

#### REPORT

# Preliminary Tactical Restoration Plan for the South Peace Northern Caribou Ranges

Caribou Tactical Restoration Plan

Submitted to:

Ministry of Forests, Lands, Natural Resource Operations and Rural Development #400, 10003 110th Ave Fort St. John, BC V1J 6M7

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# **Executive Summary**

#### Background

The South Peace Northern Caribou (SPNC) population of woodland caribou consists of six Central Mountain caribou herds (Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette and Narraway) and one Northern Mountain herd (Graham). Population census surveys indicate rapidly declining populations in all the South Peace caribou ranges, with an estimate of only 219 animals in the Central Mountain herds combined, and 181 in the Graham Northern herd in 2016. The estimated number of caribou represents a significant decrease over the past 20 years and is well below the federal and provincial population objectives. The loss and fragmentation of woodland caribou habitat resulting from anthropogenic disturbances, the subsequent increase in predator and primary prey populations in early seral habitats, and wolf predation has been identified as the main limiting factor to woodland caribou populations. To address the declines, BC's caribou recovery plans include actions related to habitat protection and restoration, predator-prey management, and direct population actions such as translocation of wild caribou and maternity penning.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) is in the process of developing a Provincial Caribou Recovery Program. This Program has a goal to identify and restore habitat to improve disturbed habitats and erase some of the negative impacts of anthropogenic activities on caribou habitat. Restoring habitats will also support the Province to meet federal caribou recovery habitat intactness targets set up under the federal *Species at Risk Act*. Habitat recovery actions include restoring industrial landscape features such as roads, seismic lines, pipelines, cutlines, and cleared areas in an effort to reduce habitat changes which have increased predator numbers and ultimately increased the caribou mortality rate within fragmented and disturbed landscapes.

#### Types of Restoration

Two methods of habitat restoration hold the most promise in BC for caribou: functional and ecological restoration. Functional restoration includes the application of techniques on human disturbances that aim to limit or deter predator use of linear disturbances in an attempt to restore historic caribou-predator encounter rates. Functional restoration techniques do not necessarily result in the restoration of linear disturbance areas to their predisturbance structural state; however, the perceived benefits include an immediate impact on the targeted biological process, cost-effectiveness and speed of treatment. Functional restoration techniques have focused on tree felling, but have also incorporated mounding and tree planting between tree felling segments to promote ecological habitat recovery in the long-term.

Ecological restoration seeks to return a disturbance to a similar state of ecological function, or habitat state, as before the disturbance. Methods for ecologically restoring linear features within caribou ranges have focused on 1) leave for natural vegetation recovery where advanced regeneration is evident, and 2) site preparation such as soil mounding/scarification followed by conifer seedling planting, or use of coarse woody debris with planting to address poor site conditions. Ecological restoration is considered to be most effective for broad ecological goals in the long term, but will take longer to achieve reductions in predation efficiency (FNFN 2017). In addition, ecological restoration may be prohibitive to apply at scales sufficiently large to have an impact on caribou population dynamics. Treatments are costly and are logistically challenging to cover very large and remote areas over a short time frame.

#### Preliminary Tactical Restoration Plan Overview & Methodology

This preliminary tactical restoration plan presented herein, is the first phase of a multi-year caribou habitat restoration program in British Columbia aimed to determine a set of priority caribou habitat restoration areas within the SPNC population of caribou. The objectives of this preliminary tactical restoration plan for the South Peace region are to:

- identify the key principles or criteria to spatially define priority areas at, and within, the range scale.
- identify what type of habitat restoration activities should be undertaken.
- identify where restoration activities should be undertaken in each range to achieve the greatest return on investment.
- identify how to sequence and coordinate restoration plans within the larger SPNC ranges.

It should be noted that First Nations and stakeholder engagement, has not yet commenced at the time of writing this preliminary plan; however, FLNRORD will be initiating and leading an engagement process over the coming year. However, what has been prepared can be used as a guide for habitat restoration in the region and uses a strategic list of ecological and economic criteria and land cover data to propose restoration areas within each range, and to begin to identify the spatial and temporal sequence in which areas that could be restored to maximize restoration value to caribou, success, and cost-effectiveness. The intent of this preliminary tactical restoration plan is to be used as background material to support an engagement process with First Nations and impacted stakeholders to refine priorities for restoration areas and subsequent restoration efforts.

This preliminary tactical restoration plan summarizes the current state of knowledge and restoration efforts on each of the main SPNC ranges including a brief outline of the Phase 1 and Phase 2 Quintette restoration plan prepared in 2017 and 2018. In order to determine areas within the SPNC ranges that may be candidates for caribou habitat restoration, Golder undertook a desktop analysis of existing linear disturbance features within each of the ranges in order to determine potential areas for restoration within each range. For each range, linear disturbance was denoted as either 'no treatment' or as a 'treatment candidate'.

#### 1) No-Treatment linear features included:

- Any linear disturbance that may have an active disposition (i.e., crown land tenure) or protective notation, such as a pipeline, lease road, recreational trail, or ecological reserve.
- Disturbance areas within each range where elevations and subsequent biogeoclimatic ecosystem classification subzones limit the value of physical habitat restoration measures based on time lag for tree or vegetation growth as well as potential overlap between caribou and predators (e.g., alpine non-forested ecosystems, considered no-treatment).
- All cutblocks, and fire events within the last 40 years.

#### 2) Treatment Candidate linear features included:

All linear features that did not meet the criteria for "No Treatment"

 Linear features that overlapped with crown land tenures that supported caribou recovery objectives (e.g. Section 17 Designated use Areas).

#### Results

Results of the preliminary linear disturbance mapping found potential restoration treatment candidate areas in all ranges. The Narraway range had the largest amount of potential treatment candidate linear disturbance features (7,872 km) that could be restored, whereas the Scott range had the smallest (16 km) (Table 9 provided in Section 8.8 summarizes results in each range). In regards to habitat intactness, all six analyzed caribou ranges exceeded the minimum threshold for self-sustaining populations of caribou (65% undisturbed habitat). Preliminary restoration polygon areas were developed based on linear disturbance overlap with high density caribou areas based on telemetry, high-elevation winter range and summer range, low-elevation winter range, provincially designated Ungulate Winter Range (UWR), and Wildlife Habitat Area (WHA) polygons as well as Provincial biologists' historical knowledge of herd movements through time and spatial overlap by caribou. These preliminary restoration polygon areas and decisions around how to prioritize each restoration polygon require further refinement in the next stage of this tactical restoration plan.

#### Next Steps: Refining Methodologies and Priorities

It is recognized that there is an urgent need to spatially identify and prioritize restoration areas within the Province's caribou ranges, so that implementation can begin as quickly as possible on the ground. This analysis is intended to serve as a starting point for refining priorities for restoration areas. In order to develop an effective restoration program, detailed landscape level planning and engagement with First Nations and impacted stakeholders is a necessary next step.

A critical success factor will be ensuring that First Nations are engaged throughout the entire restoration planning process and develop methods for including of Indigenous Traditional Ecological Knowledge (TEK) on objectives of restoration, the planning and selection of restoration priority areas, or the treatment types on finer scale linear disturbance segments.

Moving forward, it is important to establish criteria for selecting priority areas among ranges, and within ranges. Criteria considered have included habitat recovery potential such as which caribou range would benefit most from restoration activities (e.g., population-growth rates, additional management already occurring, reduced limiting factors and costs). However, a decision support process has not been established on where to focus restoration between, or within, ranges.

Habitat restoration is one tool in the toolbox for caribou population recovery. Habitat restoration alone will not recover caribou populations. Parallel management levers will need to be considered to stabilize caribou populations, given the time lag for habitat to recover. These additional management measures may include predator control, alternate prey management and caribou population augmentation (e.g., maternal penning, translocations), and should be suited to the specific needs of each herd. However, the Province is aware that the time for action to recover habitat is now, and seeks input on where to focus restoration treatments to the long term benefit of the species.

# **Study Limitations**

Golder Associates Ltd. (Golder) was contracted in December 2017 through the Society for Ecosystem Restoration in Northern British Columbia (SERNbc) to prepare a Preliminary Tactical Restoration Plan for the South Peace Northern Caribou Ranges to begin discussions around restoring habitat within the South Peace Northern Caribou (SPNC) ranges. The intent of this preliminary plan is to provide the background material to support the development of a planning tool which is informed by First Nations and Indigenous Communities through discussions with FLNRORD around the criteria used to determine priority restoration areas both between and within ranges, as well as to inform subsequent detailed restoration programs or plans for each of the seven South Peace ranges in British Columbia (BC; Graham, Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette, Narraway). This plan is preliminary only, and considered incomplete prior to receiving feedback from the Ministry of Forests, Lands, Natural Resources Operations and Rural Development (FLNRORD), First Nation and Indigenous land rights holders and other relevant stakeholders within each range. A list of ecological and economic criteria (Watters pers comm. 2017a) and land cover data have been used to identify restoration areas within each range. Similar criteria and methods have been used in past and ongoing restoration programs (ABMI 2016; Golder 2015a, b, 2017a, b, 2018a). This preliminary plan does not yet contain Traditional Ecological Knowledge (TEK), stakeholder feedback on areas of use, or detailed disturbance mapping and ground-truthing of linear disturbance segments to determine if natural vegetation recovery is underway.

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## **1.0 INTRODUCTION**

Woodland caribou (*Rangifer tarandus caribou*) in British Columbia (BC) occur in 54<sup>1</sup> ranges that have been classified into three ecotype based populations – Southern Mountain, Central Mountain and Northern Mountain – based primarily on feeding behaviour and habitat associations (BC MoE 2018b). The South Peace Northern Caribou (SPNC) population of woodland caribou consists of six Central Mountain caribou ranges (Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette and Narraway) and one Northern Mountain range (Graham). The Central Mountain caribou ranges have varying degrees of maternal penning and/or predator management underway, while the Graham herd has been used as a control with no maternal penning or predator management program thus far.

Federally, the Central Mountain (Designatable Unit [DU] 8) population of woodland caribou is listed as Endangered and the Northern Mountain (DU 15; COSEWIC 2011) population is listed as Special Concern by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC 2014). Neither population have been assessed under the *Species at Risk Act* (SARA), but prior to being separated into three populations, the Southern Mountain population was listed as Threatened and on Schedule 1 of SARA (Government of Canada 2018). In BC, the Central Mountain caribou population is listed as S1S2 ('Critically Imperiled/ Imperiled') and is on the provincial Red list, and the Northern Mountain caribou population is listed as S2S3 ('Imperiled/ Special Concern') and is on the provincial Blue list (BC CDC 2018).

Population census surveys indicate rapidly declining populations in all the South Peace caribou ranges (BC MoE 2014a), with an estimate of only 219 animals in the Central Mountain herds combined, and 181 in the Graham Northern herd in 2016 (Seip and Jones 2016). The estimated number of caribou represents a significant decrease over the past 20 years (Seip and Jones 2016) and is well below the federal recovery plan's population objective of 2,000 caribou in the Central Mountain population (EC 2014) and the provincial population objective of at least 1,200 caribou in the SPNC population (BC MoE 2014a). The Burnt Pine herd is now presumed functionally extirpated (BC MoE 2014a), and the Moberly/Scott herds' continued existence is attributed to an ongoing maternity pen and predator management program (ECCC and BC MoE 2017). The Moberly herd has increased since 2014, due to a combination of maternity penning and predator management, however is still less than 25% of its estimated population in 1997 (ECCC and BC MoE 2017). The loss and fragmentation of woodland caribou habitat resulting from anthropogenic disturbances, the subsequent increase in predator and primary prey populations in early seral habitats, and wolf predation have been identified as the main limiting factors to woodland caribou populations (BC MoE 2014a; EC 2014; ECCC and BC MoE 2017).

The South Peace region of Northeast BC has experienced rapid land-use change since the 1990s as a result of resource extraction activities such as oil and gas exploration and development, large-scale commercial forestry, agriculture, mining, and wind energy development (Schneider et al. 2003; Nitschke 2008; Williamson-Ehlers 2012). Within the Central Mountain local population unit ranges, 21% of the high-elevation habitat and 24% of the non-high elevation habitat is allocated to existing coal mining tenures, while 14% of the high elevation and 46% of the non-high elevation habitat is considered part of the Timber Harvesting Land Base, and therefore feasible for harvest (ECCC and BC MoE 2017).

An analysis conducted as part of the 2017 joint federal-provincial study of the Central Mountain population showed 50.4% of the non-high elevation portion of the Narraway range (includes the South Narraway and

<sup>&</sup>lt;sup>1</sup> This number of populations includes the Burnt Pine herd which is now considered functionally extirpated (Seip and Jones 2013a).

Bearhole-Redwillow ranges) is disturbed including seismic lines, and 44.5% of the range is disturbed, when seismic lines are excluded. For the (Scott, Moberly, Kennedy Siding, and Burnt Pine herds (referred to as the Pine River range within the analysis), 62.6% of the ranges are disturbed including seismic lines, and 62.1% is disturbed when seismic lines are excluded (ECCC and BC MoE 2017). Disturbances were mapped following methodology developed for the boreal caribou recovery strategy (EC 2012), which included anthropogenic disturbances with a 500 m buffer and fires less than 40 years old (EC 2014). The analyses demonstrated that the minimal threshold of 65% of undisturbed habitat provides a 60% chance that a local caribou population will be self-sustaining (EC 2012; EC 2014). There has been no similar threshold analysis completed for Southern Mountain or Central Mountain caribou; however, the 65% threshold of undisturbed habitat is referenced in the Southern Mountain caribou federal recovery plan for identifying critical habitat in low elevation winter ranges and Type 1<sup>2</sup> matrix range (EC 2014). Maximum thresholds of disturbance in high elevation critical habitat have not yet been developed, with management in these areas focused on minimizing and mitigating disturbance to reduce predator movement corridors (ECCC and BC MoE 2017). The linear disturbance footprint within each range is depicted in Appendices A through F (Figures A-1, B-1, C-1, D-1, E-1 and F-1).

The cumulative resulting disturbance from anthropogenic activities (e.g., linear disturbances from industrial development, cutblocks, and mining) threatens the integrity of forest ecosystems by producing forested landscapes that are younger and increasingly fragmented (Schneider et al. 2003; Williamson-Ehlers 2012). Land-use development (i.e., oil and gas, infrastructure, agriculture, and forestry) in the Peace Region between pre-1970 and 2008 resulted in a decrease in mid-seral (-29%), moderate to closed forests (-25%), and interior forest habitat (-31%), and accounted for an increase in edge habitat (+89%), mixed forest (+72%), early seral habitat (+67%), shrub habitat (+49%), late seral (+48%), and landscape openness (+47%) (Nitschke 2008). Early seral habitats support higher densities of moose (*Alces americanus*), elk (*Cervus elaphus*), and deer (*Odocoileus* sp.), which in turn support higher predator densities (particularly wolves [*Canis lupus*]), and lead to increased risk of predation on caribou (Wittmer et al. 2005; Nitschke 2008; Wilson 2009).

To address the declines, BC's caribou implementation plans include actions related to habitat protection and restoration, predator-prey management, and direct population actions such as translocation of wild caribou and maternity penning (ECCC and BC MoE 2017). The provincial Implementation Plan for the Ongoing Management of SPNC (*Rangifer tarandus caribou* pop. 15) in BC includes the goal of increasing the population of SPNC to  $\geq$  1,200 animals within 20 years across their range (Golder 2017a). Seasonal suitability maps have been developed by BC MoE which classify core habitat use in winter and summer in both high and low elevation. The Implementation Plan identifies as its goals to protect  $\geq$ 90% of high elevation winter range (HEWR), and to manage the industrial footprint in high and low elevation habitats in all ranges in a manner that supports the recovery of the populations (BC MoE 2013a). Figure 1 displays the location of the SPNC ranges in BC.

<sup>&</sup>lt;sup>2</sup> Type 1 matrix habitat is defined as area within the local population unit of caribou that have not been designated as summer or winter range and may comprise seasonal migration areas and low use areas (EC 2014). Type 2 matrix habitat consists of areas surrounding annual ranges that may contain predators that can influence caribou predation rates in the annual range with trace occurrences of caribou (EC 2014).



## 2.0 OBJECTIVES OF A PRELIMINARY TACTICAL RESTORATION PLAN FOR SOUTH PEACE NORTHERN CARIBOU RANGES

To manage the historical footprint, caribou habitat restoration planning is needed to identify what habitat restoration activities should be undertaken, where they should be undertaken, and how to sequence restoration plans to address financial costs and effort to undertake restoration activities. To address the recovery management action of habitat restoration, and to move towards coordinated, accelerated habitat restoration programs within priority areas to build large intact central mountain caribou habitat areas in BC, Golder was contracted to develop a preliminary tactical restoration plan for the SPNC ranges. This preliminary tactical restoration plan can be used as a planning tool for First Nations and Indigenous Communities and the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) to start discussions around the criteria to use to determine priority restoration areas and the details for subsequent detailed restoration programs or plans that would need to be developed for each of the seven SPNC ranges in BC (Graham, Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette, and Narraway).

The overall objective of caribou habitat restoration is to transition anthropogenically disturbed, low quality woodland caribou habitat into higher quality habitat, with a particular focus on the immediacy of addressing linear disturbance effects on wolf movement and subsequent predation risk to caribou. Current science and the Federal direction to move towards more than 65% undisturbed habitat within ranges suggests that range areas need focused and concentrated restoration efforts to return them to ecologically functioning caribou habitat. Recommended approaches by caribou ecologists and conservation planners is for restoration efforts to be coordinated (i.e., industrial operators, governments, regulators, academia), prioritized for the greatest value to caribou populations, implemented at a landscape or sub-range scale (e.g., Parker Caribou Range Restoration Pilot Program [Golder 2015a] and the Quintette Caribou Range Restoration Project [Golder 2017a]) and have consistent and long term funding sources.

The objectives of this preliminary tactical restoration plan for the South Peace region are to:

- identify the key principals or criteria to spatially define priority areas at, and within, the range scale.
- identify the type of habitat restoration activities that should be undertaken.
- identify where restoration activities should be undertaken in each range to achieve the greatest return on investment.
- identify how to sequence and coordinate restoration plans within the larger SPNC ranges.

The Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) is in the process of developing a Provincial Caribou Recovery Program. Within this Program, a primary objective is to identify habitat to be restored and reduce disturbance in high-value caribou habitat while erasing some of the negative impacts of anthropogenic activities. Restoring habitats will also help support the Province in meeting federal caribou recovery habitat intactness targets set up under the federal SARA. Habitat recovery actions include: restoring industrial landscape features such as roads, seismic lines, pipelines, cutlines, and cleared areas in an effort to reduce habitat changes which have increased predator numbers and ultimately caribou mortality rates within fragmented and disturbed landscapes.

Two methods of habitat restoration hold the most promise in BC for caribou: functional and ecological restoration. Functional restoration includes the application of techniques on anthropogenic disturbances that aim to limit or deter predator use of linear disturbances in an attempt to restore historic caribou-predator encounter rates. Functional restoration techniques do not necessarily result in the restoration of linear disturbance areas to their pre-disturbance structural state, however the perceived benefits include an immediate impact on the targeted biological process, cost-effectiveness and speed of treatment. Functional restoration techniques along linear disturbances have focused on tree felling to disrupt predator sightlines, but have also incorporated mounding and tree planting between tree felling segments to promote ecological habitat recovery over the long-term.

Ecological restoration seeks to return a disturbance to a similar state of ecological function, or habitat state, as was present before the disturbance. Methods for ecologically restoring linear features within caribou ranges have focused on 1) leave for natural vegetation recovery where advanced regeneration is evident, and 2) site preparation such as soil mounding/scarification followed by tree planting, or use of coarse woody debris with planting to address poor site conditions. Ecological restoration is considered to be most effective for broad ecological goals in the long term, but will take longer to achieve reductions in predation efficiency (FNFN 2017). In addition, ecological restoration may be prohibitive to apply at scales sufficiently large to have an impact on caribou population dynamics. Treatments are costly and have logistical challenges to cover very large and remote areas over a short time frame.

It is recognized that there is an urgent need to spatially identify and prioritize restoration areas within the Province's caribou ranges, so that implementation can begin as quickly as possible on the ground. This analysis is intended to serve as a starting point for refining priorities for restoration areas. In order to develop an effective restoration program, detailed landscape level planning and engagement with First Nations and impacted stakeholders is a necessary next step.

A critical success factor will be ensuring that First Nations are engaged throughout the entire restoration planning process and develop methods for including of Indigenous Traditional Ecological Knowledge (TEK) on objectives of restoration, the planning and selection of restoration priority areas, or the treatment types on finer scale linear disturbance segments.

Moving forward, it is important to establish criteria for selecting priority areas among ranges, and within ranges. Criteria considered have included habitat recovery potential such as which caribou range would benefit most from restoration activities (e.g., population-growth rates, additional management already occurring, reduced limiting factors and costs). However, a decision support process has not been established on where to focus restoration between, or within, ranges.

Habitat restoration is one tool in the toolbox for caribou population recovery. Habitat restoration alone will not recover caribou populations. Parallel management levers will need to be considered to stabilize caribou populations, given the time lag for habitat to recover. These additional management measures may include predator control, alternate prey management and caribou population augmentation (e.g., maternal penning, translocations), and should be suited to the specific needs of each herd. However, the Province is aware that the time for action to recover habitat is now, and seeks input on where to focus restoration treatments to the long term benefit of the species.

This preliminary tactical restoration plan for the SPNC ranges has been prepared as a guide for habitat restoration in this region by using a strategic list of ecological and economic criteria (Watters pers comm. 2017b) and land cover data to propose restoration areas within each range, and to begin the identification of the spatial and

temporal sequence in which areas could be restored to maximize restoration value to caribou, success, and cost-effectiveness. This Project follows similar methods as previous restoration plans (Golder 2015a, 2017a, b, 2018) and includes preliminary linear disturbance mapping of each range, a summary of current land uses, an overview of a proposed restoration program approach for each range, and an outline of the authorization process and assessments. The Quintette range is the subject of a separate tactical plan and is generally discussed here within the context of the overall Central Mountain ranges. However, for more detailed information on the Quintette herd, please refer to the *Phase 1 – Quintette Caribou Habitat Restoration Plan* (Golder 2017a) and *Phase 2 - Quintette Caribou Habitat Implementation Plan – FINAL* (Golder 2018a).

# 3.0 DESKTOP REVIEW METHODOLOGY

Provincial reports were consulted for background data on the SPNC ranges (e.g., areas, ranges, migrations, ecoregion, hydrology, climate, ecosystems, Ungulate Winter Ranges [UWRs], and Wildlife Habitat Areas [WHAs]). Federal and provincial recovery strategies, implementation plans, actions plans, caribou telemetry data, research papers and science updates were consulted for current state information on each SPNC range (Refer to Appendix A through Appendix F for maps of each range). Provincial population status reports for the Central Mountain populations (DU8) dating back to 2011 were reviewed to determine trends in population levels. Provincial reports were reviewed to determine methods used to mitigate downward trends including predator management and maternal penning of caribou. Consultant reports were accessed to review the results of previous restoration activities and research, and Provincial biologists were interviewed to obtain historical movement and habitat use observations.

## 4.0 ECOLOGICAL SETTING

The SPNC ranges are comprised of seven ranges spread over a total of 3,282,558 hectares (ha) in northeastern BC. The Quintette range comprises 607,519 ha of the SPNC ranges and the remaining 2,675,039 ha occur in the six other ranges. The majority of the SPNC ranges occurs in the Central Canadian Rocky Mountains ecoregion, and the eastern extent of the range occurs in the Southern Alberta Upland ecoregion (Demarchi 2011).

