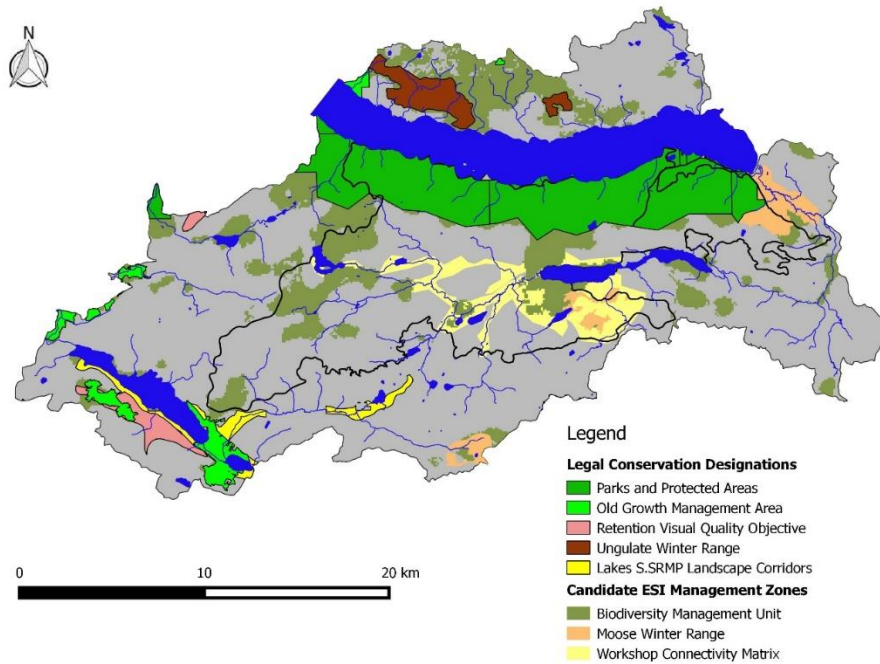


Island Lake Wildfire Ecosystem Restoration Plan



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1 Introduction

1.1 Purpose

This collaborative and holistic Ecosystem Restoration Plan for the 2018 Island Lake Wildfire attempts to consider all values and address ecological integrity and resilience in the context of climate change and the development history of the region. The plan was built in collaboration with impacted First Nations, the provincial government and SERNbc, consistent with BC's commitment to reconciliation. It identifies management zones, suggests zone-specific treatment options with the potential to maintain or restore important values to watersheds and landscapes and proposes a pathway for implementation.

1.2 Why Restoration?

Climate change, decades of wildfire suppression, an accumulation of fuels following the mountain pine beetle outbreak, and forest management practices, have combined in a perfect storm to instigate wildfire seasons unprecedented in their severity in BC.¹ Under natural conditions, most ecosystems in BC's interior rely on wildfire to regenerate.² Prior to industrial development, sub-boreal landscapes were covered by mosaics of irregular patches of forest varying in age, composition and structural complexity. Wildfires, and fires managed by indigenous communities, created complexity at multiple scales in concert with local climate, topography, moisture, species composition and human presence.³ Some organisms depend on habitat provided by wildfires.⁴ At the broadest scale, on a pre-industrial sub-boreal landscape under a stable climate, fire restores ecosystems and maintains values.⁵

Active ecosystem restoration, however, is an important tool for several reasons. First, as the climate continues to change, designing management strategies that maximise forest and community resilience matters more and more, for public safety and to maintain values.⁶ Wildfires provide excellent opportunities to change practices to improve resilience; for example, by planting deciduous trees around communities in a newly-burned area. Second, from a human perspective, as recognised and used by indigenous communities, wildfires change the availability of ecosystem services: they reset succession; they allow for growth of berry-bearing shrubs; they remove habitat for mature and oldgrowth specialists, while providing habitat for shrub and snag specialists; they change snow and rain interception; they may influence water temperature, flow and sedimentation with subsequent impacts to fish; they remove biomass, decreasing available timber and funneling carbon into the atmosphere. From this perspective, particularly for people living in communities close to wildfires, active ecosystem restoration can provide opportunities to work with wildfire to restore values and services. Third, many interior BC ecosystems have been heavily impacted by development, particularly industrial-scale forestry. Landscapes have been simplified, oldgrowth decimated and in-stand diversity reduced. The cumulative effects of wildfire and forestry can degrade ecosystem function and necessitate action. Fourth, standard practices following wildfire involve salvage harvest and re-planting to re-establish an industrial forest, focusing on timber as a value. Because salvage harvest compounds the effects of wildfire, however, this type of restoration has negative consequences for many values.⁷ Active ecosystem restoration must design treatments thoughtfully to address specific values—restoration must work with wildfire to capitalise on the benefits of renewal while avoiding compounding negative effects.

This ecosystem restoration plan aims to assess the condition of values important to the communities affected by the Island Lake Wildfire and to design treatments most likely to maintain or restore values and services.

1.3 Context: Ecosystem Resilience

Maintaining important values requires that these values are resilient to pressures over time. Ecological resilience is the ability of a system to absorb, recover from and adapt to disturbance or stress caused by agents of change⁸. In an era of increasing natural disturbance due to climate change, and subsequent increased anthropogenic disturbance (e.g., salvage harvest), resilience will determine whether ecosystems remain in states that provide the full suite of ecosystem services, or whether they undergo a regime shift to a new state with lower diversity and impoverished function. The mountain pine beetle outbreak, in concert with practices that homogenised landscapes, created a situation perfectly suited for catastrophic wildfires, decreasing resistance as well as resilience. Fire suppression controlled small, but not large, wildfires, removing the patchy firebreaks that lasted for several decades in burned stands.⁹

Functional ecosystems are most resilient in the face of change. Current evidence strongly supports a relationship between forest resilience and biodiversity at multiple scales (including species diversity, genetic variability and regional pool of species and ecosystems)¹⁰. Resilience is also influenced by the condition of the ecosystem (e.g., large primary forests are more resilient) and by the condition of the surrounding landscape (e.g., if a degraded ecosystem is surrounded by resilient ecosystems it is more likely to recover). Sub-boreal pine ecosystems, like those in the Island Lake area, given their naturally patchy nature, are resilient to severe disturbances due to broad genetic variability and tolerant to a wide range of conditions provided that surrounding ecosystems support source populations of organisms. Resilience of particular species increases when sufficient habitat exists to avoid fragmentation and to provide source populations to re-populate disturbed areas.

1.4 Context: Climate Change

The climate is changing and impacts are already being felt.¹¹ BC has become warmer and wetter over the last century.¹² Extreme rainfall and drought have both increased—sometimes within the same year. These trends will continue, with variation over shorter time periods. More winter precipitation will fall as rain, and spring snowfall will decrease, resulting in lower snowpacks, earlier snowmelt, and longer fire seasons. As the climate changes, natural disturbances and hydrological regimes will respond, and ecosystems will disassemble and reassemble, sometimes into novel combinations, as maladapted populations decline, move or adapt. Ecosystem restoration should capitalise on the opportunity to foster resilient ecosystems that continue to maintain values.

Projections for the Island Lake Wildfire region suggest that, by 2055, mean annual temperature will be 3.5°C warmer, summer precipitation will remain similar or may decrease, about 10 - 30% less precipitation will fall as snow, and climate moisture deficit will increase, particularly in summer¹³. Wildfire frequency, size and severity will likely increase. Some areas, particularly on steep, south-facing slopes, may no longer support productive forests.

Tree growth could increase in some ecosystems (e.g., relatively higher elevation ESSF) due to elevated CO₂ coupled with warmer temperatures. Growth potential, however, may not be realised because of limited moisture or nutrients, because tree populations are not adapted to changed seasonality and

increased extreme events, and/or because maladaptation increases susceptibility to insects and disease. Insect (including mountain pine beetle, spruce beetle and hardwood defoliators) and disease outbreaks will likely increase tree mortality in some ecosystems. Several deciduous and coniferous species, including aspen, lodgepole pine, interior spruce and willows that have defined the ecosystems of the Island Lake area, will likely suffer diebacks due to a variety of factors including physiological stress, pathogens and insects. Adapting restoration to climate change means that planting must select trees likely to be adapted to future conditions. Planting a diverse portfolio of species and provenances will decrease risk in the face of uncertainty.

Mass wasting and flooding will increase in some areas with changed precipitation; impacts will be felt downstream. The timing and magnitude of peak flows will change, summer flows may be lower, and stream temperature will increase. Restoration treatments in riparian areas and on steep slopes need to address potential risks to watershed health posed by changed water flow. Restoration treatments that leave trees standing in burned areas may reduce flash flooding.

Climate change influences risk to wildlife species. Changed snowpack alters predator-prey dynamics; changed ecosystems affect food availability. Moose are vulnerable to increased temperature, increased parasite loads and decreased summer nutrient availability. Cumulative effects of management and climate change (e.g., salvage harvest) will increase risk for some wildlife species¹⁴. Restoration treatments must consider the relative value of removing dead trees to improve movement and leaving structure in increase habitat complexity; different options will benefit different organisms.

Impacts of climate change are already present on the landscape, and trends can be extrapolated. However, projecting impacts of climate change into the future is fraught with uncertainty due to incomplete ecological and climate models. Restoration in the face of uncertainty requires acceptance of uncertainty and a focus on resilience, precaution and using a portfolio of strategies.

The conditions that favour wildfires will continue. Climate-savvy ecosystem restoration aims to improve resistance to wildfire and to maintain or restore resilience by adopting a diversity of approaches and minimising cumulative effects of natural disturbance, treatment response and climate change.

1.5 Context: Development History

The Island Lake Wildfire lies within a landscape heavily impacted by cumulative effects of development. Over the surrounding area, industrial forestry, mining, agriculture, private land and development of a dense road network have created landscape conditions that pose high risk to forest biodiversity, ecosystem function, watershed health, moose, furbearers and grizzly bears and have removed the potential for First Nations to practice their rights.¹⁵ Risk increased substantially between 2002 and 2015 primarily due to salvage harvest. Forest biodiversity in nearly 2/3 of the forested area of the Prince George TSA portion of Carrier-Sekani First Nations' territory faces moderate-high or high risk. Within-stand retention averaging less than 12% does not moderate risk or support recovery of young stands. Aquatic ecosystems are at high risk across the landscape due to high forest clearance (more than 40 – 60%) and high road density (more than 1.2 km/km²) in many nearby watersheds. Because of an existing protected area adjacent to Francois Lake and to guidelines in the Vanderhoof Access Management Plan, road density within the Island Lake Wildfire is relatively low. This context increases the importance of restoring function and resilience after the Island Lake wildfire and to considering values beyond timber.

1.6 Context: Existing Reconciliation Objectives

BC has committed to implementing the UN Declaration of the Rights of Indigenous People (UNDRIP). In many parts of the Province, government staff are working collaboratively with First Nations to advance stewardship and wildfire-recovery initiatives. These collaborative stewardship initiatives involve participatory processes and inclusive decision-making. A recent, wildfire-recovery related example is the Joint Leadership Council, where BC is collaborating with Secwepemc communities on ecosystem restoration programming for the Elephant Hill Wildfire area.

UNDRIP includes several articles of particular relevance (emphasis added):

“Indigenous peoples have the right to

- ***participate in decision-making*** in matters which would affect their rights... (article 18)
- *be secure in the enjoyment of their own means of subsistence and development...* (article 20)
- *their traditional medicines and to maintain their health practices, including the **conservation of their vital medicinal plants, animals and minerals...*** (article 24)
- *the lands, territories and resources which they have traditionally owned, occupied or otherwise used or acquired.* (article 26)
- *redress...for the lands, territories and resources...which have been...damaged without their free, prior and informed consent.* (article 28)
- ***the conservation and protection of the environment and the productive capacity of their lands or territories and resources.*** States shall establish and implement assistance programmes for indigenous people for such conservation and protection... (article 29)
- *determine and **develop priorities and strategies for the development of use of their lands or territories and other resources.** States shall consult and cooperate in good faith with the indigenous peoples concerned through their own representative institutions in order to obtain their **free, prior and informed consent prior to the approval of any project affecting their lands or territories and other resources...*** (article 32)”

These articles form the basis for collaboration in this plan.

The current relationship between First Nations and the province is challenging for several reasons: interactions are transactional, with many small decisions (e.g., cutblock approval) providing the focus instead of larger decisions to guide decision-makers; Nations are often “informed” rather than asked to collaborate; capacity is limited; administrative boundaries do not match; First Nations have no jurisdiction. First Nations have followed their policy and laws for millenia; however, these policies are difficult to enforce in the context of provincial laws and regulations. Nations are currently developing policy to change historic patterns.

1.6.1 Nadleh Post-Emergency Planning

Nadleh Whut’en have assessed their response to the nearby Shovel Lake Wildfire emergency and drafted recommendations to address the challenges they experienced that are also relevant to Island Lake.¹⁶ Nadleh representatives note that, to date, recovery plans have not been collaborative. They suggest that *“Nadleh’s traditional approach, combined with the latest scientific knowledge, needs to be used during restoration”*. Objectives relevant to ecosystem restoration include¹⁷

- Policy and licensing for outside harvesters (mushrooms and berries; collaboration with provincial government and including funding for enforcement)
- Water use policy
- Hunting and harvest area planning for community and non-community members
- Cattle number guidelines
- Fencing guidelines (collaboration with provincial government)
- Decommissioning of firefighting access roads
- Decommissioning of forestry roads in burn zones
- Stabilisation plan to minimise erosion.

1.6.2 Wet'suwet'en Yin'tah Stewardship

The southwest edge of the Island Lake Wildfire overlaps with the Office of the Wet'suwet'en. The Wet'suwet'en Yin'tah Stewardship principles, practices and prescriptions guide activities¹⁸. Principles include the requirement for healthy, full functioning ecosystems to provide the basis for sustaining cultural practices and values, multi-scale planning, application of the precautionary principle, and sustenance of biodiversity. Practices include protection of medicinal plant communities, no use of herbicide or pesticides, preservation of rare ecosystems, old forests, minimising impacts to wildlife habitat, maintenance of structural diversity and preserving water quality and quantity. While practices do not specifically address restoration, practices and prescription to reduce erosion, eliminate shortening of early seral stages, tolerate non-crop vegetation, promote structural and species diversity, manage range use to minimise negative impacts and avoid extensive road systems provide guidance to restoration.

1.6.3 Nadleh Whut'en First Nations Land Use Plan

Nadleh Whut'en has developed a Land Use Plan that describes its expectations for lands management and participation in decision-making.¹⁹ Restoration on Nadleh Whut'en's traditional territory is included explicitly in goal statements: "*ensure that key land and water resources necessary for the community to thrive are protected from further degradation and are restored to a healthy situation*". Relevant objectives for activities within the traditional territory address natural environment, water, cultural uses, wildlife and access management. Nadleh is currently developing templates for policies on water quality, mushrooms, berries, birch, range fencing and timber.

1.6.4 Stellat'en Land Use Plan

Stellat'en are currently developing a Land Use Plan that will include criteria for managing the entire territory for biodiversity and restoring rights. The LUP team has identified critical cultural areas and specific management areas in the planning process.²⁰

1.6.5 Yinka Dene Surface Water Policy

Nadleh Whut'en and Stella'ten enacted a water management regime, the Yinka Dene Surface Water Policy²¹, that regulates surface waters throughout their territories, including the Island Lake Wildfire. The policy establishes a foundational objective that "*waters within the traditional territories of the Carrier Sekani First Nations should remain substantially unaltered in terms of water quality and flow.*" The policy includes a water classification system and associated management goals for protection of

water resources and uses and restoration of productivity of aquatic habitats. The policy calls for restoration of degraded aquatic systems and habitat.

1.6.6 Stellat'en Rights-Based Harvest

Food security is an important issue in relation to the cumulative effects of wildfires on Stellat'en First Nation members. Wild foods include moose, berries, wild onions and cabbage, cattail tubers, dandelion roots and leaves, and young nettles. A traditional ecological knowledge study has documented preferred harvesting areas (pre-wildfire) as well as priorities for restoring moose and associated practice of rights and culture related to moose in the territory.²² Stellat'en First Nation is working with Firelight to complete a rights-based harvest study, which aims to determine the types and volumes of traditional foods a typical family would ideally harvest per year (for direct consumption, as well as to satisfy trading and sharing obligations). The goal of this work is to help inform decision around natural resource management, specifically around restoring and protecting habitat required to restore and maintain healthy population levels of key cultural and food species. The outcomes of this work serve to inform guidelines and thresholds regarding the amounts of plants, fish, birds, small and large animals needed from the local ecosystem in order for Stellat'en to fully exercise their Aboriginal rights to hunt, gather, fish and harvest for subsistence and cultural purposes.

1.7 Context: Existing Restoration Objectives

1.7.1 Society for Ecosystem Restoration in Northern BC (SERNbc)

The Society for Ecosystem Restoration in Northern BC (SERNbc) initiated this project to *“undertake a holistic assessment of the fire area and plan restoration treatments that focus on a variety of objectives including future wildfire mitigation, enhancement of biodiversity and other ecosystem values, preparedness for climate change, as well as the maintenance of timber values”*.²³ SERNbc, with members representing the BC government, academia, non-governmental organisations, industry and professional biologists, aims to *“manage the structure and function of vulnerable and degraded ecosystems in northern BC to achieve a desired future condition that will sustain ecological services and human socio-economic needs”*.²⁴ An innovative, collaborative and integrated approach to restoration that goes beyond restoring fire-guards and timber values to include all biophysical values is needed to achieve this mission. This project works towards collaborative, holistic ecosystem restoration by exploring what opportunities exist within the current regulatory regime.

1.7.2 Provincial Government

This plan matches the vision described in a draft provincial ecosystem restoration strategy to restore forests to *“an ecologically appropriate conditions creating a resilient landscape that supports the economic, social, and cultural interests of British Columbians”*. The plan is consistent with the provincial goal to address First Nations' rights, title and interests by adopting the UN Declaration of the Rights of Indigenous People. To date, most restoration activities have neither met the provincial priority to *“position British Columbia as a world leader in ecosystem restoration”*, nor addressed First Nations' rights.²⁵ This plan moves beyond standard restoration activities by collaborating with First Nations and considering all values.

1.7.3 Chief Forester's Guidance on Post-fire Retention

The Chief Forester provides guidance for retention planning following natural disturbance, stating that the “government expects that the planning will be done in full partnership with impacted communities and indigenous people” and that “Government will ensure that appropriate planning is conducted”.²⁶ This plan follows the guidance for partnership.

The Chief Forester provides six points to consider—in order of priority—when planning restoration activities (emphasis added):

1. **Ensure human safety** and minimize damage to existing infrastructure.
2. Sustain, restore or enhance the capacity of ecosystems to **provide ecosystem values**, such as those related to water quality and wildlife habitat
3. Consider the collective disturbances on the landscape to **mitigate cumulative impacts** on environmental and societal values.
4. Facilitate the adaptation of forests to **improve resilience to climate change**.
5. Minimize impacts to timber supply by shifting logging from undamaged stands to damaged stands wherever possible
6. Recover value from the burnt timber before the wood quality deteriorates.

This guidance explicitly places long-term provision of ecosystem values and climate change adaptation above the short-term economic gain from salvaging timber and calls for a focus on what to retain rather than what to log. This plan is consistent with this guidance.

1.7.4 Omineca Environmental Stewardship Initiative (ESI)

The Omineca ESI demonstration project provides excellent opportunities for innovative collaborative and restoration approaches. The Omineca ESI, a collaboration between Carrier Sekani First Nations and provincial government, aims “to develop a new collaborative approach to establishing environmental legacies and to generate high quality, accessible and trusted environmental information”.²⁷ Objectives include assessing risk to priority values and using results to inform management responses to minimise effects. Work to date has assessed risk to forest biodiversity, moose and fish and proposed candidate spatial units for application of special management to maintain or restore values. **The work of the collaborative ESI project team has set the foundation for ecosystem restoration work by establishing relationships, gathering and compiling trusted data and by working with licensees to develop a memorandum of understanding guiding immediate measures to change management and decrease risk to values.**

2 Developing the Plan: Approach

2.1 Principles

Development of this plan was governed by three over-arching principles:

1. **Collaborate with First Nations' communities impacted by the Island Lake Wildfire to ensure that the plan aims to achieve their vision and interests.** The communities of Nadleh Whut'en, Stelat'en, Ts'il Kaz Koh, Saik'uz, Nak'azdli Whut'en, Tl'azt'en and Talka Lake First Nations collaborated through an Advisory Council, with representatives of each community providing input on design of the consultation process, potential treatments and implementation options.
2. **Promote ecological integrity and resiliency in light of climate change and the development context of the region.** This principle is consistent with the interests of the supporting First Nations and with the work of the Omineca Environmental Stewardship Initiative (ESI), an ongoing collaborative planning process between Carrier Sekani First Nations (CSFN) and the BC government.
3. **Coordinate with other programs to create synergies, ensure consistency and avoid overlap.** The Omineca ESI provides a strong foundation for Ecosystem Restoration by providing an existing model of collaboration, developed relationships and mutually trusted information. Licensees have already signed a memorandum of understanding on immediate measures to change management to meet Omineca ESI objectives. Before this project began, provincial agencies and forest license holders had already begun assessing restoration options in portions of the wildfires.

2.2 Methods

2.2.1 Collaboration Plan

Collaboration with First Nations, provincial government and stakeholders was critical to developing an ecosystem restoration plan with the potential to address all values. An Advisory Council, with representatives from seven Carrier Sekani First Nations, SERNBC, the Omineca ESI Project Team and the BC government (FLNR), guided the plan vision, collaboration strategy and methodological approach (Appendix 1). Supported by the Advisory Council and consulting team, community members, particularly from two nations substantially affected by the wildfire (Nadleh Whut'en and Stelat'en), FLNR Region and District staff and topic experts identified management issues and restoration treatment options in a series of meetings and workshops. We held meetings in Nadleh, Stellaquo and Burns Lake to allow participation from interested community members. We gathered advice and knowledge from topic experts and talked with FLNR district staff to discuss licensee obligations and interests.

This plan was completed on a tight timeline (initiated mid-January; completed May), challenging full communication. Fortunately, the existing relationship between the provincial government and CSFNs built for the Omineca ESI facilitated communication and a memorandum of understanding signed between the ESI and licensees for immediate measures supports activities consistent with the ESI direction.

2.2.2 Values

We began with the consensus priority values identified by the Omineca ESI project team. We confirmed and built upon this list with the Advisory Council and in subsequent meetings and workshops with First Nations and FLNR. The final priority value list is inclusive of all suggestions and covers a wide array of ecological services (Table 1).

Table 1. Priority values for consideration in the Island Lake Ecosystem Restoration Plan.

Value	Type	Rationale
Mature and old forest biodiversity	Coarse-filter biodiversity	<ul style="list-style-type: none"> • Omineca ESI priority value • Mature and old forest serves important ecological functions and supports a range of species • Mature and old forest provides resilience to climate change
Young natural forest	Coarse-filter biodiversity	<ul style="list-style-type: none"> • Omineca ESI priority value • Characteristic ecosystem of the region • Supports a range of species • Provides structure as forest ages
Moose	Cultural value Indicator species	<ul style="list-style-type: none"> • Omineca ESI priority value • Subsistence value • Declining in region • Indicates functioning ecosystem patchwork
Water and fish	Coarse-filter aquatic biodiversity Cultural value	<ul style="list-style-type: none"> • Omineca ESI priority value • Subsistence value • Declining water quality in region • Change in water quantity with climate change
Timber	Economic value	<ul style="list-style-type: none"> • Omineca ESI priority value • Regional economic driver • Timber supply falldown brought closer by climate change and past management
Marten	Indicator species Furbearer	<ul style="list-style-type: none"> • Indicates forest structure • Habitat declined in area
Grizzly bear	Indicator species Cultural value	<ul style="list-style-type: none"> • Indicates unroaded area • At risk in study area
Northern goshawk	Indicator species	<ul style="list-style-type: none"> • Indicates large mature and old forest patches • Declining precipitously in region • Link to goshawk management plan
Medicinal plants	Cultural value Non-timber forest product	<ul style="list-style-type: none"> • Cultural value affected by wildfire and forest harvesting • Restoration activities pose risk
Berries	Cultural value Non-timber forest product	<ul style="list-style-type: none"> • Cultural and subsistence value • Wildfire poses opportunities to improve berry production
Fungi	Non-timber forest product	<ul style="list-style-type: none"> • Post-fire morel bloom poses opportunities and challenges
Carbon	Climate change value	<ul style="list-style-type: none"> • Important in climate change mitigation

Landscape connectivity	Climate change value Coarse-filter biodiversity value	<ul style="list-style-type: none"> • Important for climate change resilience • Critical part of landscape design
Range	Economic value	<ul style="list-style-type: none"> • Economic driver in region • Interacts with other values

2.2.3 Spatial Analyses

We used existing spatial data layers, available from provincial geo-databases and ESI work, to analyse the pre-disturbance and current condition of values as a basis for determining zones for treatment options (Table 2). We performed overlays and calculated summary statistics using SELES²⁸ with 20-m resolution raster data and created maps from raster and vector data in QGIS.

