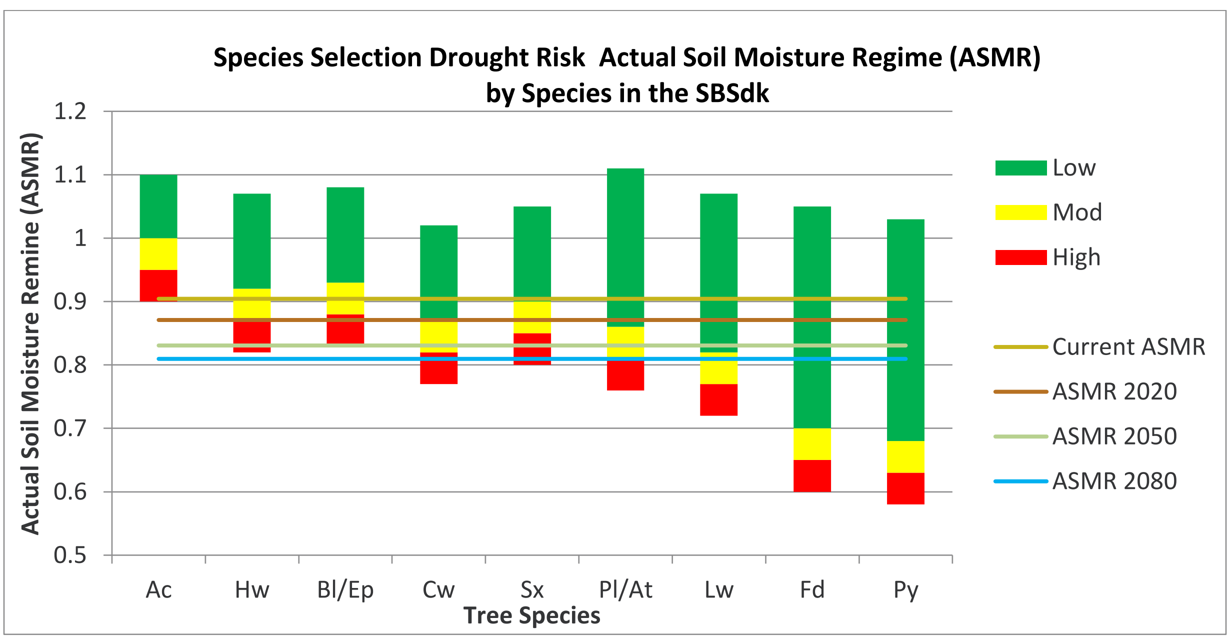

Figure 17 Species Selection Drought Risk Tool Showing Drought Risk by Tree Species

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