The Central Canadian Rocky Mountains ecoregion consists of steep-sided, but round topped mountains and foothills that are lower than ranges of the Rockies to either the south or the north, while the Southern Alberta Upland ecoregion is a rolling plateau that rises slowly to the north of the Peace River (Demarchi 2011).

The boundary between the two is quite indistinct and dissected by eastward flowing rivers. The area is drained by the Moberly, Pine, Sukunka, Wolverine and Murray Rivers which all ultimately drain into the Peace River in BC; and by Redwillow, Wapiti, Red Deer, and Belcourt Rivers which all flow into Alberta before joining the Peace River (Demarchi 2011).

Pacific air spills over the mountains of the Hart Range, bringing moist, mild air to the eastern valleys, while Arctic air passes from east to west bringing very cold, dense air to the western valleys and lowlands. The Hart Foothills are in a rainshadow of easterly flowing Pacific air coming over the main Hart Ranges, however, when low-pressure systems build up in central Alberta, moisture can be pushed westward into this area bringing considerable precipitation. In the winter, cold dense Arctic air often stalls along the eastern margin or in the valleys, bringing periods of intense cold and considerable snowfall (Demarchi 2011).

The BC provincial Biogeoclimatic Ecosystem Classification (BEC) system groups together ecosystems into categories using a hierarchical classification system. Geographic areas influenced by similar climatic conditions are classified into BEC zones and subzones, defined by their stable "late-seral" or "near-climax" vegetation communities (Pojar et al. 1991). In the Central Group ranges, the Boreal White and Black Spruce (BWBS) zone occurs in the outer eastern valleys of the eastern boundary with the Alberta Plateau; the Sub-Boreal Spruce (SBS) zone occurs in the interior and western valleys, the Engelmann Spruce – Subalpine Fir (ESSF) zone occurs on all the middle and upper mountain slopes; and the Boreal Altai Fescue Alpine (BAFA) zone occurs on the mountain summits (Demarchi 2011). The Central Group ranges are comprised of 19 different BEC units summarized in Appendices A through F [Figures A-2, B-2, C-2, D-2, E-2 and F-2]). Further detail on the BEC units overlapping each range and restoration potential is provided in Table 7 of Appendix G.

# 5.0 SOUTH PEACE NORTHERN CARIBOU RANGE AND RECOVERY TOOLS

Federal and provincial recovery strategies, implementation plans, caribou telemetry data, and science updates were consulted for baseline "current state" information on each SPNC herd to develop this preliminary tactical restoration plan. Population status reports for the Central Mountain subpopulations (DU8) dating back to 2011 were reviewed to determine trends in population, and methods used to mitigate downward trends including wolf predator management control and maternal penning of caribou. A detailed background summary for each range is provided in Appendix G. Below is a summary of the current recovery measures underway within each of the ranges for consideration in the development of this preliminary tactical restoration plan.

The Peace Northern Caribou Committee (PNCC) is a collaborative regional forum, established in 2011, and includes representatives from government agencies, industry, First Nations (West Moberly First Nation [WMFN], Saulteau First Nation [SFN], and McLeod Lake Indian Band), and recreation and community groups. The forum focuses on the recovery of the South Peace Region's at-risk caribou herds through the development of local initiatives (WMFN and SFN 2014).

The Central Mountain ranges are associated with alpine and subalpine habitats of the eastern foothills of the Rocky Mountains. The Graham range resides north of the Peace arm of the Williston Reservoir, while the rest of the range is located between the Peace and Parsnip arms of the Williston Reservoir and extend in a southeast fashion along the Rocky Mountains to the Alberta border where the Narraway range crosses over (BC MoE 2013a). The SPNC ranges generally move from west to east when migrating from summer to winter habitats with calving activities occurring in the high elevation subalpine and alpine habitats (Jones et al. 2004). A background summary on residence, habitat use, migration patterns and population estimates for each range is provided in Appendix G.

Many of the mountain complexes in this area have been designated as caribou and mountain goat UWR by the province, and several of these mountain complexes have also been designated as WHA or Proposed WHA's for caribou calving and rutting (Goddard 2005; BC MoE 2018b). The designation of UWR's and WHA's give protection to areas within the SPNC ranges while still allowing for particular industrial uses subject to assessment of impacts and mitigation measures (ECCC and BC MoE 2017). In addition, there are a number of additional land designations, with various protection or access measures, including: parks and protected areas, mineral / coal reserves, resource review areas (RRA), Old Growth Management Areas (OGMAs) and environment, conservation and recreation reserves (e.g. Section 16 Map Reserves, Section 17 Designated Use Areas).

The areas, elevation class, and proportion of each range by BEC unit are summarized in Appendix G. Elevation classes are based on caribou use. High elevation classes generally overlap high-elevation range where caribou have their calves to avoid predation, low elevation classes are areas where caribou spend (or historically spent) the winters. Mid-elevation classes are considered the 'matrix habitat' between high and low elevation classes. High elevation habitat that is largely predator-free has been identified as a key element to managing SPNC ranges (BC MoE 2013b). High elevation habitat provides a refuge from predators, as well as provides an accessible food source through the winter, particularly lichen-bearing windswept ridges (BC MoE 2013a; Jones 2007, 2008).

Wolf and grizzly bear predation are the suspected causes of low calf survival and high adult mortality (Seip and Jones 2013a, 2016). In northern BC, wolves are most commonly associated with the distribution of moose, and the most current (2017) estimate for the moose population in the Peace region is between 37,500 and

60,500 animals (BC FLNRORD 2018a). Estimated wolf densities measured in northern BC have ranged from 10 to 44 wolves per 1,000 km<sup>2</sup> (Hatler et al. 2008), and the most recent (2014) estimate for the wolf population in the Peace region is between 1,300 to 3,000 wolves (BC FLNRORD 2014a).

The extent of wolf predation on caribou has been unsustainable over the last few decades (BC MoE 2014c). During this time, industrial exploration and development, forest harvesting, and road building has altered the landscape (BC MoE 2014c). The corresponding increase in the extent and distribution of early-seral habitat has benefited other ungulates and resulted in an increase in wolf populations and distribution across caribou ranges (BC MoE 2014c). Predator management is deemed a necessity tool in the recovery efforts of the SPNC ranges (BC MoE 2014c; Environment Canada 2014). Predator management programs are designed to achieve a wolf density below

3 wolves/1000 km<sup>2</sup> within caribou habitat areas (including core habitat and the surrounding matrix habitat areas), which is believed to be the threshold for self-sustaining caribou populations (BC FLNRORD 2017).

In response to the continued decline of the caribou herds in the South Peace, a predator management program was initiated in the winter of 2015 with the creation of a removal zone in the SPNC ranges (BC MoE 2014d). The Moberly, Scott, Kennedy Siding, and Quintette ranges were included in the removal zone, while Graham, Burnt Pine and Narraway were not (Table 1; Seip and Jones 2016). The program's effectiveness was limited in 2015 as it started late and suffered from poor snow conditions that inhibited tracking and trapping. In total 57 wolves were killed in 2015, 41 were shot from a helicopter and 16 by trapping (Seip and Jones 2016). In 2016, 201 wolves were killed within or adjacent to the predator management area from January to March. Of those, 155 were shot from a helicopter and 46 were trapped (Seip and Jones 2017). During the 2017 program 93 wolves were killed, 62 by shooting from helicopter, and 31 by trapping. In addition 13 wolves from different packs were collared to help locate their packs for future removal programs as at least 30 to 40 wolves remained in the removal zone by the end of April 2017 (Seip and Jones 2017).

Other management tools for managing predator populations are being explored, and include reducing ungulate prey populations through increased hunting quotas and restoring habitat with limited ungulate forage plants (EC 2014); however, direct predator management is currently the primary focus of the Province in this region (BC MFLRNO 2017).

Maternal penning as a strategy to reduce predation on newborn caribou in the South Peace area was recommended by First Nations, and provincial and federal governments (BC MoE 2013a; Environment Canada 2014; McNay et al. 2013). The Klinse-Za maternal penning program, led by West Moberly First Nation, Saulteau First Nation and the Province of BC, is currently in its fifth year of implementation (Table 1; Appendix G; PNCC 2014). The program is an emergency measure to slow the decline of the Klinse-Za herd (Scott and Moberly herds) and prevent their extirpation, and is run concurrently with a predator removal program (McNay et al. 2013; WMFN undated) with habitat restoration activity.

A summary of restoration plan implementation, and maternal penning and predator control programs for the SPNC ranges is provided in Table 1, with further details for each range provided in Appendix G.

SPNC Range	Restoration Plan Implemented	Maternal Penning Program	Predator Control Program	Supplementary Feeding Program
Graham	N/A	N/A	N/A	N/A
Moberly	√C	√A	√В	N/A
Scott	N/A	√A	√В	N/A
Kennedy Siding	N/A	N/A	√B	√D
Burnt Pine	N/A	N/A	N/A	N/A
Quintette	√E	N/A	√В	N/A
Narraway	N/A	N/A	N/A	N/A

# Table 1: Summary of Restoration Plan Implementation, and Maternal Penning and Predator Control Programs for the South Peace Northern Caribou (SPNC) Ranges

<sup>A</sup> McNay et al. 2013, PNCC 2014, Seip and Jones 2016, 2017, WMFN undated; <sup>B</sup> Seip and Jones 2016, 2017; <sup>C</sup> BC FLNRORD 2018b; <sup>D</sup> Heard and Zimmerman 2018; <sup>E</sup>A pilot implementation plan has been prepared for one area within the Quintette range, Golder 2017a, 2018

# 5.1 Graham Range

The Graham range has not been part of the Central Mountain recovery efforts to date (Table 1) as it has been monitored as a control comparison for the predator management and maternal penning programs in the Central Mountain ranges (Seip and Jones 2016). In the absence of predator management and population management programs (e.g., maternal penning), the Graham range shows a continuing decline in population (refer to Appendix G for details).

# 5.2 Moberly Range

In June 2013, the WMFN released a draft action plan for the Klinse-Za range of woodland caribou (McNay et al. 2013). The draft action plan follows the requirements of the federal SARA. It includes the goal of restoring at least 654 caribou within 21 years (McNay et al. 2013). A long-term outcome of the draft action plan is to allow sustainable First Nation harvest of caribou to resume, following a decades-long self-imposed moratorium on woodland caribou hunting by WMFN (Cision 2018). Actions under the plan which have been implemented include maternal penning, predator control to reduce caribou mortality (McNay et al. 2016), and road deactivation moving towards habitat restoration. The priority actions recommended in the plan are to reduce caribou mortality through predator management and penning cows during the natal period. In particular, the goals include:

Establish thresholds for maximum levels of disturbance to critical habitat (0% HEWR, 5% calving and summer range (CSR), 10% Low Elevation Range, and 20% matrix habitat) and adopt specific range plans to restore disturbed land and protect against new disturbance, where necessary, to meet disturbance thresholds. Establish a Stewardship Team to initiate implementation and management of this Action Plan and to coordinate actions with other planning initiatives (McNay et al. 2013).

The Moberly range is the subject of the Klinse-Za maternal penning project. The Klinse-Za maternal penning project was originally comprised of just Moberly herd individuals, but the placement of some Scott caribou in the maternity pen has resulted in the herds becoming mixed into one (Seip and Jones 2016). Data collected after 2014 tends to combine the Scott and Moberly herds into a single herd; however, this Plan recognizes the two ranges as being distinct.

In 2015, 11 adult females were moved into a maternal pen and produced five calves that survived to be released. A survey in 2016, showed that of the 14 females that were not penned, only three had calves indicating the penned females had a higher survival rate for their offspring (Seip and Jones 2016). The calf recruitment rate of 16.7% was higher than the average of 14.3% from 2003 to 2015. There was no adult mortality from spring 2015 to spring 2016 in comparison to an average of 23.2% from 2003 to 2015.

In 2016, 14 adult female caribou were captured in March, with one dying in the third week of captivity. Eleven of the cows produced offspring and all the calves survived until they were all released in July (Seip and Jones 2017). In March 2017, seven of the calves were confirmed still alive. An additional calf may have survived but the cow's habitat choice of dense forest hampered detection from the air. The penned cows had a calf survival rate of 64 to 73% for the year (Seip and Jones 2017).

The population of the range was counted at 61 individuals in March 2017, which is an increase from 54 in the previous year and a population increase of 13%. Twelve calves were counted in 2017, resulting in a calf recruitment rate of 20% of the population, seven were born in the maternity pen, and the other five calves that survived were from the 20 adult cows that were not penned (Seip and Jones 2017). No collared caribou were killed by predation from spring 2016 to 2017; however, three collared adult females and one uncollared caribou were killed during two separate avalanche events (Seip and Jones 2017). The increased calf recruitment rate with the decrease in adult mortalities is an indication that penning, along with removal of wolves, has had a positive contribution to population increase (Seip and Jones 2016).

In addition to the Klinse-Za maternal penning project, the Moberly range is the subject of a habitat restoration project, and a predator management program (Table 1).

The habitat restoration project has included the deactivation of the Fisher Creek Forest Service Road (2.3 km in the Mount Bickford area), within the Moberly range. Habitat restoration works, including the deactivation of deep pits, earth barriers, and logs, were conducted by WMFN and SFN from September to October 2017 (BC FLNRORD 2018b). The project was part of a joint partnership between WMFN and SFN, and supported by Wildlife Infometrics, Woodlands North and the BC Government with the aim to restore caribou populations in the area (BC FLNRORD 2018b). The cost of the project was approximately \$140,000 (BC FLNRORD 2018b). Re-activation of this segment of road by removing logs and earthworks was conducted by an unknown party with heavy equipment between 9 October and 19 October 2017. FLNRORD has now deactivated the road again at a cost of \$20,000 (BC FLNRORD 2018b).

The predator management program in 2015 removed 29 wolves from the range, accounting for 59% to 100% of the population (Seip and Jones 2016). As a result of predator management and maternal penning, the population was counted at 61 individuals in March 2017.

## 5.3 Scott Range

In addition to the Klinse-Za maternal penning project (Section 5.2), the Scott range is the subject to a predator management program (Table 1). The predator management program began late in 2015 and data for the Scott and Kennedy Siding herds was combined. Only two wolves were removed from these ranges accounting for an estimated 4% to 6% of the wolf population (Seip and Jones 2016). In 2016, 86 wolves were removed from the Scott / Moberly ranges, and in 2017 there were 57 wolves removed from the ranges (Seip and Jones 2017).

# 5.4 Kennedy Siding Range

The Kennedy Siding range encompasses 295,927 ha and includes 12,000 ha of pine-lichen winter habitat, and 65,639 ha of high-elevation winter habitat (BC MoE 2014a). The low-elevation pine forest has historically suffered from mountain pine beetle (MPB; *Dendroctonus pondersosae*) attacks killing off much of the canopy trees; however, caribou continue to migrate and feed in the area (BC FLNRORD 2014b) (Appendix D; Figures D-3 and D-4). Increases in snow depth and hardness through January and February contribute to difficulty with feeding, causing the caribou to migrate to high elevations on the west side of the Rocky Mountains where they feed on terrestrial lichens on windswept alpine ridges (BC MoE 2014a). Recovery efforts in this caribou range include a predator management program and a supplementary feeding program initiated in 2014 by Heard and Zimmerman (2018), with support from McLeod Lake Indian Band. To date there has been no maternal penning program within the Kennedy Siding range (Table 1).

## 5.5 Burnt Pine Range

The Burnt Pine range was approximately 20 individuals in the early 2000s, but has gradually declined and was presumed extirpated by 2013. Historically, there was overlap between the Burnt Pine and Kennedy Siding ranges, however radio collared animals from Kennedy Siding have been documented using the Burnt Pine range in late winter (BC MoE 2014a). In 2010, 19 caribou were counted in the Burnt Pine range, but 13 of those were with a radio collared caribou from the Kennedy Siding range. If those caribou did migrate from the Kennedy Siding range, then the Burnt Pine range for 2010 would be six, a number that was echoed in the 2011 survey when five individuals were observed (Seip and Jones 2011). Therefore, it is possible that the Burnt Pine herd range could be recolonized with Kennedy Siding caribou in the future if that range increases in abundance (BC MoE 2014a). To date there has been no maternal penning or predator management programs within the Burnt Pine range (Table 1).

## 5.6 Quintette Range

The Quintette Range has undergone preliminary planning for habitat restoration. A high level Phase 1 of the Quintette Caribou Habitat Restoration Plan was initiated by FLNRORD in 2017 based on the Quintette Strategic Action Plan (QSAP) in response to the rapidly increasing rate of decline of the Quintette herd. The goal of the restoration plan was twofold: the recovery of the Quintette herd to a level that supports a sustainable Treaty 8 caribou harvest, and to meet the Government of Canada's Species at Risk recovery targets (BC FLNRORD 2017). The overall objective of the Restoration Plan was to transition anthropogenically disturbed, low quality woodland caribou habitat into higher quality habitat, with a particular focus on linear disturbances. Habitat

restoration will reduce the benefits that predators and their primary prey gain through linear corridor use, and establish a vegetation trajectory on these corridors that will, in the long term, lead to increased intactness of woodland caribou habitat. The Plan was designed to be implemented over a multi-year period, with desktop disturbance mapping and implementation planning completed in 2017-2018, implementation of restoration treatments to occur beginning tentatively in 2019 (continuing for approximately 5 years), and post-treatment monitoring to be conducted following restoration implementation.

Initial GIS mapping found a total length of 1,487 km (19%) of linear disturbances in the Quintette range had potential for restoration candidacy (Golder 2017a). These linear disturbance features included mapped cutlines, recreational trails, resource roads, and road / right-of-way's. Three restoration zones were selected in the Quintette range with guidance from FLNRORD based on a number of ecological, logistical and economic criteria (e.g., elevational considerations, access, and budget) (Figure 2).



A more detailed Phase 2 Quintette Implementation Plan was developed based off the Phase 1 Restoration Plan that focused on a 42,205 ha area with low and mid-elevation habitat for restoration based on the results of FLNRORD internally-led workshop in May 2017. In the fall of 2017, the sources of the linear disturbance layers were checked for updates and refined to eliminate overlaps in the linear disturbance dataset prior to a field reconnaissance program. A field reconnaissance program was conducted by low-level fly-over via helicopter between 30 September and 2 October 2017 to ground-truth the treatment candidate sites mapped during the desktop linear disturbance mapping.

In addition, a desktop archaeological overview assessment was completed for the purposes of:

- Identifying known archaeological sites within the Restoration Area, to the degree possible, using existing records;
- Identifying and assessing archaeological resource potential within the Restoration Area; and
- Assessing the need for, and providing recommendations regarding the nature and scope of, further archaeological work, if necessary for the Restoration Area.

FLNRORD led a stakeholder engagement process for the Quintette Restoration Plan and had a stakeholder engagement meeting in February 2018. In addition, FLNRORD began an Indigenous community engagement process aimed to develop an Indigenous Inclusion Plan (IIP) that outlines opportunities for collaborating with First Nations through the implementation of restoration efforts. Details of the engagement process by FLNRORD can be found in Appendix B of the *Phase 2 - Quintette Caribou Habitat Implementation Plan – FINAL* (Golder 2018a).

Within the Restoration Area, following the mapping and field reconnaissance survey, 496.5 km (66%) of linear disturbances were classified as 'No Treatment', based on existing dispositions, protective notices or visual human use along roads, 218.5 km (30%) were recommended to 'Leave for Natural Regeneration' (Golder 2018a). The stakeholder engagement also identified a total of 8.7 km (1%), originally classified as treatment candidates, which were re-classified as 'No Treatment - Stakeholder Conflict' due to overlapping use or future use by stakeholders. After stakeholder engagement, a total of 27.9 km (approximately 4%) of linear disturbances were assigned to be 'Treatment Candidates' (Appendix A: Mapbook in Golder 2018a). A table detailing the Treatment candidate segment locations, site specific considerations and their associated treatment recommendations is provided in Appendix D of Golder 2018a. Treatment recommendations included areas proposed for direct seedling planting, and areas with required site preparation treatments such as screefing, ripping, topsoil spreading and tree/hand felling. The restoration technique(s) selected for each Treatment candidate segment was determined using the Treatment Decision-Making Flow Chart (summarized in Figure 5 of Golder 2018a). For the Quintette restoration plan, in consultation with FLNRORD, the restoration program will use Sitka alder (Alnus viridis ssp. sinuata), in combination with conifer seedlings (hybrid white spruce [Picea engelmannii X glauca], black spruce [Picea mariana], lodgepole pine [Pinus contorta], and subalpine fir [Abies lasiocarpa]), to enhance the site conditions along the treatment lines. In addition, live willow staking was proposed as an option to be used where there are road crossings and where a treatment line crosses a river or stream to provide quick establishment of vegetation to aid in controlling human and potential predator access. Twin Sisters Native Plants Nursery (TSNPN) is currently growing the FLNRORD requested seedling species to be planted out in June 2019. Finally, a monitoring plan was developed that will guide determination of vegetation response to the restoration treatments over time. Monitoring for compliance, effectiveness, and validation were incorporated into this implementation plan, with

monitoring events to occur after the first, fifth, tenth, and fifteenth growing seasons after treatment. In addition, wildlife response monitoring is proposed using data collected from motion activated remote cameras established by FLNRORD and placed along post-restoration linear disturbance features.

As part of the predator management program, approximately 41 to 68% of the estimated wolf population in Quintette was removed in 2015, and 100% of the estimated wolf population in Quintette was removed in 2016 (Seip and Jones 2016) (Table 1). To date there is no maternity penning programs from the Quintette herd.

#### 5.7 Narraway: Bearhole-Redwillow and South Narraway Range

The Narraway range is split into two subgroups: the Bearhole—Redwillow herd and the South Narraway herd. The two groups are largely separate on their winter ranges, but based on the movements of some collared animals, there seems to be some interchange (Appendix F; Figures F-3 and F-4; BC MoE 2014a). The range is 636,307 ha in size.

A low calf recruitment rate of 7.7% since 2007, combined with a high adult mortality rate, indicates a declining population of Bearhole-Redwillow caribou. Surveys indicate this subgroup had a minimum count of 18 caribou in 2016, down from a minimum count of 49 and a population estimate of 80 individuals in 2008 (Seip and Jones 2016). From March 2016 to March 2017, only two adult caribou had radio-collars to facilitate monitoring. Six adults and three calves were confirmed, for a minimum population of nine individuals, suggesting a calf recruitment of 33% and low adult mortality. However, the small sample size prevents making reliable conclusions on populations trends (Seip and Jones 2017). To date there has been no maternal penning or predator management programs in the Bearhole—Redwillow range (Table 1), although the predator removal in adjacent areas may have reduced the number of wolves in the range leading to the low mortality rates of caribou (Seip and Jones 2017).

Surveys conducted in March 2016 found 35 South Narraway caribou and a population estimate of 41, which shows an ongoing decline from 2008 when the minimum count was 102 individuals and a population estimate of 179 (Seip and Jones 2016). Ten radio-collared caribou were located in five different groups within this range. A March 2017 survey identified 19 adults and 4 calves for a minimum population of 23 caribou, with calves representing 17% of the population. The population estimate for this herd is 20 to 43 individuals, which represents an ongoing decline (Seip and Jones 2017). To date there has been no maternal penning or predator management programs in the South Narraway range (Table 1).

## 6.0 HABITAT RESTORATION: CURRENT STATE OF KNOWLEDGE

Research into the recovery of caribou has found that predator-prey systems need to be managed over the entire caribou range including both core habitat and the surrounding matrix habitat areas. Type 1 matrix habitat is defined as area within the local population unit of caribou that have not been designated as summer or winter range and may comprise seasonal migration areas and low use areas (EC 2014). Type 2 matrix habitat consists of areas surrounding annual ranges that may contain predators that can influence caribou predation rates in the annual range with trace occurrences of caribou (EC 2014). The Federal Recovery Strategy for Southern Mountain caribou recommends maintaining 65% undisturbed habitat in low elevation and Type 1 matrix range as an important threshold to providing a 60% chance that a local population will be self-sustaining; there should be minimal disturbance in high-elevation winter range (EC 2014). Coordinated actions to restore caribou habitat is a key step to meeting current and future caribou population and habitat objectives.