Table 2. Maps used in spatial analyses

Variable	Source	File Name
Forest Age	VRI from Data BC	erp_AgeSev.tif
BGC Variant 2012	Data BC	erp_BEC2012.tif
Biodiversity Management Units	Omineca ESI	erp_BMU_High2018.tif
Crown Forest Land Base	Omineca ESI	erp_cflb_upd.tif
Consolidated Cutblocks	Data BC	erp_Cutblocks.tif
Forest Tenture Cutblocks	Data BC	erp_Cutblocks_ften.tif
Candidate Moose UWR	Omineca ESI	erp_EsiMoose.tif
Fire Guards	John DeGagne	erp_FireGuard.tif
Past Fire Disturbance	Omineca ESI	erp_FirePast.tif
Fire Perimeters	SERN BC	erp_FirePerim.tif
First Nations Communities	Omineca ESI	erp_FN_Community.tif
Goshawks	Generated	erp_Goshawk_v2.tif
Island Lake Fire Severity	SERN BC	erp_Island_Severity.tif
Lakes	FWA from Data BC	erp_Lake.tif
Lakes North SRMP Connectivity Corridor	Joanna Lee, FLNR, Skeena	erp_LCM_LakesN_SRMP.tif
Legal Conservation Zones	MOE via Omineca ESI	erp_Legal_Conserve.tif
Mountain Pine Beetle 2015 Mortality	Omineca ESI	erp_MPB2015.tif
PEM SS1 (most likely site series)	Omineca ESI	erp_pem_ss1.tif
Huckleberry sites	Generated	erp_pem_ss1_Huck_Club.tif
Roads	Data BC	erp_Roads.tif
Island Fire Severity	SERN BC	erp_Shovel_Severity_plusone.tif
Special Management Zone	Generated	erp_SMZ.tif
Streams	FWA from Data BC	erp_Stream.tif
Tenure	Data BC	erp_Tenure.tif
THLB	Omineca ESI	erp_thlb_upd.tif
Urban and private land	Omineca ESI	erp_urban_priv.tif
Wildland Urban Interface	Generated	erp_urban_priv_2km.tif

Vegetation Resources Inventory	Data BC	erp_vri.tif
Watershed ID	FWA from Data BC	erp_Watershed_ID.tif
Wetlands	FWA from Data BC	erp_Wetland.tif
Workshop connectivity matrix	Generated	erp_WorkshopZones.tif
Grizzly bear secure habitat	Generated	erp_ws_gb_Secure.tif
Hydrological function score (100-ECA)	Generated	erp_ws_HydroFunction.tif
ECA risk class	Generated	erp_ws_riskECA.tif
Pre-fire ECA risk class	Generated	erp_ws_riskECA_prefire.tif
Road-related watershed risk	Generated	erp_ws_riskRd.tif
Riparian-related watershed risk	Omineca ESI	Streams_fire_severe
Watershed Fish-based Value	Omineca ESI	erp_wsHeightValue.tif
Watershed sensitivity to development	Omineca ESI	erp_wsSensitivityRankNS.tif

Burn severity: We overlaid burn severity mapping, provided by SERNbc, on maps of pre-existing land condition to assess the potential impact of fire and current condition of values.

Forest biodiversity: We characterised the pre-disturbance ecological variability using forest age (based on VRI, consolidated cutblocks and mountain pine beetle disturbance intensity), ecosystem type (BEC variant and site series based on PEM and/or TEM), leading species (with a focus on deciduous species) and riparian areas.

Watershed value and sensitivity: We identified high-value fisheries watersheds, using analyses from the Omineca ESI that consider known and inferred fish-bearing reaches. We identified sensitive watersheds using variables such as wetland and lake area and ruggedness. We assessed risk to function based on equivalent clearcut area, road density, and severely burned riparian areas.

Moose: We identified areas of potential moose habitat, using analyses from the Omineca ESI that note where forage and cover lie in close proximity. Static forage habitat includes large stream riparian areas, wetlands and brush sites close to mature and old forest. The ESI identified candidate moose UWRs improving analyses by expert interpretation and field verification of sites. We focussed restoration treatments on these latter sites.

Grizzly bears: We identified secure core areas for grizzly bears. These areas are remote (> 500 m from a road) and large (> 10,000 ha) and have potential to provide suitable habitat.

Goshawks: For all potential nesting sites (> 100-ha patches of mature-old forest) in and around the wildfire, we calculated the percent mature and old forest (>100 years old) within 2.8 km of potential territory centres forming 2,500-ha circles around each centre. Where the circle included more than 60% mature and old forest, we mapped the area as a potential goshawk foraging territory.

Timber: We estimated the suitability of stands for immediate salvage and contribution to mid-term timber supply considering pre-fire age and volume, burn severity, accessibility and hauling distance.

Reforestation: We estimated the benefits of reforestation for resilience, climate change adaptation, carbon sequestration, timber and non-timber values considering BEC variant and site series, historic deciduous component, potential for natural regeneration, proximity to human settlement and suitability

for innovative silviculture (e.g., expanded diversity of stock, changed density, clump planting, encouraging shrub growth).

Existing zoning: We summarised existing and emerging land-use zoning including protected areas, legal old growth management areas, retention visual quality areas, wildlife habitat areas, ungulate winter ranges (existing and candidates from Omineca ESI), candidate biodiversity management units (from Omineca ESI).

2.2.4 Developing Treatment Options

We built a matrix linking potential restoration treatments to each value to be refined at workshops (Table 3).

Table 3. Preliminary matrix of treatments for maintaining and/or restoring identified values.

	Fuel management	Forest Biodiversity	Watershed Health	Moose	Goshawk	Grizzly	Furbearers	Cultural Areas	Berries	Medicinal Plants	Mushrooms	Timber	Range
Harvesting Treatments													
<ul style="list-style-type: none"> • Avoid Salvage harvesting <ul style="list-style-type: none"> ○ Retain live trees ○ Retain large dead trees ○ Retain deciduous shrubs and trees ○ Retain riparian vegetation • Partial cut leaving mature live trees • Clearcut salvage 		X	X		X	X	X	X	X	X		X	
		X	X	X	X	X	X	X	X	X		X	
	X	X	X	X	X		X	X				X	
	X		X	X		X	X					X	
	X		X	X								X	
Planting and Seeding Treatments													
<ul style="list-style-type: none"> • Plant conifers <ul style="list-style-type: none"> ○ Plant climate-adapted mix of species ○ Reduce stocking and plant in clumps • Plant or promote deciduous trees and shrubs • Plant berry bushes • Seed exposed soil <ul style="list-style-type: none"> ○ Rye grass for short-term stabilisation ○ Native species for long-term 	X	X	X									X	
	X	X	X	X								X	
	X	X	X	X		X			X	X			
	X		X					X	X	X			X
			X										X
			X										X
Access Treatments													
<ul style="list-style-type: none"> • Rehabilitate roads and fire guards • Plant roads and fire guards • Upgrade road drainage • Maintain roads and guards • Manage access 		X	X	X		X							
		X	X	X		X						X	
		X	X	X		X						X	
	X		X			X		X	X	X		X	X

Compiled workshop and meeting summaries are available on request.²⁹

3 Wildfire Area Description

3.1 Location

The Island Lake Wildfire, initiated by lightning, burned 20,966 ha (209 square kilometres) between August 1 and September 2018, starting at Island Lake and spreading to cover the area south of Francois Lake between Binta Lake and Anzus and Borel Lakes (Figure 1). The interface wildfire impacted land owners on both sides of Francois Lake as well as communities in Grassy Plains, Fraser Lake, Stellaquo, Nautley and Endako. It burned part of Francois Lake Provincial Park.

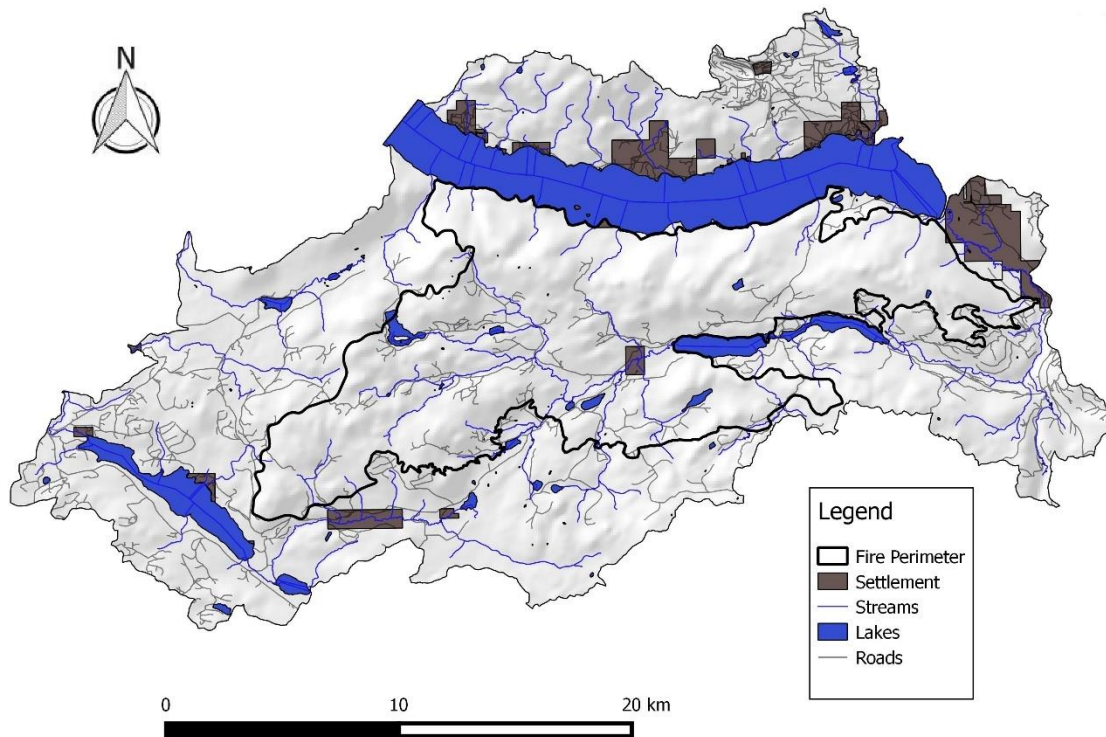


Figure 1. Island Lake Wildfire boundary.

Territories of two First Nations—Stellat'en and Nadleh—were substantially affected by the Island Lake Wildfire; these nations have been involved in the Omineca ESI planning in the region over the past two years. In 2018, nearly a quarter of Nadleh's territory was impacted by wildfires, with Shovel Lake the largest, followed by Island Lake. Similarly, over 183,000 ha of Stellat'en territory burned, with a large portion in the Shovel Lake and Island Lake Wildfires. These massive fires impacted many areas that were vitally important to the practice of culture, rights and way of life.

Note that maps presented here and below include the extent of watersheds fully or partially affected by fire. Assessment and restoration treatments consider watershed-scale hydrological and ecological context.

3.2 Ecology and Values

3.2.1 Ecosystems

The Island Lake Wildfire burned through a landscape of sub-boreal ecosystems typically shaped by fire. Low elevation ecosystems within the fire area include dry and moist sub-boreal spruce biogeoclimatic subzones (primarily SBSmc2, with SBSdw3 adjacent to Francois Lake and SBSdk in the valley between Anzus and Binta Lakes); Engelmann spruce subalpine fir (ESSFmv1) covers higher elevations (Figure 2). Within biogeoclimatic subzones, variation in soil, topography and disturbance leads to diverse ecosystems. On south-facing slopes, dry open ecosystems provide spring wildlife habitat. These ecosystems typically burn frequently; as the climate continues to shift, they may revert to shrubland and grassland. In the gently rolling terrain, dotted with lakes and wetlands, rich and wet ecosystems, with important cultural and wildlife values, are scattered throughout (Figure 2).

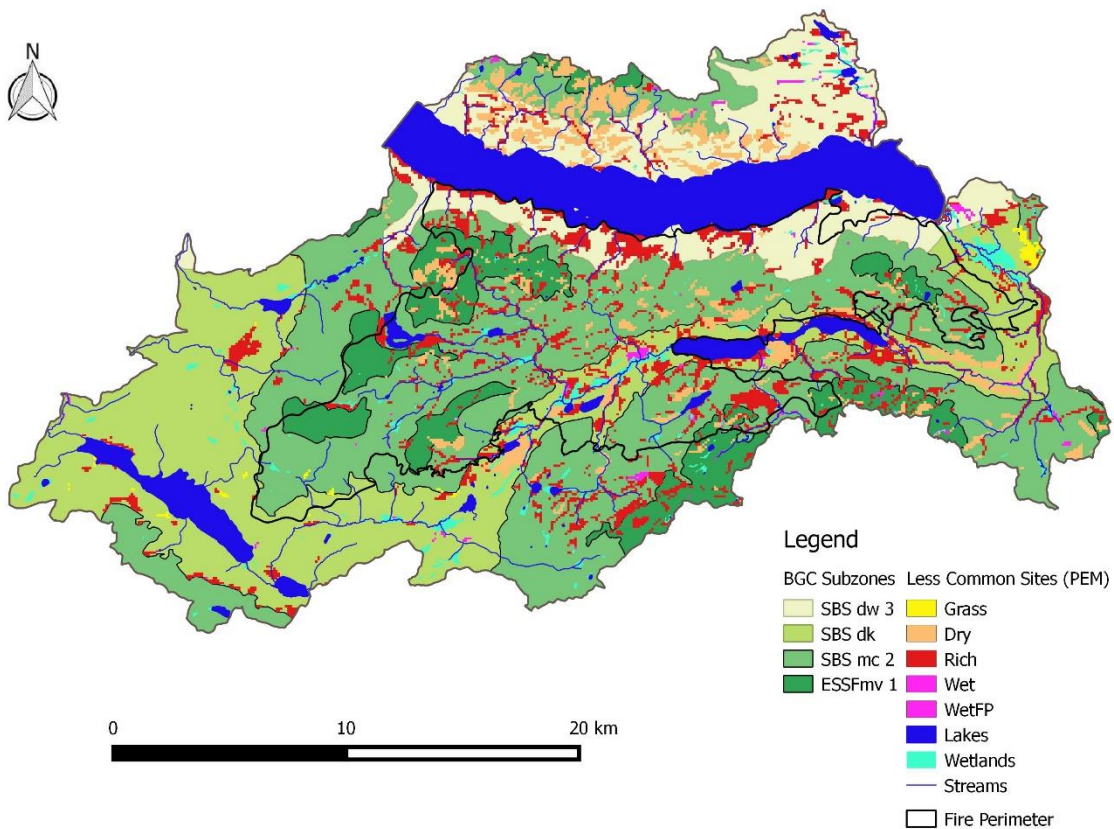


Figure 2. Ecosystems of the Island Lake Wildfire area. Biogeoclimatic subzones are shaded in green. Dark green shows ESSFmv1 at higher elevations. Groups of special site series within subzones are shown as small patches of brighter colour.

Historically, these SBS subzones would have been replaced by wildfire about every 100 years, while the ESSF subzone would have been replaced about every 200 years.³⁰ A landscape shaped by wildfire would include a rich mosaic of deciduous (primarily trembling aspen, paper birch in rich sites and black cottonwood on floodplains), coniferous (primarily lodgepole pine in seral stands, hybrid white spruce and subalpine fir in older stands, black spruce in upland forest and wetlands, and Douglas-fir in dry and warm sites) and mixed stands of different ages, with open dry forest on south-facing slopes and patches

of old forest on wet sites and areas skipped by fire. These landscapes would be resilient to wildfire due to their heterogeneous nature.³¹ Young stands would be structurally and compositionally complex with legacies from disturbance and deciduous seral species.

Effective fire control over the past few decades decreased natural disturbance rate considerably, leading to a homogenised landscape vulnerable to insect attack and subsequent severe wildfire.³² Prior to wildfire suppression, there is no evidence that mountain pine beetle played a major role in stand replacement.³³ Fire suppression has controlled small wildfires, leaving stands to mature instead of being reset into patches of young forest, with few fine fuels, that slow fires.³⁴ A recent wildfire (2010) to the south demonstrates this effect as it stopped the progression of the Island Lake wildfire. Over much of the landscape, industrial forestry has increased anthropogenic disturbance (Figure 3) replacing natural disturbance. Recent harvest has focused on salvaging stands killed by mountain pine beetles.

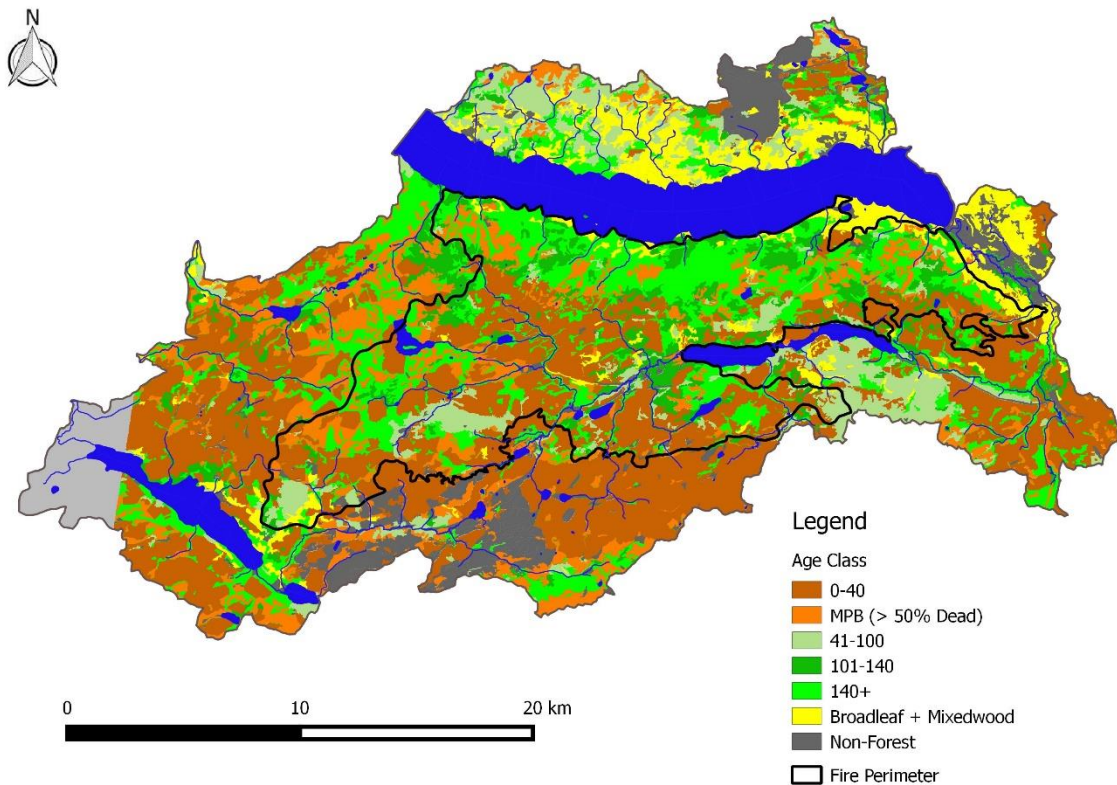


Figure 3. Forest age before the Island Lake Wildfire.

Across all BEC subzones except the SBSdw3, the age-class distribution is bimodal, with a high proportion young (logged) and a high proportion mature, but little mid-seral forest (Figure 4). Under historical disturbance frequencies, 28 – 49% of the area in SBS subzones is expected to be over 100 years, with about a quarter of the area over 140 years old; ESSF would have a higher proportion of old forest, 52 – 72% over 100 years and about half over 140 years. Prior to the fire, the amount of forest over 100 years was much higher than expected for the SBSdw3 (94%) and at the top end of historic values for SBSdk and SBSmc2 (47% and 50%); the amount of forest over 100 years was within historic range for ESSF

(Figure 4; 66% in ESSF). The amount over 140 years (not shown on graph) was similar to expected for the SBSdk (25%), SBSmc2 (33%) and ESSF (41%), but considerably higher in the SBSdw3. The SBSdw3 lies within a protected area and is unlogged. Past fire suppression activities may have decreased the rate of natural disturbance, although the areas considered are too small to draw conclusions.

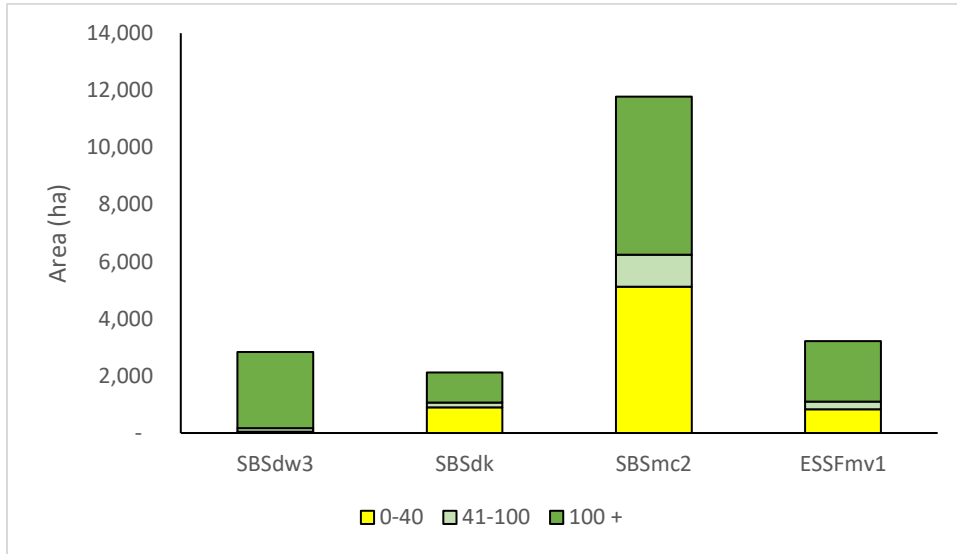


Figure 4. Area of each biogeoclimatic subzone divided by age class before the Island Lake Wildfire.

Forest harvesting differs from wildfire. Although the recent harvest disturbance rate has been at least as high as historic wildfire, the type and pattern of disturbance differs. These differences have important implications to ecological function and resistance to future wildfire. First, harvesting targets mature stands while fire burns all ages, leaving a higher proportion of mature stands. Second, wildfire only burns portions of stands (recent studies show that in boreal forests, about 40% of burned areas are left in skips)³⁵ while harvesting leaves low levels of retention in stands.³⁶ Third, wildfire removes fine fuels but leaves large structures, while harvesting removes large structure but leaves fine fuels, resulting in stands vulnerable to future wildfire.³⁷

3.2.2 Fire Severity

The Island Lake Wildfire ignited from a lightning strike during a drought period and grew to over 20,000 ha in three weeks. The high severity of the fire was fueled by high concentrations of downed wood resulting from the mountain pine beetle outbreak that killed lodgepole pines 20 – 25 years ago.

Although the wildfire was severe and difficult to contain, a fifth of the area was skipped entirely, and an additional 11% burned at low severity, leaving a variety of structure (Figure 5 and 6).

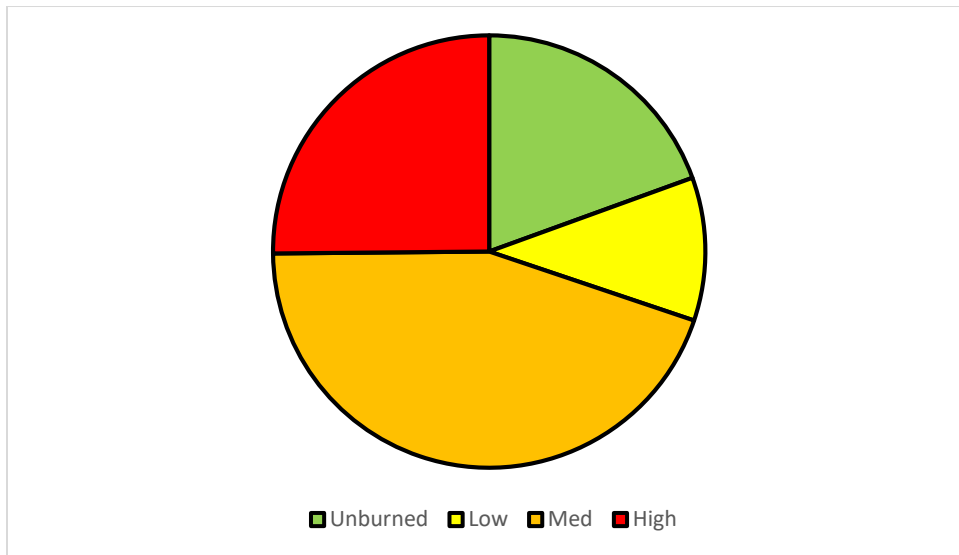


Figure 5. Proportion of Island Lake Wildfire area that burned at low, medium and high severity and that remained unburned.

The fire severity maps highlight several patterns. First, some plantations burn while others do not. The unburned cutblocks date from an era of prescribed burning that removed fine fuels from the site prior to planting. These show up clearly as skipped areas. Second, deciduous stands, stopped the fire at the northeast corner. Third, a previous fire (2010) stopped the wildfire on the southern boundary. Burn severity varied slightly by age class: about 33% of forests younger than 100 years and 25% older than 100 years remained unburned or burned at low intensity while 42 – 46% burned at moderate intensity across age classes (Figure 7).