"Restored habitat" for caribou has not been clearly defined in either provincial or federal caribou recovery strategies. The majority of caribou habitat restoration to-date has occurred in the boreal caribou ranges, in northern Alberta or northeastern BC. As caribou habitat restoration initiatives have become more widespread in the last decade, there has been much debate regarding what treatment types are appropriate for habitat restoration, and how to measure success. However, in general, practitioners recognize that the treatment type is not a one size fits all solution, but is focused on the site limiting factors, the amount of natural vegetation recovery present at a site, whether the site has the conditions that will lead to a natural restoration path (van Rensen 2015), as well as the objective for the particular restoration program. Restoration treatments have in recent years been identified as addressing one of two objectives; either functional or ecological restoration.

**Functional Restoration** is the application of techniques on anthropogenic disturbances that aim to limit or deter predator use of linear features to ultimately restore historic caribou-predator encounter rates. This type of restoration does not necessarily result in the restoration of linear disturbance areas to their pre-disturbance structural state (i.e., ecological restoration) (Demars and Benesh 2016). Perceived benefits of functional restoration, over ecological restoration, include more immediate impacts on the targeted biological process, cost-effectiveness and speed of treatment. Functional restoration techniques have focused on tree felling, but have also incorporated mounding and tree planting between tree felling segments to promote support for habitat recovery in the long-term (Photos 1 and 2).

In addition, controlling off-road access, which contributes to compacted soil and inhibits revegetation recovery (Bentham and Coupal 2015) has been identified as an important focus for restoration treatments at site specific locations.



Photos 1 and 2: Tree-felling to control predator access (REMB Parker Landscape Scale Caribou Pilot Range Restoration Project)

**Ecological restoration** has the primary objective to return a disturbance to a similar state of ecological function as that present before the disturbance. Ecological restoration aims to structurally restore areas to their previous, undisturbed structural state (Demars and Benesh 2016). Methods for ecologically restoring linear features within boreal caribou ranges have focused on 1) 'leave for natural recovery' (van Rensen et al. 2015); and 2) soil mounding and seedling planting to address poor site conditions (Bentham and Coupal 2015; Pyper et al. 2014) (Photos 3 and 4).



Photo 3: 'Leave for Natural Recovery' treatment (REMB Parker Landscape Scale Caribou Pilot Range Restoration Project).



Photo 4: Mounding with seedling (black spruce) planting treatment in a treed bog (Canadian Natural Resources Ltd. Primrose and Wolf Lake, Cold Lake Alberta).

#### 6.1 Caribou Habitat Restoration in Boreal Ranges

Boreal caribou habitat restoration projects have been on-going within boreal caribou ranges since 2001 in Alberta and since 2015 in BC (Golder 2015a). The Caribou Range Restoration Project (CRRP) was implemented between 2001 to 2007 in west-central Alberta (Szkorupa 2002), and explored the use of silviculture methods to restore linear features, including tree/shrub seedling planting, seeding of tree species, tree/shrub transplanting, mounding and soil de-compaction (BC FLNRORD 2015; CRRP 2006, 2007a,b). Several other initiatives and trials in Alberta boreal caribou ranges have been completed (e.g., DES 2004; Golder 2005, 2009, 2011, 2012; Enbridge 2010; Osko and Glasgow 2010) or are ongoing (Golder 2010; OSLI 2012) to effectively restore linear disturbances and polygon features resulting from the oil and gas industry. The focus of most initiatives has been on establishing vegetation along pipelines or seismic lines, with the combined goals of creating line-of-sight breaks, directly restoring habitat with transplanted vegetation, planting shrub and tree seedlings, sowing native shrub and tree seed, reducing human access to reclaimed areas to allow undisturbed natural vegetation growth, and reducing wildlife usage to reduce or eliminate the benefits wildlife obtain from linear corridor usage.

Tree regeneration on seismic lines within treed areas is considered a key determinant of recovery success (MacFarlane 2003). Vegetation re-growth on seismic lines is mainly influenced by the moisture and nutrient regime, the method of clearing used, and the level of human use (e.g., Golder 2009; van Rensen et al. 2015). Natural vegetation regeneration does occur, with linear disturbances on mesic sites the most likely to regenerate naturally without restoration treatments implemented (all things being equal), whereas linear disturbances in a bog or fen is less likely to regenerate naturally (van Rensen et al. 2015). Natural regeneration to 3 m vegetation height within 30 years is inversely related to terrain wetness, line width, proximity to roads as a proxy for human use of lines, and lowland ecosites such as fens and bogs (van Rensen et al. 2015). Areas adjacent to major rivers illustrate high probability of regeneration. Overall, terrain wetness and the presence of fens have the strongest negative effect on natural regeneration (van Rensen et al. 2015).

However, natural regeneration can also be hindered, depending on the level of disturbance, both during construction of the feature, and use by humans on Off Highway Vehicles (OHVs). Conventional seismic lines cleared by bulldozers may take as long as 112 years to reach 95% recovery to woody vegetation in the absence of restoration efforts (Lee and Boutin 2006). This slow tree regeneration has been attributed to root damage from the original disturbance, compaction of the soil in tire ruts, insufficient light reaching the forest floor, maintenance of apical dominance from surrounding stands, introduction of competitive species (i.e., planted seed mixes), drainage of sites (i.e., regeneration slowest on poorly drained sites with low nutrient availability such as bogs) and repeated disturbances (e.g., OHVs, animal browsing, repeated exploration) (Revel et al. 1984; MacFarlane 1999, 2003; Sherrington 2003).

Seismic lines in west-central Alberta that were allowed to regenerate naturally, without any significant human activity (e.g., re-cleared to ground level for winter access or seismic program use), achieved an average height of 2 m across all ecosite types within 20 to 25 years (Golder 2009). Restoration efforts have also been negatively compromised when OHVs destroyed seedlings after planting (Enbridge 2010; Golder 2011, 2012). Research conducted on wolf movement along linear features has found that wolves selected linear features as travel corridors and moved two to three times faster along linear features compared to natural forest (Dickie et al. 2016). The research found that silviculture practices and linear deactivation (i.e., tree felling and fencing) of conventional seismic lines and pipelines would likely benefit caribou restoration efforts as wolves selected these linear features to increase travelling speeds (Dickie et al. 2016). Travel speeds of wolves can be reduced (by 1.5 - 1.7 km/hr) along linear disturbances when vegetation heights along the disturbances exceeded 0.5 m (Dickie et al. 2017).

## 6.2 Caribou Habitat Restoration in Mountain Ranges

In 2013, the BC Government released two documents: the Planning and Approval of Development Activities in the Peace Northern Caribou Plan Area (BC MoE 2013c) and the Guidelines for Development of Caribou Mitigation and Monitoring Plans for SPNC (BC MoE 2013b). These guidance documents informed proponents that development activities being proposed in HEWR would require Caribou Mitigation and Monitoring Plans (CMMP) as part of permit conditions.

Thus far, habitat restoration initiatives in mountain ranges have been tied to restoration of mining sites and to habitat offsets from these mining sites, with some research focused initiatives occurring on linear corridors. Mine CMMPs developed in the South Peace region include:

- Roman Mine (including a revision to the revegetation plan on the adjacent Trend Mine; Stantec 2012) (Quintette range)
- Quintette Mine (Teck Coal Ltd. 2013) (Quintette range)
- Sukunka Mine (Stantec 2015a) (Quintette range)
- Bonanza Ledge Mine (not yet finalized; Golder 2017b) (Quintette range)

The Guidelines for Development of Caribou Mitigation and Monitoring Plans for SPNC (BC MoE 2013b) describes a four-level mitigation hierarchy to guide the development and application of mitigation measures in CMMPs. The four level mitigation hierarchy is: 1) Avoid; 2) Minimize; 3) Restore On-Site; and 4) Offset. CMMPs describe proposed "Restore On-Site" measures, within the project/activity footprint (e.g., mine permit area), to remedy impacts to caribou components (BC MoE 2013b).

Caribou Habitat Restoration Plans (CHRP) developed for linear corridors and associated facilities that will occur in part within the South Peace region include:

- Pine River Aerial Crossing (Stantec 2017a) (bordering Burnt Pine and Moberly range)
- Wynwood Expansion Project (Stantec 2017b) (bordering Burnt Pine and Moberly range)
- High Pine Expansion Project (Stantec 2015b) (Moberly range)

Habitat restoration initiatives proposed in CMMPs and CHRPs have included: minimizing the use of seed mixes and forage species that attract moose and deer; seeding spoil slopes with coniferous tree/shrub mix; planting moderate tree densities to discourage browse species; inoculating arboreal lichen onto conifer species; spreading logs, stumps, rocks and woody debris piles; and deactivating and restoring roads to impede predator movement (Stantec 2012, 2015a, 2015b, 2017a, 2017b; Teck Coal Ltd. 2013; Golder 2018). These CMMP and CHRP initiatives have yet to be implemented or are still in early stages, therefore the efficacy of these techniques in mountain ranges is unknown. There remains considerable uncertainty on the efficacy of caribou habitat restoration in high elevation, mountainous areas.

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For the Pilot Phase 2 Quintette Caribou Habitat Implementation Plan, in addition to conifer seedlings, pioneering woody species have been selected for planting disturbed sites to kick-start successional processes by providing micro-climatic conditions for later seral species, and help control soil erosion (Polster 1989, 1991, 2011, 2017; Walker and del Moral 2003). Sitka alder was selected as a pioneering woody species (Darris 2011), in combination with a mixture of conifer seedlings, to enhance the site conditions along the treatment lines. Sitka alder has the potential to reach 5 m in height relatively quickly, and has a relatively low desirability as ungulate browse (Kabzems pers comm. 2017). It is expected that Sitka alder will compete for light with the planted conifers in the short term, and may decrease the conifer growth rate. However, over time, as conifers increase in height, the treated areas will move closer to a plant community similar in species and structure to the adjacent undisturbed areas (Kabzems pers comm. 2017). Willow (*Salix* sp.) is another commonly used species in restoration projects. Live willow stakes have been planned to be used at road crossings with moist conditions, at river/stream crossings to stabilize riparian slopes, and at other select moist locations (Polster 1991, 2009; Walter et al. 2005). Staking sites need to be carefully considered to minimize the attractant to alternate prey (e.g., moose and deer).

For the Pilot Phase 2 Quintette Caribou Habitat Implementation Plan (see Section 5.6 and Appendix G), a total of 218.5 km of candidate treatment lines were assigned 'Leave for Natural Recovery' following the field reconnaissance survey and stakeholder engagement process (29% of the total potential Treatment candidates that were ground-truthed; Golder 2018a). The program found that most of the linear disturbances within the Priority Area appear to have not been low-bladed during their construction, therefore either age of the disturbances, and/or microsites and organic matter remained intact which likely facilitated the substantial revegetation. Treatment candidate features in the Priority Area based on the background query, field reconnaissance and after initial stakeholder engagement, resulted in 27.9 km of linear disturbance segments (approximately 4%) planned for treatment (Golder 2018a). Restoration technique used to expose mineral soil for seedling planting), hand or tree felling, slash rollback, planting of seedlings, and live staking. This plan is still a pilot, and is currently undergoing engagement and consultation on the final plan considerations. Implementation is planned for 2019.

# 7.0 METHODOLOGY - PRELIMINARY TACTICAL RESTORATION PLAN7.1 Targets and Goals

The overall objective of the SPNC habitat restoration project is to transition low quality caribou habitat into higher quality habitat by reducing the benefits predators and their primary prey gain through linear corridor use, reducing predator access and movement from low elevation to high elevation caribou habitat, and establishing and/or promoting a vegetation trajectory on these corridors that will increase caribou habitat intactness in the long-term.

Within the Pilot *Phase 1 - Quintette Caribou Habitat Restoration Plan* (Golder 2017a), conservation targets, goals, key ecological attributes (KEAs) and indicators, and human well-being targets were outlined. These targets, goals, KEAs and indicators are also considered within the overall approach of this preliminary tactical plan for the SPNC and are summarized here.

Conservation targets are species, ecological communities, and ecological systems that are the focus of the restoration work. The conservation targets for habitat restoration programs within the SPNC are:

- South Peace Northern Caribou (woodland caribou –central mountain population and northern mountain population [Graham] SPNC herds). SPNC have been harvested by First Nations for centuries and have great cultural significance (EC 2014). Owing to their dwindling numbers, many First Nations have self-imposed moratoria on subsistence hunting of SPNC caribou in an effort to curb the decline (EC 2014).
- Coniferous forest. Central mountain caribou rely on late successional and old-growth coniferous forest for their primary winter habitat (Apps and McLellan 2006; Cichowski et al. 2004; COSEWIC 2014; Serrouya et al. 2008; Stevenson et al. 2001).

Goals are the desired state or conditions to be achieved (CMP 2013). The goals for habitat restoration programs within the SPNC should be SMART goals: Specific, Measurable, Appropriate, Realistic and Time-limited (CMP 2013). A short-term goal will be to block linear corridors in a manner that prevents motorized access by humans, and restricts their usage as travel corridors by wolves and other ungulates. The number of linear corridors to be blocked will be determined following the selection of priority restoration areas and site specific knowledge of strategic access management blocking locations.

A long-term goal will be to ecologically restore linear corridors back to mature coniferous forest suitable at lowand mid-elevation habitat. Suitable caribou habitat is habitat with the necessary biophysical attributes to support sustainable caribou populations. Biophysical attributes include little to no sensory disturbance, access to ice-free water, snow-free or low snow areas, minimum physical obstructions, low predation risk, access to lichen, emergent vegetation, mineralized soils, and wetlands, and canopy snow interceptions (EC 2014). The Project goals and measurable targets will likely be refined during further discussion between government, First Nations and stakeholders.

KEAs are aspects of a conservation target's biology or ecology that, if present, define a "healthy" target, and if missing or altered, would lead to the loss or extreme degradation of that target over time (CMP 2013). Indicators are measurable entities that document changes in KEAs over time (CMP 2013); restoration projects should have both short and long term indicators and measurable targets (Golder 2015c) to take into account the short term goal of reducing predator movement into caribou habitat and the long term goal of achieving functional habitat.

Indicators to assess ecological or functional restoration are outlined in the Habitat Restoration Monitoring Framework (Golder 2015c) and include:

- density and percent cover of targeted tree species
- leader growth
- growth and vigour of targeted vegetation
- presence of invasive species
- presence and level of ATV tracks and game trails (to determine access control) or alternatively presence or absence of predators and human use.

Additional wildlife monitoring, through the use of remote cameras or telemetry, can be used to determine if functional restoration is effective in the short term to prevent or slow down predator mobility (e.g., Dickie et al. 2016 and 2017, AMBI 2016). A Before-After-Control-Impact (BACI) approach can be used to determine the efficacy of treatments. Wildlife response to habitat restoration treatments can be monitored using data collected from motion activated remote cameras established by FLNRORD (Watters pers. comm. 2017a). Cameras can be placed on disturbed (linear features) and undisturbed (game trails) prior to treatment implementation as a means of collecting baseline wildlife use on two types of features. Cameras are suggested to continue to be deployed after treatments are implemented to assess the impacts of treatments on wildlife use.

The indicators (i.e., % of surviving planted seedlings, percent cover, density of targeted vegetation, evidence of chlorosis, evidence of access) would be measured during vegetation monitoring surveys following implementation at pre-determined paired treatment plots/intervals during the restoration project timeline (Golder 2015c). Indicators for wildlife movement and use of restoration sites should be monitored in parallel, to measure the efficacy or need to adaptively manage treatments.

#### **Human Well-being Targets**

It is recognized that there is an urgent need to spatially identify and prioritize restoration areas within the Province's caribou ranges, so that implementation can begin as quickly as possible on the ground. Detailed planning has been used in the past as a means to both protect a restoration program investment, as well as to determine where to treat or not to treat for restoration. In past restoration planning exercises, a number of ecological, regulatory, land use, stakeholder, and logistical criteria have been used to identify large restoration areas which would improve the habitat condition within a particular caribou range. However, a common missing link in past restoration programs is the lack of active First Nation and Indigenous Community participation throughout the entire restoration planning process and the inclusion of Indigenous Traditional Ecological Knowledge (TEK) on objectives of restoration, the planning and selection of restoration priority areas, or the treatment types on finer scale linear disturbance segments. Rather, programs to-date have focused around scientific considerations and past program results. The interests of First Nations and Indigenous Communities is critically important and tied to meet the conservation targets for caribou. Suggested targets include:

A recognized key component to achieving a successful restoration project is First Nation and Indigenous Community involvement and engagement (CMP 2013) throughout the entire habitat restoration process. Indigenous Communities are the land knowledge holders, who may want to be included in all steps of the restoration process, from planning the where, the what, the when and the how (Golder 2018b).

- Include opportunities for TEK and traditional use activities (e.g., gathering food and medicinal plants, trapping, hunting) to be captured into the restoration treatments.
- Develop capacity building for communities to participate in and lead habitat restoration efforts. For example, Year 1 (2017) implementation of the Pilot Boreal Caribou Habitat Restoration Program in the Parker Range had 36% Aboriginal spend and 48% local business spend (Golder 2017c). Feedback from Fort Nelson First Nation indicated that the program offered the opportunity for their aboriginally owned businesses, contractors and environmental technicians to become knowledgeable on implementing restoration treatments on future programs (K. Capot-Blanc pers. comm. 2018).

The primary interests of stakeholder groups will also be important to integrate into restoration planning. The primary stakeholders, and their primary interests are listed as follows:

- Ministry of Environment and Climate Change Strategy (MENV) and FLNRORD: resilient, self-sustaining northern mountain caribou populations (MCST 2005).
- Lease or Tenure Holders: opportunities for exploration and development of resources, including forestry and mining.
- Snowmobile Groups and other Recreational Users: opportunities for recreational use activities within designated trail systems.

## 7.2 Approach

The development of this preliminary tactical restoration plan for the SPNC ranges is intended to guide habitat restoration in the South Peace region by using a strategic list of ecological and economic criteria and land cover data to identify restoration areas within each range. It is assumed that once developed, this preliminary tactical restoration plan will be implemented over a 20 year time period, given the size of the SPNC ranges and the amount of disturbance.

#### 7.2.1 Selection Criteria

FLNRORD led an internal workshop on 11 May 2017 to review the Phase 1 Quintette Restoration Plan. An outcome of the workshop was the identification of a Priority Area for restoration in the Quintette range, approximately 45,205 ha in size (Watters pers comm. 2017a). This workshop lead to the creation of the Pilot Phase 2 Quintette Caribou Habitat Implementation Plan (Golder 2018a) and planning for FLNRORD-led restoration works that are tentatively scheduled to occur in 2019. As part of this internal workshop, FLNRORD representatives and Subject Matter Experts (SMEs) developed a list of criteria to guide future caribou restoration prioritization projects in BC. Within this preliminary tactical restoration plan, we have considered the criteria developed by FLNRORD, as well as those considered for other caribou restoration programs (e.g., Parker Boreal Caribou Range Restoration Project [Golder 2015a]) to develop the selection criteria used within this plan (Section 9.0).

The following selection criteria were considered when selecting areas for restoration for the Pilot Phase 2 Quintette Caribou Habitat Implementation Plan (in order of priority):

- Areas with high caribou use, determined from radio collar data and analysis using kernel density estimators (KDE). In some ranges, there are multiple herds overlapping, further elevating their priority for restoration.
- Overlap with core habitat mapping for HEWR and High Elevation Summer Range (HESR; Seip pers comm. 2018b), as they provide the most important habitat to caribou, are off-limits to additional forest harvesting, and there is strong resistance to additional habitat destruction by other industries.
- Overlap with core habitat mapping for Low Elevation Winter Range (LEWR; Seip pers comm. 2018b). These areas are currently still available for forest harvesting and industrial activity; however, continued exploitation of LEWRs in this way is currently being re-evaluated.
- Areas where restoration would have the support of First Nations and primary stakeholders (this criteria not captured within this preliminary tactical restoration plan; Refer to Section 9.0 Next Steps).
- Overlap with provincially-designated areas (e.g., WHAs, Provincial Parks, and OGMAs), because it is assumed these areas will be less impacted by future industrial land uses.
- Overlap with existing areas where linear disturbance has occurred (e.g., cutlines, forestry roads, and pipeline right-of-way's).
- Extent of linear disturbance features extending from low to high elevation caribou habitat (in the context of predators and predation risk to caribou).
- Extent of cutblocks and presence of moose and other ungulates at low to mid-elevation caribou habitat (in the context of caribou being primary prey to wolves).
- Areas where restoration of caribou habitat will have an indirect positive benefit to other ecological values (e.g., benefit to other ungulates by reducing predator access along existing linear disturbances).

Areas considered less suitable for restoration candidacy include:

- Areas that overlap with, or are in proximity to, known proposed developments.
- Recent (<40 year) wildfire areas.</li>
- Areas with active MPB distribution and/or with high susceptibility ranking may be less suitable.
- Areas with fringe caribou habitat (e.g., low elevation with limited to no current caribou use) adjacent to high density forestry and other land use (e.g., ski resorts).
- Linear features that overlap with current mine and cutblock footprints, because it is assumed they will be restored under current permit conditions.
- Linear features under active disposition, or on land other than Crown land.
Future harvest management plans were not taken into consideration in this preliminary Plan, but should be considered in future restoration planning. Frequent engagement with forest licensees is recommended in order to determine proposed/submitted or approved cutting permit areas to ideally focus restoration efforts away from active forest harvesting operations in an effort to protect restoration investments. Identified treatment candidate sites that may overlap with future harvest management plans may lack effectiveness for caribou in the long-term.

## 7.3 Current State of Disturbance and Environmental Data

Following the identification of criteria used to select restoration areas, this preliminary tactical restoration plan approach involved compiling a dataset relating to the priority criteria for each of the caribou ranges. Environmental data, including caribou and wolf telemetry data, and designated land use areas were also obtained and are summarized in Appendix H.

Linear disturbance data collated for this preliminary tactical restoration plan includes:

- Recreational trails
- Roads, including forest service roads, and Oil and Gas Commission (OGC) petroleum development roads and access roads
- Cutlines
- Pipelines
- Transmission lines
- Railways

Linear disturbance data for each range is presented on Figures A-1 through F-1 in Appendices A through F. Sources for this disturbance data is presented in Appendix H.

Environmental data considered for treatment candidate determination includes:

- Hydrological regime (e.g., watercourses, waterbodies, wetlands) (all figures in Appendices A through F)
- BEC units (Figures A-2 to F-2 in Appendices A through F)
- Caribou herd and wolf telemetry data (Figures A-3 to F-3 in Appendices A through F)
- HEWR, HESR and LEWR (Figure 1, and Figures A-4 to F-4 in Appendices A through F)
- Caribou 90% KDE data (Figures A-4 to F-4 in Appendices A through F)
- Linear disturbance candidates and collar locations for caribou and wolves (Figures A-5 to F-5 in Appendices A through F)
- WHAs, proposed WHAs, UWRs, and proposed UWRs (Figures A-6 to F-6 in Appendices A through F)
- Parks, protected areas, and OGMAs (Figures A-7 to F-7 in Appendices A through F)
- Cutblocks (Figures A-8 to F-8 in Appendices A through F)

- Wildfires and MPB affected areas (Figures A-9 to F-9 in Appendices A through F)
- MPB susceptibility rating (Figures A-10 to F-10 in Appendices A through F)
- Archaeological potential and sites (Figures A-11 to F-11 in Appendices A through F)

Sources for this environmental data is presented in Appendix H. At this initial stage, detailed desktop and field validation to determine current vegetation status on each linear disturbance and linear disturbance segment has not been completed. This more detailed inventory on vegetation regrowth to quantify treatment candidate areas, and pre-treatment determination will need to be planned and conducted once priority restoration areas are chosen (Section 9.0).

# 7.4 Treatment Candidacy (No-Treatment versus Treatment Candidate)

Permanent, actively used linear disturbances such as roads, railways, pipelines, transmission lines, and recreational trails, other than those defined as unclassified, were considered as 'no treatment' candidates. For each range, linear disturbance was denoted as either 'no treatment' or as a 'treatment candidate'. No-treatment linear disturbances constitute any linear disturbance that may have an active disposition (i.e., crown land tenure) or protective notation, such as a pipeline, lease road, recreational trail, or ecological reserve. All cutblocks, and fire events within the last 40 years were also excluded as 'treatment candidate' areas as these disturbances create large openings that would be difficult to restore, would be restored by others (forestry companies for cutblocks), or be restored through natural succession. Where linear features passed through either cutblocks or large fire areas, the locations of these linear features were excluded from the treatment candidate summary.

Wetlands were mapped using data from the Freshwater Atlas of BC with two major wetland types present in the area: marshes and swamps. Marshes are shallowly flooded areas dominated by emergent graminoid vegetation (MacKenzie and Moran 2004). As such, linear disturbances that overlapped marshes were removed as potential candidates for restoration as they are typically non-forested. Swamps are typically forested mineral wetlands dominated by trees and tall shrubs (MacKenzie and Moran 2004) and therefore, may provide foraging habitat for caribou. Swamps were retained as potential restoration 'treatment candidates' because they generally are considered forested, and if linear features have been created through this type of habitat, swamps may benefit from restoration to replace trees that have been removed.

Areas with active overlapping crown land tenure (e.g., pipeline right-of-way's, forestry roads under active tenure, and active well pads) were generally considered as 'no treatment' candidates. However, there were a number of cases where overlapping tenure uses were not necessarily equivalent to existing footprint or where tenure use may be trumped in the future with the overall goals of the caribou recovery program. Golder had discussions with FLNRORD (Jason Pederson - Authorizations Specialist, Scott Schilds – Ecosystems Biologist, and Morgan Kennah – Director of Strategic Initiatives) to make the final decision if an overlapping tenure could remain as a 'treatment candidate'. The final decision was to leave in as potential 'treatment candidate' the following overlapping tenure areas:

Tenure Subtype = 'Investigative Licence'. These areas were generally proposed wind power and waterpower investigative areas that are still in the exploratory phase that may or may not be fully developed and in some cases may be abandoned or rejected (Schilds pers comm. 2018).

- Tenure subtype = 'Section 17 Designated Use Area'. Many of these areas have been designated for the protection of caribou, and support habitat restoration activities (Schilds pers comm. 2018).
- Tenure purpose = 'Commercial Recreation'. These areas included: hunting camps, heli hiking and heli skiing areas, private camps, and areas of multiple use that likely will not be directly impacted by the caribou restoration project (Schilds pers comm. 2018).
- Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation of Interest' plus Tenure Sub purpose of 'Watershed Reserve'. These areas are reserves for the protection of watersheds and likely would not be impacted by the caribou restoration project (Pederson pers comm. 2018).

High elevation BEC units (non-forested alpine sites) were not included as potential candidates for restoration (considered 'no treatment'). These areas included the BAFAun and IMAun biogeoclimatic units. These BEC units were not included as possible 'treatment candidate' areas based on the following reasoning:

- alpine BEC units are generally non-forested
- there is a large time lag required to recover understory species in alpine areas
- these naturally open areas provide habitat for caribou during particular times of the year due to the lack of predators at high elevations

Remaining linear disturbances were considered as restoration 'treatment candidates' (Appendices A through F [Figures A-5, B-5, C-5, D-5, E-5 and F-5], and are denoted in green). Linear disturbances considered 'no treatment' are summarized in the Appendices and figures referenced above and are denoted in red. Remote sensing and ground-truthing are necessary to verify site specific treatment recommendations (refer to Section 9.0 Next Steps). Following field verification, treatment candidacy can be further refined to upland sites meeting site-specific criteria such as that outlined in the Phase 2 - Quintette Implementation Plan (Figure 5 in Golder 2018a):

- Less than 30% vegetation cover and less than 100 cm in height
- Greater than 30% vegetation cover, but less than 50 cm in height
- A game trail exists

These site level criteria and the decision around when to treat, and how to treat, have previously been linked to minimizing impact to naturally revegetating disturbance areas and to focus restoration efforts on sites specific to enhancing conifer tree growth and reduce or minimize predator and human movements.

This preliminary tactical restoration plan for the South Peace includes the development of a desktop linear disturbance inventory allowing consideration of where restoration areas may be located spatially within the ranges. Determining the priority of these restoration polygon areas, as well as the site level detail relating to individual linear segments, and treatment types, would occur in the future as next steps (refer to Section 9.0 Next Steps).

#### 7.4.1 Leave for Natural Recovery

As part of this preliminary tactical restoration plan, there are two options for restoration of linear disturbance features, either to consider as a 'treatment candidate' or to 'leave for natural recovery' if a linear feature already has vegetation beginning to grow back along a disturbance. The decision to recommend a restoration treatment on a linear segment, or to leave a segment to naturally revegetate will need to consider several factors including:

- research on the attributes of linear disturbances (legacy seismic lines in particular) that display natural vegetation recovery (van Rensen 2014; van Rensen et al. 2015).
- research results on predator movements in relation to vegetation height on linear disturbances and type of disturbance (Dickie et al. 2016, 2017; Finnegan et al. 2014).

For the purposes of this preliminary tactical restoration plan, data on the linear feature attributes, including tree heights and cover and presence/absence of human or predator activity, were not obtained. Therefore, it is unknown what percent of treatment candidate lines would potentially be considered as 'leave for natural recovery'. As part of the next phase of the preliminary tactical restoration plan, once a priority area has been selected, ground-truthing of potential linear candidates will be required (see also Section 9.0 Next Steps). The amount of 'leave for natural recovery' candidates will ultimately influence financial considerations for treating a restoration polygon and can vary by as much as 22% (Golder 2018a) to 60% (Bentham and Coupal 2015) within a restoration treatment area.

# 7.5 **Preliminary Restoration Polygon Areas**

Several key assumptions, determined through discussions with FLNRORD, a restoration workshop of provincial experts (held on 11 May 2017), and experience from developing previous restoration projects, were made to inform decisions for spatially locating preliminary restoration polygon areas and to assess the potential treatment types. Four factors were considered to be the top criteria for spatially drawing restoration areas:

- High density of caribou as determined through review of telemetry data;
- Overlap with core habitat mapping including high elevation habitat (HEWR, HESR) and wildlife ranges (UWR, WHA);
- Overlap with core LEWR; and
- Overlap with existing disturbances that can be restored, and presence of disturbance mapping (Section 7.4).

A 1 km buffer was used around HEWR, HESR and LEWR to account for some disturbance area impacting predator movement into core habitat areas. This buffer was an arbitrary setting that could be increased. For example, in northeastern Alberta, a buffer of 5 km was used around caribou ranges to account for surrounding influences of alternate prey and predators on caribou populations (ALT 2009).

These additional criteria were considered to be important in descending order:

Support from First Nations and Indigenous communities.

- Avoiding overlap with known or potential future development or high quality recreational areas that would reduce the value of restoration.
- Support from primary stakeholders.
- The potential for a site to respond positively to restoration activities.
- Legislation / land use designations that may increase chances of successful restoration.
- The presence of linear features extending from low to high elevations that increase the risk of providing access for predators.
- Cutblocks and linear features that lead to high elevations may lead to an increase in predator presence at high elevations.
- The potential for restoration to have adverse effects to species preferring early seral vegetation.

For this preliminary tactical restoration plan, restoration areas have not been given a priority ranking. However, each restoration polygon area is described qualitatively and quantitatively by polygon and by range providing information to support priority setting. At this preliminary stage, feedback and contributions from First Nations and Indigenous Communities have not yet been captured within this plan. A final plan would benefit from criteria developed through TEK and land knowledge holders to determine restoration priority areas.

Figures 2 through 8, illustrate the proposed restoration polygon areas for each range, by Restoration Polygon Area number (e.g., Polygon 1, Polygon 2, etc.), with BEC high elevation zones excluded. These polygons provide preliminary areas only, and are considered incomplete prior to receiving feedback from FLNRORD, First Nations, Indigenous land rights holders, and relevant stakeholders within each range (Refer to Section 9.0). A list of ecological and economic criteria (Watters pers comm. 2017b) and land cover data have been used to identify and summarize each of the preliminary restoration areas within each range. However, until priorities are determined, it is unknown which order restoration areas will be evaluated for treatment.

#### 7.5.1 Habitat Intactness Calculations

Habitat intactness was calculated for each range and for each restoration polygon by applying a 500 m buffer to identified anthropogenic disturbances (linear disturbances and cutblocks) and also including identified fire disturbed polygons (recent less than 40 years with no buffer included) as per the following calculation:

Habitat intactness (ha) = Total range (ha) – linear disturbance area (including 500 m buffer) – cutblock area (including 500 m buffer) (ha) – recent wildfire area (<40 years with no buffer) (ha)

These values are provided in the introductory text for each range presented within the Results Section (Sections 8.1.1, 8.2.1, 8.3.1, 8.4.1, 8.5.1, 8.7.1), and in the results tables for each range broken down by Restoration Polygon Area (Tables 2 to 8).

# 8.0 RESULTS

The SPNC ranges encompass a large area (3,282,558 ha) with land management measures and policies that both assist and conflict with caribou habitat needs. The land base is managed by several government agencies that fall under numerous provincial acts and regulations. In BC, specific amounts of habitat important for the winter survival of ungulates are maintained under the Forest and Range Practices Act (FRPA) and protected under the Government Actions Regulation (GAR) as UWR and WHAs. Since 2011, UWRs and WHAs are also addressed within the provincial Oil and Gas Activities Act (OGAA). UWR is defined as an area that contains habitat that is necessary to meet the winter habitat requirements of an ungulate species. UWR designations are based on ungulate habitat requirements in winter, as interpreted by the BC Ministry of Environment (BC MoE) regional staff from current scientific and management literature, local knowledge, and other expertise (BC MoE 2018). WHAs are smaller discrete mapped areas that are necessary to meet the habitat requirements of a Species at Risk or regionally important wildlife species (BC MoE 2018). The UWR and WHA's current protection status makes these areas a priority for caribou restoration efforts to be applied, as restoration efforts are less likely to be impacted through potentially detrimental future land use. Other habitat protection measures in the SPNC ranges include provincial parks and OGMAs. OGMAs are legally established areas of old growth forest where forestry is prevented or constrained. Anthropogenic disturbances in the SPNC ranges include forestry, mining, oil and gas developments, and recreational trails (Appendices A through F [Figures A-8, B-8, C-8, D-8, E-8 and F-8]).

Forest pests have been a major source of natural disturbance in the SPNC ranges. The MPB was first confirmed in the Dawson Creek area in February 2004. The main provincial outbreak expanded rapidly, but it was thought at the time the terrain of the Rocky Mountains and relative scarcity of host material (i.e., lodgepole pine) at heights of land would prevent its spread east (Duthie-Holt et. al. 2007). This was not the case, as scattered infestations were observed on eastern slopes of the Hart Range which likely originated from the main outbreak. Initial spread rates were low from 2004 to 2006; however, conditions were optimal in 2006 and the outbreak spread significantly into the Peace Forest District, north into the Fort St. John Timber Supply Area and east into Alberta (Duthie-Holt et. al. 2007). Currently, the majority of MPB outbreaks have passed through much of the South Peace area, but are still prevalent in the Narraway range (Charleston, pers. comm. 2018). The Narraway and Scott ranges have the highest amount of lodgepole pine leading stands (Charleston, pers. comm. 2018).

In addition to existing infestation areas, the FLNRORD Forest Health Program maintains a spatial database of bark beetle susceptibility ratings, created by Geospatial Services Group in 2014 (DataBC 2017a). The hazard rating is calculated based on the proportion of pine basal area per hectare, stand age, stand density, and proximity to existing infestation (BC FLNRORD 2014b). Areas susceptible to MPB and other forest pests may be considered within a prioritization process for where to focus restoration efforts. It may be more ideal to focus restoration efforts outside of medium to high susceptibility forest pest infestations areas.

The following sections summarize the results of the preliminary desktop review found in each caribou range.

## 8.1 Graham Range

The Graham range encompasses a total area of 928,356 ha located just north of the east arm of Williston Lake. UWRs cover 436,344 ha (47%) of the range, and WHAs cover approximately 229,159 ha (25%) of the range (Appendix A; Figure A-6). There are two provincial parks (Butler Ridge Park and Graham-Laurier Park) making up 206,554 ha (22%) of the landbase in the Graham range, along with 927 ha (0.1%) managed as OGMAs (Appendix A; Figure A-7). Two lakes exist within this range (Emerslund Lakes, Lady Laurier Lake), Christina Falls, and 11 major creeks/rivers (largest is Halfway River).

#### 8.1.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Graham range include forestry, mining, oil and gas developments, and recreational trails (Appendix A; Figures A-1 and A-8). Habitat intactness for the entire range was calculated to be 540,463 ha (58%) of intact habitat, and 387,893 ha (42%) of non-intact habitat. This does not meet the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations of caribou (EC 2014; ECCC and BC MoE 2017). It should be noted; however, that MPB affected areas have not been factored into these disturbance area calculations.

According to provincial Vegetation Resource Inventory (VRI) data, 226,872 ha (24%) of the Graham range has been affected by MPB infestation (Appendix A; Figure A-9). Approximately, 86,771 ha (9%) of the Graham range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix A; Figure A-10). MPB infestation has largely moved through this area and will likely not be a concern in prioritizing restoration in this range (Charlston, pers. comm. 2018).

There are 204 historic and archeological sites in the Graham range (Government of BC 2018), and approximately 45,291 ha (4.9%) of the Graham range has been identified as having archaeological potential (Appendix A; Figure A-11; Government of BC 2018).

#### 8.1.2 Graham Proposed Restoration Polygon Areas

Based on preliminary disturbance mapping, a total of 1,916 km (46%) of linear disturbances within the Graham range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 2, Figure 3). Two restoration polygon areas<sup>3</sup> are proposed, developed through buffering the core habitat areas and caribou 90% KDE by 1 km. A large portion of anthropogenic disturbance occurs east of these 2 polygons, but is considered of less priority for habitat restoration given the extent of forestry, tenure and density of disturbance footprint in relation to where caribou are known to occur. A buffer of 1 km was used to account for treating linear disturbance which occurs between currently high densities of disturbance (higher predation risk and predator movement) to the core habitat areas. This buffer could be increased in subsequent versions of this plan.

Restoration area polygon 1 is relatively large, located on the west side of the Graham range, and captures the majority of HESR as well as some of HEWR, Graham Laurier Park, and a good portion of UWR and WHA. In addition, this area has a very low susceptibility to MPB, and a lower influence of forestry cutblocks (Figure 3). There is still crown tenure (e.g., communication sites, gas and oil pipelines, roadways, industrial license of occupation) overlapping this polygon, but it is located in the southern portion of this polygon.

Restoration area polygon 2 shares a border with polygon 1 and heads east to the edge of the 1 km buffer around the HEWR, and 90% KDE (Figure 3). In total, 2,236 km (54%) of the linear treatment candidates fall within the two restoration areas, which exclude high elevation BEC units and were considered no-treatment disturbances (Table 2, Figure 3).

<sup>&</sup>lt;sup>3</sup> Note that the numbered restoration polygon areas are not numbered in order of priority, but rather just presented for information purposes only. Restoration polygon priorities will be determined through ongoing First Nation engagement and consultation and discussion with stakeholders.

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/km²)	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	281	723	1,004	370,231	0.27	290,325 (78%)/ 79,906 (22%)	53,911	100,324 / -	194,475 / -	-	155,567
2	1,635	1,513	3,148	266,183	1.18	123,261 (46%)/ 142,923 (54%)	5,908	105,938 / -	83,085 / 985	723	13,441
Total Restoration (sum of restoration polygons)	1,916	2,236	4,152	636,414	0.65	413,586 (65%) / 222,829 (35%)	59,819	206,262 / -	277,560 / 985	723	169,008
No Restoration Treatment <sup>(a)(b)</sup>	3,542	3,563	7,105	291,943	2.43	-	-	22,897 / -	110,070 / 3,050	204	37,546

#### Table 2: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Graham Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidate' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN

# 8.2 Scott Range

The Scott range encompasses a total area of 414,619 ha that borders the southern portion of Williston Lake by Mackenzie, BC. Ungulate Winter Ranges cover 142,048 ha (34%) of the range, and there are no WHAs in this range (Appendix B; Figure B-6). There is one provincial park (Heather-Dina Lakes Park) and three ecological reserves (Blackwater Creek Ecological Reserve, Patsuk Creek Ecological Reserve, and Heather Lake Ecological Reserve) together making up 6,375 ha (1%) of the landbase in the Scott range, along with 14,267 ha (3%) managed as OGMAs (Appendix B; Figure B-7). Canty Lake exists within this range and two major creeks (Selwyn and Colin creeks).

## 8.2.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Scott range include forestry, mining, oil and gas developments, and recreational trails (Appendix B; Figure B-8). Habitat intactness for the entire range was calculated to be 197,423 ha (48%) of intact habitat, and 217,195 ha (52%) of non-intact habitat. The current habitat intactness does not meet the minimum of 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and BC MoE 2017). It should be noted as well, that MPB affected areas have not been factored into these disturbance area calculations. According to provincial VRI data, 82,886 ha (20%) of the Scott range has been affected by MPB infestation (Appendix B; Figure B-9). Approximately, 52,618 ha (13%) of the Scott range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix B; Figure B-10). MPB infestation may be a concern in this range due to the large amount of lodgepole pine present, and should be discussed when prioritizing restoration in this range (Charlston, pers. comm. 2018).

There are 21 historic and archeological sites in the Scott range (Government of BC 2018), and approximately 31 ha (0.01%) of the Scott range has been identified as having archaeological potential (Appendix B; Figure B-11; Government of BC 2018).

## 8.2.2 Scott Proposed Restoration Polygon Areas

The overall focus for identifying restoration polygons in the Scott range was the eastern portion of the range, following SME feedback that it is highly unlikely for caribou to re-establish to the Parsnip Arm (Seip pers comm. 2018b). In general, most treatment candidate lines and wolf telemetry locations occur in the eastern portion of the range, occurring at lower elevations and on the outside edges of the known caribou locations and mapped core habitats. Given the low amount of restoration candidacy surrounding the core habitat areas and known caribou locations, only one restoration polygon area is recommended. This polygon was developed by buffering the HEWR and HESR by 1 km, which captured all 90% KDE's in caribou location data which has actually been obtained from the Scott, Moberly, Burnt Pine and Kennedy Siding overlapping locations. This polygon would address the linear disturbance footprint that is leading from the low/mid elevations to the high elevation habitat.

Based on preliminary disturbance mapping, a total of 16 km (5%) of linear disturbances within the Scott range are considered as treatment candidates, prior to fine scale vegetation and attribute data collection (Table 3, Figure 4). Remote sensing and ground-truthing is necessary to verify site specific treatment recommendations.

In total, 285 km (95%) of the mapped and classified linear disturbances within the restoration area polygon, excluding high elevation BEC subzones, are considered 'no treatment' disturbances (Table 3, Figure 4).

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/ km²)	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	16	285	301	164,578	0.18	137,388 (83%)/ 27,190 (17%)	13,293	- / 512	91,393 / -	10,020	1,391
Total Restoration (sum of restoration polygons)	16	285	301	164,578	0.18	137,388 (83%)/ 27,190 (17%)	13,293	-/512	91,393 / -	10,020	1,391
No Restoration	14	3,520	3,520	250,040	1.41	-	-	2,659 / 94	39,130 / -	4,247	4,985

#### Table 3: Summary of Restoration Candidacy in Preliminary Restoration Polygon Area in Scott Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidate' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



# 8.3 Moberly Range

The Moberly range encompasses a total area of 328,865 ha. UWRs cover 80,114 ha (24%) of the range, and WHAs cover approximately 26,077 ha (8%) of the Moberly range (Appendix C; Figure C-6). There are three provincial parks (Bocock Peak Park, Klin-Se-Za Park, and Pine Le Moray Park) that cover 3,927 ha (1%) of the landbase, along with 20,016 ha (6%) managed as OGMAs (Appendix C; Figure C-7). Five main lakes (Simpson, Doonan, Bickford, Wright, and Carbon) exists within this range, along with the Pine River and McNairn Creek.

#### 8.3.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Moberly range include forestry, mining, oil and gas developments, and recreational trails (Appendix C; Figure C-8). There is also a large component of crown land tenure overlapping with Commercial Recreation – Multiple Use – License of Operation / Environment, Conservation & Rec – Sec 17 Designated Use Area – Fish and Wildlife Management that has been created for caribou protection, thus restoration can still occur within this overlapping tenure. Habitat intactness for the entire range was calculated to be 139,542 ha (42%) of intact habitat, and 189,323 ha (58%) of non-intact habitat. The amount of intact habitat does not meet the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and BC MoE 2017). It should be noted as well that MPB affected areas have not been factored into these disturbance area calculations. According to provincial VRI data, 40,740 ha (12%) of the Moberly range has been affected by MPB infestation (Appendix C; Figure C-9). Approximately, 21,225 ha (6%) of the Moberly range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix C; Figure C-10).

There are 39 historic and archeological sites in the Moberly range (Government of BC 2018), and approximately 22,779 ha (7%) of the Moberly range has been identified as having archaeological potential (Appendix C; Figure C-11; Government of BC 2018).

## 8.3.2 Moberly Proposed Restoration Polygon Areas

Based on preliminary disturbance mapping, a total of 195 km (21%) of linear disturbances within the Moberly range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 4, Figure 5). Remote sensing and ground-truthing is necessary to verify site specific treatment recommendations.

In total, 733 km (79%) of the mapped and classified linear disturbances within the proposed restoration polygon areas, excluding high elevation BEC subzones, are considered 'no treatment' disturbances (Table 4, Figure 5).

Four restoration polygon areas are proposed for the Moberly range (Figure 5). These polygons were created by encompassing all 90% KDEs and HEWR and HESR habitats with a 1 km buffer. For Moberly, topographical separations between restoration areas were created using the mapped hydrology and larger rivers.

Polygon 1 occurs within the current maternity pen location and captures the current habitat restoration activities within the range near Mount Bickford. This polygon was created given the overlap with parallel management recovery levers, First Nations support for road reclamation in this area, and linkage between



low and high elevation habitat. Polygon 1 is on the southern edge of the range bordered to the south by Hwy 97. This polygon captures both HEWR and HESR as well as the 90% KDEs for caribou locations and is bordered to the north by the Moberly River and Doonan Creek. This polygon captures a good portion of mid-elevation BEC units, as well as designated WHA (Figure 5).

Restoration polygon 2 is located north of polygon 1. This restoration polygon captures all HEWR and HESR as well as 90% KDEs. Carbon Creek and Peck Creek occur on the north boundary and this polygon and encompass Klinse-Za Park. The western portion of this polygon is designated as crown tenure (Commercial Recreation – Multiple Use – License of Operation / Environment, Conservation & Rec – Sec 17 Designated Use Area – Fish and Wildlife Management) that has been created for caribou protection, thus restoration can still occur within this overlapping tenure.