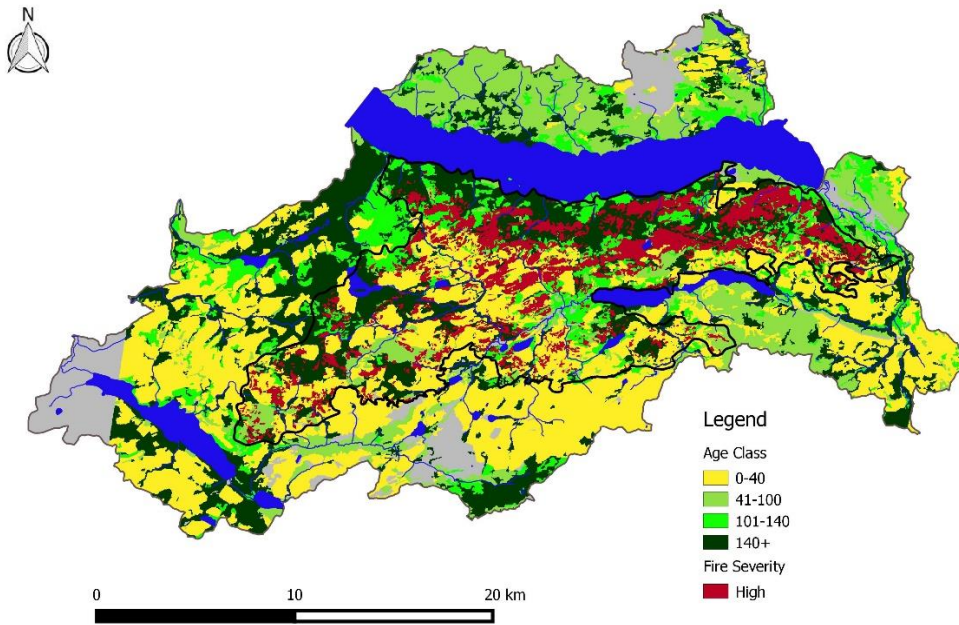
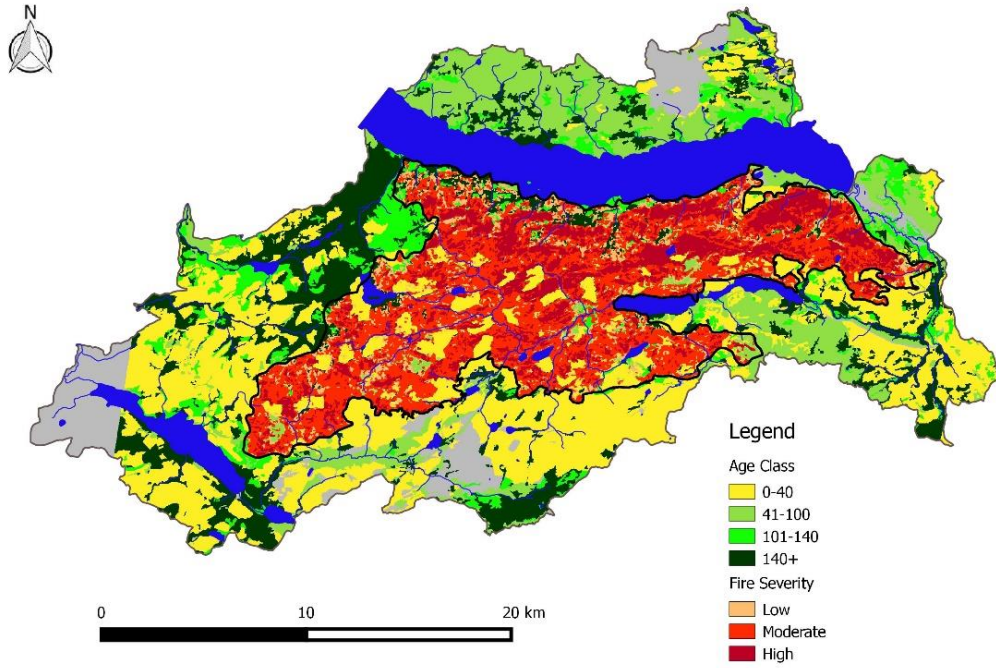


Figure 6. Burn severity for Island Lake Wildfire. Top panel shows all severities; bottom panel focuses on high severity burns.



Figure 7. Area burned in the Island Lake Wildfire at each severity within each age class. The total height of each bar shows the total amount of each age class prior to the wildfire; coloured bars represent severity classes.

3.3 Land-use Designations

The burned area includes a large portion of Francois Lake Provincial Park (Figure 8); no other legally-designated conservation areas lie within the burn. An area around Binta Lake to the southwest of the boundary includes old growth management areas and retention visual quality objectives.

The Vanderhoof Access Management Plan designates zones for motorised and non-motorised use, some of which overlap the burned area, and provides policy associated with each zone (Figure 9). The Island Lake and South Francois zones are managed for semi-primitive motorised use, with low road density; Anzus and Borel Lakes are managed for semi-primitive non-motorised use from April to November. Roads in both motorised and non-motorised semi-primitive zones are managed to maintain or reduce overall road density.³⁸

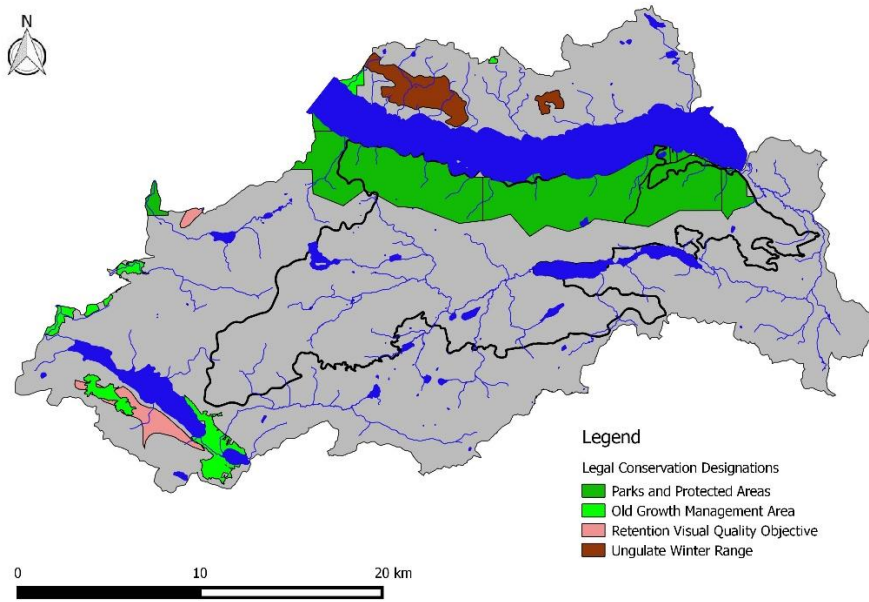


Figure 8. Legal conservation designations in Island Lake Wildfire area.

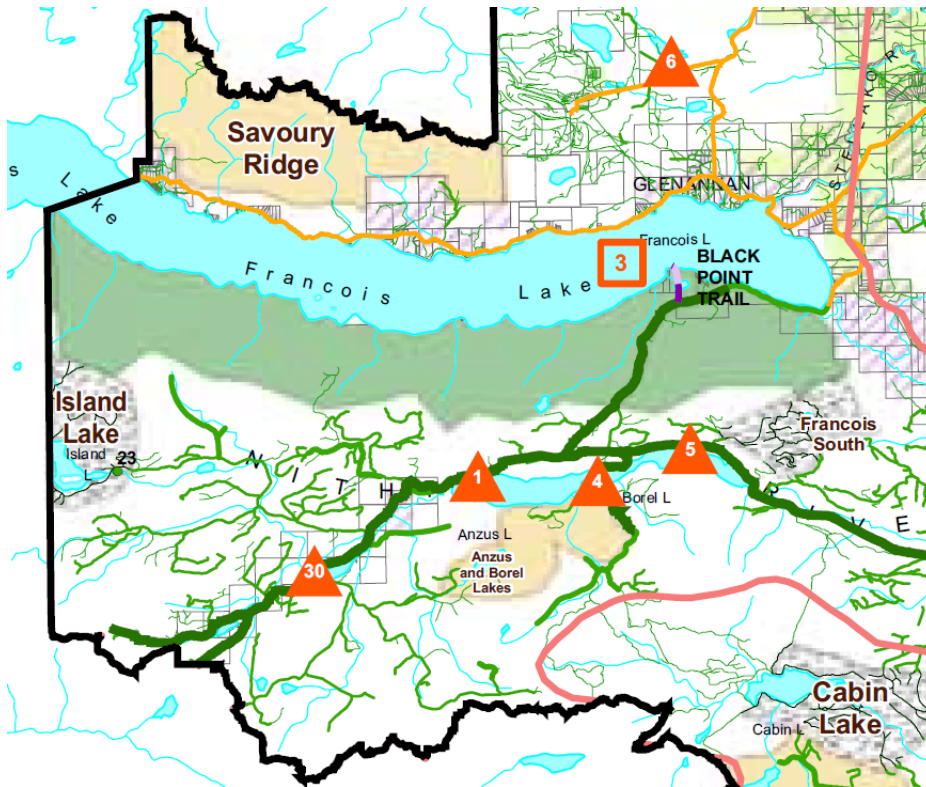


Figure 9. Portion of Vanderhoof Access Management Plan map showing semi-primitive non-motorised zones (grey) and semi-primitive motorised zones (tan) that are managed to maintain or reduce road density as well as numbered recreation sites.

As well as existing designations, the wildfire falls within an ongoing broader-scale Omineca ESI planning process led by Carrier Sekani First Nations and the provincial government. The Omineca ESI has identified about 3,470 hectares (Table 4) of candidate biodiversity management area (BMAs) and moose winter range (candidates for designation as Ungulate Winter Range with attached specific measures to conserve habitat) as well as alternative management practices in riparian areas (Figure 10). These independently-developed areas include the Francois Lake Protected Area, highlighting its value, and extend to Island Lake and Anzus Lake. The ESI and forest licensees have agreed to pursue immediate measures to support these initiatives, and are currently collaborating to develop policy. ESI candidate designations represent areas of high value and provide important knowledge to inform restoration planning.

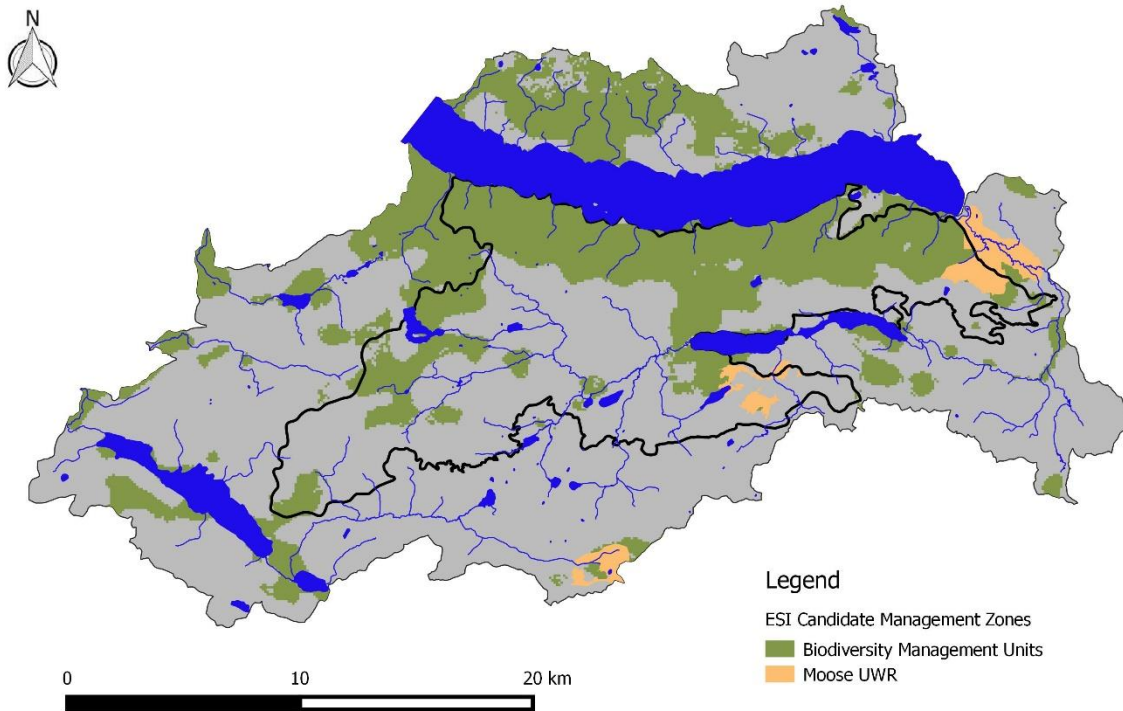


Figure 10. Candidate biodiversity management areas and moose winter range polygons developed by the Omineca ESI project team.

Table 4. Area included in existing legally-designated zones and emerging zones developed by the Omineca ESI project team.

Unit	Area (ha)	Area (%)
Wildfire Area in CFLB	20,221	100
Existing Legal Designations		
• Francois Lake Park	5,697	28
Area with no legal designations	14,524	72
Emerging Designations		
• Candidate Biodiversity Management Units	3,015	15
• Candidate Moose UWR	455	2
Area with no existing or emerging designations	11,054	55

3.4 Tenures and Obligations on Crown Land

3.4.1 Forest and Land Tenures

The Island Lake Wildfire overlaps two resource districts: Stewart-Nechako within Omineca and Nadina within Skeena-Stikine (Figure 11). It includes part of a woodlot at the eastern tip and a piece of private land.

Several major licensees have volume-based tenures in the wildfire region. West Fraser and BC Timber Sales have harvesting operations, some with active cutblocks that may not have been completely harvested prior to the wildfire (Figure 11). Hampton, Canfor and some non-renewal forest licensees have completed harvesting, but potentially have obligations to achieve free-growing status.

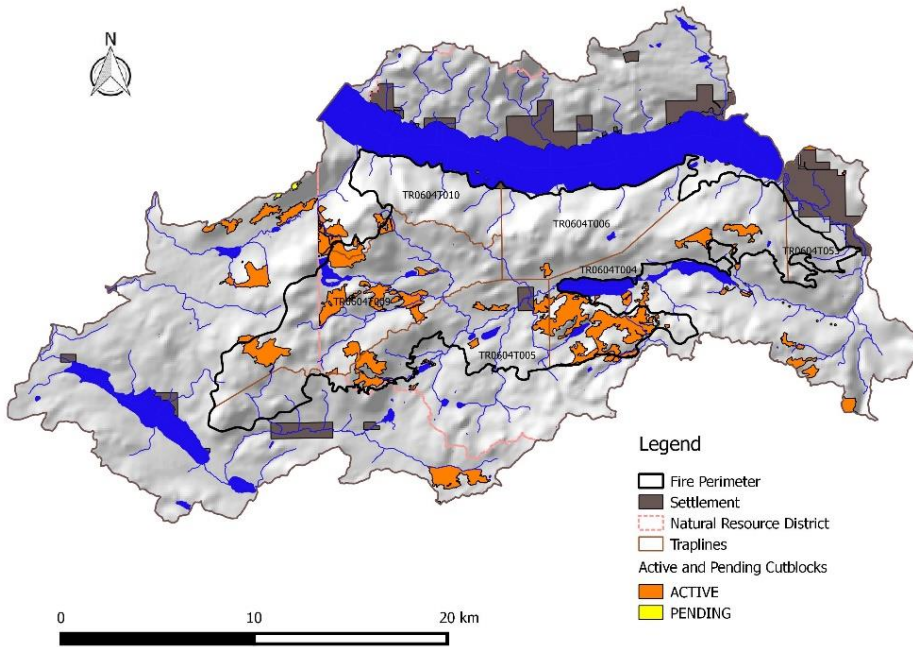
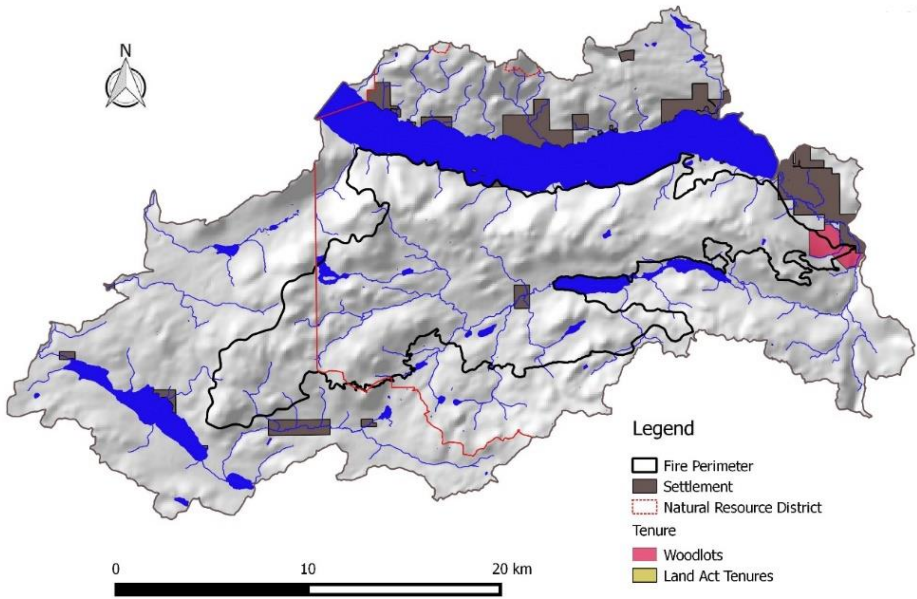


Figure 11. Tenures (forestry, Land Act and traplines) overlapping Island Lake Wildfire region.

4 Recommended Treatments and Surveys

4.1 Restoration Zone Overview

Priorities for treatment are guided by zoning that shows the potential of each area to support values (Table 5, Figure 12 and 13). Zones were developed in workshops, informed by existing and emerging designations and local expertise.

Table 5. Restoration zones to guide treatments for Island Lake Wildfire.

Zone	Function
<ul style="list-style-type: none"> • Fire guards 	<ul style="list-style-type: none"> • Resist wildfire • Rehabilitate
<ul style="list-style-type: none"> • Special Restoration Zone (cultural and ecological values have precedence) 	<ul style="list-style-type: none"> • Maintain/restore forest biodiversity and ecological function • Increase resilience • Maintain/restore watershed health and fish habitat • Maintain/restore moose habitat • Maintain/restore grizzly bear habitat • Maintain/restore goshawk habitat • Maintain/restore furbearer habitat • Maintain/restore cultural resources • Maintain/restore berry habitat • Maintain/restore medicinal plant habitat • Manage mushroom harvest
<ul style="list-style-type: none"> • Timber Restoration Zone 	<ul style="list-style-type: none"> • Maintain mid-term timber supply • Provide access to short-term timber supply for sawlog and/or biomass • Increase resilience

The Special Restoration Zone is built around existing legal conservation designations (5,697 ha of park) and candidate areas developed by the Omineca ESI project team (3,470 ha of biodiversity management units and moose habitat), with area added at Ecosystem Restoration Planning workshops and meetings to include culturally important areas and ecosystem connectivity (1,882 ha). The Special Restoration Zone does not currently include core secure area for grizzly bears or potential goshawk habitat as these units need to be confirmed and potentially refined first. This planning process and result is consistent with the Chief Forester’s guidance on post-fire restoration.

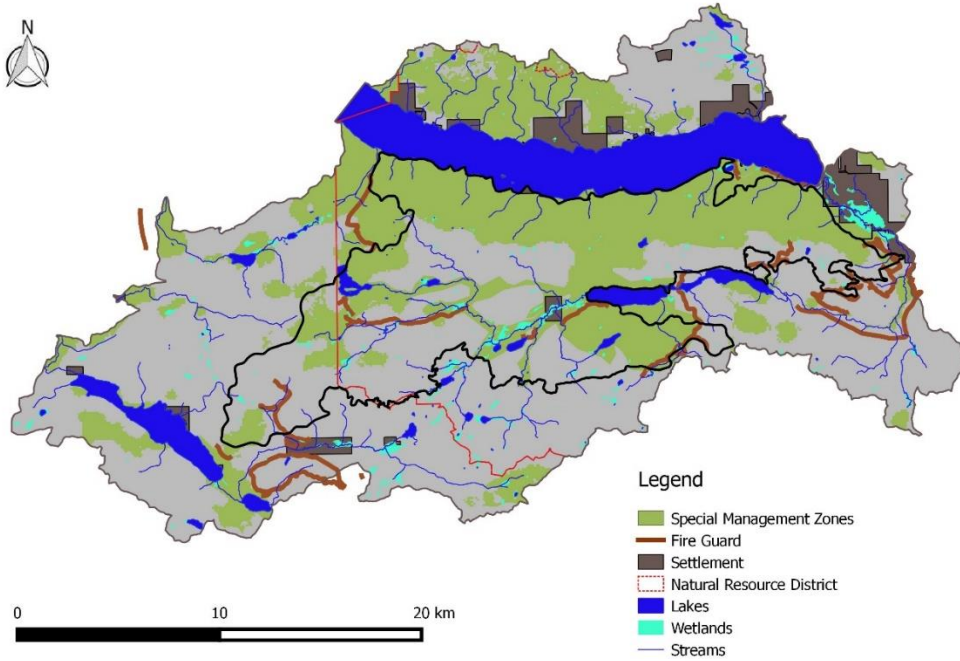


Figure 12. Broad restoration zones for Island Lake Wildfire; grey area is timber restoration zone.

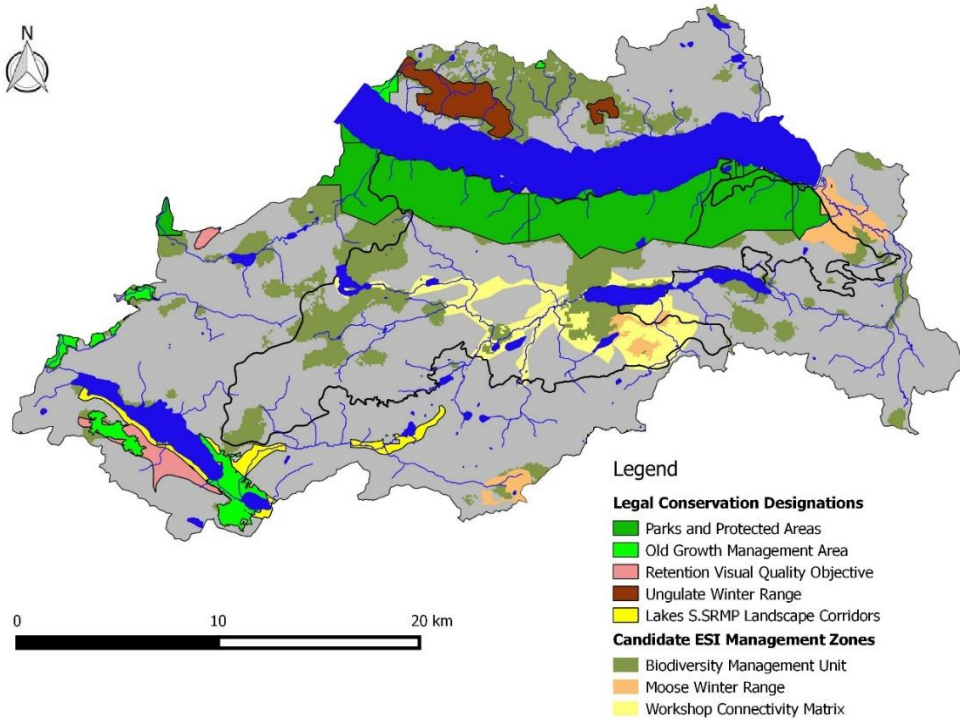


Figure 13. Special Restoration Zone within Island Lake Wildfire coloured by origin and function.

4.2 Zone: Wildland Urban Interface (WUI)

The Island Lake Wildfire is classed as an interface fire due to its proximity to private land. Public safety and community infrastructure are at risk in the interface. As described in the Chief Forester's Guidance for post-fire restoration, public safety has the top priority in restoration. Long-term maintenance of low fire hazard (resistance to fire initiation and spread) is the primary objective near to settlement.

It is impractical to draw large boundaries around all pieces of private land. The first task for this interface zone is to determine an appropriate WUI boundary.

4.2.1 Potential Treatments to Restore Values in WUI

Treatments in the WUI could include

- **Assess and reduce fuel hazards**
 - remove wood decked as part of fire suppression activities
 - leave large trees and snags while removing all small-diameter trees, creating shaded fuel breaks³⁹
 - remove accumulations of downed wood and fine fuels
 - prune lower branches of trees.
- **Ensure reforestation strategies reduce the risk of future high-severity fires**
 - **Ensure wide spacing**; remove or decrease stocking requirements, with the exception of deciduous species.
 - **Encourage deciduous species**; consider planting aspen to create deciduous buffer around community.

4.2.2 WUI: Implementation

Any planting of interface areas should set low future fire hazard as a top priority rather than timber harvest (e.g., low stocking standards; planting deciduous trees). Forest Districts will need to develop policy instruments to support alternative practices within WUIs.

Removal of decked wood should be implemented through existing fire guard reclamation plans and harvesting permit obligations.

Coniferous stocking standards should be reduced or removed (this will require District Manager approval). Deciduous planting should be a priority.

4.2.3 WUI: Next Steps

- **Define WUI area**
 - **Designate staff** to develop plan and seek funding to support involvement; potential funding and information sources include
 - BC's Strategic Wildfire Prevention Initiative (SWPI) and Indigenous and Northern Affairs Canada's On-Reserve Forest Fuel Reduction Treatment Funding⁴⁰
 - Forest Enhancement Society of BC⁴¹
 - UBCM community resiliency website⁴²
 - **Coordinate amongst local communities** and jurisdictions to ensure consistent management of WUI; e.g., Nadleh, Stelat'en, Regional District)

- **Seek expert advice** on treatments (e.g., consult with Lori Daniels UBC, Bob Gray, Bruce Blackwell)⁴³ as needed for current best management practices in WUIs; attend regional FireSmart workshop
- **Ensure that treatments reduce hazard** (e.g., training for Wildfire Threat Assessment)
- **Consult with communities that have completed similar plans** to identify challenges and opportunities
- **Work with Forest Districts to ensure approval of special management within WUI**, including
 - planting deciduous trees
 - providing flexible stocking standards.
- **Develop policy mechanisms to support alternative harvesting and silviculture within WUI** (task for Forest District)

4.3 Zone: Fire Guards

4.3.1 Values in Fire Guards

Fire guards result from active fire suppression rather than representing an underlying value. They cross a variety of ecosystems, including riparian areas, and reduce the security of moose habitat. Planting fire guards provides an opportunity to sequester carbon, provide long-term timber, manage access and restore hydrology.