Restoration polygon 3 is north of polygon 2. Clearwater creek flows south out of Williston Lake which borders the polygon on the western side. This polygon captures all HESR and 90% KDE caribou locations. Crown tenure covers almost all of this polygon, with cutblocks along the entire western edge and eastern edge. Bocock Peak Park is in this polygon as well as a number of UWR areas.

Polygon 4 is east of Carbon creek and south of Williston Lake. This restoration polygon covers the 90% KDE caribou occurrences, as well as a 1 km buffer around HEWR and HESR (Figure 5).

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/ <sup>km2</sup> )	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	87	280	367	35,600	1.03	14,188 (40%)/ 21,412 (60%)	1,053	14,990 / 6,833	8,204 / -	5,187	-
2	35	129	164	58,369	0.28	41,228 (71%)/ 17,141 (29%)	3,079	5,585 / 12,029	21,410 / -	1,910	2,669
3	62	203	265	60,973	0.43	44,345 (73%)/ 16,628 (27%)	2,214	-/-	22,843 / -	-	1,142
4	11	121	132	21,326	0.62	7,147 (34%)/ 14,179 (66%)	481	5,503 / -	5,620 / -	15	-
Total Restoration (sum of restoration polygons)	195	733	928	176,268	0.53	106,908 (61%)/ 69,361 (39%)	6,827	26,078 / 18,862	58,076 / -	7,112	3,811
No Restoration	137	2,553	2,690	152,597	1.76	-	-	- / 1,931	21,619 / -	12,904	117

#### Table 4: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Moberly Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidates' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



# 8.4 Kennedy Siding Range

The Kennedy Siding range encompasses a total area of 295,928 ha. UWRs cover 60,306 ha (20%) of the range, and WHAs cover approximately 16,558 ha (6%) of the Kennedy Siding range (Appendix D; Figure D-6). There are two provincial parks (Bijoux Falls Park and Pine Le Moray Park) that cover 86,429 ha (29%) of the landbase in the range, along with 28,294 ha (10%) managed as OGMAs (Appendix D; Figure D-7). Four railway points (populated areas) are located within this range including: Kennedy, Caswell and Azouzetta and Azu Ski Village. Two main lakes exists within this range (Otto and Heart Lake), with the Parsnip, Misinchinka and Burnt Rivers plus a number of smaller creeks occurring throughout.

#### 8.4.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Kennedy Siding range include forestry, mining, oil and gas developments, and recreational trails (Appendix D; Figure D-8). Habitat intactness for the entire herd was calculated to be 183,194 ha (62%) of intact habitat, and 112,734 ha (38%) of non-intact habitat. This does not meet the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and BC MoE 2017). It should be noted that MPB affected areas have not been factored into these disturbance area calculations. According to provincial VRI data, 11,953 ha (4%) of the Kennedy Siding range has been affected by MPB infestation (Appendix D; Figure D-9). Approximately, 32,420 ha (11%) of the Kennedy Siding range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix D; Figure D-10).

There are 10 historic and archeological sites in the Kennedy Siding range (Government of BC 2018), and approximately 8,558 ha (3%) of the Kennedy Siding range has been identified as having archaeological potential (Appendix D; Figure D-11; Government of BC 2018).

## 8.4.2 Kennedy Siding Proposed Restoration Polygon Areas

Based on preliminary disturbance mapping, a total of 245 km (25%) of linear disturbances within the Kennedy Siding range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 5, Figure 6). Remote sensing and ground-truthing is necessary to verify site specific treatment recommendations.

In total, 730 km (75%) of the mapped and classified linear disturbances, excluding high elevation BEC subzones, are considered 'no treatment' disturbances (Table 5, Figure 6).

Four restoration polygon areas are proposed for the Kennedy Siding range. Polygon 1 occurs on the southwest side of the range, south of Hwy 97 and southwest of Pine Le Moray Park. The Misinchinka River occurs within the eastern extent of this polygon. This restoration area encompasses LEWR, HEWR and HESR plus a 1 km buffer. This area also picks up a large designated UWR.

Polygon 2 occurs east and southeast of Pine Le Moray Park, encompassing the eastern portion of the Kennedy Siding range. All LEWR and HEWR has been captured with a 1 km buffer. A large number of treatment candidate lines occur at mid to low elevation BEC units within this polygon. There is also overlap between Burnt Pine and Kennedy Siding caribou locations and known wolf locations in polygon 2.

Polygon 3 overlaps Pine Le Moray Park. Pine Le Moray Park is a Protected Area; therefore, no industrial resource extraction or development is permitted inside Park boundaries (e.g., mining, logging, hydro-electric development, transmission lines, or oil and gas exploration and development; Government of BC 1999, 2000). Tourism-related infrastructure is also not permitted inside Park boundaries (Government of BC 1999). From aerial imagery it appears that Pine Le Morey Park has limited disturbance. Anthropogenic use of the Park is limited to recreational activities such as snowmobiling, backcountry hiking, horseback riding, fishing, canoeing and cycling (BC Parks 2018). Given the low level of disturbance in Polygon 3, it is considered to have a low potential to complete restoration activities (Figure 6).

Polygon 4 occurs on the west side of the range, is bordered by Highway 97 on the south and east portion of the polygon. This polygon captures HESR and Kennedy Siding 90% KDE's plus a 1 km buffer. Extensive recreational activity occurs in this polygon as it is located east of the municipality of Mackenzie, and captures Powder King Mountain Ski Resort. In addition, popular snowmobile areas are located behind the ski resort and directly east of Mackenzie near Mount Morphee. Polygon 4 captures the HESR with a 1 km buffer and borders polygon 1 to the south. Given the level of stakeholder and recreational interest in polygon 4, it is considered to likely be the lowest priority area for treatment within the Kennedy Siding range (Figure 6).

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/km²)	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	2	319	321	62,469	0.51	45,919 (74%)/ 16,550 (26%)	326	- / -	38,927 / -	5,584	-
2	214	201	415	53,998	0.77	27,324 (51%)/ 26,673 (49%)	2,824	16,467 / 35,558	12,414 / -	1,229	-
3	25	29	54	43,197	0.13	35,514 (82%)/ 7,683 (18%)	963	- / 5,427	-/-	18	86,394
4	4	181	185	77,528	0.24	63,985 (83%)/ 16,544 (17%)	48	- / 16,898	8,716 / -	14,470	4
Total Restoration (sum of restoration polygons)	245	730	975	237,192	0.41	172,742 (73%)/ 64,450 (27%)	4,161	16,467 / 57,883	60,057 / -	21,302	86,398
No Restoration	18	1,093	1111	58,736	1.89	-	-	92 / 7,562	250 / -	6,993	31

#### Table 5: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Kennedy Siding Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidates' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



## 8.5 Burnt Pine Range

The Burnt Pine range encompasses a total area of 70,963 ha. UWRs cover 7,943 ha (11%) of the range, and WHAs cover approximately 4,769 ha (7%) of the Burnt Pine range (Appendix E; Figure E-6). There are no federal or provincial parks, and only 152 ha (0.002%) of OGMAs in the Burnt Pine range. The one main water feature within this range is Iver Lake.

#### 8.5.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Burnt Pine range include forestry, mining, oil and gas developments, and recreational trails (Appendix E; Figure E-8). Habitat intactness for the entire herd was calculated to be 7,198 ha (10%) of intact habitat, and 63,766 ha (90%) of non-intact habitat. The level of habitat intactness does not meet the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and BC MoE 2017). It should be noted that MPB affected areas have not been factored into these disturbance area calculations.

According to provincial VRI data, 22 ha (0.03%) of the Burnt Pine range has been affected by MPB infestation (Appendix E; Figure E-9). Approximately 177 ha (0.2%) of the Burnt Pine range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix E; Figure E-10).

In addition to current disturbance within the Burnt Pine range, the Willow Creek Coal Mine is at the northern portion of the range and has been issued an EA Certificate (#M98-01 Approval Certificate). This mine had ceased operations in 2013 when previously owned by Walter Energy, but is now proposing the re-open the mine through new owners Conuma Coal Resources. Conuma Coal Resources is proposing to expand this coal mine and it is currently in the permitting stage of the project (BC EAO 2018).

There are five historic and archeological sites in the Burnt Pine range (Government of BC 2018), and approximately 6,773 ha (10%) of the Burnt Pine range has been identified as having archaeological potential (Appendix E; Figure E-11; Government of BC 2018).

## 8.5.2 Burnt Pine Proposed Restoration Polygon Areas

Based on preliminary disturbance mapping, a total of 520 km (72%) of linear disturbances within the Burnt Pine range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 6, Figure 7). Remote sensing and ground-truthing is necessary to verify site specific treatment recommendations.

In total, 203 km (28%) of the mapped and classified linear disturbances within the Priority Zone, excluding high elevation BEC subzones, are considered 'no treatment' disturbances (Table 6, Figure 7).

Two restoration polygons are proposed for Burnt Pine, capturing the two distinct areas of historical and current caribou locations. Polygon 1 occurs south of Hwy 97 and north of Brazion creek. This restoration polygon captures the 90% KDEs of caribou locations, as well as a 1 km buffer around HEWR and HESR. This polygon has a high amount of overlap with UWR and Proposed WHA.

Restoration polygon 2 is south of Brazion creek and captures the 90% KDEs for Burnt Pine and Kennedy Siding as well as a 1 km buffer around HEWR and HESR. This polygon has a high amount of overlap with WHA, Proposed WHA, and UWR areas.



Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/km²)	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	219	125	344	15,278	2.25	2,161 (14%)/ 13,116 (86%)	128	- / 3,454	4,396 / -	-	-
2	301	78	379	13,953	2.72	2,463 (18%)/ 11,490 (82%)	639	3,699 / 13,953	3,548 / -	-	-
Total Restoration (sum of restoration polygons)	520	203	723	29,231	2.47	4,624 (16%)/ 24,607 (84%)	767	3,699 <i>1</i> 17,407	7,944 / -	-	-
No Restoration	491	1,067	1,558	41,732	3.73	-	-	1,070 / 7,686	-/-	153	-

#### Table 6: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Burnt Pine Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidates' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



# 8.6 Quintette Range

The Quintette range is 607,519 hectares (ha) in size, with the majority occurring in the Central Canadian Rocky Mountains ecoregion. The eastern extent of the herd range occurs in the Southern Alberta Upland ecoregion (Demarchi 2011). The Quintette herd is associated with alpine and subalpine habitats of the eastern foothills of the Rocky Mountains south and west of the town of Tumbler Ridge (Seip and Jones 2011). Additional detail on the Quintette range can be found in Golder 2017a and 2018a.

#### 8.6.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Quintette range include forestry, mining, oil and gas developments, and recreational trails (Golder 2017a). According to the 2017 joint federal-provincial study of the Central Mountain herds, nearly 58% of the mid and low elevation portion of the Quintette range is disturbed by anthropogenic (with the addition of a 500 m buffer) or natural disturbances, which exceeds the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and MoE 2017).

Habitat restoration activities have the potential to impact historic and archeological sites during physical reclamation means. The Plan would consider mitigations to avoid damage or impact to these sites. There are 677 historic and archeological sites in the Quintette caribou range, and approximately 62,360 ha (10%) of the Quintette range has been identified as having archaeological potential (Golder 2017a).

## 8.6.2 Quintette Proposed Restoration Polygon Areas

Phase 1 of the Quintette project developed three possible restoration zones that are summarized in Figure 2. Based on preliminary disturbance mapping, a total of 1,487 km (16%) of linear disturbances within the Quintette range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 7, Figure 2). In total, 7,941 km (84%) of the mapped and classified linear disturbances within the Priority Zone, excluding high elevation BEC subzones, are considered 'no treatment' disturbances (Table 7, Figure 2).

Zone 1 encompassed the low elevation winter range that was identified as important habitat by provincial radio collaring efforts (Seip and Jones 2014). Zone 2 included the majority of the high use elevation habitat that would not be treated as part of the restoration project; but linear features in this zone that lead from the low and mid elevations to the high elevation are important to restore to block predator access into high elevation winter caribou habitat. Zone 3 had very few recent caribou telemetry locations. After Phase 1 of the Quintette program, FLNRORD selected a priority area within the mapped Zone 2 area to proceed with and is currently proceeding through the planning and engagement process (Golder 2018a).

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	Total Area (ha)
Zone 1	892	113,772
Zone 2	307	91,317
Zone 3	288	87,297
Total Restoration (sum of restoration polygons)	1,487	292,386
No Restoration <sup>(a)(b)</sup>	7,941	315,134

#### Table 7: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Quintette Range

(a) Cutblocks, wildfires <40 years old, and roads were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. Only the Walter Energy mine footprint was available at the time; that footprint was excluded from treatment candidacy. Other mine footprints were not available at the time of writing Golder 2017a. Future planned cutblocks have not yet been added. Overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.</p>

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the Parkland and Alpine high elevation BEC subzones.

# 8.7 Narraway Range

The Narraway range encompasses a total area of 636,308 ha. UWRs cover 238,985 ha (38%) of the range, and WHAs cover approximately 67,747 ha (11%) of the Narraway range (Appendix F; Figure F-6). There are four provincial parks (Waipiti Lake Park, Bearhole Lake Park, Monkman Park, and Kakwa Park) and one protected area (Bearhole Lake Protected Area) making up 300,717 ha (46%) of the landbase in the Narraway range, along with 71,830 ha (11%) managed as OGMAs (Appendix F; Figure F-7). Twenty six lakes (including Wapiti, Upper Blue, Lower Blue and Blackhawk Lakes) exist within this range, and four waterfalls, along with the Narraway, Wapiti, and Murray Rivers.

#### 8.7.1 Linear Disturbance, Land Use and Archaeological Potential

Anthropogenic disturbances in the Narraway range include forestry, mining, oil and gas developments, and recreational trails (Appendix F; Figure F-8). Habitat intactness for the entire range was calculated to be 232,599 ha (37%) of intact habitat, and 403,708 ha (63%) of non-intact habitat. This does not meet the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations (EC 2014; ECCC and BC MoE 2017). It should be noted that MPB affected areas have also not been factored into these disturbance area calculations. According to provincial VRI data, 186,401 ha (29%) of the Narraway range has been affected by MPB infestation (Appendix F; Figure F-9). Approximately, 37,339 ha (6%) of the Narraway range is rated medium or high susceptibility to MPB infestation (DataBC 2017a; Appendix F; Figure F-10).

There are 180 historic and archeological sites in the Narraway range (Government of BC 2018), and approximately 45,444 ha (7%) of the Narraway range has been identified as having archaeological potential (Appendix F; Figure F-11; Government of BC 2018).

## 8.7.2 Narraway Proposed Restoration Polygon Areas

Based on preliminary disturbance mapping, a total of 7,872 km (67%) of linear disturbances within the Narraway herd range are considered as 'treatment candidates', prior to fine scale vegetation and attribute data collection (Table 8, Figure 8). Remote sensing and ground-truthing is necessary to verify site specific treatment recommendations.

In total, 3,805 km (33%) of the mapped and classified linear disturbances within the Priority Zone excluding high elevation BEC subzones are considered 'no treatment' disturbances (Table 8, Figure 8).

Four restoration polygon areas are recommended for the Narraway range. Restoration polygons for the Narraway consider the South Narraway separate from the Bearhole/Redwillow. Restoration polygon 1, capturing the South Narraway is considered to have the greatest likelihood of contributing to intact habitat. Polygon 2 is located on the western side of the range and encompasses HESR and WHA. Polygons 3 and 4 have abundant linear disturbance features but do not contain as many occurrences of caribou, compared to Polygons 1 and 2 based on recent aerial surveys in the area (Seip pers comm. 2018c). In addition, the density of linear features within Polygons 3 and 4 make them difficult candidates to add intact habitat to the range in the short term. For all four polygons a 1 km buffer was included around all 90% KDE's, and HESR, HEWR and LEWR (Figure 8).

Restoration Polygon	Length of Restoration Candidacy (km) <sup>(a)</sup>	No Treatment (km) <sup>(a)</sup>	Total (km) <sup>(a)</sup>	Total Area (ha)	Linear Density (km/ha)	Habitat Intactness: Intact/ Not Intact (ha/%)	Overlap with HEWR (ha)	Overlap with WHA/ Proposed WHA (ha)	Overlap with UWR/ Proposed UWR (ha)	Overlap with OGMA (ha)	Overlap with Parks (ha)
1	815	630	1,445	211,499	0.68	132,764 (63%)/ 78,734 (37%)	54,119	65,089 / -	73,991 / -	25,412	171,518
2	1,069	537	1,606	97,376	1.65	51,415 (53%)/ 45,961 (47%)	9,336	- / 90,460	11,886 / -	5,718	20,537
3	3,261	1,278	4,539	75,978	5.97	1,539 (2%)/ 74,440 (98%)	-	- / 1,406	33,220 / -	10,314	-
4	2,727	1,360	4,087	70,590	5.79	1,221 (2%)/ 69,369 (98%)	-	- / -	62,613 / -	10,331	7,779
Total Restoration (sum of restoration polygons)	7,872	3,805	11,677	455,443	2.56	186,939 (41%)/ 268,505 (59%)	63,455	65,089 / 91,866	181,710 / -	51,775	199,834
No Restoration (a)(b)	3,814	2,999	6,813	180,865	3.77	-	-	- / 20,845	57,273 / -	20,056	100,884

#### Table 8: Summary of Restoration Candidacy in Preliminary Restoration Polygon Areas in Narraway Range

(a) No Restoration = summary of area located outside of restoration polygons. Cutblocks (all), wildfires <40 years old, and all linear disturbance were overlapped when making these calculations. Unclassified roads with no other designation/disposition were left as potential candidates. In addition, all tenure areas with: Tenure Subtype = 'Investigative Licence', Tenure subtype = 'Section 17 Designated Use Area', Tenure purpose = 'Commercial Recreation', Tenure purpose = 'Environment, Conservation, & Recreation' plus tenure subtype of 'Notation Of Interest' plus Tenure Subpurpose of 'Watershed Reserve' were included as potential 'treatment candidate' areas. Swamp wetlands were included as 'treatment candidates', but marsh wetlands were 'no treatment'. Future planned cutblocks are not included. Ultimately overlap of linear disturbance within future cutblock areas should be removed from planning candidate areas as long term habitat securement is unlikely.

(b) Linear disturbances were not considered candidates for treatment in No Priority zones in the BAFAun or IMAun (alpine) high elevation BEC units.



# 8.8 **Results Summary**

The following table provides a summary by range of the results found for linear disturbances available for treatment, range disturbance features, and habitat intactness values (Table 9). Based on the minimum 65% undisturbed habitat that has been identified as a threshold for self-sustaining populations of caribou, the six summarized ranges do not meet this threshold based on the desktop analysis (EC 2014; ECCC and BC MoE 2017).

<b>Table 9: Summary of Treatment Candidate Area</b>	s, Disturbance and Habitat	Intactness by Caribou Range
	-,	

	Restoration	Range Disturt	oance Feature	s	Habitat Intactness <sup>4</sup>			
Range	Treatment Candidate (km)	Overlapping Crown Tenure (ha)	Cutblocks (ha)	Wildfire (<40 yrs) (ha)	Non-Intact (ha) (% total herd area)	Intact (ha) (% total herd area)		
Graham	1,916	298,960	30,176	36,228	387,893 (42%)	540,463 (58%)		
Scott	16	163,059	65,977	2,354	217,195 (52%)	197,423 (48%)		
Moberly	195	177,806	30,538	33,161	189,323 (58%)	139,542 (42%)		
Kennedy Siding	245	40,065	19,593	2,374	112,734 (38%)	183,194 (62%)		
Burnt Pine	520	8,025	10,779	484	63,766 (90%)	7,198 (10%)		
Quintette	1,487	-	-	-	-	-		
Narraway	7,872	20,021	20,574	52,315	403,708 (63%)	232,599 (37%)		
Total	12,251	-	-	-	-	-		

<sup>&</sup>lt;sup>4</sup> Habitat intactness calculated by the following equation: Habitat intactness (ha) = Total range (ha) – linear disturbance area (including 500 m buffer) – cutblock area (including 500 m buffer) (ha) – recent wildfire area (<40 years with no buffer) (ha)



# 9.0 NEXT STEPS

# 9.1 First Nations, Indigenous Communities and Stakeholder Involvement

This preliminary tactical restoration plan presented herein is the first phase of a multi-year caribou habitat restoration program in British Columbia aimed to determine a set of priority caribou habitat restoration areas within the SPNC ranges. It should be noted that TEK and Indigenous engagement has not yet commenced at the time of writing this preliminary plan; however, FLNRORD will be initiating and leading an engagement process over the coming year. However, what has been prepared is intended to be used as a guide for habitat restoration priority planning in the region and uses a strategic list of ecological and economic criteria provided by FLNRORD and land cover data to propose restoration areas within each range, to begin the identification of the spatial and temporal sequence in which areas could be restored to maximize restoration value to caribou, success, and cost-effectiveness.

The intent of this preliminary tactical restoration plan is to be used as background material to support the development of a planning tool which is informed by First Nations and Indigenous Communities through discussions with FLNRORD around the criteria to use to determine priority restoration areas both between and within ranges, as well as to inform subsequent detailed restoration programs or plans that would need to be developed for each of the seven SPNC ranges in BC (Graham, Moberly, Scott, Burnt Pine, Kennedy Siding, Quintette, Narraway).

In past restoration planning exercises, a number of ecological, regulatory, land use, stakeholder, and logistical criteria have been used to identify restoration program areas (Figure 9). More recently, cultural criteria have been identified. The following matrix summarizes criteria which have been previously used, or identified, to select areas *within a range* for restoration. Although some of the criteria used within this preliminary tactical plan are consistent with past planning exercises, cultural criteria has not been considered at this preliminary stage. Other considerations for tactical planning for landscape level restoration programs include an achievable size of a restoration area in terms of economic cost of treatments, accessibility, feasibility, as well as the influence the implementation of the program will have on both the linear density and habitat intactness ratio (e.g., ABMI 2016).

Few programs have considered how to set priorities **between ranges**. Criteria to use to set priorities between ranges should also consider cultural inputs. Past programs have used limited wildlife modelling to compare projected change in caribou and predator numbers expected following habitat restoration (ALT 2009, FNFN 2017), or focusing on the caribou herd in greatest decline; but criteria specific to the SPNC needs to be developed.

Figure 9: Summary of Ecological, Regulatory/Land Use/Stakeholder, Logistical and Cultural Criteria used in	past
restoration planning	

EC	OLOGICAL	LOGISTICAL					
	Core Habitat Areas <sup>1</sup> / High Value Caribou Habitat <sup>2</sup> Calving habitat <sup>2,3,4</sup> Caribou locations, high use areas <sup>2,3</sup> Predator location/numbers and overlap with caribou <sup>3</sup> (biologically meaningful area such as a wolf pack territory area <sup>4</sup> ) Seismic density <sup>5</sup> Mortality event locations Existing Natural Vegetation Recovery ("Leave for Natural") Large area to create intact habitat patches		Footprint inventory and natural revegetation recovery High Cost (e.g., mounding/seedlings estimated cost of \$12,000/km) <sup>4</sup> Accessibility Available Seed Source and Seedlings (Timeline) Ground Conditions Available sites (polygonal and linear disturbances not under active disposition, designated trails, and not falling under existing reclamation requirements) Predicted Natural Recovery (fine scale attributes; vegetation height/cover, wetness, nutrients, distance to road, forest stand) <sup>3,7,9,10</sup> Archeological potential <sup>3,7</sup> Stakeholder engagement				
RE	GULATORY / LAND USE / DISTURBANCE	CL	JLTURAL				
	Current level of disturbance % Gain-in-Undisturbed habitat <sup>2,3,5</sup> Protected Areas <sup>2</sup> Low Economic Value Resource Areas <sup>3,5</sup> Provincially-designated land with potential for less future disturbance (WHA, UWR, Parks, OGMA) <sup>2 (with noted exceptions, not protection), 7</sup> Resource Review Areas <sup>3</sup> Outside Fire Areas < 40 years <sup>3,5,7</sup> Disturbance under Active Dispositions on Crown Land 'No Treatment', consider reclamation requirements <sup>3,7</sup> Outside Future harvest management plan areas <sup>2,3,7</sup> Outside Future harvest management plan areas <sup>2,3,7</sup> Utside MPB current distribution and susceptibility ranking <sup>7</sup> Limited future development potential <sup>3,5,7</sup> Limited stakeholder conflicts <sup>7</sup> Type of Disturbance (conventional seismic, low impact seismic, pipeline, etc.) <sup>3</sup>		Protection and Restoration Zones <sup>2</sup> Oral history <sup>6</sup> ; high value caribou habitat TEK (knowledge holders, previous studies, studies, important caribou environmental features, critical areas, observations, kills) Spring calving habitat (muskeg, bog, fen, treed fen with access to water to avoid predators) Winter foraging areas (stands of large spurce/pine with ample ground lichen loads; south facing slopes with early green-up) Fall rutting habitat (< calving and late winter) <sup>6</sup> Ecological restoration on linear in calving and winter habitat, include measures to restore lichen loads <sup>6</sup> Critical Cultural Interest Areas <sup>6</sup> Important caribou habitat may be located outside of provincial and federal defined caribou range boundaries based on TEK <sup>2,6</sup> Avoidance of, or mitigating impacts from treatments to, archaelogical sites or high potential sites <sup>3</sup>				
1 2 3 4	BC Government has identified spatial boreal caribou ranges and cores; and revised ranges and cores FNFN 2017 REMB Parker Pilot Landscape Level Restoration (Golder 2015a) Demars and Benesh 2016	5 6 7 9 10	ABMI 2016 Leech et al. 2016 Golder 2017a van Rensen et al. 2015 Government of Alberta 2017				

This preliminary tactical restoration plan requires inputs from SME's, First Nations and Indigenous Communities and land rights holders prior to confirming restoration areas and how to prioritize those areas. Stakeholders from the PNCC, which includes representatives from government agencies, industry, First Nations (WMFN, SFN, McLeod Lake Indian Band), and recreation and community groups, should meet to refine and gather consensus on restoration objectives, and restoration area criteria considerations into a prioritization process including the inclusion of elevation, timelines, cost and feasibility.

The engagement should provide meaningful inclusion for First Nations and indigenous communities within the planning process prior to selection of priority area criteria and weighting of those criteria, selection of priority areas, as well as implementation of restoration treatments. This would include a discussion around how to prioritize one range over another range, and/or how to prioritize one restoration area over another area, and how to incorporate TEK. Figure 10 has been prepared as an example decision support tool to identify one approach to selecting one range over another, and one restoration area over the other. In this example, considerations of high caribou use, restoration candidacy potential, DU determination/population risk rating, existing parallel management levers (e.g., predator management, maternal penning) and current population estimates for each range are incorporated to support priority range selection. In this example, the Quintette (Golder 2017a), Moberly and Kennedy Siding ranges have a higher potential for restoration implementation to effect the population.



Footnotes: Preliminary criteria, and weighting

(1) Restoration order considers focusing on areas with reduced stakeholder conflicts/ overlap, availability of sites with restoration candidacy, overlap with WHA/UWRs

(2) Parallel management levers refer to population enhancements such as maternal penning as well as predator and prey control programs. For the Quintette and Moberly, there are also parallel restoration planning process underway.

(3) Ranges are listed in descending order of population estimates from Seip and Jones 2016. The order listed considers focusing on

herds with the greatest number of caribou first, over herds with fewer caribou in hopes that restoration will generate greater oppor-

tunity for more animals. However, this order could be reversed if priority is to focus on the herds of smallest estimated population size first.

(4) Refer to Figures 2 to 8 for restoration polygon locations.

#### Figure 10: Example Decision Support Tool for Determining Priority Ranges and Restoration Areas within a Range



# 9.2 Acquiring Linear Inventories and Determining Treatment Candidacy

Following selection of priority restoration areas, each area selected for detailed restoration planning will require further desktop analysis of linear disturbance vegetation cover and heights using (likely a combination of) remote sensing and field validation to complete the linear disturbance mapping. Once detailed linear disturbance mapping is complete, restoration treatment types can be selected, including the identification of 'Leave for Natural' linear segments which are on (or have the site attributes to be on) a natural path of vegetation recovery which are recommended as a 'leave for natural recovery' treatment. 'No treatment' candidates are likely to include areas that are identified as a stakeholder conflict, and to leave open (e.g., Golder 2018a).

Treatment class can be completed once remote sensing and ground-truthing of linear disturbance vegetation and attribute cover has been collected, and will involve assigning a relative treatment priority value to each line segment based on the following preliminary criteria:

- Probability of regeneration (considers a combination of vegetation cover, vegetation height, and soil moisture)
- Presence/absence of game trail
- Presence/absence of ATV trail
- Distance to high grade road
- Distance to polygonal disturbance (e.g. cutblock, mine footprints)
- Areas with overlapping legislative protections, for example overlap with provincially protected areas (WHA, UWR, OGMA, parks) which will afford immediate protection to restoration efforts
- Areas with high caribou usage (from KDE analysis developed by Seip and Jones 2013b and First Nation TEK and field inputs)
- Areas with high overlapping use by wolves and caribou
- Linear disturbances under an existing permit of the Ministry or the OGC, whereby the permit may be altered to add habitat restoration specifications
- Areas with MPB activity (i.e., Narraway range) and current spruce and/or balsam bark beetle infestations
- Archaeological potential and minimizing treatment impacts on areas of high archaeological potential or sites (Appendices A through F; Figures A-11, B-11, C-11, D-11, E-11, and F-11; Government of BC 2018)
- Available funding and resources.

Percentage change of habitat intactness expected following restoration treatments can then be calculated for each restoration area. In addition, the restoration objectives of meeting functional restoration versus ecological restoration (or a combination thereof) will need to be considered on a site-by-site or restoration polygon by polygon area.



Treatment candidacy linear segments would require physical restoration treatments. Determining the linear segment distances and types of treatments will provide a basis for developing schedules and budgets for restoration treatment plans. Restoration treatment selection should consider the restoration treatment matrix (Appendix I) to align with BEC units, as well as consideration of the site limiting factors. These tables were originally created by Tim Vinge of Alberta Environment and Sustainable Resource Development Land Management Branch for use in Alberta boreal caribou habitats, and modified by Golder for the Boreal Caribou Restoration Toolkit to apply to the BEC subzones present in boreal caribou habitat range (Golder 2015d); and then updated to address conditions in the Quintette range. The preliminary treatment matrix tables include details on limiting factors to tree establishment, management considerations, mechanical site preparation, and vegetation treatments (if required) based on site characteristics such as site type, moisture/nutrient regime, and degree of prior disturbance. Restoration prescription types should be implemented in consideration of the measures in Appendix G, with modifications where additional feedback and considerations are made by SMEs.

A restoration treatment decision-making flow chart was prepared for the Quintette Caribou Habitat Restoration Plan (Figure 12 within Golder 2017a), which could be discussed and adjusted during stakeholder engagement in hopes of incorporating SME and First Nation TEK into the types of treatments, objectives of treatments (i.e.,, functional or ecological restoration or both) and strategic locations for treatments. This process will provide more detailed metrics for understanding financial and schedule considerations which can created for each restoration area, within each range. Considerations will need to be made for strategically implementing restoration given funding constraints and ongoing changes to land use designations and protections.

# 9.3 Acquiring Detailed Remote Sensing Data

Detailed spatial imagery from remote sensing needs to be acquired, interpreted and verified in the field prior to determining areas where natural vegetation recovery and areas where restoration treatment candidacy occur within the SPNC ranges. On previous restoration projects, this remote sensing process has determined that from 22% (Golder 2018a) to up to 60% of existing linear disturbances are naturally on a path to recovery (Golder 2015a). Given the financial considerations for acquiring detailed remotely sensed data with field trothing, we recommend that this step would occur only within restoration areas of highest priority for restoration planning and treatment implementation.

#### **Overlapping Data**

Several data sources were utilized to complete the linear disturbance mapping within this preliminary plan. This resulted in numerous overlaps in the linear disturbance dataset. Most of these have been removed, however there remain some areas where the start and end of separate linear features have a slight overlap. The overall effect on the length of restoration candidacy lines is minimal, but if required, these remaining overlaps can be removed with additional manual effort to refine treatment candidate areas.

#### Mine Disturbances

Mines have been reported in the Quintette range (Roman Mine (including a revision to the revegetation plan on the adjacent Trend Mine; Stantec 2012), the Quintette Mine (Teck Coal Ltd. 2013), Sukunka Mine (Stantec 2015a), and Bonanza Ledge Mine (not yet finalized; Golder 2017b). In addition, the Willow Creek Mine expansion project is located in the northern portion of the Burnt Pine range (Section 8.5.1). A request was made through (MEMPR) for any information on current or proposed mines on 13 March 2018, but at the time of this report writing, no additional data has been obtained. Current and approved mine footprints are recommended to be excluded as treatment candidate areas, as these project footprints are expected to have project specific CMMPs to address the footprint. Mine footprint data will need to be overlaid with existing linear disturbances and removed from the treatment areas as part of the next phase of the preliminary tactical restoration plan for the South Peace.

#### Data Gaps and Management

Due to various constraints, this preliminary tactical restoration plan does not include digitization of features not displaying on sourced datasets that informed the plan. There may be linear features present on new imagery that was not found in the current linear database that will need to be digitized for inclusion in the linear dataset. Following adding additional datasets if available, it may be necessary to manually digitize relevant features not showing within gaps in the dataset. This would be necessary as part of the next phase of the preliminary tactical restoration plan for the South Peace; but could be focused within priority restoration areas.

Data for this multi-year habitat restoration project should be managed within a framework that effectively facilitates the compilation, analysis, manipulation and communication of large and complex spatial data sets for the purpose of landscape management planning.

Some of the datasets used to identify areas of exclusion are updated on a regular basis. Depending on the timing of the next phase of the preliminary tactical restoration plan for the South Peace, updates to wildfires and cutblock (including proposed future harvest plans) spatial information may be available and should be included. Crown tenures are also updated frequently and exclusions should be re-assessed if updated data is available. The exclusionary criteria of crown tenures could also be assessed in more depth by reviewing individual tenures rather than applying blanket exclusions according to the more general subtype classification.

## 9.4 Seed and Seedling Sourcing

Due to the length of time it takes to obtain appropriately sized seedlings, sourcing of seed and seedlings should occur as soon as possible once an area is selected for restoration as part of the preliminary tactical restoration plan. Sources for seeds and seedlings, as well as the timeline for treatments and planting, needs to be further investigated in the next phase of the preliminary tactical restoration plan for the South Peace. Seedling planting can be conducted in the spring or fall. If possible, seedlings could be sourced from Twin Sisters Native Plants Nursery (TSNPN; see Section 9.4.1). Ideally larger seedlings (ideally two years old) are recommended for planting in order to increase the chance of planting success (Golder 2018a; Kabzems pers comm. 2017). The extra time and cost associated with obtaining two-year-old seedlings should be considered that is attributed to overwintering the seedlings and storing them for an extra year.
#### 9.4.1 Building Local Capacity

Habitat restoration programs provide an opportunity to enhance local markets and economies. Services needed include seed sourcing, seedlings, contractors with excavators and heavy equipment, tree planters, Health Safety and Environment specialists, restoration specialists, tree fellers, environmental field technicians, reclamation specialists, accommodation, and equipment rentals. Sourcing these services should consider local communities, aboriginally owned companies and local businesses (e.g., Golder 2017c). Local support will engage the local communities to embrace habitat restoration efforts and support long term protection of these treatments from re-use.

One example of local capacity is the Twin Sisters Native Plant Nursery (TSNPN) located in Moberly Lake, BC, and joint owned by West Moberly First Nation and Saulteau First Nation (TSNPN 2018). The nursery was originally established to provide a source of seedlings to reclaim Walter Energy's mine sites (Davis pers comm. 2017). The TSNPN now services other mine companies, as well as oil and gas, forestry, hydroelectrical, and landscaping companies (Government of BC 2015; Davis pers comm. 2017). The work undertaken at the TSNPN is helping to address the shortage of local plant stock in northern BC required for use in reclamation (Royal Roads University 2013; Government of BC 2015).

The nursery has two 7,000 square foot greenhouses, each with a capacity of 234,000 seedlings if cropped only once per year (Davis pers comm. 2017). By taking advantage of varying growth rates of various species, over 500,000 seedlings can be produced per season (Davis pers comm. 2017). Staff at the nursery collect, dry, clean and cold store native seeds (including cold storing since 2014), facilitate the germination of seeds, tend to seedlings, and ship plants (TSNPN 2017).

In 2016, TSNPN began collecting seed for the High Pine Pipeline Project for Spectra Energy (Enbridge). This pipeline will cross through caribou habitat, and so staff at the nursery are selecting the most appropriate species of seed to collect, clean, store, stratify and grow to restore this caribou habitat (Davis pers comm. 2017). The TSNPN are also collecting seed specific to caribou dietary requirements and has participated in the collection and storage of lichens for the Klinse-Za Maternal Penning Program (Davis pers comm. 2017). The nursery are supplying coniferous seedlings for FLNRORD's Quintette Restoration Project.

A next step within this tactical plan, is for FLNRORD to develop a contracting process which is fair and transparent, but which pulls in local capacity building.

## 9.5 Develop Annual Implementation and Monitoring Plans

This preliminary tactical restoration plan is designed to be a multi-year program. Each phase of the program will require the development of an Implementation planning document for the particular zone or restoration area within an area to be treated. The following elements should be captured within each implementation plan.

- Clearly identify boundaries for the implementation area, and temporal considerations.
- Review elevations to focus treatments based on current FLNRORD priorities.
- Review linear inventory mapping and treatment candidate sites to plan ground-truthing field program.
- Review potential archeological requirements prior to ground-truthing, and incorporating any archeological field work with the ground-truthing.

- Reviewing imagery to document accessibility to the area:
  - Identify the locations of potential watercourse crossing locations, and determine if disturbance to the watercourse may be required to cross.
  - If disturbance is a possibility, incorporate a field watercourse crossing assessment into the groundtruthing plan.
- Ground-truthing of potential restoration segment sites to confirm treatment recommendation.
- Confirmed restoration segment sites will be given a treatment prescription. An example treatment matrix for linear restoration of Engelmann Spruce Subalpine Fir – Bullmoose Moist Very Cold Variant (ESSFmv2) is provided in Appendix I.
- The following will be noted for each treatment site to guide logistical planning for field implementation:
  - Treatment site location.
  - Treatment access route or other considerations (ground access vs. aerial support).
  - Site conditions which may impact treatment options (e.g., terrain, site wetness, pipeline crossing agreements, impact to existing vegetation between restoration segments).
  - Update vegetation mapping for the site where a variance occurs from original mapping interpretation (surrounding stand type, height of vegetation per strata, vegetation species composition, % vegetation cover, game trail/ human access presence, width, line orientation).
- Seed and seedling requirements will be finalized, and will be sourced, as required.

An overall monitoring program design which captures both vegetation / habitat response to the restoration treatments, as well wildlife response to treatments should be considered within the entire South Peace region. Once restoration priority areas are determined, and restoration measures are implemented on the ground, revegetation response to the restoration treatments should be monitored to determine the efficacy of the treatments as well as as-built monitoring of where restoration has been implemented. Vegetation monitoring can follow guidelines in the Boreal Caribou Habitat Restoration Monitoring Framework which was designed following learnings from restoration programs which began in 2002, as well as for consistency with current BC vegetation monitoring protocols (Golder 2015c). Monitoring for compliance (where applicable, if restoration implementation is conducted by third parties or by industrial proponents; or if implementation is conducted by Government of BC, as-built maps and tracking should be completed), effectiveness, and validation will be incorporated into the study design, and monitoring will occur after the first, fifth, tenth, and fifteenth growing seasons after treatment. Reference plots will be established during treatment periods on untreated gaps of linear features (reference plots- disturbed) and on linear features that are already on a successional vegetation trajectory (reference plots- natural revegetation). These reference plots will be compared to the treatment plots to evaluate the effectiveness of the treatments at achieving the overall objectives of the program, which is to reduce predator and primary prey access and establish a vegetation trajectory that will increase boreal caribou habitat intactness.

The desired outcome of caribou habitat restoration is to create a restored landscape, where disturbed range is returned to functional or ecological objectives that can support self-sustaining caribou populations without predator control. Monitoring is needed on both the vegetation and treatment response to the restoration programs, but just as important, is parallel monitoring on the impact of restoration and concurrent recovery actions on the caribou populations themselves.

## 9.6 Obtain Authorizations

Restoration treatments on legacy disturbance footprint within the SPNC ranges not under an existing permit of another Ministry or the OGC will require authorization by FLNRORD under the *Forest and Range Practices Act.* The restoration treatments, and associated obligation to the treatment activities, will be identified and tracked by FLNRORD as a Forestry Licence to Cut. Identification of a 'licensee' who will be carrying out the on the ground activities must be provided. It is expected that authorization will be on a yearly basis, specific to the area of restoration treatment. This allows consultation to be led by FLNRORD on the specific treatment area, activities and access. Authorization will also be needed for any cutting of Crown timber for the use of tree-felling treatments (will need to report number and location).

Authorization applications should be submitted at least 6 months prior to targeted treatment start dates.

This authorization timeline will allow for Indigenous community consultation led by FLNRORD; feedback received during the consultation phase and from the FLNRORD will be incorporated into future implementation plans.

Additional authorizations which would need to be obtained within each restoration area's implementation plan are detailed within Golder (2018). Authorizations will include, but may not be limited to:

- Archaeological Overview Assessment and Chance Find Permit;
- Watercourse crossing plan which will form the basis for a notification package that must be sent to FrontCounter BC at least 45 days prior to the establishment of any required crossing structures, as required under the BC Water Sustainability Act.
- Any required water source and associated water use permit would need to be submitted to FrontCounter BC at least 60 days prior to the start of access preparation, to secure water resources necessary if watercourse crossings are planned as freezing in of access.

Road use agreements and third party crossing agreements (rail, pipeline) would also need to be obtained.

## 9.7 First Nations Engagement and Involvement

In the next phase of the preliminary tactical restoration plan for the South Peace, a workshop is recommended between the Province and First Nations as a starting point to engagement to select priority restoration areas. Engagement with First Nations should be initiated to provide the opportunity for early input on the restoration planning and prioritization process as well as to incorporate TEK into the restoration planning and treatment options/considerations/selection which will be led by FLNRORD. This will likely entail community focused sessions and/or field visits to discuss what habitat restoration objectives and considerations mean for the communities. Considerations including spiritual and cultural values need to be considered within the planning process.

In addition, it is strongly recommended to develop a transparent process be developed to facilitate opportunities to integrate the involvement of Aboriginal Peoples and Businesses as a core function in the execution of the multi-year habitat restoration implementation plan (Indigenous Inclusion Plan [IIP]). Potential services and roles may include, but are not limited to, seed and seedling sourcing, environmental technologists, wildlife monitors, medics, general contractors, equipment operators, surveyors, safety supervisors, field technicians, data collectors, researcher assistants, archaeologist assistants, tree fallers, and danger tree assessors. The IIP would outline the necessary administrative, contractual, and logistical arrangements required to facilitate Indigenous participation in the Plan as much as practical. The IIP will outline our strategy to facilitate the participation of qualified local Indigenous resources, where appropriate and available, and in accordance with health and safety policies and protocols. The IIP will seek to support (e.g., wildlife survey) to Aboriginal individuals, where needed and feasible; identifying opportunities to augment consultant/contractor's existing workforce through direct hires; and retaining Aboriginal businesses as service suppliers under this contract (e.g., transportation, field technicians, wildlife (bear) monitors, and heavy equipment operators), where feasible.

## **10.0 SUMMARY**

Habitat restoration is one tool in the toolbox for caribou population recovery. Habitat restoration alone will not recover caribou populations. Parallel management levers including predator management and population augmentation are recognized as immediate levers given the time lag for habitat to recover. This preliminary tactical restoration plan is considered preliminary; forming the basis for pulling together available data and inputs that can be used as criteria for selecting restoration areas. Proposed restoration areas have been mapped, but require government, First Nation and Subject Matter Expert input to agree upon the criteria used, as well as how to weight the criteria to select priority areas for restoration. This preliminary tactical restoration plan for the South Peace is considered a multi-phase habitat restoration project designed to be implemented over a multi-year period in low- and mid- elevation habitat to achieve the objectives of the South Peace Strategic Action Plan (BC MFLRNO 2017).

### 11.0 CLOSURE

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### **13.0 PERSONAL COMMUNICATIONS**

- Capot-Blanc K. 2018. Land and Resource Coordinator, Forest Nelson First Nation. Presentation at the BC Boreal Caribou Restoration Workshop, April 17, 2018.
- Charleston, A. 2018. Stewardship Officer, FLNRORD. Personal communication with Tanya Seebacher (Golder) on 27 April 2018.
- Davis, S. 2017. Manager at Twin Sisters Native Plants Nursery. Personal communication with Catherine Grima (Golder) on 9 March 2017.
- Kabzems, R. 2017. Research Silviculturist, FLNRORD. Personal communication with Catherine Grima (Golder) on 20 November 2017.
- Kabzems, R. 2018. Research Silviculturist, FLNRORD. Personal communication with Tanya Seebacher (Golder) on 3 March 2018.
- McNay, S. 2017. Project Manager/Ecologist at Wildlife Infometrics. Personal communication with Paula Bentham (Golder) in March 2018.
- Pederson, J. 2018. Authorizations Specialist, FLNRORD. Personal communication with Tanya Seebacher (Golder) on 23 March 2018.
- Schilds, S. 2018. Ecosystems Biologist, FLNRORD. Personal communication with Tanya Seebacher (Golder) on 22 March 2018.
- Seip, Dale. 2018a. Biologist at Ministry of Environment and Climate Change Strategy, BC. Personal communication with Paula Bentham (Golder) on 13 March 2018.
- Seip, Dale. 2018b. Biologist at Ministry of Environment and Climate Change Strategy, BC. Personal communication with Paula Bentham (Golder) on 12 March 2018.
- Seip, Dale. 2018c. Biologist at Ministry of Environment and Climate Change Strategy, BC. Personal communication with Paula Bentham (Golder) on 22 March 2018.
- Watters, M. 2017a. Wildlife Ecologist, FLNRORD. Personal communication with Michelle Bacon (Golder) and Paula Bentham (Golder) on 1 March 2017.
- Watters, M. 2017b. Wildlife Ecologist, FLNRORD. Meeting notes provided to Tanya Seebacher (Golder) in May 2017.

APPENDIX A

# **Graham Range Figures**













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APPENDIX B

# Scott Range Figures



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APPENDIX C

## Moberly Range Figures









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APPENDIX D

## Kennedy Siding Range Figures





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APPENDIX E

## **Burnt Pine Range Figures**



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APPENDIX F

# Narraway Range Figures























APPENDIX G

# Summary of SPNC Ranges

### **Graham Range**

The Graham range resides north of the Peace River and moves between high and low elevation habitats in the winter (Appendix A; Figures A-3 and A-4). Telemetry studies have shown that the Graham range is composed of a resident population that remains near the winter range along the eastern foothills of the Rocky Mountains, and a migratory population that moves to the more mountainous western areas in spring (BC MoE 2014a). According to telemetry data and calf survival surveys, Butler Ridge, Aylard Ridge, Husky Ridge, and the Hackney Hills provide high quality year-round habitat for the Graham range (BC MoE 2014a).