4.3.2 Impacts to Values in Fire Guards

Fire guards clear standing trees, compact soil, damage drainage pathways and riparian ecosystems, provide access to previously inaccessible areas, disturb cultural sites, and alter recreational features.

4.3.3 Potential Treatments to Restore Values in Fire Guards

Fire guard reclamation is a critical short-term rehabilitation activity that is considered part of fire suppression. The Chief Forester’s guidance calls for decommissioning and rehabilitation of fire guards as part of any salvage logging.⁴⁴ Reclamation plans have been completed for fire guards associated with the Island Lake Wildfire.⁴⁵ These plans prescribe a variety of site-specific activities: reclaim guards by pulling back material across the guard; control access; recontour and rehabilitate streams; address drainage issues by clearing out material and installing waterbars; replace damaged culverts and bridges; seed slopes (forestry mix of grass seed) and place straw to minimise erosion. Reclamation plans also include removing or burning decked timber to reduce future wildfire hazard, especially near communities and on community egress routes.

Restoration of fire guards moves beyond reclamation. Potential site-specific treatments include

- **Build appropriate fire guards into permanent fire breaks** particularly in WUI and strategic locations; fire guards that connect roads could be strategically important, but will require access management
 - Consider installing barriers for short-term access control
- **Restore temporary fire guards**
 - **Plant conifer seedlings** to capture carbon, provide long-term timber, manage access and restore hydrology
 - **Plant shrubs in riparian areas** (e.g., dogwood, willow)

- Monitor for invasive species

4.3.4 Fire Guards: Implementation

Reclamation treatments to control hazards (e.g., removing decked wood), erosion and sediment are funded as part of provincial fire suppression activities (BC Wildfire). These treatments will be completed in 2019 for both Nadina and Stewart-Nechako districts.

Development of a strategic plan for long-term fire breaks is in process in the Nadina.⁴⁶

Restoration treatments, focused on planting, can be managed by SERNbc with funding agencies accessible to SERNbc (e.g., Forests For Tomorrow FFT, Forest Carbon Initiative FCI). Provided that access is available, at least by off-road vehicle, planting does not need to be completed in 2019 as part of rehabilitation. For guards that will be rolled-back, planting would be best done in conjunction with reclamation activities (e.g., a small planting crew working behind the machine). Restoration plans are divided by district.

Shrubs can be propagated in nurseries or gathered from unburned ecosystems (See discussion in Section 4.4.4 below).

4.3.5 Fire Guards: Next Steps

- Continue to implement reclamation plan
- Keep communities informed about the status of fire guards (task for Forest Districts)
- Restore fire guards
 - Consult with communities about fireguard treatment preferences
 - Assess suitability for restoration
 - Develop prescriptions
 - Work with SERNbc to fund activities
 - Identify and hire suitable contractors; consider potential for community training and employment
- Consider opportunities for providing deciduous shrubs for restoration
 - In consultation with UNBC researchers including Carla Burton

4.4 Special Restoration Zone: Forest Biodiversity

The special restoration zone includes areas identified to manage a holistic suite of ecological and cultural values. The zone includes candidate biodiversity management units defined by the Omineca ESI plus moose habitat and connectivity corridors designed to include culturally important sites as well as wet, rich and dry site series. The special restoration zone overlaps potential goshawk and grizzly bear habitat, but does not explicitly include it due to uncertainty in habitat projections.

The special restoration zone includes 78% of pre-fire mature forest (over 100 years old; Figure 14). The unburned and low severity burned stands represent some of the last live mature stands within the fire area with critical ecological importance as source populations for recolonization of disturbed sites as well as providing resilient micro-sites to support organisms in hotter, drier conditions. The moderate and high severity burned mature stands provide structurally complex young and mixed age stands characteristic of these ecosystems, provide habitat for specially adapted organisms and provide structure that speeds recovery towards mature stand characteristics. The young and immature stands

are included due to their importance for connectivity and/or because they represent special site series (wet, dry or rich site series).



Figure 14. Area of forest within Special Restoration Zone by burn severity and pre-burn age class.

4.4.1 Forest Biodiversity Values

As forests age, they change in structure, composition and function. Recently-disturbed forests are full of light, feeding fast development of herbs and shrubs, and, especially in naturally-disturbed forests, area scattered with legacies from disturbance that add structure. Mid-seral and mature forests can be dark and uniform with little understory. As forests reach old age, they become more structurally and compositionally complex, creating myriad habitats. Forests play critical ecological functions in harnessing the sun’s energy through photosynthesis, storing carbon in live and dead trees, collecting, filtering and transporting water, gathering nutrients from the atmosphere (e.g., nitrogen by way of epiphytic lichens), providing nurse logs for the next generation of trees, and building soil. Forest biodiversity and ecosystem function are inextricably intertwined. Functional ecosystems sustain viable populations of adapted species; in turn, natural biodiversity maintains ecosystem function and resilience. Functioning forests deliver ecosystem services valued by people, including food, water, fuel, medicines and timber, recreation and tourism opportunities, and cultural and spiritual values.

4.4.2 Impacts to Forest Biodiversity Values

Wildfire resets succession, creating young natural forest from mature and old forest. Habitat for mature and old forest specialists decreases. Over large natural landscapes, wildfires in fire-prone ecosystems leave structural legacies that provide habitat for disturbance specialists, increase diversity and provide resilience.⁴⁷ For example, severe fires lead to increased abundance of flowering plants and holes bored in snags by insects; both are critical habitat components for maintaining diverse wild bee populations that pollinate a variety of flowering plants under different conditions.⁴⁸ Post-wildfire salvage harvesting poses the biggest risk to biodiversity.⁴⁹

4.4.3 Potential Treatments to Restore Forest Biodiversity Values

Given that wildfire—even severe wildfire—is a critical part of forest development in fire-prone ecosystems, and that salvage harvesting puts biodiversity at risk, the most appropriate treatment for biodiversity is to leave burned areas to develop naturally. Desire for zero harvest has also been expressed by First Nations leaders at workshops.⁵⁰

Where other values overlap with the biodiversity management zone, treatments should aim to maintain as many structural elements as possible and to create structurally and compositionally diverse ecosystems at multiple scales. Rehabilitating roads decreases risk to biodiversity.

The Chief Forester’s guidance calls for maintenance of landscape-scale heterogeneity and connectivity of wildlife habitat. It also acknowledges the importance of partially disturbed stands as unique and complex habitat providing resilience over time and speeding recovery and notes that *“live trees must be left on the landscape, wherever possible, even if they are within the THLB”*.

Potential site-specific treatments include

- **Leave stands to develop naturally** (no treatment) wherever possible in biodiversity management zone
 - Retain (do not salvage or plant) all stands with live green trees (conifers and/or deciduous)
 - Retain (do not salvage or plant) stands with large burned snags and/or downed wood
- Where appropriate, to address other values (e.g., timber), consider **partial salvage, while retaining all live-tree remnant patches, all live Douglas-fir and large live and dead trees**
- **Use existing road access** (no new roads)
- **Support adaptation of young stands** to climate change
 - In burned plantations or young stands with no live trees and no large structural legacies, **cluster-plant climatically-adapted species and seed**
 - plant portfolios of species to maximise diversity and resilience
 - leave room for naturally-regenerating willow, alder, dogwood, aspen and cottonwood
 - **to facilitate transformation of dry ecosystems to grassland and/or shrubland with climate change, avoid planting these sites or consider planting widely-spaced Douglas-fir**
- **Do not control deciduous vegetation**
 - no brushing or herbicide
- **Encourage shrubs in riparian areas** (e.g., willow, dogwood); see Watershed Health Value below
- **Use native seed mix** where seeding is needed for sediment control

4.4.4 Forest Biodiversity Values: Implementation

Volume-based licensees within the Prince George TSA (West Fraser and BCTS) have signed immediate measures agreements with the Omineca ESI to support ESI direction related to biodiversity management. Collaboration is ongoing; restoration planning should coordinate with the Omineca ESI.

Avoiding treatment carries no direct costs. Some climatically-adapted stock is more expensive. Cluster-planting to lower densities is cheaper than status quo planting. Processing burnt timber can be challenging for mills and pellet plants. Past practices have seen about 30% of a wildfire area with active

stand knock-down and planting with class A stock and 70% left to regenerate naturally.⁵¹ Active restoration designed to restore timber values should be directed away from the Special Restoration Zone.

Developing and distributing native seed mix provides opportunities for collection, processing and storage, but also requires policy change. Native seed mixes from Alberta have been used in the Peace.⁵²

Newly-issued Cutting Permits within the fire perimeter may conflict with direction in this Ecosystem Restoration Plan. Deferring Cutting Permits until ongoing planning processes are complete would be consistent with the Chief Forester’s guidance for planning restoration. Cutting Permit issuance includes a review of eligibility *“a key aspect of which is ensuring that First Nation interests, with respect to the area to be harvested, have been appropriately addressed”*.⁵³ Ensuring consistency with indigenous rights title and interest would meet with UNDRIP and reconciliation efforts. Ideally, zoning can be incorporated into Forest Stewardship Plans to include restoration activities prior to Cutting Permit issuance.

4.4.5 Forest Biodiversity Values: Next Steps

- **Coordinate with Omineca ESI** to ensure consistent planning
- **Identify roads suitable for restoration**
- **Confirm stand age and burn severity** by aerial survey followed by ground-truthing of priority sites
 - Survey to confirm and map live tree component and large structure
 - Consider potential to use drones for surveys
- **Develop silvicultural prescriptions to increase resilience and maintain/restore forest biodiversity** values in young and immature stands with no live trees or large legacies
 - Survey to confirm surviving trees in plantations
 - Identify stands that would benefit from planting
 - Plant portfolios of species to maximise diversity and resilience
 - Obtain RESULTS prescriptions with site series information
 - Use Tree Species Selection Tool until portfolio analyses are completed
 - Delineate patches within stands with high deciduous potential (e.g., wet, rich site series) and do not plant with conifers
 - Identify dry site series (e.g., SBSdw3/02,03 and SBSdk/02,03) that may shift to open areas (grassland and shrub ecosystems) with climate change; avoid planting or consider planting widely-spaced Douglas-fir; consider planting saskatoons and rocky mountain juniper
- **Develop policy mechanisms to support alternative silviculture within special restoration zone** (task for Forest District)
 - Alternative stocking standards (lower density, clump planting)
 - Encourage deciduous species

4.5 Special Restoration Zone: Watershed Health and Riparian Values

4.5.1 Watershed Health and Riparian Values

All workshop groups focussed their plans around riparian corridors, recognising the vital importance of hydriparian ecosystems as the circulatory system of watersheds and the sensitivity of these

ecosystems. Water quality is fundamentally important for fish habitat productivity, for other aquatic and terrestrial biota, and for human consumption. Functioning hydroriparian ecosystems sustain healthy fish populations that support First Nations’ harvesting rights and associated cultural practices.⁵⁴ The Island Lake Wildfire area includes watersheds with high value for fish, including critical spawning and rearing habitat (Figure 15). Some of these watersheds are also sensitive to disturbance due to rugged terrain and lack of buffering lakes and wetlands.

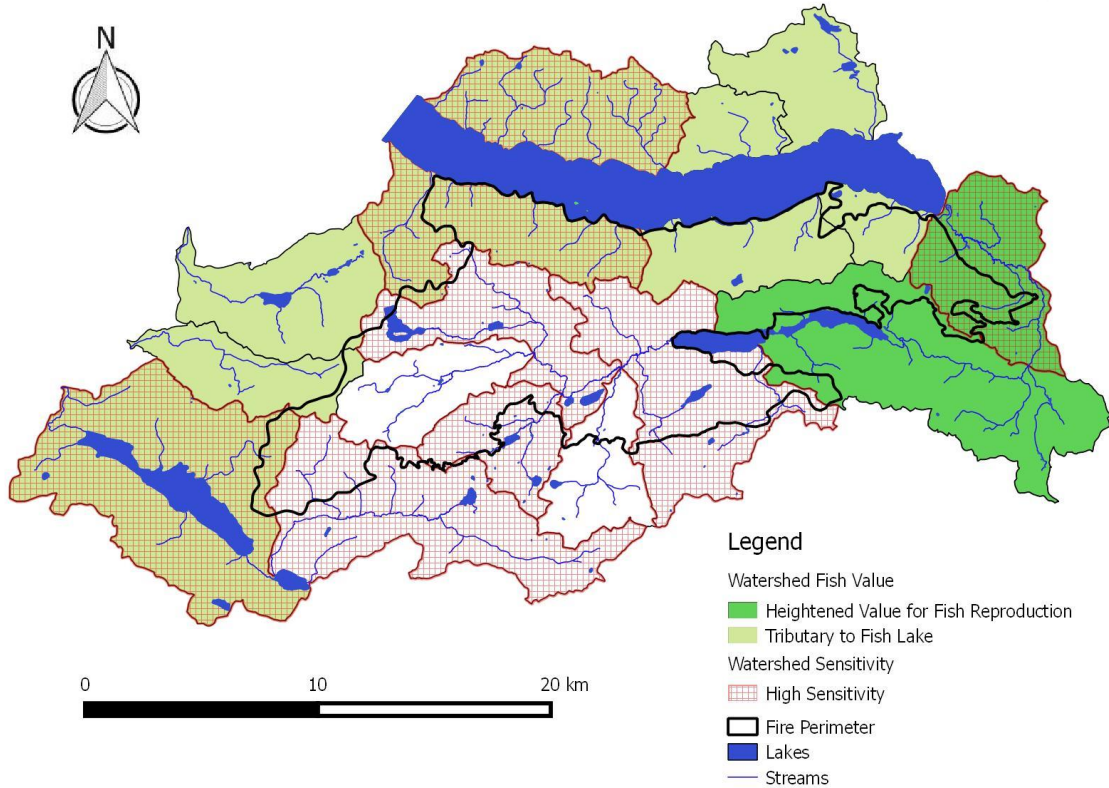


Figure 15. High value and sensitive watersheds within the Island Lake Wildfire.

Riparian ecosystems support a distinct vegetative community and provide a suite of riparian functions including maintaining stream bank stability, filtering sediment and nutrients to maintain water quality, moderating water temperature, and providing habitat structures for aquatic and terrestrial organisms. Riparian ecosystems are particularly sensitive to disturbance. Forest harvesting, and related roads and skid trails, within riparian areas (particularly floodplains) can reduce habitat connectivity for fish (e.g., access to backchannels and tributaries), increase water temperature and change stream morphology. Chronic fine sediment delivery to streams is mainly associated with exposed soils related to roads and fireguards parallel to and crossing streams. Trampling by livestock can increase sedimentation, alter nutrient balance and change stream morphology.

Existing road density is low to moderate throughout most of the Island Lake Wildfire with the exception of the area at the head of Francois Lake (Figure 16, Appendix 2). Regions of low road density include Francois Lake Park and areas designated through the Vanderhoof Access Management Plan.

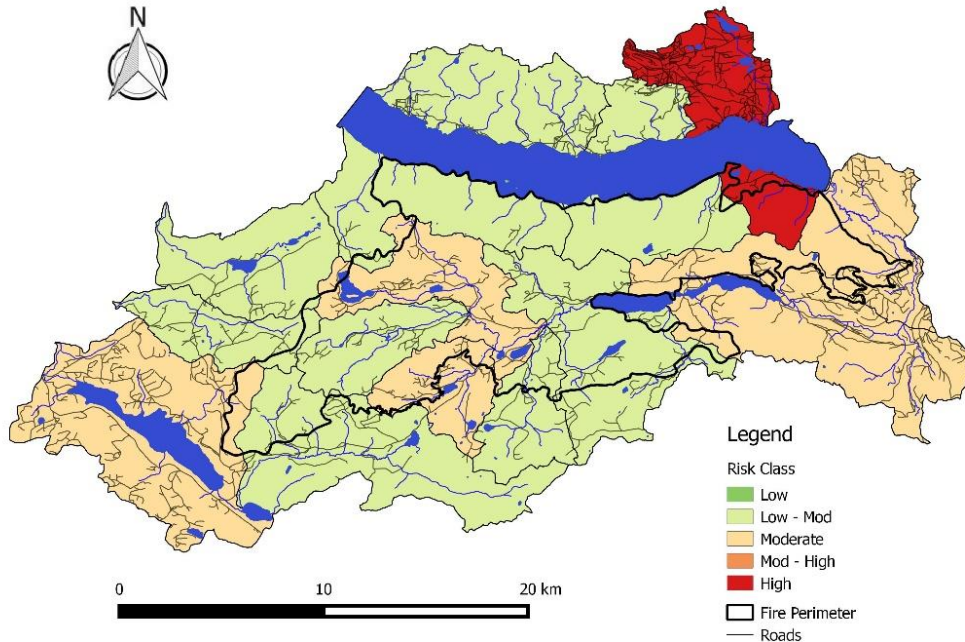


Figure 16. Risk associated with road density within assessment watersheds prior to the Island Lake Wildfire (low risk < 0.6 km/km²; low – mod 0.6 – 1.2 km/km²; mod 1.2 – 1.8 km/km²; mod – high 1.8 – 2.4 km/km²; high > 2.4 km/km²).

4.5.2 Impacts to Watershed Health and Riparian Values

Loss of forest cover due to natural disturbance or harvesting changes hydrology, increasing runoff within a watershed and leading to higher, and potentially harmful, peak flow events.⁵⁵ Increased hydrophobicity of soil further impacts drainage. As water delivery increases, systems are increasingly sensitive to poorly-maintained or designed roads that deliver more sediment to streams.

Erosion can increase by more than 100 times at the hillslope scale following wildfire⁵⁶. Erosion depends mainly on the amount of exposed soil and on the erosive force of rainfall⁵⁷. While even shallow slopes (e.g. > 15%) allow erosion, the erosive force of runoff increases with slope angle and slope distance⁵⁸. The toes of long slopes have more upslope water contribution. The Erosion Risk Management Tool for the US is an interactive website that estimates erosion at the hillslope scale following wildfire. It considers climate, soil texture, dominant vegetation type, slope gradient and length, and soil burn severity (<https://forest.moscowfsl.wsu.edu/cgi-bin/fswapp/ermit/erm.pl>)⁶⁰. Treatments to limit soil erosion from hillslopes include creating erosion control barriers (e.g., logs) to slow runoff and store sediment and adding mulch (e.g., straw) to dissipate rainfall energy⁶¹.

Watershed-scale hydrologic responses to wildfire depend on fire severity and extent, hillslope and watershed characteristics, time since the fire, non-fire-related disturbance, and weather⁶². Severe fire increases soil exposure and soil hydrophobicity.

Different types of watersheds will differ in their sensitivity to wildfire. Watershed attributes provide a general indication of the timing of slope- and watershed-scale streamflow response to rain and snowmelt: watershed size, elevation, aspect, relief, drainage density, lake area, alpine area, and forest cover, soil properties, hydrologic regime and the extent and distribution of logging and other disturbances⁶³.

Equivalent clearcut area (ECA) represents the area of a watershed that is hydrologically equivalent to a recent clearcut. Prior to the Island Lake Wildfire, the risk based on ECA varied from low in Francois Lake Park to moderate to high (> 36% clearance) in the centre of the wildfire region; following the wildfire, most watersheds are at high risk of high peak flows with more than 48% cleared (Figure 17). The watershed at the far east of the burned area is of particular concern due to high risk, high fisheries value and high sensitivity (Figure 15, Figure 17).

Wildfire burns many elements important to riparian function, including downed wood that controls channel morphology and vegetation that provides shade for stream ecosystems. Loss of vegetation on stream banks and coupled steep slopes can lead to sedimentation that fills interstices and reduces survival of the benthic invertebrates that feed fish and fish eggs. Some streams lie within the severely burned area on slopes > 15% (Figure 18, Appendix 2).

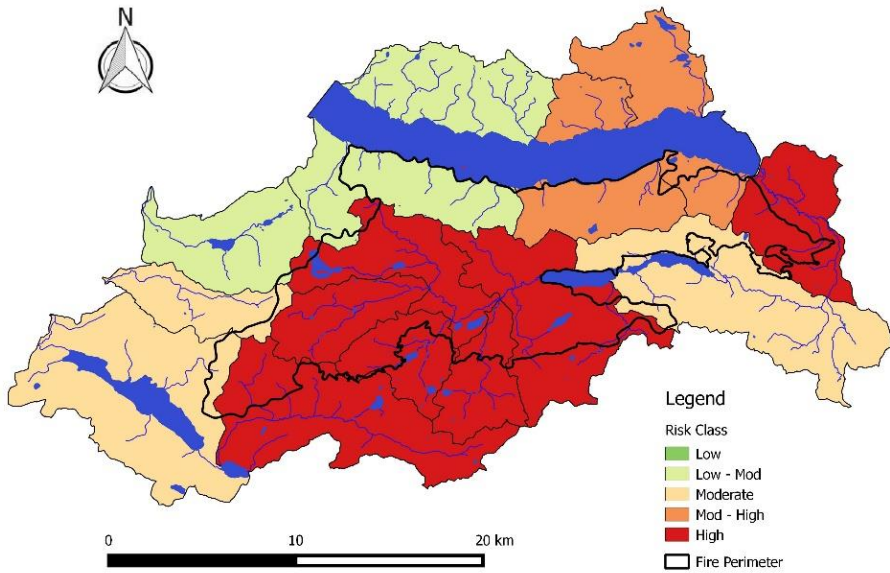
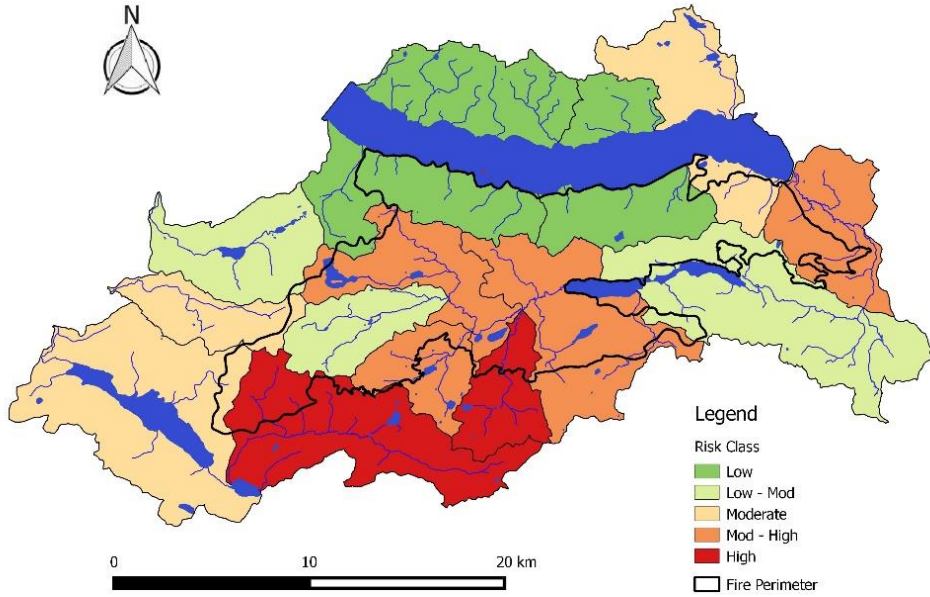


Figure 17. Equivalent clearcut area (ECA) before (top panel) and after (bottom panel) the Island Lake Wildfire for each assessment watershed in the study area (low risk < 12% clearance, low-moderate 12 – 24%, moderate 24 – 36%, moderate – high 36 – 48%, high risk > 48% clearance).

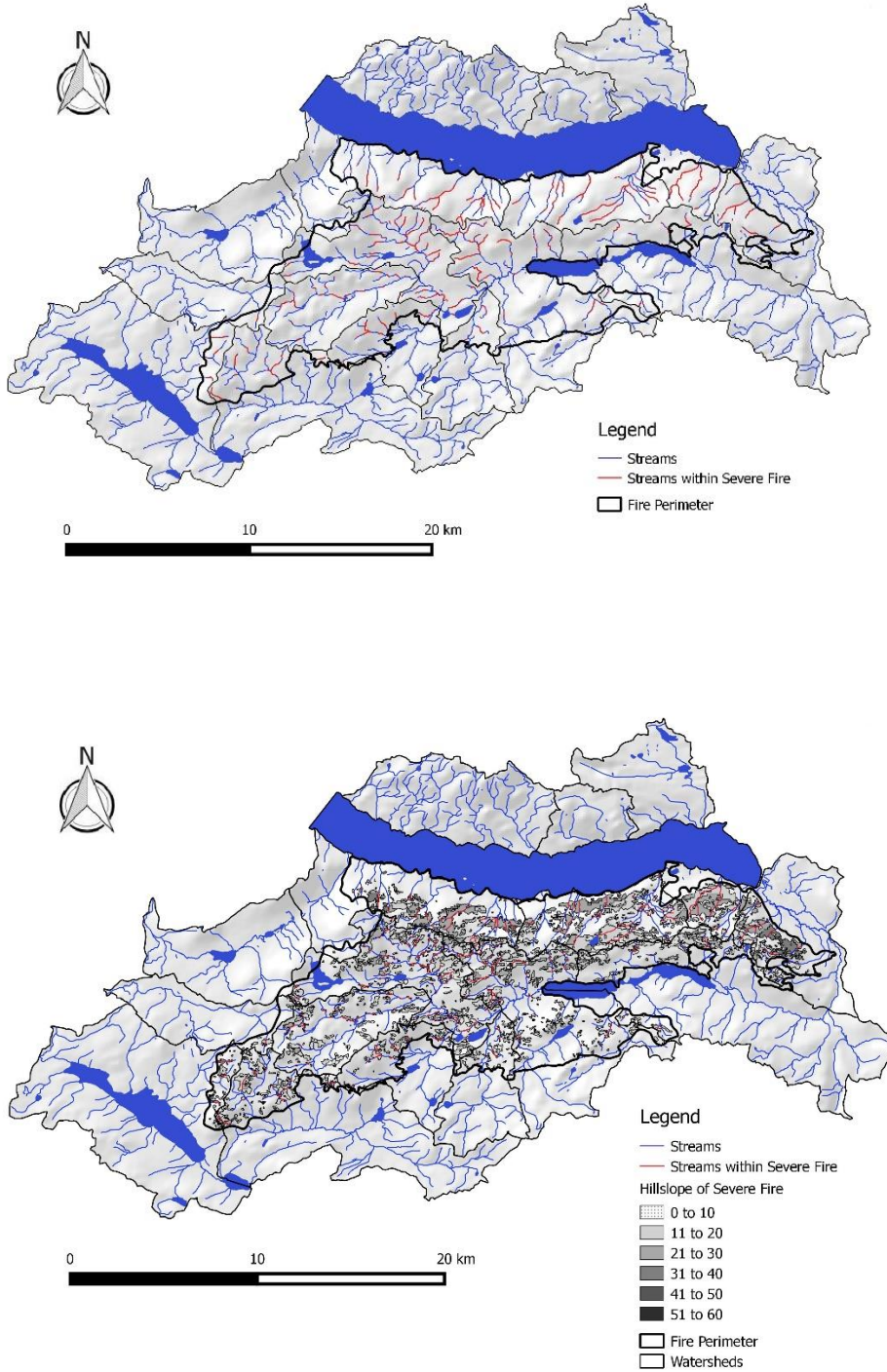


Figure 18. Stream within the severely burned area (top panel) and hillslope class (%; bottom panel).

4.5.3 Potential Treatments to Restore Watershed Health Values

High-value and sensitive watersheds are priorities for restoration activities that maintain values. Steep slopes are particularly at-risk following loss of forest cover. At the scale of available data (one-hectare resolution digital elevation model), no land within the study area is steeper than 60% slope; at smaller scales, however, steep slopes should be identified as a priority for restoration; after fire, even slopes of 15% can be at risk. Streams within the severely burned area should be surveyed for the need for restoration. As per the Chief Forester’s guidance, any areas with proposed salvage harvest should first undergo watershed assessment procedures to identify areas where salvage will likely impact water resources.

- **Plant severely burned riparian areas⁶⁴ at high risk of sedimentation**
 - Plant deciduous shrubs/saplings on exposed soil
 - Seed exposed erodible soil with fall rye as needed to stabilise and decrease sedimentation risk
- **Encourage deciduous trees and shrubs** in riparian areas
 - Allow infill by deciduous species along riparian areas
 - Plant deciduous species where severe burn inhibits natural regeneration
- **Retain all remaining standing live and dead trees on slopes and in riparian buffers** to reduce flash flooding associated with land clearance (cumulative effects of fire and past forest harvest).⁶⁵ Retention is particularly important given increased floods and droughts expected with climate change.
- **Maintain/restore roads to minimise sediment delivery**
- **Rehabilitate roads** in watersheds with high road density
 - Use existing roads for salvage harvest
 - Maintain or reduce road density in zones designated by the Vanderhoof Access Management Plan

4.5.4 Watershed Health: Implementation

Ensure that activities are consistent with the Yinke Dene Surface Water Policy.⁶⁶

Aspen are not considered a deleterious species with a certain distance of a stream (10m in Nadina, 30 – 50m in Vanderhoof).⁶⁷ Modifying the policy in Nadina to match Vanderhoof would increase resilience. Alternatively, developing policy that bases decisions on ecological criteria rather than fixed distances could further improve management.

Expertise is developing in other regions about best practices regarding sites and situations in which to plant deciduous trees and shrubs.

Existing analyses, commissioned by SERNbc, identifies roads suitable for rehabilitation within the Stewart-Nechako District. Criteria include roads not needed for forest harvest or silviculture in the near to mid-term that are suitable for planting.⁶⁸ A road rehabilitation working group convened as part of the Omineca ESI is examining practical aspects of road rehabilitation.

4.5.5 Watershed Health: Next Steps

- Start with high-value and sensitive watersheds that face the highest risks
- **Identify best practices for planting deciduous trees and shrubs**
 - Learn from experience elsewhere; for example
 - Ensure roots are sufficiently developed to support growth (shorter stem, longer roots)
 - Can plant cuttings rather than nursery plugs⁶⁹; ensure more than half is buried
 - seed collection is challenging because seeds are fine and hard to collect with a short window of viability
 - Potential sources of expertise include
 - Carla Burton
 - Burns Lake Community Forest
 - Woodmere Nursery has experience growing deciduous stock (primarily alder and birch)⁷⁰
 - Okanagan Indian Band has a nursery with rose, aspen and cottonwood that they use for riparian restoration
 - Twin Sisters nursery (Moberly Lake)⁷¹ and Keefer Ecological produce deciduous shrubs
 - Alberta nursery can provide “512 plugs” (5 cm diameter x 12 cm long container stock) if planned in advance; currently they are using Alberta seed, but could collect seeds and send to nursery for local stock
- **Update Omineca road rehabilitation analysis** to account for wildfire condition and treatment
 - Extend this work to the Nadina portion of the wildfire
 - Work with Omineca ESI road rehabilitation working group for further advice on practicality and other issues
- Identify steep slopes with priorities for restoration
- Assess severely burned riparian reaches that would benefit from seeding or planting
- Survey roads near streams and stream crossings to assess sediment delivery and confirm culvert function
- **Develop policy for riparian management in restoration context**
 - ESI immediate measures for riparian management are insufficient

4.6 Special Restoration Zone: Moose habitat units

4.6.1 Moose Values

Moose have high ecological, economic and cultural importance. Indigenous peoples rely on moose for social, ceremonial and sustenance purposes. Moose provide subsistence and recreational opportunities for resident and non-resident hunters. Moose populations have declined precipitously in the region,⁷² likely due to cumulative effects of forest harvesting and climate change. The decline has been so severe that First Nations families in the area report that they have been lucky to harvest a moose every few years.⁷³

Suitable moose habitat includes forested cover habitat in close proximity to more open forage habitat. Access to abundant, high quality forage in summer and winter is essential to overwinter survival. In

winter, moose browse on woody shrubs, including willow, red-osier dogwood, highbush cranberry and young subalpine fir, augmented with a variety of other species, in low elevation ecosystems. Deep snow limits habitat availability. In spring, moose follow receding snow to access new growth, including leaf buds of deciduous shrubs and wetland herbs, with high food value. Summer browse quality (e.g., digestive protein, tannins) influences fall body condition and subsequent reproductive success and overwinter survival.⁷⁴ An ongoing study across the province found that moose are dying due to acute malnutrition.⁷⁵ Shrubs in the middle of large clearcuts provide insufficient nutrients for survival; those within forest edges provide sufficient nutrients throughout the summer.⁷⁶ Moose avoid the middle of clearcuts.

Moose use forest cover to buffer temperature, intercept snow and provide security from predators. Mature and old forest, particularly open-grown spruce and subalpine fir, provides effective thermal cover; higher density forest intercepts snow and facilitates movement, reducing energy expenditure.

The Island Lake Wildfire lies within the southern portion of the Omineca ESI region. In this southern portion, mature forest is in short supply and much of the landscape is young due to harvesting following the mountain pine beetle outbreak. Although more than half of the southern area is capable of providing moose habitat, only 12% is currently suitable, with 3% secure from roads and other developments that increase mortality risk.⁷⁷ Salvage logging has increased the area of large clearcuts—areas that moose avoid and that provide poor quality food. Because shaded conditions provide the best quality food for moose, large scale conversion of native forests to plantations with little retention creates nutritional conditions that impact moose health.

4.6.2 Impacts to Moose Values

The Island Lake Wildfire burned critically important traditional moose harvesting areas. Wildfire removes mature and old cover habitat and burns forage. Forage bushes in open areas provide low quality food that poses risk to moose overwinter survival.⁷⁸ Any areas of high forage production near to standing live trees provide the best opportunity for moose to survive. Over time, blowdown of burned snags impedes moose movement.

4.6.3 Potential Treatments to Restore Moose Values

Planting commercially preferred conifers in the burned area will exacerbate the already high risk to moose over time by creating a large homogenous area with low cover and forage value to moose. Retaining remaining live trees will be critical to provide cover and to provide the shade needed for high quality browse. FLNRO is currently completing spatial analyses and developing recommendations for managing burns for moose.⁷⁹

- **Promote shrub growth in riparian areas and on rich sites**
 - Retain rich site series as Wildlife Tree Patches
 - Do not plant conifers in rich site series
 - Plant willow and dogwood on wet sites
 - Avoid controlling brush (no herbicide or mechanical brushing)
- **Promote subalpine fir**
 - Do not harvest any living subalpine fir tree
 - Include subalpine fir seedlings when planting in all zones⁸⁰

- **Maintain structure to provide cover and shade**
 - Leave all live trees
 - Avoid partially salvaging stands with >30% green trees that provide cover habitat
 - Remove downed wood (e.g., from beetle-killed trees) that impedes movement
- **Rehabilitate roads** near moose habitat
 - Use existing roads for salvage harvest
 - Plant trees on roads identified for rehabilitation to control access and provide habitat
 - Control industrial access to traditional moose hunting areas⁸¹
- Monitor moose and moose forage response to wildfire over time

4.6.4 Moose: Implementation

Current practice is for licensees to leave retention patches in areas where aspen or other deciduous brush would have challenged regeneration (often rich patches); recognition and expansion of this practice in moose habitat units would increase value for moose. Within both Nadina and Vanderhoof districts, current estimates indicate <5% of sites require brush control,⁸² hence leaving brush in moose habitat units should not greatly impact timber values.

SERNbc has submitted a plan to plant for browse. Burns Lake Community Forest is planting red osier dogwood plugs grown in a nursery in BC.⁸³

Existing analyses, commissioned by SERNbc, identifies roads suitable for rehabilitation within the Stewart-Nechako District. Criteria include roads not needed for forest harvest or silviculture in the near to mid-term that are suitable for planting.⁸⁴ A road rehabilitation working group convened as part of the Omineca ESI is examining practical aspects of road rehabilitation.

4.6.5 Moose: Next Steps

- **Assess suitability of forage and cover habitat** following wildfire
 - Focus on ESI candidate moose winter range
 - Consider replacement areas as necessary
- **Coordinate with Omineca ESI** to develop best management practices around moose habitat
- **Coordinate with experts** (e.g., Jeff Werner FLNRO, Roy Rea UNBC) to take advantage of the opportunity to learn about moose response to burned habitat
- **Update Omineca road rehabilitation analysis** to account for wildfire condition and risk to moose
 - Extend this work to the Nadina portion of the wildfire
 - Work with Omineca ESI road rehabilitation working group for further advice on practicality and other issues

4.7 Special Restoration Zone: Goshawk habitat units

4.7.1 Goshawk Values

The interior subspecies of the northern goshawk (*Accipiter gentilis atricapillus*) has recently been blue-listed as at risk.⁸⁵ The Skeena population (including the Nadina District) faces great threat; the population almost completely collapsed between 2014 and 2017 with only 4 of 100 known pairs nesting

(0 successful known nests in the Nadina). Less information is available for the goshawk population in Omineca.

Goshawks nest in areas with about 100 ha of mature forest (> 100 years old) surrounded by a foraging territory extending about 3km past the active nest site (~2,500 ha) that contains at least 50 – 60% mature and old forest.⁸⁶ Forest harvesting has severely reduced the availability of goshawk habitat throughout the region. Prior to the wildfire, about 30% of the Shovel Lake study area was over 100 years old.

Climate change adds cumulative effects associated with changes in timing of biting insects that potentially impact chick survival.

4.7.2 Impacts to Goshawk Values

The Island Lake Wildfire severely burned about 30% of existing mature forest, reducing goshawk breeding habitat. Goshawks forage in burned forest provided that snags remain for perching; hence the wildfire has not necessarily reduced foraging habitat while snags remain.

4.7.3 Potential Treatments to Restore Goshawk Values

Potential goshawk habitat remains within the park and on the edge of the wildfire area (Figure 19).

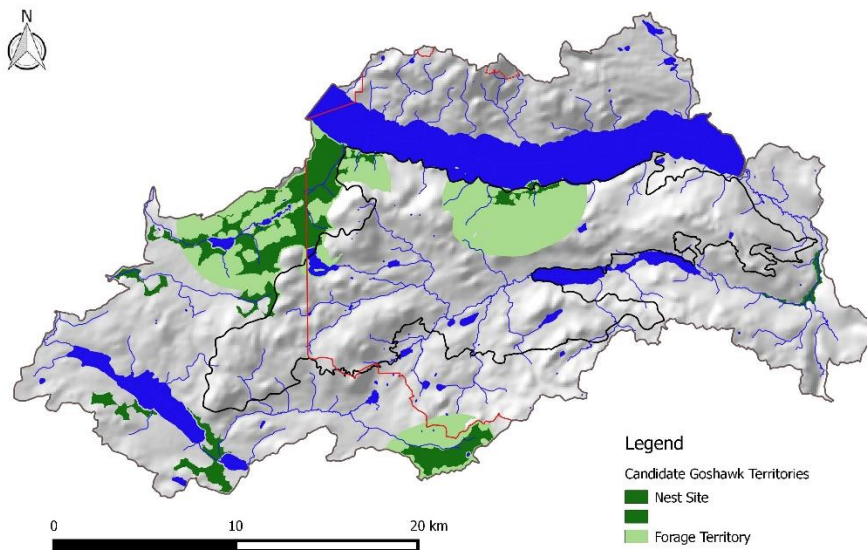


Figure 19. Modelled candidate goshawk territories in the wildfire study area.

Retaining burned trees in potential goshawk foraging habitat (see Figure 19) maintains the values of the stand.

- **Retain all trees within confirmed potential goshawk breeding territory**
- **Avoid salvage harvest within 3km** of confirmed potential goshawk breeding territory

4.7.4 Goshawk: Implementation

Licensees already manage known goshawk breeding territories by leaving a 100-ha buffer around active nests. In the Skeena, a goshawk management group is developing policy to manage potential breeding territories. Developing a similar process in the Omineca region would ensure consistency and improve goshawk management.

The coarse scale of this analysis means that mapped potential goshawk habitat must be confirmed prior to treatment.

4.7.5 Goshawk: Next Steps

- **Confirm location** of potential goshawk breeding territory
 - Complete finer-scale analyses in consultation with Frank Doyle
- Coordinate activities with Skeena goshawk management group
- Consider adding Omineca representatives to the Skeena goshawk management group

4.8 Special Restoration Zone: Grizzly Bear Secure Core Area

4.8.1 Grizzly Bear Values

Grizzly bears are wide-ranging omnivores that are key components of predator-prey systems, including grizzly-salmon ecosystems. Grizzly bears are culturally and spiritually significant to many First Nations. The Carrier-Sekani belief system considers grizzly bears as possessing “human-like” spirituality that requires that they deserve an equal place on the landscape, warranting protection as one would protect family. It is a cultural prerogative to respect their place within the Territory, which includes managing that Territory in a way that healthy and sustainable grizzly bear populations can persist.

Grizzly bears are used as an indicator of landscape-scale ecosystem integrity because they are particularly sensitive to human access; they provide an excellent indicator of risk related to roads and human presence. Where nearby habitat is attractive, high-traffic roads can act as population sinks (i.e., mortality locations).⁸⁷ Core areas of secure, productive habitat can function to sustain populations to offset the effect of nearby sinks. Core security areas have sufficient suitable habitat and minimal human use and are large enough to accommodate a female grizzly bear’s daily foraging requirements (>10,000 hectares).⁸⁸ The Island Lake Wildfire region currently has no secure areas large enough to provide habitat for grizzly bears given suitability (Figure 20).

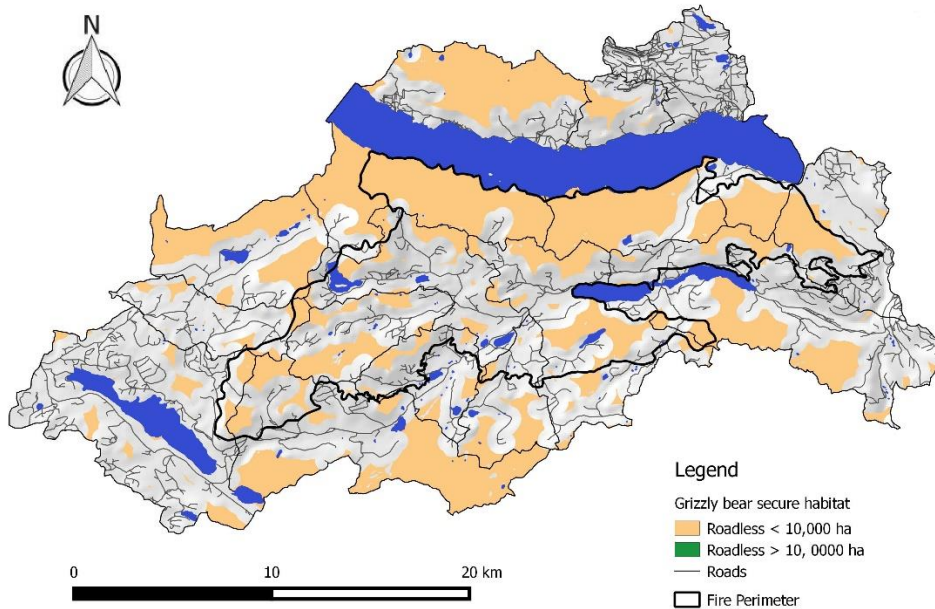


Figure 20. Potential grizzly bear secure areas (roadless and large enough to support a female grizzly’s daily foraging requirements).

4.8.2 Impacts to Grizzly Bear Values

Human access to grizzly bear habitat poses the highest risk to grizzly bear survival and reproduction.⁸⁹ Road density in the Island Lake Wildfire region (Figure 16 above) already puts grizzly bears at high risk. Expanded access from fire guards and salvage operations would increase risk further.

Grizzly bears forage in meadows, riparian areas and early seral forest with high concentrations of grasses, herbs and berry bushes. Habitat value may have been improved by the wildfire. Planting dense conifers in burned areas would reduce the value of this early seral habitat.

4.8.3 Potential Treatments to Restore Grizzly Bear Values

- **Rehabilitate fire guards**
- **Rehabilitate roads or restrict access** to form potential core security habitat
 - Use existing roads for salvage harvest; do not build new roads
 - Maintain or reduce road density within zones designated in the Vanderhoof Access Management Plan
- **Encourage deciduous vegetation** in potential core security habitat
 - Do not plant dense conifers in potential core security habitat

4.8.4 Grizzly Bear: Implementation

Existing analyses, commissioned by SERNbc, identifies roads suitable for rehabilitation within the Stewart-Nechako District. Criteria include roads not needed for forest harvest or silviculture in the near

to mid-term that are suitable for planting.⁹⁰ A road rehabilitation working group convened as part of the Omineca ESI is examining practical aspects of road rehabilitation.

4.8.5 Grizzly Bear: Next Steps

- **Update Omineca road rehabilitation analysis** to account for wildfire condition and risk to grizzly bears
 - Extend this work to the Nadina portion of the wildfire
 - Work with Omineca ESI road rehabilitation working group for further advice on practicality and other issues

4.9 Special Restoration Zone: Furbearers

4.9.1 Furbearer Values

Trapping furbearers is an important cultural and economic activity for many First Nations people. Marten are excellent indicators of forest structure and landscape connectivity⁹¹. Marten are “likely very sensitive” to climate change.⁹² They require mature forest with abundant structure providing access to subnivean (under-snow) habitat. Good habitat is provided by a range of fallen and leaning trees and tip-up root wads, which collectively provide protected under-snow hollows and runways during the critical winter season. Changed disturbance regimes will likely decrease structure over long-term, particularly if followed by salvage harvest. Fisher depend on large standing cottonwood trees with heart-rot cavities for denning, complex forest structure and large pieces of downed wood.

4.9.2 Impacts to Furbearer Values

Loss of large structure and landscape loss of mature/old forest compounds existing loss of habitat due to forest harvesting.⁹³ Trappers with traplines in the nearby Shovel Lake Wildfire were unsuccessful all winter post-fire.⁹⁴

4.9.3 Potential Treatments to Restore Furbearer Values

Marten will use young natural forest with sufficient structure, particularly if connected to mature forest that supports its primary prey, red squirrels.

- **Retain sufficient structure** (live trees, dead snags and downed wood) to support marten movement and prey
- **Retain large riparian structure** (live and dead trees, particularly standing cottonwoods in groups with heart rot) to support fisher reproductive habitat⁹⁵

4.9.4 Furbearers: Implementation

Management for furbearers is consistent with management for forest biodiversity: maintain large structure and live trees.

4.10 Special Restoration Zone: Multi-use Cultural Use Area

4.10.1 Cultural Values

The most valuable cultural areas support multiple values and services.

Stellat'en First Nation provided a briefing note detailing values and criteria relevant to post-fire restoration⁹⁶: *“Stellat'en rights and traditional activities are usually practiced in combination (i.e., people go out on the land to hunt, pick berries, and other activities at the same time, in the same areas); however, the dearth of available wildlife and habitat now means that other remaining traditional harvest activities – such as harvesting berries and medicine plants – are even more essential to the practice of rights, and to cultural continuity (practicing, sharing and teaching Indigenous knowledge out on the land while engaging in traditional activities).*

There are numerous characteristics and values (ecological, cultural, spatial) that compose areas identified as important to Stellat'en. For example, high value needs to be placed on ecosystem complexes that include forest and edge habitat in proximity to wetlands and higher elevations, as moose rely on these areas. Sheltered connectivity between areas of high habitat value for moose is also important, such as networks of wetlands with forest cover. As part of the recent moose traditional knowledge study, Stellat'en identified areas of critical importance for cultural and spiritual reasons; and key values that help identify places essential for harvesting and the practice of rights (e.g. areas where hunting, berry-picking, and other wildlife/fish habitat are all accessible together, within accessible distance from the community). ...Our study highlights that multiple cultural and ecological factors should be considered in applying the 'assembly rules' for restoration.” See Appendix 3 for more information.

4.10.2 Impacts to Cultural Values

The wildfire has impacted all cultural values in the area, including opportunities to gather food and medicine, fish and hunt, and pass on knowledge to future generations.

4.10.3 Potential Treatments to Restore Cultural Values

- **Work with communities to develop priorities for restoration**, for example
 - Planting berry bushes
 - Rehabilitating roads (to decrease risk to moose, grizzly bears and riparian areas)
 - Planting deciduous trees (to increase resilience)
 - Rehabilitating riparian areas
 - See forest biodiversity, watershed health and wildlife sections for more potential treatment options

4.10.4 Multi-use Cultural Values: Implementation

Traditional use studies have been completed for the wildfire region and further work is ongoing to document use and rights.⁹⁷

4.10.5 Multi-use Cultural Values: Next Steps

- Summarise existing studies and ongoing work
- Confirm important uses and priorities for restoration.

4.11 Special Restoration Zone: Berries

4.11.1 Berry Values

First Nations in the area have relied on berries for food for millenia. Berries harvested include huckleberry, blueberry, saskatoon, soopallalie, raspberry, strawberry, gooseberry. Vaccinium species

found in the study area include black huckleberry (*Vaccinium membranaceum*), dwarf blueberry (*V. caespitosum*) and velvet-leaved blueberry (*V. myrtilloides*). Traditionally, blueberries and huckleberries were enjoyed fresh and also dried on racks over a slow-burning fire, then wrapped in skunk cabbage or thimbleberry leaves and stored for winter use (see Appendix 4).

Huckleberries and blueberries are also considered a general medicine because of their Vitamin C content. They have been used, mixed with choke cherries, to treat chest conditions and colds and often eaten to assist digestion after a big meal (Appendix 5).

Berry crops have declined over the past several decades. Productivity shifts amongst years, meaning that preferred harvest areas move.⁹⁸

4.11.2 Impacts to Berry Values

Berry production will take time to recover (4 – 7 years for surviving shrubs to regrow). First Nations burned areas to maintain berry production, but these were usually low-severity burns conducted in autumn. Black huckleberry is persistent in old-growth stands, but copes well with light to moderate severity fire, resprouting from rhizomes. Bushes grow best in the open under a partial shade of 10 – 20% canopy cover. Optimal fruit production is associated with open forest approximately 7 – 15 years after disturbance (Appendix 4). Severely burned stands may have lost berry rhizomes, but plants in light and moderate burns could have high productivity in a decade with appropriate protection or restoration activities. The response of dwarf blueberry and velvet-leaved blueberry to fire are less-well known.

4.11.3 Potential Treatments to Restore Berry Values

Potential black huckleberry habitat is common across the wildfire area, while habitat for *Vaccinium myrtilloides* is confined to SBSdw3 ecosystems in the northeast (Figure 21).