BEC Subzone	Subzone Name	Elevation Class <sup>(a)</sup>	Area (ha)	Proportion of Range (%)
BAFAun	Boreal Altai Fescue Alpine Undifferentiated	High	86,576.13	9.3%
BWBSmw	Boreal Black and White Spruce Moist Warm	Mid	122,768.53	13.2%
BWBSwk2	Boreal Black and White Spruce Murray Wet Cool	Mid	129,490.06	13.9%
ESSFmv4	Engelmann Spruce – Subalpine Fir Moist Very Cold Graham	High <sup>(b)</sup>	379,715.75	40.9%
ESSFmvp	Engelmann Spruce – Subalpine Fir Moist Very Cold Parkland	High <sup>(b)</sup>	59,012.78	6.4%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	Mid	32,572.15	3.5%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	High <sup>(b)</sup>	17,359.12	1.9%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	Mid	18,176.22	2.0%
SBSmk2	Sub-Boreal Spruce Williston – Moist Cool	Mid	23,217.06	2.5%
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	Mid	18,607.11	2.0%
SWBmk	Spruce – Willow – Birch – Moist Cool	Mid	28,391.82	3.1%
SWBmks	Spruce – Willow – Birch – Moist Cool Scrub	Mid	12,469.83	1.3%
Total		•	928,356.56	100.00%

<b>Table 1: Proportion</b>	of BEC Subzones	in the Graham	Range
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(a) This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).

A 2016 aerial census survey found 181 caribou including 21 calves (Seip and Jones 2016). As of March 2017, there were 21 collared adult females, down from 26 the previous year, and a mortality rate of 19%. The same survey counted 86 caribou including 75 adults and 11 calves resulting in a calf recruitment rate of 12.8% (Seip and Jones 2017).

The Graham range is not part of the Central Mountain recovery efforts as it has been monitored as a control comparison for the wolf predator management and maternal penning programs in the Central Mountain range (Seip and Jones 2016). In the absence of predator management and population management programs, the Graham range shows a continuing decline in population.

## **Scott Range**

Telemetry data of the Scott range have been limited due to lack of study. Historically, the herd spent summers in the mountains east of the Parsnip River and migrated to low elevations west of the Parsnip River in early winter (Appendix B; Figures B-3 and B-4). In recent years, with the flooding of the Williston Reservoir, the herd primarily

stays in the mountains on the eastern side of their range (BC MoE 2014a). Owing to the lack of caribou activity west of the Parsnip Arm of the Williston Reservoir, it is assumed that there is a negligible chance of the western portion of the Scott range being reoccupied (D. Seip pers comm. 2018a). Therefore, that portion of the Scott range is not considered to be a priority for restoration activities (D. Seip pers comm. 2018a). The Scott range is 414,618 ha and includes 129,620 ha of high-elevation winter habitat consisting of alpine and subalpine forests where the caribou can access terrestrial and arboreal lichens, respectively (BC MoE 2014a).

BEC Subzone	Subzone Name	Elevation Class <sup>(a)</sup>	Area (ha)	Proportion of Range (%)
BAFAun	Boreal Altai Fescue Alpine – Undifferentiated	High	13,293.12	3.2%
ESSFmv3	Engelmann Spruce – Omineca Moist Very Cold	Mid	57,933.96	14%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	High <sup>(b)</sup>	73,560.12	17.7%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	High <sup>(b)</sup>	11,333.04	2.7%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	Mid	45,480.93	11%
SBSmk1	Sub-Boreal Spruce – Mossvale Moist Cool	Mid	18,952.27	4.6%
SBSmk2	Sub-Boreal Spruce Williston – Moist Cool	Mid	100,551.83	24.3%
SBSvk	Spruce – Willow – Birch – moist cool	Mid	9,301.20	2.2%
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	84,212.08	20.3%	
Total			414,618.55	100.00%

(a) This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).

A 2013 survey located 20 individuals and found a population estimate of 20 to 44 animals, which is similar to the 22 caribou counted in a 2007 survey (Seip and Jones 2013a).

In June 2013, the West Moberly First Nation released a draft action plan for the Klinse-Za herd (Scott and Moberly herds) of woodland caribou (McNay et al. 2013). The draft action plan follows the requirements of the federal *SARA*. It includes the goal of restoring the herd at least 654 caribou within 21 years (McNay et al. 2013). A long-term outcome of the draft action plan is to allow sustainable First Nation harvest of caribou to resume, following a decades-long self-imposed moratorium on woodland caribou hunting by West Moberly First Nation (Cision 2018). Actions under the plan which have been implemented include maternal penning, predator control to reduce caribou mortality (McNay et al. 2016), and road deactivation moving towards habitat restoration. The priority actions recommended in the plan are:

Reduce caribou mortality through predator management and penning cows during the natal period.

- Establish thresholds for maximum levels of disturbance to critical habitat (0% HEWR, 5% calving and summer range (CSR), 10% Low Elevation Range, and 20% matrix habitat) and adopt specific range plans to restore disturbed land and protect against new disturbance where necessary to meet thresholds for disturbance.
- Establish a Stewardship Team to initiate implementation and management of this Action Plan and to coordinate actions with other planning initiatives (McNay et al. 2013).

In addition to the Klinse-Za maternal penning project, the Scott range is the subject to a predator management program. The predator management program began late in 2015 and data for the Scott and Kennedy Siding ranges was combined. Only two wolves were removed from these ranges accounting for an estimated 4% to 6% of the wolf population (Seip and Jones 2016). In 2016, 86 wolves were removed from the Scott / Moberly ranges, and in 2017 there were 57 wolves removed from the ranges (Seip and Jones 2017).

#### **Moberly Range**

The Moberly range resides in the mountains north of the Pine River and south of the Peace Arm of the Williston Reservoir (Seip and Jones 2011). This range encompasses 328,865 ha including 68,177 ha of high-elevation winter habitat, although caribou are also known to use low-elevation habitats in the winter (BC MoE 2014a). In the summer, Moberly caribou move west and occupy high-altitude habitats within the central core of the Rocky Mountains (Appendix C; Figures C-3 and C-4).

BEC Subzone	Subzone Name	Area (ha)	Proportion of Range (%)	
BAFAun	Boreal Altai Fescue Alpine – Undifferentiated	High	6,927.69	2.1%
BWBSmw	Boreal Black and White Spruce Moist Warm	Mid	23,614.88	7.2%
ESSFmv2	Engelmann Spruce – Subalpine Fir Bullmoose Moist Very Cold	Mid	116,830.19	35.5%
ESSFmvp	Engelmann Spruce – Subalpine Fir Moist Very Cold Parkland	High <sup>(b)</sup>	8,841.68	2.7%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	High <sup>(b)</sup>	47,046.88	14.3%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	High <sup>(b)</sup>	9,323.57	2.9%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	29,033.20	8.8%	
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	Mid	87,247.08	26.5%
Total			328,865.17	100.00%

Table 3: Proportion of BEC Subzones in the Moberly Range

(a) This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).



A 2012 census survey identified 25 caribou, and on three occasions in the winter of 2012 and 2013, efforts to locate and collar caribou found just 16 individuals (Seip and Jones 2013a). The herd appears to be in decline as surveys from 1997 found 191 caribou versus in 2009 when the minimum population was 48 (Seip and Jones 2011). The predator control program in 2015 removed 29 wolves from the range, accounting for 59% to 100% of the population (Seip and Jones 2016). As a result of predator control and maternal penning, the population was counted at 61 individuals in March 2017.

The Moberly range is the subject of the Klinse-Za maternal penning project. The Klinse-Za maternal penning project was originally comprised of just Moberly herd individuals, but the placement of some Scott caribou in the maternity pen has resulted in the herds becoming mixed into one (Seip and Jones 2016). Data collected after 2014 tends to combine the Scott and Moberly herds into a single herd; however, this Plan recognizes the two herds as being distinct. However, areas where the two herds overlap in occurrence could be a restoration selection criteria.

In 2015, 11 adult females were moved into a maternal pen and produced five calves that survived to be released. A survey in 2016, showed that of the 14 females that were not penned, only three had calves indicating the penned females had a higher survival rate for their offspring (Seip and Jones 2016). The calf recruitment rate of 16.7% was higher than the average of 14.3% from 2003 to 2015. There was no adult mortality from spring 2015 to spring 2016 in comparison to an average of 23.2% from 2003 to 2015.

In 2016, 14 adult female caribou were captured in March, with one dying in the third week of captivity. Eleven of the cows produced offspring and all the calves survived until they were all released in July (Seip and Jones 2017). In March 2017, seven of the calves were confirmed still alive. An additional calf may have survived but the cow's habitat choice of dense forest hampered detection from the air. The penned cows had a calf survival rate of 64 to 73% for the year (Seip and Jones 2017).

The population of the herd was counted at 61 individuals in March 2017, which is an increase from 54 in the previous year and a population increase of 13%. Twelve calves were counted in 2017, resulting in a calf recruitment rate of 20% of the population, seven were born in the maternity pen, and the other five calves that survived were from the 20 adult cows that were not penned (Seip and Jones 2017). No collared caribou were killed by predation from spring 2016 to 2017; however, three collared adult females and one uncollared caribou were killed during two separate avalanche events (Seip and Jones 2017). The increased calf recruitment rate with the decrease in adult mortalities is an indication that penning, along with removal of predators, has had a positive contribution to population increase (Seip and Jones 2016).

In addition to the Klinse-Za maternal penning project, the Moberly range is the subject of a habitat restoration project, and a predator management program.

The habitat restoration project has included the deactivation of the Fisher Creek Forest Service Road (2.3 km in the Mount Bickford area), within the Moberly range. Habitat restoration works, including the deactivation of deep pits, earth barriers, and logs, were conducted by West Moberly First Nations and Saulteau First Nations from September to October 2017 (BC FLNRORD 2018b). The project was part of a joint partnership between West Moberly First Nations and Saulteau First Nations, and supported by Wildlife Infometrics, Woodlands North and the BC Government with the aim to restore caribou populations in the area (BC FLNRORD 2018b). The cost of the project was approximately \$140,000 (BC FLNRORD 2018b). Re-activation of this segment of road by removing logs and earthworks was conducted by an unknown party with heavy equipment between 9 October and 19 October 2017. FLNRORD has now deactivated the road again at a cost of \$20,000 (BC FLNRORD 2018b).

The predator management program in 2015 removed 29 wolves from the range, accounting for 59% to 100% of the population (Seip and Jones 2016). As a result of predator management and maternal penning, the population was counted at 61 individuals in March 2017.

### **Kennedy Siding Range**

The Kennedy Siding range moves from low-elevation pine forests in the early winter to subalpine and alpine areas between the Parsnip and Burnt Rivers in late winter (Seip and Jones 2011). The Kennedy Siding range encompasses 295,927 ha and includes 12,000 ha of pine-lichen winter habitat, and 65,639 ha of high-elevation winter habitat (BC MoE 2014a). The low-elevation pine forest has historically suffered from mountain pine beetle (MPB; *Dendroctonus pondersosae*) attacks killing off much of the canopy trees; however, caribou continue to migrate and feed in the area (BC FLNRORD 2014b) (Appendix D; Figures D-3 and D-4). Increases in snow depth and hardness through January and February contribute to difficulty with feeding, causing the caribou to migrate to high elevations on the west side of the Rocky Mountains where they feed on terrestrial lichens on windswept alpine ridges (BC MoE 2014a).

BEC Subzone	Subzone Name	Area (ha)	Proportion of Range (%)	
BAFAun	Boreal Altai Fescue Alpine – Undifferentiated	High	4,160.51	1.4%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	Mid	110,610.61	37.4%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	High <sup>(b)</sup>	10,064.41	3.4%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	Mid	74,275.16	25.1%
SBSmk1	Sub-Boreal Spruce – Mossvale Moist Cool	Mid	4,791.19	1.6%
SBSvk	Sub-Boreal Spruce – Very Wet Cool	Mid	19,105.12	6.5%
SBSwk1	Sub-Boreal Spruce – Willow Wet Cool	Mid	14,004.01	4.7%
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	Mid	58,916.66	19.9%
Total			295,927.67	100.00%

(a) This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).

A variety of survey methods have been used to monitor caribou, including ground and aerial surveys, telemetry data, and motion sensing cameras that have been used to identify individuals by antler and body characteristics. Using these methods, researchers reported the population in 2017 to be 63 individuals including: 27 adult cows, 18 adult bulls, and 18 calves, representing 29% of the overall population (Seip and Jones 2017). This is an increase from 2011 when population estimates were between 44 and 57 individuals, and down from at least 120 caribou in 2007 (Seip and Jones 2011). Surveys in 2015 and 2016 found the population to have stabilized at 50 individuals (Seip and Jones 2016). The population increase in 2017 represents a 33% increase from 2016, and the herd seems to have benefitted from the predator management program that was implemented in 2015 (Seip

and Jones 2017). In 2015, predator removal data for the Kennedy Siding and Scott herds was combined, and two wolves were removed, accounting for 4% to 6% of the population (Seip and Jones 2016). In 2016, 50 wolves were removed from the Kennedy Siding herd, followed by another 11 wolves in 2017 (Seip and Jones 2017).

A supplementary feeding program for the Kennedy Siding range was initiated in 2014 by Heard and Zimmerman (2018), with support from McLeod Lake Indian Band. The Kennedy Siding range was provided high quality food pellets from October to mid-January, each year for three years (2014/2015 to 2017/2018 seasons). Sixty-five caribou were recorded feeding on the pellets during the 2017/2018 season, consuming approximately 1.14 kg pellets/day (Heard and Zimmerman 2018). Supplementary feeding has appeared to contribute to caribou population growth because, following the initiation of supplementary feeding, the herd stopped declining and began increasing in number, and calf recruitment and female annual survival rate increased, even during the 2017/2018 season, when little predator management occurred (Heard and Zimmerman 2018).

To date there has been no maternal penning program for the Kennedy Siding range.

## **Burnt Pine Range**

The range occurs on the east side of the Rocky Mountains, is south of the Pine River, and north of the Burnt River (Appendix E; Figures E-3 and E-4) (BC MoE 2014a). The range is 70,963 ha including 20,586 ha of highelevation winter habitat (BC MoE 2014a).

BEC Subzone	Subzone Name	Area (ha)	Proportion of Range (%)	
BAFAun	Boreal Altai Fescue Alpine Undifferentiated	High	766.24	1.1%
BWBSmw	Boreal Black and White Spruce Moist Warm	Mid	5,889.10	8.3%
ESSFmv2	Engelmann Spruce – Subalpine Fir Bullmoose Moist Very Cold	Mid	6,358.33	9.0%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	High <sup>(b)</sup>	17,811.75	25.1%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	High <sup>(b)</sup>	2,555.35	3.6%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	Mid	16,909.28	23.8%
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	20,673.01	29.1%	
Total			70,963.06	100.00%

Table 5: Proportion of BEC Subzones in the Burnt Pine Range

(a) This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).

The Burnt Pine herd was considered part of the Moberly herd until telemetry data indicated little to no movement between the ranges. The Burnt Pine herd was approximately 20 individuals in the early 2000s, but has gradually declined and was presumed extirpated by 2013. Historically, there was overlap between the Burnt Pine and Kennedy Siding ranges, however, radio collared animals from Kennedy Siding herd have been documented using



the Burnt Pine range in late winter (BC MoE 2014a). In 2010, 19 caribou were counted in the Burnt Pine range, but 13 of those were with a radio collared caribou from the Kennedy Siding range. If those caribou did migrate from the Kennedy Siding range, then the Burnt Pine range for 2010 would be six, a number that was echoed in the 2011 survey when five individuals were observed (Seip and Jones 2011). Therefore, it is possible that the Burnt Pine herd could be recolonized with Kennedy Siding caribou in the future if that herd increases in abundance (BC MoE 2014a). To date there has been no maternal penning or predator management programs within the Burnt Pine range.

### **Quintette Range**

The Quintette Range has undergone preliminary planning for habitat restoration. A high level Phase 1 of the Quintette Caribou Habitat Restoration Plan was initiated by FLNRORD in 2017 based on the Quintette Strategic Action Plan (QSAP) in response to the rapidly increasing rate of decline of the Quintette herd. The goal of the restoration plan was twofold: the recovery of the Quintette herd to a level that supports a sustainable Treaty 8 caribou harvest, and to meet the Government of Canada's Species at Risk recovery targets (BC FLNRORD 2017). The overall objective of the Restoration Plan was to transition anthropogenically disturbed, low quality woodland caribou habitat into higher quality habitat, with a particular focus on linear disturbances. Habitat restoration will reduce the benefits that predators and their primary prey gain through linear corridor use, and establish a vegetation trajectory on these corridors that will, in the long term, lead to increased intactness of woodland caribou habitat. The Plan was designed to be implemented over a multi-year period, with desktop disturbance mapping and implementation planning completed in 2017-2018, implementation of restoration treatments to occur beginning tentatively in 2019 (continuing for approximately 5 years), and post-treatment monitoring to be conducted following restoration implementation.

Initial GIS mapping found a total length of 1,487 km (19%) of linear disturbances in the Quintette range had potential for restoration candidacy (Golder 2017a). These linear disturbance features included mapped cutlines, recreational trails, resource roads, and road / right-of-way's. Three restoration zones were selected in the Quintette range with guidance from FLNRORD based on a number of ecological, logistical and economic criteria (e.g., elevational considerations, access, and budget) (Figure 2).

A more detailed Phase 2 Quintette Implementation Plan was developed based off the Phase 1 Restoration Plan that focused on a 42,205 ha area with low and mid-elevation habitat for restoration based on the results of FLNRORD internally-led workshop in May 2017. In the fall of 2017, the sources of the linear disturbance layers were checked for updates and refined to eliminate overlaps in the linear disturbance dataset prior to a field reconnaissance program. A field reconnaissance program was conducted by low-level fly-over via helicopter between 30 September and 2 October 2017 to ground-truth the treatment candidate sites mapped during the desktop linear disturbance mapping.

In addition, a desktop archaeological overview assessment was completed for the purposes of:

- Identifying known archaeological sites within the Restoration Area, to the degree possible, using existing records;
- Identifying and assess archaeological resource potential within the Restoration Area; and
- Assess the need for, and provide recommendations regarding the nature and scope of, further archaeological work, if necessary for the Restoration Area.

FLNRORD led a stakeholder engagement process for the Quintette Restoration Plan and had a stakeholder engagement meeting in the February 2018. In addition, FLNRORD began an indigenous community engagement process aimed to develop an Indigenous Inclusion Plan (IIP) that outlines opportunities for collaborating with First Nations through the implementation of restoration efforts. Details of the engagement process by FLNRORD can be found in Appendix B of the *Phase 2 - Quintette Caribou Habitat Implementation Plan – FINAL* (Golder 2018).

Within the Restoration Area, following the mapping and field reconnaissance survey, 496.5 km (66%) of linear disturbances were classified as 'No Treatment', based on existing dispositions, protective notices or visual human use along roads, 218.5 km (30%) were recommended to 'Leave for Natural Regeneration' (Golder 2018a). The stakeholder engagement found a total of 8.7 km (1%), originally identified as treatment candidates, which were classified as 'No Treatment - Stakeholder Conflict' due to overlapping use or future use by stakeholders. After stakeholder engagement, a total of 27.9 km (approximately 4%) of linear disturbances were assigned to be 'Treatment Candidates' (Appendix A: Mapbook in Golder 2018a). A table detailing the Treatment candidate segment locations, site specific considerations and their associated treatment recommendations is provided in Appendix D of Golder 2018. Treatment recommendations included areas proposed for direct seedling planting, and areas with required site preparation treatments such as screefing, ripping, topsoil spreading and tree/hand felling. The restoration technique(s) selected for each Treatment candidate segment was determined using the Treatment Decision-Making Flow Chart (summarized in Figure 5, Golder 2018). For the Quintette restoration plan, in consultation with FLNRORD, the restoration program will use Sitka alder (Alnus viridis ssp. sinuata), in combination with conifer seedlings (hybrid white spruce [Picea engelmannii X glauca], black spruce [Picea mariana], lodgepole pine [Pinus contorta], and subalpine fir [Abies lasiocarpa]), to enhance the site conditions along the treatment lines. In addition, live willow staking was proposed as an option to be used where there are road crossings and where a treatment line crosses a river or stream to provide guick establishment of vegetation to aid in controlling human and potentially predator access. Twin Sisters Native Plants Nursery is currently growing the FLNRORD requested seedling species to be planted out in June 2019. Finally, a monitoring plan was developed that will guide determination of vegetation response to the restoration treatments over time. Monitoring for compliance, effectiveness, and validation were incorporated into this implementation plan, with monitoring events to occur after the first, fifth, tenth, and fifteenth growing seasons after treatment. In addition, wildlife response monitoring is proposed using data collected from motion activated remote cameras established by FLNRORD placed along restoration of linear disturbance features post-restoration.

As part of the predator management program, approximately 41 to 68% of the estimated wolf population in Quintette was removed in 2015, and 100% of the estimated wolf population in Quintette was removed in 2016 (Seip and Jones 2016).

To date there is no maternity penning programs from the Quintette herd.

#### Narraway: Bearhole—Redwillow and South Narraway Range

The Narraway herd is split into two subgroups: the Bearhole—Redwillow herd and the South Narraway herd. The two groups are largely separate on their winter ranges, but based on the movements of some collared animals, there seems to be some interchange (Appendix F; Figures F-3 and F-4; BC MoE 2014a). The range is 636,307 ha. Population estimates are limited to counting individuals associated with radio-collared caribou due to their wintering in forested habitats, which makes aerial surveying difficult (Seip and Jones 2011).

The Bearhole—Redwillow herd resides entirely in BC north of the Red Deer valley, and is associated with low elevation boreal forest, east of the town of Tumbler Ridge (Seip and Jones 2011). This subgroup migrates to the

east side of the Rocky Mountains to winter in low-elevation forests. In the summer, the herd moves to the west side of the Rocky Mountains remaining in low elevation boreal forest (BC MoE 2014a).

The South Narraway subgroup resides to the south of the Red Deer valley. Like the Bearhole—Redwillow subgroup, the South Narraway subgroup migrates to the east side of the Rocky Mountains to winter in low-elevation forests; however, their range extends into Alberta. Habitat types include pine-lichen forests, tamarack bogs, and mature spruce forests (BC MoE 2014a). In summer, the South Narraway move to the west side of the Rocky Mountains and reside in subalpine forest habitat (BC MoE 2014a). Due to the trans-provincial nature of this herd, data was collected and provided by the Alberta Ministry of Environment and Parks (Seip and Jones 2017).

BEC Subzone	Subzone Name	Area (ha)	Proportion of Range (%)	
BAFAun	Boreal Altai Fescue Alpine Undifferentiated	High	74,416.38	11.7%
BWBSmw	Boreal Black and White Spruce Moist Warm	Mid	109,911.38	17.3%
BWBSwk1	Boreal Black and White Spruce Murray Wet Cool	Mid	103,288.39	16.2%
ESSFmv2	Engelmann Spruce – Subalpine Fir Bullmoose Moist Very Cold	Mid	253,642.16	39.8%
ESSFmvp	Engelmann Spruce – Subalpine Fir Moist Very Cold Parkland	High <sup>(b)</sup>	43,646.35	6.9%
ESSFwc3	Engelmann Spruce – Subalpine Fir Cariboo Wet Cold	Mid	15,222.69	2.4%
ESSFwcp	Engelmann Spruce – Subalpine Fir Wet Cold Parkland	Mid	20,278.50	3.2%
ESSFwk2	Engelmann Spruce – Subalpine Fir Misinchinka Wet Cool	Mid	13,503.12	2.1%
IMAun	Interior Mountain-heather Alpine – Undifferentiated	348.88	0.1%	
SBSwk2	Sub-Boreal Spruce Finlay – Peace Wet Cool	Mid	2,050.00	0.3%
Total	·	·	636,307.85	100.00%

Table 6: Proportion of BEC	Subzones in the Narraway -	<b>Bearhole/Redwillow Range</b>
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This elevational class is based on mountain caribou habitat elevations. (b) Despite high elevation, included this BEC unit in potential for restoration as per recommendation by FLNRORD (Kabzems pers comm. 2018).