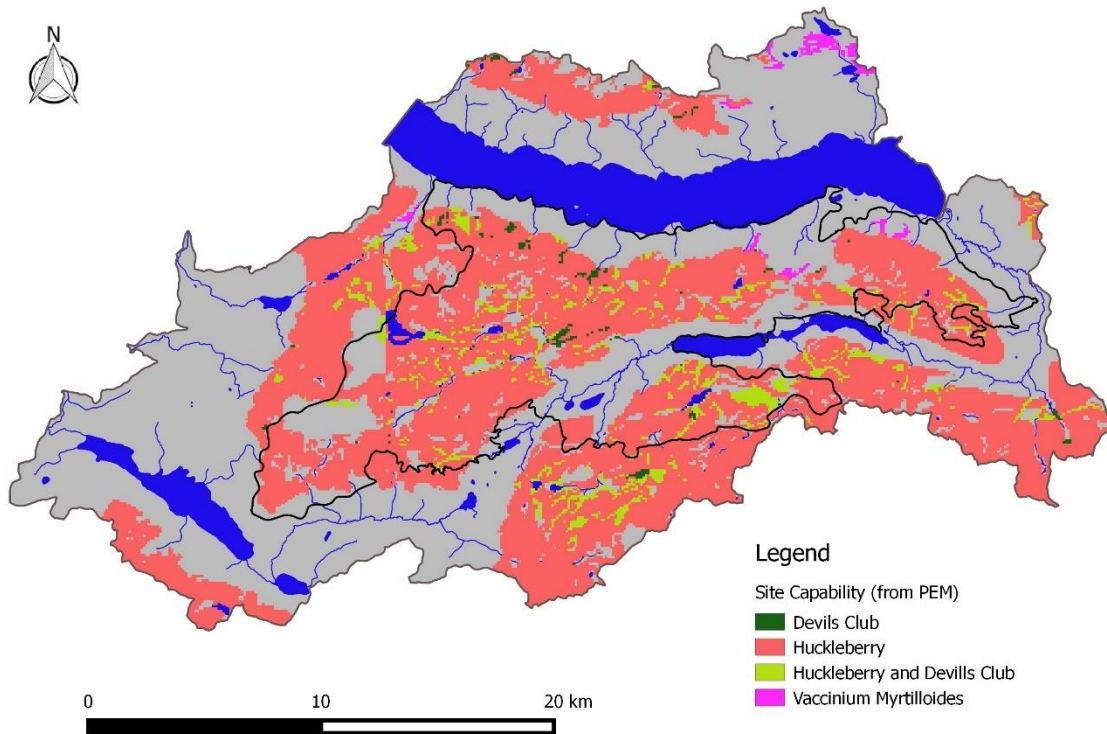


Figure 21. Site series that support huckleberries (*Vaccinium membranaceum*), blueberries (*V. myrtilloides*) and an important medicinal plant, devil's club (*Oplopanax horridus*).

- **Set up berry treatment units to facilitate adaptive management** and research in collaboration with UNBC
 - **Survey areas for sprouts from surviving root crowns** to document survival related to fire severity and ecosystem
 - Stratify the study area by fire severity and assess a minimum of 5 separate locations suitable for each target species
 - Use TEM or PEM maps and Appendix 5 to identify suitable potential habitat
 - Consider accessibility to communities
- **Plant huckleberries and blueberries in appropriate ecosystems** where plants have not survived
 - Appropriate ecosystems include
 - Black huckleberry: SBSmc2/02, 01, 04, 06; ESSFmv1/03, 01, 04
 - Dwarf blueberry: SBSdw3/03
 - Velvet-leaved blueberry: SBSdw3/05
 - Accessible to communities
 - Follow documented methods for effective propagation (Appendix 4)
 - If nurseries are not stocked with these native species, provide them with seeds and/or cuttings with sufficient lead time (6 – 18 months) to grow stock big enough to transplant in spring or fall
 - Direct seeding or planting of bare cuttings will **not** establish these species

- Monitor huckleberry and blueberry growth in areas with light or moderate burns to improve knowledge related to recovery, particularly of dwarf blueberry and velvet-leaved blueberry.

4.11.4 Berries: Implementation

Restoration of berry plants provides excellent opportunities for local employment, both for recovery surveys and for seed and/or cutting collection and planting.

UNBC has signed a formal letter of support with CSFN for research projects related to wildfire research and recovery.⁹⁹ They are interested in studying plants of interest to First Nations and have an enhanced forestry lab providing opportunities to support research on berry bushes and other wild plants. UNBC researchers¹⁰⁰ can identify research funding.

The Burns Lake Community Forest plants huckleberry plugs grown in a nursery in southern BC and may be a useful source of advice.¹⁰¹

4.11.5 Berries: Next Steps

- **Develop a berry management group** with members from each interested First Nation, consultants as desired and UNBC researchers to establish links between communities and UNBC
 - Identify funding sources and apply for funding
 - Implement the surveys and planting treatments described above
 - Discuss options for nursery production of bushes, including UNBC, Woodmere, Twin Sisters or other local greenhouses¹⁰²

4.12 Special Restoration Zone: Medicinal Plants

4.12.1 Medicinal Plant Values

First Nations in the area have relied on wild grown medicinal plants for millenia. Medicinal plants harvested in the area include devil's club (*Oplopanax horridus*), Labrador tea (*Rhododendron groenlandicum*), Indian hellebore (*Veratrum viride*), fireweed (*Chamaenerion angustifolium*), lady fern (*Athyrium filix-femina*), cow parsnip (*Heracleum maximum*), common juniper (*Juniperus communis*), wild mint (*Mentha arvensis*), nodding onion (*Allium cernuum*), willow (*Salix* spp.) red osier dogwood (*Cornus stolonifera*), prickly rose (*Rosa acicularis*), wild raspberry (*Rubus idaeus*), soapberry (*Shepherdia canadensis*), various blueberries (*Vaccinium* sp.), highbush cranberry (*Viburnum edule*), Saskatoon berry (*Amelanchier alnifolia*), kinnikinnick (*Arctostaphylos uva-ursi*), choke cherry (*Prunus virginiana*).¹⁰³

Devil's club is a particularly important physical and spiritual medicine (for more details, see Appendix 6). The inner bark and/or the roots have been used either alone or mixed with other medicines to treat a wide variety of ailments including cancer, arthritis, tuberculosis, abdominal ailments and viruses. Because of its importance to indigenous cultures, devil's club has been the focus on many recent research trials that support its effectiveness at inhibiting certain bacteria and fungi and preventing growth in several types of cancer cells as well as benefits as a tonic and for the treatment of arthritis and rheumatism. Many people also still use devil's club for spiritual purposes.

Respect for the ecosystem and plants is crucial to harvest of medicinal plants.¹⁰⁴

4.12.2 Impacts to Medicinal Plant Values

Devil's club is a particularly important medicine. It lives in rich, moist, mature ecosystems. When wildfire burns these ecosystems, it reduces the availability of devil's club and other medicinal plants, compounding impacts from forest harvesting and herbicide use.¹⁰⁵

4.12.3 Potential Treatments to Restore Medicinal Plant Values

Ecosystems that would support devil's club after the forest recovers sufficiently are dotted across the wildfire area (Figure 21 above).

- Set up medicinal plant treatment units to facilitate adaptive management and research in collaboration with UNBC
- **Survey areas for surviving plants** to document survival related to fire severity and ecosystem
 - Stratify the study area by fire severity and assess a minimum of 5 separate locations suitable for each target species
 - Use TEM or PEM maps and Appendix 5 to identify suitable potential habitat
 - Consider accessibility to communities
- Include important medicinal plant locations in cultural management area; develop management strategy for each important species and location
- No use of herbicides that will impact medicinal plants
- **Consider seeding or planting important plants in appropriate ecosystems**
 - See Appendix 5 for ecosystems
 - Follow documented methods for effective propagation; research methods where none exist; Twin Sisters includes Devil's Club in their list of species
- Monitor growth to improve knowledge of effective restoration treatments.

4.12.4 Medicinal Plants: Implementation

Restoration of medicinal plants provides excellent opportunities for local employment, both for recovery surveys and for seed and/or cutting collection and planting.

UNBC has signed a formal letter of support with CSFN for research projects related to wildfire research and recovery.¹⁰⁶ They are interested in studying plants of interest to First Nations and have an enhanced forestry lab providing opportunities to support research on wild plants. UNBC researchers can identify research funding.¹⁰⁷

4.12.5 Medicinal Plants: Next Steps

- **Develop a medicinal plant management group** with members from each interested First Nation, consultants as desired and UNBC researchers to establish links between communities and UNBC
 - Identify priority species for management (e.g., devil's club)
 - Identify relevant questions for research and monitoring
 - Identify funding sources and apply for funding
 - Implement the surveys and planting treatments described above.

4.13 Special Restoration Zone: Morel Mushroom Harvest

4.13.1 Mushroom Values

Morel mushrooms fruit abundantly following fire, attracting commercial and recreational harvesters to burned areas, boosting local economies but often negatively impacting communities and ecosystems. Nadleh and Stellat'en are working to ensure that restoration and recovery is planned collaboratively in relation to mushroom management. A void in regulation of post-fire commercial mushroom harvesting provides an opportunity for nations to implement regulations that reflect their laws and governance.

4.13.2 Impacts to Mushroom Values

An influx of people rushing to harvest mushrooms can impact local communities and a variety of ecosystem values. Impacts include interpersonal conflict, wildlife conflict, human waste and litters, and resource extraction without consent.

4.13.3 Potential Treatments to Restore Mushroom Values

- **Develop mushroom harvest management group** to focus on management issues
- **Develop a mushroom harvesting plan focused on indigenous-led stewardship¹⁰⁸** to direct a variety of activities including
 - permitting
 - education
 - campsite organisation
 - monitoring to minimise impacts.
- **Control access to prime mushroom habitat** to improve the chances of regulating harvest and controlling impacts.
- Close the wildfire area to motorised vehicles except on existing roads to reduce impacts.¹⁰⁹

4.13.4 Mushrooms: Implementation

A mushroom management plan was developed in time for the 2019 influx that includes a harvester orientation package and permit as well as maps and signs for the program which is being implemented by Nadleh and Stellat'en in 2019¹¹⁰. No external agencies have provided funding or support.

Points of leverage to support management of forest foods include developing certification for sustainably managed forest foods, 14-day regulatory limit for staying on crown land, the need for health inspections, and that mushroom buyers may cooperate to maintain their opportunity.

Implementation has been mostly successful except for a few people in non-compliance.¹¹¹

4.13.5 Mushrooms: Next Steps

Coordinate ecosystem restoration and mushroom management activities.

4.14 Timber Restoration Zone

4.14.1 Timber Values

Timber harvest has driven the economy of the region for several decades. Following the mountain pine beetle outbreak, timber harvesting was increased to salvage killed trees. The region is now faced with a

decrease in timber supply due to the planned falldown in timber supply exacerbated by mountain pine beetle and wildfire disturbance and subsequent salvage uplifts in harvesting activity beyond sustainable levels.

4.14.2 Impacts to Timber Values

Wildfire reduces short-term timber supply by consuming and damaging mature trees and removing feedstock from the processing stream unless mills can handle charred wood. Salvage harvest can be economical under some conditions. Wildfire reduces mid-term timber supply by burning immature stands that would be harvested in the future.

Changes to hydrology due to loss of forest cover and changed soil hydrophobicity may increase the impacts of drought on tree growth and lead to loss of productive soil through mass wasting. While the nutrient flush can improve growth rates, trees may be more susceptible to stem rusts.¹¹²

Wildfire provides an opportunity to plant for future forest resilience and carbon capture. Dense planting may maximise carbon sequestration, but will lead to a uniform forest that will be vulnerable to future wildfires; a diversity of patterns and stock types established at low densities will be most resilient. Burned areas are potentially resistant to further wildfires for several decades due to the reduction in fine fuels.¹¹³

4.14.3 Potential Treatments to Restore Timber Values

The Island Lake Timber Restoration Zone, covering about 9,100 ha, aims to maintain mid-term timber supply and build resilience into the forest for long-term timber supply. Stand age before the wildfire, combined with burn severity, can guide appropriate treatments (Figure 22):

- Unburned and low severity plantations, covering over 2,000 ha, require no additional treatment;
- Plantations burned at moderate and high severity can be surveyed to determine the need to replant;
- About 325 ha of 41 – 100-year-old forest remains unburned or lightly burned and will contribute to mid-term timber supply;
- The moderately and severely burned areas should be surveyed for biomass salvage potential and reforestation need;
 - areas likely to recover naturally need not be replanted
 - any live trees in the moderately burned areas should be left for mid-term timber supply. Given the high risk to ecological function over the entire area, live trees should be left even in the timber zone (as per Chief Forester’s Guidance).

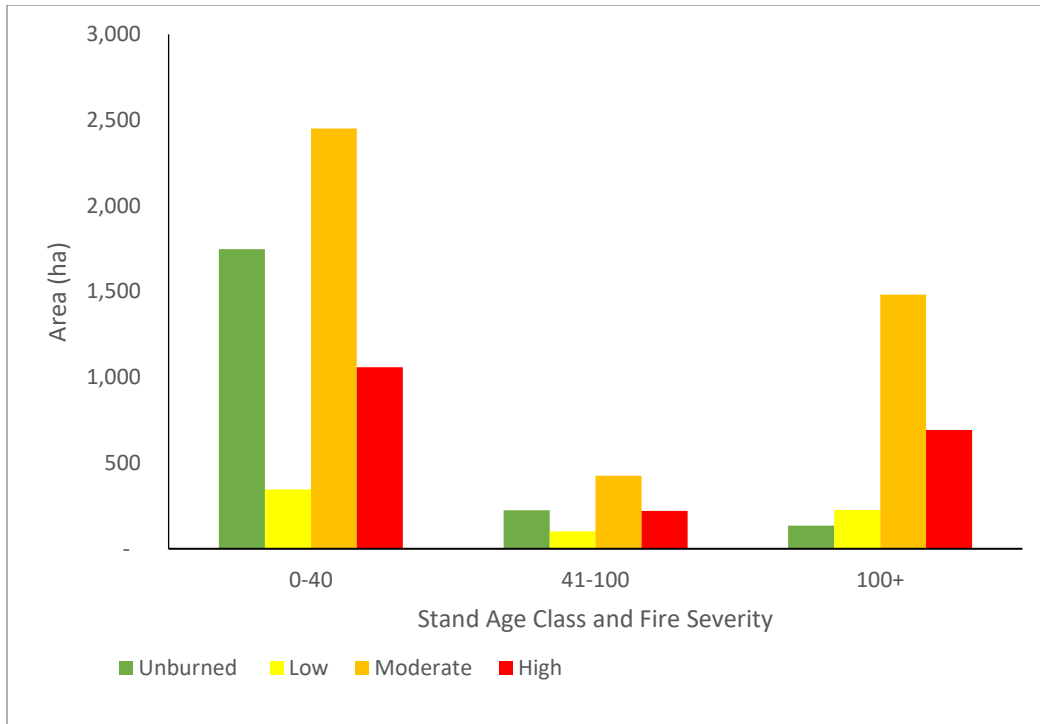


Figure 22. Area of timber restoration zone in each pre-fire stand age and severity class.

Re-tooling of mills allows handling of burned wood to provide short-term timber supply. Local mills will salvage some burnt trees if they were alive prior to the fire and if only the bark is charred.¹¹⁴ The growing biomass industry provides new opportunities to salvage for biomass, increasing the utilization of residual material. Although pellet plants may not process burned wood, bioenergy plants chip burnt timber.¹¹⁵ Biomass salvage can be used to manage fuel to reduce fire hazard linked to fine fuels.

The Chief Forester's guidance calls for retention of marginally-impacted or non-impacted stands to contribute to mid-term timber supply, and for retention of live trees within moderate severity burns.

Planting conifers provides long-term timber supply. Standard practices call for removal of standing timber either by salvage for sawlogs, salvage for biomass or pile-and-burn as part of site preparation. Wildfire provides an opportunity to improve the resistance and resilience of stands by increasing the diversity of climate-adapted species, densities and patterns planted at both stand and landscape scales. Planting under standing burned trees, if safety consideration allow, retains legacies, provides microclimatic benefits for regeneration,¹¹⁶ and reduces the costs associated with removing trees. Leaving standing timber to naturally seed a burned stand is an option, particularly if a cone crop is available.

- **Salvage harvest for sawlogs and/or biomass** (chip on site or haul and chip)
 - Ensure that salvage activities limit disturbance of soil (e.g., winter salvage on snow)
- **Plant for increased resiliency** after removing standing trees via salvage or pile-and-burn as needed;

- Top priority for planting is severely burned steep slopes to avoid slope failure (except for south-facing slopes with grassland or likely to convert to grassland)
 - Severely burned slopes are susceptible to erosion even at low gradients (e.g., >15%) not normally listed as unstable
- Plant along fireguards and roads identified for rehabilitation to help reach FFT targets
- Elsewhere, prioritise planting where other values are low
 - Younger blocks (0 – 40 years pre-fire) have little structure; survey (GIS then field) previously-existing plantations to ensure consistency with values. Avoid planting young blocks with high berry potential, on moist, rich sites with high productivity (shrubs for moose), riparian areas (unless sediment is a concern)
 - Recent plantations are required to be replanted under existing FSPs; requires DM decision to change planting prescription (need a good rationale)
 - Delay planting until surveys are completed
 - Avoid planting areas with high biodiversity or wildlife values
- **Plant diverse portfolio of climate-adapted species in varied densities and patterns**
 - Consider decreased stocking and modified practices (e.g., clumping) for wildlife and berries
 - Increase species diversity for resilience and biodiversity values
 - if plantation was not free-to-grow before fire—request amendment to FSP stocking standards based on need to improve resilience.
 - Match species to site conditions
 - Consider potential for increased drought pressure when planting; apply drought risk assessment tool¹¹⁷
 - Plant aspen near community for future fire resilience and community safety; coordinate with community safety plan
- Identify dry site series (e.g., SBSdw3/02,03 and SBSdk/02,03) that are naturally open areas (grassland and shrub ecosystems); these may spread with climate change; **to facilitate transformation, avoid planting or consider planting widely-spaced Douglas-fir**
- Consider delaying planting for 3 years due to black army cutworm that feeds on seedlings following high severity wildfires; consider planting larch as they seem less vulnerable to cutworms
- Increase flexibility in free-to-grow policy for acceptable species in burned areas; develop District Manager policy¹¹⁸
- **Leave stands to regenerate naturally** (natural patterns are more diverse and hence more resilient than planted stands)

4.14.4 Timber: Implementation

Communication will be key to implementing treatments. Coordination with the Omineca ESI will facilitate.

Licensees are responsible for planting burned stands with an existing cutting permit (CP), unless they surrender the stand. Licensees are also responsible for re-planting burned plantations that have not yet met free-growing requirements. They can apply for funding from the province (section 108, 107 and exemption from free-growing requirements under section 97.1). Amending FSPs to address alternative

silviculture is possible given clear rationale and location. Exemption from free-growing regulations can allow operational research trials (e.g., larch plantations).

The province is responsible for planting burned mature stands that have been surrendered or have no current CP, previously-existing plantations that have achieved free-to-grow and immature stands. Planting can be managed by SERNbc with funding agencies accessible to SERNbc (e.g., FFT, FCI, section 108).

Two companies are interested in bioenergy harvest from wildfires in the area.

FLNR has ordered 400,000 seedlings to plant on about 180 ha of burned plantation in the nearby Shovel Lake Fire via the Nadina District FFT program (about 2,000 stems per hectare). The species mix is diverse, 35% spruce, 25% pine, 20% larch and 20% Douglas-fir, and matches the climate-informed species portfolio well.¹¹⁹

In Vanderhoof, past experience has shown that natural regeneration is usually sufficient three years post-fire in low and moderate severity burns.¹²⁰

The BC Wildfire Service has recently reviewed the Defined Hazard Assessment and Abatement Strategy, including the time for abating hazards and the amount of fuel that can be left on cutblocks. As recommended by the Forest Practices Board in an investigation of nearby Shovel Lake Wildfire, consider abatement requirements holistically, assessing smoke impacts and risk to biodiversity, silviculture and carbon storage.¹²¹

4.14.5 Timber: Next Steps

- **Communicate zones and treatments** to governments and licensees.
 - **Coordinate with Omineca ESI**
- **Assess marketability** of salvage-harvesting stands of different age and burn severity.
 - **Confirm stand age and burn severity**
 - **Assess opportunities for subsidising harvesting** to facilitate reforestation treatments with FESBC.
- **Develop silvicultural prescriptions to increase resilience** and maintain/restore future timber supply
 - Survey to confirm surviving trees in plantations
 - Identify stands that would benefit from planting
 - Plant portfolios of species to maximise diversity and resilience
 - Obtain RESULTS prescriptions with site series information
 - Use Tree Species Selection Tool until portfolio analyses are completed
 - Determine site series in the field where no historic prescriptions exist
 - Delineate patches within stands with high deciduous potential (e.g., wet, rich site series) and do not plant with conifers
 - Identify dry site series (e.g., SBSdw3/02,03 and SBSdk/02,03) that may shift to open areas (grassland and shrub ecosystems) with climate change; avoid planting or consider planting widely-spaced Douglas-fir
- **Develop policy mechanisms to support alternative silviculture** (task for Forest District)
 - Alternative stocking standards (lower density, clump planting)

- Encourage deciduous species

4.15 Range

4.15.1 Range Values

Use of crown land for range has a long history in the area.

4.15.2 Impacts to Range Values

Loss of natural barriers allows cattle to range more widely, potentially impacting other values. Fences can keep cattle from damaging sensitive values (e.g., wetlands and streams), but also can limit First Nations access to culturally important areas on Crown Land preventing them from exercising their rights. Increased fencing in some areas nearby has created barriers between farmers and First Nations communities. Ensuring a collaborative process to design fencing will benefit all parties.

4.15.3 Potential Treatments to Restore Range Values

- Provide offsite watering
 - Manage access to riparian areas using brush barriers
- Manage seeding to control cattle movement
 - Ensure that grass/forb seeding considers range; in seeding fire guards in areas with high range values, use forage mix
 - Use forage mix to attract cattle and keep them from sensitive areas (e.g., riparian areas, steep slopes)
- Use grazing to manage fuels where appropriate

4.15.4 Range: Implementation

- Create range management group to facilitate collaboration
 - Include interested members of each First Nation, ranchers and FLNRO staff as needed
 - Collaboration can lead to a local solution (e.g., ensure that people know they have access and that they can access resources, for example by use of stiles and cattle guards)
 - Assess potential benefits of grazing to reduce fuels and potential costs to sensitive soils and invasive species

5 Summary of Treatments

This collaborative and holistic Ecosystem Restoration Plan for the 2018 Island Lake Wildfire aims to restore a diverse, resilient landscape capable of generating the many values and services that matter to the people of the area. Ecologically, in these fire-prone systems, leaving the wildfire to recover naturally is the best strategy to maintain/restore most values. However, additional restoration treatments can take advantage of the opportunity provided by the wildfire to increase resilience at stand and landscape scales and to restore cultural values.

The plan identifies management zones and suggests zone-specific treatment options with the potential to maintain or restore important values to watersheds and landscapes. Many treatments are similar across zones, although some are more important in some zones than in others. Key restoration treatments should be applied over the landscape—with various emphases and site-specific variation.

Harvesting treatments aim to maintain legacies:

- Retain all remaining live trees (except for selected conifers in Wildland Urban Interface)
- Retain large snags
- Salvage smaller dead trees and mountain-pine-beetle-killed stands

Planting treatments aim to restore landscape diversity and resilience:

- Re-establish coniferous and deciduous forest cover in burned plantations
 - Plant climatically suited species (and provenances)
 - Decrease planting density and plant in clusters
- Encourage deciduous trees and shrubs as part of a resilient forested landscape
 - Plant deciduous trees and shrubs for moose browse (e.g., dogwood) and for slope and riparian stabilisation (e.g., cottonwood, willow)
 - Avoid herbicides and brushing
 - Avoid planting rich patches where deciduous growth would compete with conifer regeneration
 - Plant culturally important berry and medicinal plants
- Sparsely plant dry sites to facilitate climate-driven transition to open ecosystems
- Seed exposed erodible soil with fall rye for quick cover at moderate densities and higher densities of native herbaceous species if available

Access treatments aim to reduce cumulative effects:

- Maintain or reduce road density and manage access
- Rehabilitate, restore or maintain/upgrade roads to minimise sedimentation
- Rehabilitate and restore fire guards.

6 Next steps

6.1 Build Collaborative Restoration Process

Effective restoration will require a working partnership among affected First Nations, FLNR and SERNbc. The territories of Stellat'en and Nadleh First Nations were highly impacted by the Island Lake Wildfire. These communities lie in close proximity to the fire; community members rely on the now-burned area for resources and cultural practices. Reconciliation and rights dictate that these communities must play a large role in determining and overseeing restoration activities. Restoration work also provides opportunities for developing skills and building capacity within communities. Nadleh and Stellat'en can be substantially involved in managing the restoration work by designating staff time to managing restoration and pursuing funding to support involvement in management and restoration treatments. FLNR currently has responsibility for regulating and managing timber harvesting, reforestation and

access. They have staff with forest management expertise. SERNbc has a restoration mandate and has members with expertise and experience in restoration.

6.2 Funding Opportunities

Tasks requiring funding can be divided into four categories, described below. See Appendix 7 for a more detailed list of funding sources.

6.2.1 Planning, management and oversight

FLNR and SERNbc have available staff and or funding. First Nations will need funding to support new positions, build internal capacity and hire advisors as warranted. Potential funding sources include for example

- the Indigenous Forestry Initiative (Natural Resources Canada) addresses environmental stewardship,
- the provincial Rural Dividend Fund supports community capacity building and workforce and economic development,
- the Fraser Basin Council supports regional adaptation.

SERNbc should take a lead role in coordinating ecosystem restoration and in fostering collaboration as described in their purpose statement (<http://sernbc.ca/aboutsernbc.html>). Consult with regional Integrated Investment Specialists to clarify funding opportunities.

6.2.2 Surveys and field assessments

Surveys and assessments to better define site conditions are necessary to finalize treatment prescriptions in many cases. These assessments may be completed by contractors or by FLNR staff in some cases. SERNbc may be able to access to funding to support these activities.

Surveys and assessments provide employment and capacity building opportunities for First Nations.

6.2.3 Treatments

Treatments are typically performed by logging contractors, silvicultural contractors and restoration specialists. In collaboration with First Nations, SERNbc and FLNR can access funds via FESBC to support these activities. Federal Ecoaction funding is available to support treatments that benefit freshwater resources.

First Nations may seek business development funding if members are interested in developing businesses specializing in ecosystem restoration. For example, unmet demand for shrub and deciduous tree planting stock may provide an economic development opportunity.

6.2.4 Research, adaptive management and monitoring

UNBC, UBC and BVRC have research initiatives addressing wildfire ecology and recovery. First Nations, SERNbc and/or FLNR may partner with these institutions on topics of mutual interest (see next section). Traditional research funding sources include NSERC and SSHRC. The BC Wildfire Service may be willing to support research projects related to, for example, fuel management.

First Nations researchers and technicians should be funded to participate in research. Ideally, capacity building and knowledge sharing will be incorporated into research proposals.

6.3 Learn from the Wildfire; Collaborate with Researchers

Adaptive management uses the wildfire as an opportunity to learn about recovery and improve restoration treatments. Large-scale wildfire restoration is relatively new in BC and uncertainty remains about implementation and effectiveness. First Nations can partner with UNBC (and other regional research institutions such as the Bulkley Valley Research Centre) to develop a monitoring and research program. Potential topics for collaboration include

- Relationship between pre-wildfire structure and composition and burn severity; potential for drones to assess post-fire structure¹²²
- Berry shrub survival monitoring (related to fire severity and ecosystem) and planting trials (see Berry section above)
- Medicinal plant survival monitoring and planting trials (see Medicinal Plant section above)
- Slope and riparian stabilisation effectiveness trials
- Deciduous tree and shrub survival and planting trials; nutrient analysis of browse in different situations
- Success of planting on roads and fireguards
- Fuel loads and fire management.

UNBC can provide

- senior undergraduate and some graduate students to monitor outcomes of alternative restoration, working in collaboration with Nadleh and Stellat'en
- greenhouse facilities and knowledgeable curators interested in supporting restoration with different species.
- expertise in (among others) disturbance ecology (Kathy Lewis, Phil Burton, Lisa Poirier), plant/ecosystem ecology (Hugues Massicotte, Art Fredeen, Lisa Wood, Che Elkin), plant-animal interactions (Roy Rea, Chris Johnson) and economic diversification in managed forests (Oscar Venter). They are aiming to build expertise in wildfire ecology and science.

6.4 Land-use Planning

Land and resource management is currently in flux. While we have attempted to integrate this restoration plan with individual Nations' land-use planning initiatives and with draft broad-scale management direction emerging from the Omineca ESI, ongoing communication among planning initiatives is essential.

- Share information with Omineca ESI and Stellat'en Indigenous Land Use Plan
- Collaborate with Fraser Lake and Regional District to plan treatment in Wildland Urban Interface
- Mushroom Access Management

7 Benefits of plan

This plan

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- Builds a collaborative relationship with affected First Nations, consistent with BC's commitment to reconciliation;
- Integrates First Nations' and the Province's restoration investments,
- Streamlines approval of restoration projects with First Nations,
- Collaboratively identifies zones appropriate for continued timber development,
- Offers insight into culturally appropriate management of moose, berries and mushrooms,
- Identifies at-risk values and provides proactive stewardship planning to prevent SAR listing,
- Describes treatments that aim to encourage ecosystem resilience.

Appendix 1: Collaboration Plan

The Advisory Council guided plan vision, a collaboration plan (Table A1) and methodological approach. Each meeting focused on a different group of people; Advisory Council representatives were invited to all meetings. Affected First Nations and FLNR district and regional staff identified important values and management concerns in the burned areas. We held meetings in different communities to allow participation from interested community members (FLNR in Burns Lake, Ts'il Kaz Koh in Burns Lake, Stelat'en and Nadleh in Stellaquo, workshop in Nadleh). We met with topic experts to gather advice and knowledge and with FLNR district staff to discuss licensee obligations and interests. Over 50 people participated actively in workshops and meetings.

Table A1. Collaboration plan showing principle interactions and participants in each event.

Interaction	Advisory Council	Consulting Team	FLNR Staff	CSFN Reps	Topic Experts
Phone call with Advisory Committee <ul style="list-style-type: none"> Confirm/revise project approach and collaboration plan 	X	X			
Meet with FLNR (Burns Lake, Vanderhoof) <ul style="list-style-type: none"> Summarize existing knowledge Discuss implementation challenges and funding sources 		X	X	X	X
Meet with individual nations <ul style="list-style-type: none"> Address concerns Clarify key locations of values Clarify treatment options and priorities 		X		X	
Workshop with Advisory Committee and FLNR <ul style="list-style-type: none"> Present and discuss impacts, treatment options and restoration priorities 	X	X	X	X	X
Phone/meet with topic experts <ul style="list-style-type: none"> Seek advice on impacts and treatment options 		X			X
Phone/meet with FLNR/licensees <ul style="list-style-type: none"> Discuss obligations, interests and operational considerations 		X	X		
Meet with Advisory Committee to finalize plan <ul style="list-style-type: none"> Finalize restoration treatment priorities Clarify desired future participation in restoration planning and activities 	X	X			

Appendix 2. Watershed attributes and risk and area burned

The values in a watershed and the sensitivity of the watershed to development and disturbance influence risk posed by wildfire and the need for restoration. Areas with severe and moderate burn often have higher priorities for treatment. The following map shows watershed ID. Tables below show

- watershed attributes,
- watershed value, sensitivity and risk,
- area burned with moderate and high severity by slope class, and
- stream length burned with high severity.

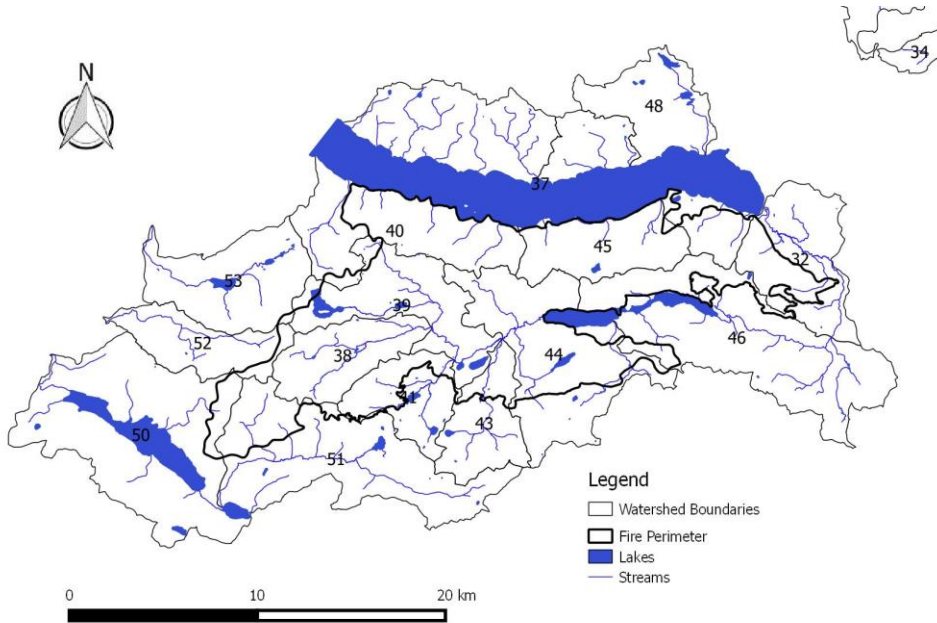


Table 6. Watershed attributes that influence sensitivity to disturbance.

WS	Area (km ²)	FMLB (km ²)	CFLB (km ²)	THLB (km ²)	Lake (km ²)	Wetland (km ²)	Stream (km)	Min. Elev. (m)	Relief* (m)	Melton** (Km/km)	H60*** (m)
32	34.2	31.3	17.4	12.5	0.0	2.2	52	722	524	0.09	821
37	55.2	0.0	0.7	0.1	55.2	-	83	709	60	0.01	719
38	23.7	23.1	22.7	19.7	0.1	0.6	34	1,007	318	0.07	1,146
39	35.1	32.3	32.7	25.8	1.6	1.0	58	919	519	0.09	1,108
40	79.3	79.1	71.4	25.4	0.1	0.2	129	715	723	0.08	946
41	21.2	20.6	20.5	17.4	0.4	0.9	29	930	374	0.08	1,004
43	21.6	21.3	21.2	19.9	0.1	0.5	30	919	481	0.10	1,050

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44	55.1	52.1	51.4	44.6	1.7	1.3	72	916	512	0.07	1,093
45	39.2	35.9	33.8	5.3	0.1	0.1	47	717	544	0.09	916
46	74.6	70.2	69.2	58.9	4.0	0.5	99	823	549	0.06	1,027
48	36.6	30.0	25.0	10.4	0.7	0.8	38	719	570	0.09	896
50	80.2	55.1	67.8	58.8	9.1	0.6	106	776	483	0.05	881
51	61.8	60.7	55.5	54.2	0.8	1.4	95	826	560	0.07	979
52	22.3	22.2	21.5	20.7	0.0	0.2	30	778	577	0.12	980
53	35.4	34.0	33.9	32.6	0.8	0.6	42	727	633	0.11	957

*Relief is maximum minus minimum elevation. **Melton index of ruggedness calculated as relief(km) divided by square root of area (km2). ***H60 is elevation with 60% of watershed area above.

Table7. Watershed value, sensitivity and estimated risk.

WS	Fish Value*	Sensitivity**	Area (km2)	ECA	ECA Risk	Peak Flow	Road (km)	Road Density (Km/km2)	Road Risk
32	Reproduction	High	34	3,422	50	5	55	52	1.5
37	Reproduction	Low	55	5,522	99	5	99	0	0.0
38	-	Low	24	2,367	54	5	62	25	1.0
39	-	High	35	3,514	65	5	70	46	1.3
40	Tributary	High	79	7,927	19	2	21	50	0.6
41	-	High	21	2,123	60	5	66	28	1.3
43	-	Moderate	22	2,158	82	5	84	17	0.8
44	-	High	55	5,512	68	5	71	54	1.0
45	Tributary	Low	39	3,918	50	5	54	32	0.8
46	Reproduction	Low	75	7,456	35	3	38	103	1.4
48	Tributary	Low	37	3,664	49	5	51	126	3.4
50	Tributary	High	80	8,019	52	5	58	140	1.7
51	-	High	62	6,185	57	5	59	43	0.7
52	Tributary	Low	22	2,230	34	3	39	26	1.2
53	Tributary	Low	35	3,543	24	2	27	23	0.6

*Heightened-value watersheds support fish spawning and/or rearing.

**Sensitivity ratings (developed by Omineca ESI) consider watershed ruggedness and lake and wetland area.

Table8. Watershed area in each slope class for high and moderate severity fire.

WS	Area in slope class					High severity area in slope class					Moderate severity area in slope class				
	0-10	11-20	21-30	31-40	41-50	0-10	11-20	21-30	31-40	41-50	0-10	11-20	21-30	31-40	41-50
32	1,104	1,297	699	283	39	41	117	138	97	7	94	164	134	71	12

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37	5,190	255	77	0		0	0	0	0		0	0	0	0	
38	774	1,363	231			82	222	50			439	652	121		
39	1,528	1,613	373			231	383	93			788	665	103		
40	909	3,319	2,796	861	41	26	174	352	84	0	72	168	363	159	8
41	1,067	883	167	7		24	84	18	0		154	312	57	7	
43	1,129	930	88	10		46	51	0	0		222	79	2	0	
44	1,854	2,617	981	60		184	453	158	0		553	754	369	16	
45	704	2,005	1,088	115	6	125	538	287	21	0	124	488	246	41	0
46	1,760	4,060	1,515	120		67	209	74	4		180	489	119	18	
48	1,780	1,109	645	74	56	21	191	181	1	0	31	108	140	1	0
50	4,605	2,704	659	52		4	36	25	0		59	121	87	6	
51	3,051	2,773	344	16		46	192	34	0		186	407	69	0	
52	1,319	847	64			7	23	0			31	59	2		
53	1,881	1,221	383	58		0	0	0	0		0	3	3	0	

Table9. Stream length (km) and high-severity burn stream length (km) by Stream Order (1 is smallest) in each watershed (WS).

WS	1	2	3	4	5*	1	2	3	4	5*
32	28	11			14	3	0			0
37	30	21	7		24	0	0	0		0
38	17	7	6	4		1	2	1	0	
39	35	13	4	7		7	1	1	1	
40	79	39	10			7	1	0		
41	16	11	2			2	1	0		
43	18	5	1	6		1	0	0	0	
44	46	12	8	0	6	7	1	0	0	0
45	34	11	1			9	1	0		
46	58	20	7		15	2	0	0		0
48	25	8	4			4	2	0		
50	72	19	1	14		1	0	0	0	

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51	58	17	15	5		3	0	0	0	
52	16	2	7	5		0	0	0	0	
53	26	5	11			0	0	0		

*Includes order 5 and above.

Appendix 3. Stellat'en Briefing Note

Stellat'en First Nation – Values and Criteria Relevant to Post-Wildfire Restoration

This briefing note summarizes some of the preliminary findings from research conducted by the Firelight Group with Stellat'en First Nation knowledge holders, with particular attention to Stellat'en knowledge and priorities for post-wildfire restoration and land use. The information regarding Stellat'en First Nation values and knowledge is based on research conducted by the Firelight Group as well as published works and community resources made available by the Stellat'en First Nation. It reflects the understandings of the Firelight authors and is not intended to be a complete depiction of the dynamic and living system of use and knowledge maintained by Stellat'en members. It may be updated, refined, or changed as new information becomes available. The information contained herein should not be construed as to define, limit, or otherwise constrain the Aboriginal rights of the Stellat'en First Nation or any other First Nations or Aboriginal peoples.

Impacts of Catastrophic Wildfires on Stellat'en

The lands, waters, wildlife and people in Stellat'en territory have all been heavily impacted by forestry, mining, hydro-electric development, and other activities related to industrial economic development (e.g. roads, railways and agriculture). Moose populations in Stellat'en territory have declined precipitously, consistent with moose declines at a larger scale across much of British Columbia.

In 2018, Stellat'en territory experienced some of the largest and most severe wildfires in a record-breaking year for British Columbia. Over 183,000 km² in Stellat'en territory burned, surrounding the community and devastating many areas that were vitally important to Stellat'en practice of their culture, Aboriginal rights, and way of life.

Increased Importance of Remaining Intact Rights Areas: The effect of the 2018 fires in combination with existing cumulative effects occur within the context of an already heavily impacted landscape that leaves few intact areas for the practice Stellat'en rights and intact habitat for culturally and ecologically important plant and animal species. The loss of important preferred harvesting areas in combination with the historical losses due to industrial forestry, mining, agriculture and the uptake of private land contribute to an increased importance of all remaining areas where Stellat'en can and do practice their rights, as well as the remaining habitat areas for culturally and ecologically important plant and animal species. In order to sustain the practice of Stellat'en rights and interests, it is essential for land management, stewardship, and restoration plans to prioritize the protections and restoration of any areas that retain the characteristics needed to support Stellat'en practice of rights. Stellat'en rely not only on remaining undisturbed areas, but also on some areas that, while somewhat disturbed, retain key characteristics to support the practice of rights (e.g. viable moose habitat, harvestable plants).

Important Harvest Activities: As salmon, fish, moose, and other wildlife populations that Stellat'en rely on for food have diminished in recent years, Stellat'en are also voluntarily reducing their hunting activity to protect remaining local populations. While Stellat'en rights and traditional activities are usually practiced in combination (e.g. people go out on the land to hunt, pick berries, and other activities at the same time, in the same areas), the dearth of available wildlife and habitat now means that other remaining traditional harvest activities – such as harvesting berries and medicine plants – are even more

essential to the practice of rights, and to cultural continuity (practicing, sharing and teaching Indigenous knowledge out on the land while engaging in traditional activities).

Areas with Multiple Cultural-Ecological Values are Important: There are numerous characteristics and values (ecological, cultural, spatial) that compose areas identified as important to Stellat'en. For example, high value needs to be placed on ecosystem complexes that include forest and edge habitat in proximity to wetlands and higher elevations, as moose rely on these areas (more detail available in Bhattacharyya et. al., 2019). Sheltered connectivity between areas of high habitat value for moose is also important, such as networks of wetlands with forest cover. As part of the recent moose traditional knowledge study, Stellat'en identified areas of critical importance for cultural and spiritual reasons; and key values that help identify places essential for harvesting and the practice of rights (e.g. areas where hunting, berry-picking, and other wildlife/fish habitat are all accessible together, within accessible distance from the community). The Shovel Lake watershed and valley was identified as an area critical to Stellat'en prior to the fires. Our study highlights that multiple cultural and ecological factors should be considered in applying the "assembly rules" for restoration. Table 1 outlines a preliminary list of criteria for consideration in selecting and prioritizing areas for restoration, this list will be refined with community members and may change (Bhattacharyya et. al., 2019).

Places of Key Cultural Importance

In-depth research with Stellat'en has led to the preliminary identification of places, landscapes features, and areas (varying in scale from specific points to entire watersheds) of cultural and ecological importance. This list is not exhaustive and is provided for discussion only, absence of an area from this list does not mean that it is not important. Further work is underway to verify this list with Stellat'en.

Some examples include:

- Red Rock Mountain
- Shovel Creek and Shovel Lake – valley bottom to height of land
- Owl Lake, Hanson Lake – surrounding areas
- Stern Lake and wetlands connected up to around 11km point near the Trout Rd.
- Tatin Lake – connected wetlands
- Sutherland Valley
- Abun Tlat, Keyah Whuchet
- Savoury
- Nithi Mountain – surrounding area
- Binta Lake-Knapp Lake – wetlands connecting them

Table A2: Summary of Selected Stellat'en Characteristics and Criteria to Inform Restoration Planning	
Characteristic	Criteria
Forests – mixed age stands; mature and old growth seral stages.	<ul style="list-style-type: none"> • Mixed age forests with intact mature and old growth trees, understory and shrub layer. • Linear fragmentation threshold
Wetlands, water bodies (lakes, rivers), forest edge, shrub forage species.	<ul style="list-style-type: none"> • Ecosystem complexes with multiple characteristics required by moose, in close proximity.

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<p>Moose corridor</p>	<ul style="list-style-type: none"> • Habitat connectivity • Available forest (visual and thermal) cover • Water and wetlands • Reasonable protection from predation (human or animal) i.e. road access, sight lines.
<p>NTFPs Berry plants, including: huckleberry, saskatoon, soopallalie, wild blueberry, wild raspberry, wild strawberry, gooseberry.</p>	<p>Note: Berry plants change productivity each year in different locations; therefore preferred harvest areas move vary spatially years.</p> <ul style="list-style-type: none"> • A diversity of species across a range of sub-watersheds and elevations to serve different families, in different years. • Free of dust, noise. • Location accessible within reasonable, affordable distance from community • Proximate to preferred hunting areas.
<p>NTFPs Medicine plants, including: Labrador tea; Indian hellebore; devil’s club; fireweed; fiddleheads; cow parsnip; juniper; wild mint; wild onion; red willow.</p>	<ul style="list-style-type: none"> • Same as above, plus: • Clean source water • Spiritually safe and clean area, and access • Areas identified by Stellat’en as culturally/spiritually significant • Requires areas that meet criteria for preferred hunting, and moose habitat, with available medicine plants.

Stellat’en Traditional Foods and Rights-Based Harvest

Stellat’en First Nation is working with Firelight to complete a rights-based harvest study, which aims to determine the types and volumes of traditional foods a typical family would ideally harvest per year (for direct consumption, as well as to satisfy trading and sharing obligations). The goal of this work is to help inform decision around natural resource management, specifically around restoring and protecting habitat required to restore and maintain healthy population levels of key cultural and food species. The outcomes of this work serve to inform guidelines and thresholds regarding the amounts of plants, fish, birds, small and large animals needed from the local ecosystem in order for Stellat’en to fully exercise their Aboriginal rights to hunt, gather, fish and harvest for subsistence and cultural purposes.

The data collection for the rights-based harvest study (reporting in progress) was undertaken in the Fall of 2018, just after the Shovel Lake and Island Lake wildfires had dramatically altered much of Stellat’en’s land base and impacted harvesting in a such a substantial way that current levels of harvest for almost all resources was close to zero at the time of data collection. Stellat’en reported that the decline of moose has been so precipitous that a family is lucky to harvest a moose every few years.

The methods for the rights-based harvest study included convening focus groups with current land users and elders who have experience living off the land and being involved in harvesting. The discussion focused on estimating both the minimum and ideal amounts of traditional food needed to meet all food and cultural needs, including sharing, in an environment where there are plenty of healthy animals and plants.

To estimate consumption of traditional food for each hunting family, assumptions were made with respect to the immediate household size (five), daily caloric requirements (2,500 calories per person) and the proportion of energy from animal-based foods (75%) and plant-based foods (25%). Members in each of the focus groups provided estimates for several species of fish, large and small animals, birds and plants. The average numbers from the groups were converted into edible weights¹ which were then evaluated for their ability to both satisfy the nutrition and sharing needs of a family of five.

Table 2 (below) outlines the ideal and minimal amounts for the ten most harvested (preferred) food species for Stellat’en participating in the rights-based harvest study. Ecological restoration efforts should place a high emphasis on working with Stellat’en to restore habitats and populations of preferred food species in order to support food security, and physical and cultural wellbeing of Stellat’en.

Table 2- Annual Harvesting Needs for a Family of 5 – Top 10 preferred species			
	Ideal Number	Minimal Number	2018 Harvest Actual (average amounts reported by focus group participants)
Salmon	1,244	536	40
Moose	6	3	¼ (moose were so scarce they were shared between families)
Deer	12	4	1
Trout	688	676	

¹ Edible weights data derivations have not yet been verified by Stellat’en and as such are not available at this time.

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Whitefish	243	240	
Char	87	46	
Bear	2	2	1
Saskatoons	82 gallons	55 gallons	
Huckleberries and blueberries	48 gallons	21 gallons	9 gallons (all berry species combined)
Strawberries and raspberries	26 gallons	21 gallons	

References

Bhattacharyya, Jonaki, Holden, J., Whittaker, C. and the Firelight Group. 2019. *Stellat'en Traditional Ecological Knowledge: Stewarding Habitat for Duni (Moose) and Culturally Important Plants*. **Confidential, In Progress.**

Fediuk, Karen and the Firelight Group. 2019. *Stellat'en First Nation Rights-Based Harvest Study*. **Confidential, In Progress.**

NB: The primary reports summarized herein are in progress and the data have not yet been verified by Stellat'en.

Appendix 4. Berries

Blueberries – *Vaccinium* species.

Family: Ericaceae (Heath family)

Indigenous Use

Vaccinium species found in the study area include black huckleberry (*Vaccinium membranaceum*), dwarf blueberry (*Vaccinium caespitosum*) and velvet-leaved blueberry (*Vaccinium myrtilloides*). *Vaccinium* species or “blueberries” were widely used by First Nations throughout B.C. and Canada. In the Northwest, blueberries were enjoyed fresh but were also dried on racks over a slow-burning fire, then wrapped in leaves of skunk cabbage (*Lysichiton americanus*) and stored for winter use.

Although blueberries were primarily used for food (along with other edible berries), they were considered a general medicine because they are high in Vitamin C. *Vaccinium membranaceum* and likely other *Vaccinium* species, mixed with choke cherries (*Prunus virginiana*) were used to treat chest conditions and colds in general. Most kinds of blueberries and other edible berries were eaten to assist in digestion after a big meal (Burton 2012).

Dyes were made by mixing blueberries and huckleberries, sometimes with blood from animals (Emmons 1991; Turner 1995, 1997, 2001, Moerman 2002; Burton 2012)

Ecology of *Vaccinium* species in the study area

Black huckleberry - *Vaccinium membranaceum*, a medium sized shrub (up to 1.5 m tall), can be erect to spreading with densely branched stems. Young twigs are slightly angled, yellow-green, bare or slightly hairy; the old bark is greyish and shredding. It is common throughout B.C. (except on Haida Gwaii) and found in dry to moist forests and openings in the montane and subalpine zones (Douglas et al. 1997).

Black huckleberry is moderately abundant in the SBSmc but more abundant and diagnostic in the ESSF. It is moderately shade tolerant and persistent in old-growth stands and copes well with fire, resprouting from rhizomes. Black huckleberry grows best in the open but under a partial shade of 10-20% canopy cover (Burton 1998). Optimal fruit production is associated with open forest approximately 7 to 15 years after disturbances such as light fire or logging (Minore et al. 1979).

In the study area this species is primarily found in the SBSmc2 and ESSFmv1. In the SBSmc2 it is found primarily on site series 02, 01, 04 and 06 and less commonly on site series 03, 07, 10 and 05 (Appendix 1). In the ESSFmv1 it is most commonly found on site series 03, 01 and 04 and less commonly on 02 sites (Appendix 5).

Dwarf blueberry – *Vaccinium caespitosum* is a low spreading matted shrub with stems 10-30 cm tall. It has rounded yellowish-green to reddish bark that it usually finely hairy. It is restricted to dry or sub-mesic sites and prefers open forests, frequently with scattered pine and is often associated with kinnickinick (*Arctostaphylos.uva ursi*). It too is observed in old-growth forests so long as tree cover remains sparse and the canopy remains open, as is typical of the dry sites it prefers. Its response to disturbance is not well documented.