A low calf recruitment rate of 7.7% since 2007, combined with a high adult mortality rate, indicates a declining population of Bearhole-Redwillow caribou. Surveys indicate this subgroup had a minimum count of 18 caribou in 2016, down from a minimum count of 49 and a population estimate of 80 individuals in 2008 (Seip and Jones 2016). From March 2016 to March 2017, only two adult caribou had radio-collars to facilitate monitoring. Six adults and three calves were confirmed, for a minimum population of nine individuals, suggesting a calf recruitment of 33% and low adult mortality. However, the small sample size prevents making reliable conclusions on populations trends (Seip and Jones 2017). To date there has been no maternal penning or predator management programs in the Bearhole—Redwillow range, although the predator removal in adjacent areas may have reduced the number of wolves in the range leading to the low mortality rates of caribou (Seip and Jones 2017).



Surveys conducted in March 2016 found 35 South Narraway caribou and a population estimate of 41, which shows an ongoing decline from 2008 when the minimum count was 102 individuals and a population estimate of 179 (Seip and Jones 2016). Ten radio-collared caribou were located in five different groups within this herd. A March 2017 survey identified 19 adults and four calves for a minimum population of 23 caribou, with calves representing 17% of the population. The population estimate for this herd is 20 to 43 individuals, which represents an ongoing decline (Seip and Jones 2017). To date there has been no maternal penning or predator management programs in the South Narraway range.

#### Table 7: Summary of Biogeoclimatic Units Overlapping the Project Area and Restoration Potential

BEC Unit	Range	Elevation (m)	Climate	Zonal Vegetation Species
BAFAun	Graham Scott Moberly Kennedy Siding Burnt Pine Quintette Narraway	>1,800	Winters are very cold and long. Summers are brief and cool, but with very long days. The snowpack is thin and windblown.	Tree canopy: N/A Understory: Heaths and other dwarf shrubs, graminoids (grasses, sedges and woodrushes), mosses, lichens and sporadic trees in krummholz form.* Restoration Potential: No - BAFA BEC Units removed from physical restoration treatment planning as it is generally non-forested (alpine). In addition, given time lag required to recovery understory species as well as naturally open areas where anthropogenic footprints are likely providing less influence on predator mobility then within forested BEC Units. In addition, caribou use these high elevation, windswept ridges, to minimize predation risk.
BWBSmw1	Graham Moberly Burnt Pine Quintette Narraway	750 to 1,050	This zone has a drier and cooler growing season than the BWBSmw2 zone to the north, but with warmer and moister winters.	<b>Tree canopy:</b> White spruce ( <i>Picea glauca</i> ), and trembling aspen ( <i>Populus tremuloides</i> ) with seral stands containing occasional components of balsam poplar ( <i>Populus balsamifera ssp trichocarpa</i> ), and lodgepole pine. <b>Understory:</b> Highbush cranberry ( <i>Viburnum edule</i> ), prickly rose ( <i>Rosa acicularis</i> ), white spruce in undisturbed areas, twinflower ( <i>Linnaea borealis</i> ), trailing raspberry ( <i>Rubus pubescens</i> ), palmate coltsfoot ( <i>Petasites frigidus var. palmatus</i> ), pink wintergreen ( <i>Pyrola asarifolia</i> ), and bunchberry ( <i>Cornus canadensis</i> ). The well-developed moss layer is usually dominated by step moss ( <i>Hylocomium splendens</i> ), red-stemmed feather moss ( <i>Pleurozium schreberi</i> ), and knight's plume ( <i>Ptilium crista-castrensis</i> ).**
BWBSwk1	Quintette Narraway	1,050 to 1,200	In comparison to the BWBSwk2 the growing season in this unit is drier and colder, while winters are warmer and have a higher snowpack.	<b>Tree canopy:</b> White spruce, black spruce in wetter sites, lodgepole pine, trembling aspen. <b>Understory:</b> Highbush-cranberry, prickly rose, Sitka alder, black huckleberry ( <i>Vaccinium membranaceum</i> ), fireweed ( <i>Epilobium angustifolium</i> ), tall bluebells ( <i>Mertensia paniculata</i> ), twinflower, palmate coltsfoot, creamy peavine ( <i>Lathyrus ochroleucus</i> ), and red-stemmed feathermoss.** <b>Restoration Potential:</b> Yes
BWBSwk2	Graham	1,050 to 1,200	In comparison to the BWBSwk1 the growing season in this unit is longer, wetter, and warmer, while winters are colder with less snowpack.	<b>Tree canopy:</b> White spruce, with components of lodgepole pine, subalpine fir, and trembling aspen. <b>Understory:</b> Black huckleberry, prickly rose, and regenerating subalpine fir. Common herbs include bunchberry, stiff club-moss ( <i>Lycopodium annotinum</i> ), twinflower, and occasionally heart-leaved arnica ( <i>Arnica cordifolia</i> ). A carpet of moss is typically present, composed of step moss, red-stemmed feather moss, and/or knight's plume.** <b>Restoration Potential:</b> Yes
ESSFmv2	Moberly Burnt Pine Quintette Narraway	950 to 1,550	Coldest and driest of the lower elevation ESSF variants.	<b>Tree canopy:</b> Engelmann spruce ( <i>Picea engelmannii</i> ), subalpine fir and lodgepole pine. <b>Understory:</b> White-flowered rhododendron ( <i>Rhododendron albiflorum</i> ), black huckleberry, and black gooseberry ( <i>Ribes lacustre</i> ). Herb layers are generally sparse; a moss layer predominates with red-stemmed feathermoss.*** <b>Restoration Potential:</b> Yes
ESSFmv3	Scott	900 to 1,300	Subalpine climate with most precipitation in the form of snow.	<b>Tree canopy:</b> White spruce, subalpine fir, with lodgepole pine on drier sites, and black spruce in wetter areas or on north facing slopes. <b>Understory:</b> Sitka alder, black huckleberry, white-flowered rhododendron, black gooseberry, and highbush cranberry.

BEC Unit	Range	Elevation (m)	Climate	Zonal Vegetation Species
				Restoration Potential: Yes
ESSFmv4	Graham	1,000 to 1,400	Similar to ESSFmv2.	<b>Tree canopy:</b> Engelmann spruce, subalpine fir, lodgepole pine, and black spruce in lower elevations. <b>Understory:</b> White-flowered rhododendron, black huckleberry, and Labrador tea. Herb layers consist of twinflower, bunchberry, heart-leaved arnica, and tall bluebells. The moss layer is dominated by red-stemmed feathermoss.*** <b>Restoration Potential:</b> Yes
ESSFmvp	Graham Moberly Quintette Narraway	>1,500	Occurs above the ESSFmv sub-zones and is transitional to true alpine with a colder climate and dry when above ESSFmv2 and ESSFmv4.	<b>Tree canopy:</b> Subalpine fir, Engelmann spruce <b>Understory:</b> White-flowered rhododendron, black huckleberry, scrub birch ( <i>Betula nana</i> ), crowberry ( <i>Empetrum nigrum</i> ), and mountain heathers ( <i>Cassiope mertensiana, Phyllodoce empetriformis</i> ), mountain arnica ( <i>Arnica latifolia</i> ), Sitka valerian ( <i>Valeriana sitchensis</i> ), subalpine daisy ( <i>Erigeron peregrinus</i> ), pussytoes ( <i>Antennaria spp</i> ), Altai fescue ( <i>Festuca altaica</i> ), and woodrushes ( <i>Luzula spp</i> ).*** <b>Restoration Potential:</b> Yes - physical restoration treatment considered to be of a lower benefit than BEC zones occurring at mid elevation for restoration potential due to natural openness of stands and high elevation habitat provides a refuge from predators. However, these BEC units were still considered as potential treatment candidates as per recommendations by FLNRORD (Kabzems pers comm. 2018). Functional and ecological restoration in these areas may only occur on portions that pass through an existing tree/shrub complex in these parkland environments (Kabzems pers comm. 2018).
ESSFwc3	Graham Scott Moberly Kennedy Siding Burnt Pine Quintette Narraway	1,300 to 1,550	Wet and cold, similar to the ESSFwk2, but occurring at higher elevations, and therefore colder with a more persistent snowpack.	<b>Tree canopy:</b> Engelmann spruce and subalpine fir. <b>Understory:</b> White-flowered rhododendron and black huckleberry, five-leaved bramble ( <i>Rubus pedatus</i> ), oak fern ( <i>Gymnocarpium dryopteris</i> ), rosy twistedstalk ( <i>Streptopus reseus</i> ), Sitka valerian).*** <b>Restoration Potential:</b> Yes
ESSFwcp	Graham Scott Moberly Kennedy Siding Burnt Pine Quintette Narraway	1,800 to 2,000	Occurs above the ESSFwc3 and below the Alpine Tundra subzones, and has a cold and snowy climate	<b>Tree canopy:</b> Subalpine fir, Engelmann spruce <b>Understory:</b> White-flowered rhododendron, black huckleberry, Rosy twistedstalk, sitka valerian, red-stemmed feathermoss, leafy mosses ( <i>Mnium spp.</i> ), cladonia lichens ( <i>Cladonia spp.</i> ).*** <b>Restoration Potential:</b> Yes - physical restoration treatment considered to be of a lower benefit than BEC zones occurring at mid elevation for restoration potential due to natural openness of stands and high elevation habitat provides a refuge from predators. However, these BEC units were still considered as potential treatment candidates as per recommendations by FLNRORD (Kabzems pers comm. 2018). Functional and ecological restoration in these areas may only occur on portions that pass through an existing tree/shrub complex in these parkland environments (Kabzems pers comm. 2018).
ESSFwk2	Graham Scott Moberly Kennedy Siding Burnt Pine Quintette Narraway	950 to 1,300	This unit has very high snow accumulations greater than 3 m, and is wetter and warmer than the ESSFmv variants.	<b>Tree canopy:</b> Engelmann spruce, subalpine fir, with very old Sitka alder <b>Understory:</b> Devil's club ( <i>Oplopanax horridus</i> ), Indian hellebore ( <i>Veratrum viride</i> ) and Sitka valerian, white-flowered rhododendron, black huckleberry, and oval-leaved blueberry ( <i>Vaccinium ovalifolium</i> ).*** <b>Restoration Potential:</b> Yes

ら GOLDER

BEC Unit	Range	Elevation (m)	Climate	Zonal Vegetation Species
IMAun	Narraway	1,800 to 2,500	Temperatures are cold for most of the year, even during the growing season, and is affected with wind and snow.	<b>Tree canopy:</b> Stunted patches of Engelmann spruce, subalpine fir, lodgepole pine, subalpine larch ( <i>Larix Iyallii</i> ), and whitebark pine ( <i>Pinus albicaulis</i> ). <b>Understory:</b> Evergreen mountain heather ( <i>Cassiope</i> spp. and <i>Phyllodoce</i> spp.) and mountain-avens ( <i>Dryas</i> spp.)* <b>Restoration Potential:</b> No - IMA BEC Units removed from physical restoration treatment planning as it is generally non-forested (alpine). In addition, given time lag required to recover understory species as well as naturally open areas where anthropogenic footprints are likely providing less influence on predator mobility then within forested BEC Units. In addition, caribou use these high elevation, windswept ridges, to minimize predation risk.
SBSmk1	Scott Kennedy Siding	750 to 1,070	Relatively long snowy winters, with moist cool summers.	<b>Tree canopy:</b> Hybrid white spruce, lodgepole pine, trembling aspen, and Douglas-fir ( <i>Pseudotsuga menziesii</i> ) <b>Understory:</b> Soopalallie ( <i>Shepherdia Canadensis</i> ), black huckleberry, showy aster ( <i>Eurybia conspicua</i> ), oak fern ( <i>Gymnocarpium dryopteris</i> ), and queen's cup ( <i>Clintonia uniflora</i> ). <sup>††</sup> <b>Restoration Potential:</b> Yes
SBSmk2	Graham Scott	670 to 800	This unit is the driest of the sub-boreal spruce units, but similar in temperature to the other sub-boreal units.	<b>Tree canopy:</b> Lodgepole pine, trembling aspen, hybrid white spruce, Subalpine fir, and black spruce. <b>Understory:</b> Soopolallie, sitka alder, highbush-cranberry, black twinberry ( <i>lonicera involucrate</i> ), and red-stemmed feathermoss. <sup>†</sup> <b>Restoration Potential:</b> Yes
SBSvk	Scott Kennedy Siding	615 to 1,150	Wet with low mean annual temperatures.	<b>Tree canopy:</b> Hybrid white spruce, subalpine fir, lodgepole pine, Douglas-fir, and black spruce in bogs. <b>Understory:</b> Black huckleberry, devils club, oval-leaved blueberry, bunchberry, oak fern, lady fern ( <i>Athyrium filix-femina</i> ), knight's plume ( <i>Ptilium crista-castrensis</i> ), electrified cat's tail ( <i>Rhytidiadelphus triquertrus</i> ), and leafy mosses ( <i>Mnium</i> spp.). <sup>1111</sup> <b>Restoration Potential:</b> Yes
SBSwk1	Kennedy Siding	900 to 1,250	This unit has one of the highest precipitation and the coolest temperatures of the SBS Zones located in the SPNC.	<b>Tree canopy:</b> Hybrid white spruce, lodgepole pine, and subalpine fir. <b>Understory:</b> Black twinberry, black huckleberry, black gooseberry, prickly rose, heart-leaved arnica, bunchberry, and five leaved bramble ( <i>Rubus pedatus</i> ). The nearly continuous moss layer include red-stemmed feathermoss ( <i>Pleurozium schreberi</i> ), knight's plume, and electrified cat's tail. <sup>†††</sup> <b>Restoration Potential:</b> Yes
SBSwk2	Graham Scott Moberly Kennedy Siding Burnt Pine Quintette Narraway	750 to 1,200	This unit has high levels of precipitation and warmer than the BWBSdk1, which replaces it to the north.	<b>Tree canopy:</b> Hybrid white spruce, subalpine fir, lodgepole pine, and black spruce. <b>Understory:</b> Black huckleberry, thimbleberry, black twinberry, highbush-cranberry, Devil's club ( <i>Oplopanax horridus</i> ), bunchberry, trailing raspberry ( <i>Rubus pubescens</i> ), and oak fern ( <i>Gymnocarpium dryopteris</i> ). <sup>†</sup> <b>Restoration Potential:</b> Yes

BEC Unit	Range	Elevation (m)	Climate	Zonal Vegetation Species
SWBmk	Graham	800 to 1,100	This unit has a boreal subalpine climate with precipitation similar to SBSwk3, but with lower average temperatures.	<b>Tree canopy:</b> White spruce and subalpine fir that are often stunted. <b>Understory:</b> Willow species, Labrador tea ( <i>Rhododendron groenlandicum</i> ), lingonberry, ( <i>Vaccinium vitis-idaea</i> ), bunchberry, Altai fescue ( <i>Festuca altaica</i> ), and fuzzy-spiked wildrye ( <i>Leymus innovates</i> ). Mosses include step moss, red-stemmed feathermoss, and glow moss ( <i>Aulacommium palustre</i> ). <sup>†</sup> <b>Restoration Potential:</b> Yes
SWBmks	Graham	1,500-1,900	Generally speaking this unit is subalpine and sparsely treed, but data is otherwise deficient for this unit.	Similar tree canopy and understory to SWBmk but more sparse and shrubby. <b>Restoration Potential:</b> Yes - physical restoration treatment considered to be of a lower benefit than BEC zones occurring at mid elevation for restoration potential due to natural openness of stands and high elevation habitat provides a refuge from predators. However, these BEC units were still considered as potential treatment candidates as per recommendations by FLNRORD (Kabzems pers comm. 2018). Functional and ecological restoration in these areas may only occur on portions that pass through an existing tree/shrub complex in these parkland environments (Kabzems pers comm. 2018).

\*BC FLNRORD 2006 (BAFAun)

\*\*DeLong, et al. 2011 (BWBSmw1, BWBSwk1, BWBSwk2)

\*\*\*DeLong et al. 1994 (ESSFmv2, ESSFmv4, ESSFwc3, ESSFwk2)

<sup>†</sup>DeLong 2004 (ESSFmv3, SBSmk2, SBSwk2, SWBmk)

<sup>††</sup>DeLong et al. 1993 (SBSmk1)

<sup>†††</sup>DeLong 2003 (SBSvk, SBSwk1)

APPENDIX H

## Summary of Data References

Disturbance Feature Inventory	Data source	Has retired / status info
Recreation Line	Government of BC	Yes
Roads	Digital Road Atlas - Government of BC	Yes
Trails	Digital Road Atlas - Government of BC	Yes
OGC Petroleum Development Roads Pre-2006	OGC	No (assume all active)
OGC Petroleum Development Roads	OGC	No (assume all active)
OGC Petroleum Access Roads	OGC	No (assume all active)
Forest Service Roads	Government of BC	Yes
Cutlines (recent)	OGC	No (assume all can be treated)
Cutlines (1996-2004)	OGC	No (assume all can be treated)
Cutlines (2002-2006)	OGC	No (assume all can be treated)
Cutline (TRIM)	TRIM (from FLNRORD)	No (assume all can be treated)
Pipeline	IHS Markit	Yes
Transmission Lines	Canvec	No
Railway	Government of BC	No

#### Table 1: Summary of Linear Disturbance Data Used for Preliminary Tactical Restoration Plan for South Peace

#### Table 2: Summary of Environmental Data Considered for Treatment Candidate Determination

Environmental Data	Source
Biogeoclimatic Units	Government of BC
Archaeological potential and sites	Government of BC (RAAD; Government of BC 2018)
Old-Growth Management Areas (OGMAs) (legal and non-legal)	Government of BC
Mountain Pine Beetle (MPB) salvage areas	Government of BC
Pest Hazard rating	Government of BC
Parks / Protected areas	Government of BC
Caribou 90% kernel data	Calculated by Golder from telemetry data (Seip and Jones 2013b)
Burnt Pine caribou herd telemetry data (2003-2013)	FLNRORD
Graham caribou herd telemetry data (2001-2010)	FLNRORD
Kennedy Siding caribou herd telemetry data (2002-2018)	FLNRORD
Moberly caribou herd telemetry data (2002-2015)	FLNRORD
Narraway caribou herd telemetry data (2006-2018)	FLNRORD
Scott caribou herd telemetry data (1999-2016)	FLNRORD
Burnt Pine wolf telemetry data (2008-2009 and 2016-2018)	FLNRORD

#### Appendix H: Summary of Data References

Environmental Data	Source
Graham wolf telemetry data (2016-2018)	FLNRORD
Kennedy Siding wolf telemetry data (2008-2009 and 2016-2018)	FLNRORD
Moberly wolf telemetry data (2008 and 2016-2018)	FLNRORD
Narraway wolf telemetry data (2008-2010 and 2016-2018)	FLNRORD
Scott wolf telemetry data (2016-2018)	FLNRORD
Ungulate Winter Range (UWR)	Government of BC
Proposed UWR	Government of BC
Wildlife Habitat Area (WHA)	Government of BC
Proposed WHA	Government of BC
High Elevation Winter Range (HEW)	FLNRORD
High Elevation Summer Range (HESR)	FLNRORD
Low Elevation Winter Range (LEWR)	FLNRORD
Primary prey - wolf telemetry - collar data	FLNRORD
Cutblocks - all (active and pending cutting permits)	Government of BC
Recent Burns (<40 years)	Government of BC
Hydrology and Wetlands	Government of BC / Canvec

APPENDIX I

Mountain Caribou Habitat Restoration Toolkit Treatment Matrix

Site Type	ESSFmv2 Site Series (a)	Site Series name (a)	Moisture Regime (a)	Nutrient Regime (a)	Limiting Factors (a)	Disturbance Level	CWD Level (m3/ha)	Site Prep.	Mound density/ha	Target Tree Species	Vegetation Treatment	Planting Density (stems/ha)	Final Minimum Density (stems/ha)	Stock Size
Moderately Dry	02	BI - Lingonberry	subxeric to submesic	poor to medium	Very poor soil productivity; thin soils	High - No LFH	75-100	None	None	PI; BI	Natural Seed/ Applied Seed	None	2,500	None
						Low - LFH present	75-100	None	None	PI; BI	Natural Seed/ Applied Seed	None	2,500	None
Slightly Dry to Fresh	01	BI - Rhododendron - Feathermoss	submesic to mesic	poor to medium	Reduced spring soil temperatures; thick organic horizons	High - No LFH	75-100	None	None	Bl; Se	Plant/ Natural seed	BI 2,500; Se 2,000	4,000	Large
						Low - LFH present	75-100	Screefing	None	Bl; Se	Plant/ Natural seed	BI 2,500; Se 2,000	4,000	Large
Slightly Dry to Very Moist	03	BISb - Labrador tea	submesic to hygric	very poor to poor	Reduced spring soil temperatures; thick organic horizons. Soils are saturated in spring, but may experience summer drought, both resulting in poor root development	High - No LFH	75-100	Mound	500	Bl; Sb	Plant/ Natural seed	BI 2,000; Sb 1,500	3,000	Large
						Low - LFH present	75-100	Mound	1,000	Bl; Sb	Plant/ Natural seed	BI 2,000; Sb 1,500	3,000	Large
Fresh to Moist	04	Bl - Oak fern - Knight's plume	mesic to sybhygric	medium to rich	Reduced spring soil temperatures; thick organic horizons	High - No LFH	150	None	None	Bl; Se	Plant/ Natural seed	Bl 2,500; Se 2,000	4,000	Large
						Low - LFH present	75-100	Screefing	None	Bl; Se	Plant/ Natural seed	Bl 2,500; Se 2,000	4,000	Large
Moist	05	Bl - Devil's club - Rhododendron	subhygric	rich to very rich	Reduced spring soil temperatures; thick organic horizons	High - No LFH	150	None	None	Bl; Se	Plant/ Natural seed	Bl 2,500; Se 2,000	4,000	Large
						Low - LFH present	75-100	Screefing	None	Bl; Se	Plant/ Natural seed	Bl 2,500; Se 2,000	4,000	Large
Moist to Very Moist		Bl - Alder - Horsetail	subhygric to hygric	medium to rich	Reduced spring soil temperatures; thick organic horizons; high water tables limit soil aeration and thus root development	High - No LFH	150	Mound	150	Bl; Se	Plant/ Natural seed	Bl 2,500; Se 2,000	4,000	Large
	08					Low - LFH present	75-100	Mound	300	Bl; Se	Plant/ Natural seed	BI 2,500; Se 2,000	4,000	Large
Wetland	Wf	Wetland fen	subhydric	Medium	High water tables limit soil aeration and thus root development	Same Low/High	10-50	Mound	1 000	RI: Se	Plant/Natural seed	BI 1 200 or Se 1 200	1.000	Large

#### Example Treatment Matrix for Linear Restoration - ENGELMANN SPRUCE SUBALPINE FIR - BULLMOOSE MOIST VERY COLD VARIANT

a. Source: DeLong, C., D. Tanner and M.J. Jull. 1994. A Field Guide for Site Identification and Interpretation for the Northern Rockies Portion of the Prince George Forest Region. Land Management Handbook 29. Ministry of Forests Research Branch. Victoria, BC. 149 pp.