In the study area this species is primarily found in the SBSdw3, predominantly on 03 sites but also on 02, 05, 06, 01 site series (Appendix 5).

Velvet-leaved blueberry - *Vaccinium myrtilloides* is a low shrub growing in dense colonies with stems up to 40 cm tall that are rounded, with very dense velvety hairs, especially when young. It is found in dry to mesic forests and clearings on sandy and rocky soils in the ESSF and SBS; it is more

abundant than black huckleberry in the eastern SBS forests (Klinkenberg 2013). Its response to fire and shade conditions is less well understood.

In the study area, this species is predominant in in the SBSdw3, especially on 05 and to a lesser extent on 03 site series (Appendix 5).

Potential Field Surveys

In order to assess the post-fire recovery and need for restoration of any of these and other medicinal plants, it is recommended that reconnaissance surveys be conducted in the late spring or early summer after the fire. Stratify the study area by fire severity and do random walk assessments at a minimum of 5 separate locations suitable for the target species, looking primarily for new sprouts emerging from surviving root crowns. Terrestrial ecosystem classification (TEM) or predictive ecosystem classification (PEM) maps, if available, will help identify suitable habit where these species should be found.

Potential Treatments

At selected accessible locations where stands of traditionally important plants are desired, patches of the preferred species can be established by transplanting plant material that has first been propagated in a greenhouse. Unfortunately, it is not likely that direct seeding or the direct planting of bare cuttings will result in the effective establishment of any of these species. Effective propagation by seed and by cuttings has been documented for *Vaccinium membranaceum* and *Vaccinium myrtilloides* (McKechnie et al 2009; 2012). *Vaccinium* spp. generally don't do well in infertile or compacted subsoil material, so are not suitable for planting on log landings, staging areas or bulldozed fire guards.

Since nurseries don't usually carry these native species in stock, they will need to be provided with seeds and/or cuttings so they can be contracted with enough lead time (ca. 6 months, but preferably 6-18 months) to grow stock big enough to transplant. Planting should be done in the spring or fall, but not in the summer. There are local employment opportunities for recovery surveys and for both seed or cutting collection and for planting.

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Appendix 5. Proposed list of medicinal plant species for monitoring recovery and/or potential restoration

Latin name	Common name	Medicinal value	SBSdw3	SBSdk	SBSmc 2/3	ESSFmv1
<i>Amelanchier alnifolia</i>	Saskatoon berry	widely eaten for food, high in Vitamin C so helped maintain good health;		81 ; 02; 82; 03; 04; 05; 01; 06; 08		
<i>Arctostaphylos uva-ursi</i>	kinnikinnick	may have been used as a diuretic, but use may have been learned post contact	02 ; 03 ; 05	02 ; 03 ; 81; 04; 05; 06	02 ; 03; 01; 07	
<i>Cornus stolonifera</i>	red osier dogwood	bark used for skin wash, fever reduction, to control post-partum bleeding, body sores, weakness, headache, toothache;		08 ; 07; 06; 04; 01; 10		
<i>Juniperus communis</i>	common juniper	decoction of green tips as a purgative and for coughs, for fever		02 ; 03		
<i>Oplopanax horridus</i>	devil's club	decoction of inner used for TB, arthritis, cancer treatment, diabetes, upper respiratory, antiseptic, general tonic, ulcers, headache, purgative, "cure-all", tonic; delivery of afterbirth			09 ; 10; 06	
<i>Rhododendron groenlandicum</i>	Labrador tea	decoction of leaves used as a diuretic; potential for treating diabetes; used as tonic to strengthen the heart		09 ; 10	03 ; 12; 07	
<i>Rosa acicularis</i>	prickly rose	inner bark also mixed with roots of <i>Shepherdia canadensis</i> with drops of water to make an eye ointment. Morice says <i>Rosa blanda</i> used but it is not found in the area so possibly he was referring to <i>Rosa acicularis</i>	06 ; 07 ; 04 ; 02; 05; 01; 08; 03; 09	01 ; 06 ; 07 ; 08 ; 03; 04; 05; 81; 82; 01; 10		
<i>Rubus idaeus</i>	wild raspberry	a decoction of the stem of <i>Rubus idaeus</i> was mixed with <i>Prunus virginiana</i> and was taken for weak blood (anaemia); decoction of bark shavings mixed with <i>Salix</i> species and <i>Prunus</i>			08	

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		<i>virginiana</i> for leukemia; decoction of the plant stem was mixed with <i>Arctostaphylos uva-ursi</i> for treating high blood pressure		
<i>Shepherdia canadensis</i>	soapberry	berries & stems used as a digestive aid; purgative & emetic; a variety of medicinal purposes in the northwest, including cancer treatment	04; 03; 05; 01; 02; 06; 08	
<i>Vaccinium caespitosum.</i>	dwarf blueberry	fresh berries eaten, pounded and dried into cakes for winter storage, to prevent scurvy, provide Vitamin C	03; 02; 05; 06; 01	03; 02; 07; 04; 01; 10
<i>Vaccinium membranaceum</i>	black huckleberry	fresh berries eaten, pounded and dried into cakes for winter storage, to prevent scurvy, provide Vitamin C		02; 01; 04; 03; 01; 06; 03; 07; 04; 02 10; 05; 09; 11
<i>Vaccinium myrtilloides</i>	velvet-leafed blueberry	fresh berries eaten, pounded and dried into cakes for winter storage, to prevent scurvy, provide Vitamin C	05; 03	
<i>Vaccinium spp.</i>	blueberries & huckleberries	fresh berries eaten, pounded and dried into cakes for winter storage, to prevent scurvy, provide Vitamin C	03; 02; 05; 06; 01	
<i>Viburnum edule</i>	highbush cranberry	used to treat dysentery	06; 08; 07; 05; 01; 10	
<i>Heracleum maximum</i>	cow-parsnip	pulverized roots applied to rheumatic and other areas of swelling; used it to stop bleeding		
<i>Athyrium filix-femina</i>	lady fern	roots combined with other medicines for boils, ulcers and lung hemorrhage.		10

NOTES

- Site series in bold indicate the ecosystem where a species is most abundant
- Most of these species can be propagated by seed and/or cuttings in nurseries and made available for transplanting with sufficient lead time (typically a year)
- For species propagated by seed, collections should be made in late summer or fall; propagation by cutting require collecting during the dormant season (winter).
- Larger transplants (ie more time in the nursery) result in greater establishment success; early propagation and overwinter production of nursery stock is recommended

Appendix 6. Devil's Club

Devil's club - *Oplopanax horridus* (Sm.) Miq.

Family: Araliaceae (Ginseng family)

Indigenous Uses

First Nations in the study area and throughout British Columbia (BC) use *Oplopanax horridus* (devil's club) primarily for medicinal and spiritual purposes although occasionally people ate the early spring buds and young stems (Greene 1896; Compton 1993, pg. 85; Burton 2012). Devil's club was and still is highly regarded for medicinal purposes by the Carrier Sekani and other First Nations (Compton 1993; Lantz 2001; Turner 2004; Gottesfeld 1992; Johnson-Gottesfeld 1994). The inner bark of devil's club and/or the roots were used either alone or mixed with other medicines to treat a wide variety of ailments including cancer, arthritis, tuberculosis, abdominal ailments (as an emetic and to control diarrhea) and the common cold. It was also used as a tonic to keep you healthy (Burton 2012).

Traditionally it was harvested in the fall, after flowering when the leaves had fallen, and throughout the winter until the leaves opened up again (Pauline Grandison 2008) because the stems were considered to be too strong when in flower and the medicine would be bitter. Generally, devil's club stems that were tall and straight about an inch or two in diameter were preferred because they were easier to clean and would make better medicine (Sigidimnaḵ' K'igapks (Alice Azak) 2008; Burton 2012).

Prompted by its importance to indigenous cultures, devil's club has been the focus of many research trials in recent times. Research results suggest that the inner bark of devil's club has properties that inhibit the growth of certain bacteria and fungi that cause a variety of illnesses (e.g., tuberculosis and fungal pneumonia; McCutcheon et al. 1994, 1997; Kobaisy et al. 1997). More recent studies suggest that devil's club may have an effect in preventing the further growth of several types of human cancer cells as well as benefits as a tonic and for the treatment of arthritis and rheumatism (Tai et al. 2006; 2010; Tai et al. 2014). Dr. Tai's research with respect to the effectiveness of devil's club in the treatment of adult-onset diabetes is not strong to date (Tai, pers. comm. 2011), however other trials suggest that devil's club is hypoglycemic (lowers blood sugar) and so would be potentially useful in the control of diabetes (Small and Catling 1999).

Devil's club was and is still widely used for spiritual purposes by many First Nations. Stems are often placed around the house for good luck and/or to keep bad spirits away. Bracelets or necklaces are made from small pieces of the hollowed stems and worn to bring good luck. Fishing boats are sometimes washed with water in which devil's club had been steeped to protect the boat, provide good luck when fishing and to neutralize the human smell (Burton 2012).

Ecology of devil's club in the study area

Devil's club is a tall, shade tolerant, deciduous shrub with stems 1-3 m tall with punky stems armed with yellow spines 5-10 mm long. Its leaves are palmately lobed, the leaf blades shallowly 7- to 9-lobed, 10-35 cm wide, heart-shaped at the base. The flowers are small, headlike umbels in elongate panicles or racemes, up to 25 cm long; flowers are greenish-white and short-stalked. The fruits are bright red berries, 2-3 seeded, 5-8 mm wide. It is distributed in the interior of BC and along the northwest coast on moist sites, especially on well-drained seeps from the lowlands to the subalpine. It is common throughout all but northeastern BC (Klinkenberg 2017).

In the study area this species is primarily found on subhygric and hygric sites in the SBSmc2, most dominant on 09 site series and less abundant on 10 and 06 site series. It is present but not abundant in the SBSmc3 and is not generally found in the SBSdk and SBSdw3 (DeLong et al. 1993). Land Management Handbook 54 (DeLong 2004) reports that devil's club is found in the ESSFmv3 on site series 05 in moderation on mesic sites, but is less abundant in the ESSFmv1.

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Appendix 7: Summary of Potential Funding Sources

- Habitat restoration and reforestation
 - **Land Based Investment Strategy (LBIS):**
 - Directs funds towards 17 categories, including FFT (most common).
 - Typically does not fund projects directly.
 - Funds typically accessed by proponents indirectly, i.e. through FESBC or SERNbc
 - Integrated Investment Specialists help identify funds.
 - **Society for Ecosystem Restoration in Northern BC (SERNbc):**
 - Supports **restoration** and **reforestation** in Omineca region.
 - Will help to identify funding and secure funding sources, and provide technical feedback.
 - Has specific reforestation project: **FCI reforestation planning project**.
 - **Forest Enhancement Society of BC (FESBC):**
 - Supports **reforestation, restoration, wildfire prevention/mitigation**.
 - Main focus is fuel management/low value fibre removal
 - Can be used to access LBIS funding (i.e. FFT) or FCI funding.
 - Projects with multiple objectives:
 - FESBC collaborates with HCTS on projects with habitat restoration objective; and with CRI on projects with wildfire risk reduction objectives
 - **Forests For Tomorrow (FFT):**
 - Supports **reforestation** and **low value fibre removal**. Can be accessed directly through FFT district office (uncommon) or indirectly through FESBC.
 - '2% Return on Investment' rule; reforestation with harvesting goal
 - **Forest Carbon Initiative (FCI):**
 - Supports **reforestation**. Must demonstrate carbon mitigation value. Can be accessed indirectly through FESBC, or SERNbc.
 - **Community Resiliency Investment (CRI):**
 - Supports **wildfire risk reduction/mitigation**. FESBC and CRI collaborate on projects; apply to only FESBC if project has multiple objectives.
 - **Habitat Conservation Trust Foundation (HCTF) - Enhancement and Restoration Grant**
 - Supports **habitat restoration**. FESBC and HCTF collaborate on projects; apply to only FESBC if project has multiple objectives.
 - **HCTF - Public Conservation Assistance Fund (PCAF):**
 - Supports **habitat restoration, community involvement** and **public awareness**. Requires 50% volunteer involvement.
 - **Patagonia Environmental Grants**
 - **Youssef Warren Foundation Conservation Grants**
 - **The Sitka Foundation**
- Community
 - **Ecoaction community funding program**
 - Supports **habitat restoration** focussed on **freshwater**
 - Sponsored by Environment and Climate Change Canada
 - **Prince George Community Foundation**
 - **Red Cross Community Partnership BC Fires 2017**
 - Specific to communities affected by the 2017 wildfires

- **Habitat Conservation Trust Fund - Public Conservation Assistance Fund**
 - Must have 50% volunteer component
- **TD Friends of the Environment**
 - Environmental education focussed
- **Real Estate Foundation of BC**
 - Community actions related to land-use
- Economic development
 - **Northern Development Initiative Trust (NDIT)**
 - Supports **economic development** and **community capacity building** through several funding programs, not ecosystem/restoration focussed.
 - **Rural Dividend Fund**
 - Supports **economic development** and **community capacity building**, not ecosystem/restoration focussed.
 - **Indigenous Forestry Initiative**
 - Supports **economic development** in the forest sector.
- Research based funds
 - **National Science and Engineering Research Council (NSERC):**
 - About to announce call for projects with carbon focus
 - Annual grants for Master's and PhD students
 - **Social Sciences and Humanities Research Council (SSHRC):**
 - Annual grants for Master's and PhD students
 - **BC Wildfire Service**
 - Recently approved research program; working on strategy
 - **Real Estate Foundation of BC**
 - Funds research related to community planning

7.1.1 DETAILS:

7.1.2 Land Based Investment Strategy

Keywords: Ecosystem restoration; Forests for Tomorrow (FFT); Forest Health, Wildfire planning; Tree improvement; Wildfire planning; Ecosystem based management; Fish passage; Water; Recreation; Integrated Investment

Sponsor: Government of British Columbia: Ministry of Forests Lands Natural Resources Operation and Rural Development (FLNRORD).

Details:

- Link projects with funding to manage and protect BC's public forests and land base.
- LBIS funding internally allocated among 17 categories (i.e. FFT, ER etc.).
- No formal LBIS intake process. Proponents typically access this funding indirectly by applying to grant programs already funded by LBIS.
 - Regional Integrated Investment Specialist for region will help to identify active grants in the region. May directly fund projects, but uncommon.
- Forests for Tomorrow (FFT) appears to be most active program in region.
 - 'Timber-centric;' aimed at improving future timber supply
 - Abide by a '2% return on investment' (i.e. harvest) rule to determine whether a project will be funded
 - Proponents may try to directly access this funding by contacting district offices (uncommon).

- May indirectly access FFT funds through FESBC on FESBC's goal to 'improve low value or damaged forests.'
- Ecosystem Restoration category
 - Unclear how to access ER funds (contact Al Neal)

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7.1.3 SERNbc

Keywords: Ecosystem restoration; reforestation, FCI, Omineca region

Details:

- Focussed on restoration in Omineca region
- Three criteria: Ecosystem vulnerability; functional importance of the ecosystem; and, existing management mechanisms and/or programs.
- May help to identify and secure funding, as well as provide technical support.
- If reforestation is primary objective apply to SERNbc's FCI Reforestation Planning Project.

Contact:

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7.1.4 Forest Enhancement Society of BC

Keywords: Forest Carbon Initiative (FCI); Wildfire prevention; Wildfire mitigation; Climate change; Low volume fibre removal; Fuel management; FFT

Details:

- Application intake periods announced on fesbc.ca; priorities at each intake may differ.

- Typically focuses on fire fuel management (i.e. low value fibre removal) and less so restoration.
- Project should align with Integrated Investment Plans.
- Important exclusions:
 - If 'improving habitat' is primary objective; apply directly to HCTF.
 - If 'wildfire prevention/mitigation' is primary objective; apply directly to CRI
 - If project meets multiple objectives (i.e. improving habitat and wildfire risk mitigation), apply directly to FES.
 - May not apply if applying to other programs (i.e. LBIS/FFT) for same project.
- Goals:
 - Preventing and mitigating impact of wildfires (*collaboration with CRI*)
 - Improving damaged or low value forests
 - Improving habitat for wildlife (*collaboration with HCTF*)
 - Supporting use of fibre from low value or damaged forests
 - Treating forests to improve the management of greenhouse gases
 - These projects should be consistent with the provincial government's Forest Carbon Strategy.

Application process:

- Previous intake: Nov 30 2018. New deadlines announced on website.
- Apply online via FES Information Management System. <https://fesims.outcome-plus.com/>.

Contact:

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7.1.5 Community Resiliency Investment

Keywords: Wildfire risk reduction; wildfire mitigation; crown land; FESBC

Sponsors: Union of BC municipalities (UBCM), First Nations' Emergency Services Society; FESBC; FLNRORD.

Details:

- Focused on wildfire risk reduction/mitigation on Provincial Crown Land within municipal administrative boundaries.
- If project has multiple objectives outside of CRI objectives, apply directly to FESBC.

Application process:

- Last intake Dec 7 2018
- Application guide: <https://www.ubcm.ca/assets/Funding~Programs/LGPS/CRI/cri-2019-program-guide.pdf>

7.1.6 Habitat Conservation Trust Foundation

Keywords: Habitat restoration, habitat enhancement; volunteers; FESBC

Sponsors:

Details:

- Collaborates with FESBC on funding projects
- If project has multiple objectives, apply directly to FESBC
- Several grant types including:
 - Enhancement and Restoration Grants
 - In collaboration with FESBC
 - If multiple objectives, apply directly to FESBC

- Public Conservation Assistance Fund (PCAF)
 - Requires 50% volunteer involvement

Contact:

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- ¹² The understanding of climate change is adjusting continually as models are improved with new research and methods. Historical trends are based on instrumental weather data. Projections are derived from the Pacific Climate Impacts Consortium’s [regional climate summary for the Skeena Region](#) and its [Plan2Adapt](#) tool for projecting future climate conditions and [ClimateBC](#). Information is drawn from a set of 30 GCM projections based on results from 15 different GCMs, each using a combination of A2 and B1 emissions scenarios, where A2 represents roughly business as usual and B1 represents a more optimistic scenario with about ½ of emissions of business as usual. Current changes are tracking the more pessimistic scenario and projections are being updated regularly.
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- ¹⁵ Price K and Daust D 2018. Omineca ESI Risk assessment for biodiversity management options. Report to Omineca ESI Project Team; Price K and Daust D 2017. Risk assessment of impacts of forest harvesting in the PG TSA on Carrier-Sekani First Nations’ Values. Report to CSFN.
- ¹⁶ Trial by fire: Nadleh Whut’en and the Shovel Lake Fire 2018. Report commissioned and authorized by the Chief and Council of the Nadleh Whut’en First Nation and prepared by Karyn Sharp and Andreas Krebs.
- ¹⁷ Objectives are listed as recommendations in Trial by fire. See above.
- ¹⁸ Wet’suwet’en Yin’tah Stewardship Principles, Practices and Prescriptions. 2016 Draft. Prepared by D Belford, Natural Resources Liaison Office of the Wet’suwet’en.
- ¹⁹ Nadleh Whut’en First Nation Land Use Plan. Provided by Juan Cereno. Process started in 2014. Plans land use in traditional territory and on reserve land.

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- ⁴¹ Forest Enhancement Society of BC: <https://fesbc.ca/>
- ⁴² Resources available at <https://www.ubcm.ca/EN/main/funding/lgps/community-resiliency-investment.html>
- ⁴³ Phil Burton can provide additional recommendations and contact information.
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- ⁶⁹ Carla Burton has experience with this and can help. Carla Burton personal communication. Workshop summary March 20, 2019.
- ⁷⁰ Phil Burton personal communication
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- ⁷⁶ Jeff Werner Northern Silvicultural Conference 2019
- ⁷⁷ Price K and Daust D 2018 Omineca ESI risk assessment for biodiversity management options. Report to Omineca ESI
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- ⁸⁰ Subalpine fir is listed as a potential “secondary” species on most site series in the SBSmc2 in the Establishment to Free Growing Guidebooks (may require District Manager approval, particularly noted in the Prince George guidebook)
- ⁸¹ Burns Lake Community Forest is developing an access management plan as part of FSC certification that could include such access control. Ts’il Kaz Koh meeting summary February 28, 2019
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- ⁸⁵ Blue listed by Conservation Data Centre in BC <http://a100.gov.bc.ca/pub/eswp/>
- ⁸⁶ Stuart-Smith, A.K.,* W.L. Harrower, T. Mahon, E.L. McClaren, & F. I. Doyle. 2012. A scientific basis for managing northern goshawk breeding areas in the Interior of British Columbia: Best management practices. FORREX Forum for Research and Extension in Natural Resources, Kamloops, B.C. FORREX Series 29. URL: http://www.forrex.org/sites/default/files/forrex_series/176-goshawk-final.pdf
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- ⁸⁹ See Table 2 of **Appendix 3**: MacHutchon and Proctor “The effect of roads and human action of roads on grizzly bear and
- ⁹⁰ Forsite 2018. Road rehabilitation algorithm modelling update. Prepared for John DeGagne, FLNRORD Stewart-Nechako District.

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- ⁹¹ Steventon, J.D. and D.K. Daust. 2009. Management strategies for a large-scale mountain pine beetle outbreak: modelling impacts on American marten. *Forest Ecology and Management*. 257 (9): 1976-1985.
- ⁹² Climate change vulnerability of BC's fish and wildlife. 2016. FLNRO
- ⁹³ Stellat'en and Nadleh meeting summary March 15, 2019
- ⁹⁴ Bev Ketlo personal communication. Workshop summary March 20, 2019
- ⁹⁵ Guidelines for fisher habitat requirements in sub-boreal ecosystems: <https://www.bcfisherhabitat.ca/wp-content/uploads/2017/02/20170224-fisher-habitat-management-tables-sub-boreal.pdf>
- ⁹⁶ Briefing note provided by Stellat'en First Nation: Values and criteria relevant to post-wildfire restoration. More information in Appendix 3
- ⁹⁷ Firelight Group 2015. Stellat'en First Nation socio-economic baseline study (confidential draft for Stellat'en First Nation); Anon 2006. Carrier-Sekani Tribal Council Aboriginal interests and use study on the Enbridge Gateway Pipeline.
- ⁹⁸ Briefing note provided by Stellat'en First Nation: Stellat'en First Nation – Values and Criteria Relevant to Post-Wildfire Restoration
- ⁹⁹ Several researchers met with Nadleh to discuss collaboration on post-fire research and recovery; Stellat'en and Nadleh meeting summary March 15, 2019
- ¹⁰⁰ For example, Carla Burton, Lisa Woods
- ¹⁰¹ Frank Varga personal communication. Ts'il Kaz Koh meeting summary February 28, 2019
- ¹⁰² Local nurseries are preferable to those in southern BC or Alberta. Twin Sisters, Woodmere, IFS (Prince George), UNBC are options
- ¹⁰³ Briefing note provided by Stellat'en First Nation: Values and criteria relevant to post-wildfire restoration. More information in Appendix 3
- ¹⁰⁴ Participant input. Stellat'en and Nadleh meeting summary March 15, 2019
- ¹⁰⁵ Stellat'en and Nadleh meeting summary March 15, 2019
- ¹⁰⁶ Several researchers met with Nadleh to discuss collaboration on post-fire research and recovery; Stellat'en and Nadleh meeting summary March 15, 2019
- ¹⁰⁷ E.g., Carla Burton, Lisa Woods
- ¹⁰⁸ Forest Foods have developed a Mushroom Management Plan proposal (Shelby Leslie); unfortunately, funding was unsuccessful; Nadleh and Stellat'en proceeded to develop the plan without external support or funding.
- ¹⁰⁹ Secwepemc territory morel harvest 2018. Elephant Hill Fire 2018. Emergency Land Management Program. This management program has useful information on opportunities and challenges.
- ¹¹⁰ Shelby Leslie Forest Foods and Karyn Sharp Little Frog Consulting, personal communication
- ¹¹¹ Shelby Leslie and Karyn Sharp, personal communication
- ¹¹² Frank Varga personal communication. Ts'il Kaz Koh meeting summary February 28, 2019
- ¹¹³ Hessburg, P. F., Churchill, D. J., Larson, A. J., Haugo, R. D., Miller, C., Spies, T. A., ... & Gaines, W. L. (2015). Restoring fire-prone Inland Pacific landscapes: seven core principles. *Landscape Ecology*, 30(10), 1805-1835.
- ¹¹⁴ Fraser Lake is aligning business opportunities to set up a cant mill targeting burnt wood; Cathy Middleton personal communication.
- ¹¹⁵ Premium Pellet in Vanderhoof does not take burnt fiber. Two bioenergy plants in Stuart-Nechako (West Fraser and Fort Green) chip and use burnt timber.
- ¹¹⁶ Nicholls D and Ethier T 2018 Post-natural disturbance forest retention guidance 2017 wildfires. Chief Forester's Guidance. FLNRORD
- ¹¹⁷ Frank Varga is working with Craig DeLong to apply the drought tool in the Burns Lake Community Forest; Ts'il Kaz Koh meeting summary February 28, 2019
- ¹¹⁸ Cathy Middleton personal communication. Workshop summary March 20, 2019
- ¹¹⁹ Dawn Stronstad personal communication; Kiri Daust, portfolio model run for Shovel Lake SBS ecosystems
- ¹²⁰ FLNRORD meeting summary February 22, 2019
- ¹²¹ Forest Practices Board 2019. Fire hazard abatement and the Shovel Lake Wildfire. Complaint Investigation #18061. FPB/IRC/221
- ¹²² Burns Lake Community Forest uses a \$4,000 drone and free software; talk to Frank Varga