Caribou in Northern British Columbia

An Assessment of Range Condition and Population Status

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June 2022

WCS CANADA CONSERVATION REPORT #16

WCS CANADA

WCS Canada Conservation Reports:
ISSN 1719-8941 Conservation Report Series (Print)
ISSN 1719-8968 Conservation Report Series (Online)
ISBN 978-1-927895-22-1
Report online at doi.org/10.19121/2022.Report.44066

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Recommended Citation:
Cichowski, D., R.S. McNay, and J. C. Ray. 2022. Caribou in Northern British Columbia: An Assessment of Range Condition and Population Status. Prepared for the Habitat Conservation Trust Foundation, Victoria, B.C., and BC Ministry of Forests, Smithers, B.C. Wildlife Conservation Society Canada Conservation Report No. 16. Toronto, Ontario, Canada. doi.org/10.19121/2022.Report.44066

Cover Photos:
Front cover: Northern Mountain Caribou in the Horseranch caribou range. (© Garth Lenz) Back cover: Carcross caribou foraging in high elevation alpine summer habitat in northern BC in June. (Donald Reid)

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WCS CANADA CONSERVATION REPORT #16
JUNE 2022

CARIBOU IN NORTHERN BRITISH COLUMBIA:

AN ASSESSMENT OF RANGE CONDITION AND POPULATION STATUS

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BRITISH COLUMBIA

Acknowledgements

Funding for this project was provided by the Habitat Conservation Trust Foundation, the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC MFLNRORD), and the Annual Foundation.

We would like to thank the following individuals from the BC MFLNRORD for providing information and sharing their knowledge on caribou and their ranges in northern British Columbia: Kevin Hoekstra, Bill Jex, Mike Klaczek, Agnès Pelletier, Justin Strong, Conrad Thiessen, Megan Watters, and Mark Williams (retired). We also thank Blair Ells with the BC MFLNRORD for sharing the spatial dataset of anthropogenic habitat disturbance in northwestern British Columbia, Kelsey Russell with Yukon Government for providing information on transboundary caribou populations, and Norm MacLean for sharing an overview of recent information collected by the Tahltan Wildlife Department on the Tsenaglode caribou population. Don Reid (Wildlife Conservation Society Canada) and Agnès Pelletier reviewed an earlier draft of the report. Special thanks to Viktor Brumovsky, Wildlife Infometrics Inc., who conducted the GIS component of this project and to Conrad Thiessen for securing funding from BC MFLNRORD.

A Note About the Report

This report focusing on caribou and their ranges in northern British Columbia is a summary of available technical information only. A much broader understanding of caribou in northern British Columbia would be gained by the addition of Indigenous Knowledge, especially for long-term changes in population trend and distribution, for which only limited technical information is available.

This report benefitted from information provided to us by BC government biologists. We acknowledge that not all government biologists were able to provide a thorough review, and that interpretations of information presented in this report are our own.

Summary

Caribou in Northern British Columbia: An Assessment of Range Condition and Population Status.

Most populations of caribou (*Rangifer tarandus*) in southern British Columbia (BC) have undergone dramatic declines, especially in the last 10-20 years, with seven herds already extirpated and another ten having fewer than 50 individuals. By comparison, information available on caribou numbers in northern BC suggests that populations are typically larger than in the south, but recent population estimates are not available for many herds, and quantitative information on their range condition is lacking.

A bull caribou in high elevation alpine habitat in the Horseranch caribou range. (© Garth Lenz)

We know from abundant scientific information that caribou have a low tolerance for habitat disturbance, particularly from the combined impacts of anthropogenic (human-caused) habitat disturbance (e.g., from resource extraction activities and associated infrastructure) and fire, which results in changes to predator/prey dynamics. While not believed to be in as precarious a situation as their southern counterparts, there are still considerable concerns about the condition of northern caribou populations and their ranges, particularly due to: continued pressures from resource extraction activities, including mining, oil and gas exploration and development, and forest harvesting; roads associated with resource extraction, which can have wide impacts over large areas; and, limited information available about caribou population sizes and trends.

In this report we assess the level of anthropogenic habitat disturbance and fire combined as an indicator of the condition of individual herds and their ranges. We also discuss potential future habitat trends, and review and summarize available information on population sizes and trends. This report is a summary of available technical information only. A much

broader understanding of caribou in northern BC would be gained by the addition of Indigenous Knowledge.

Caribou in the Northern Mountain National Ecological Area (NMNEA) are currently listed as Special Concern under the federal *Species at Risk Act*. Although the Special Concern status does not invoke the general prohibitions under the Act as the current Threatened status of the caribou in the southern part of the province in the Southern Mountain National Ecological Area (SMNEA) does, the Special Concern listing indicates that they "may become a threatened or an endangered species because of a combination of biological characteristics and identified threats".

We focused on a study area that covers 17 caribou ranges in the mountainous portion of northern BC that stretches from approximately 57° latitude to the Yukon border and that lies west of Fort Nelson. Six of those ranges extend north into Yukon. Although information on exact range boundaries was lacking for some ranges, boundaries were still sufficient to provide a coarse filter view of the level of habitat disturbance on those ranges.

We then adapted a methodology developed by Environment and Climate Change Canada (ECCC) that estimates the level of habitat disturbance on caribou ranges, to the information that was available in our study area. Those methods and data sources are described in full on page 6.

The national recovery strategy for Southern Mountain Caribou identified critical habitat as habitat with minimal disturbance in high elevation winter and summer caribou range as well as in low elevation summer range, and a maximum of 35% habitat disturbance in low elevation winter range and matrix. Matrix range consists of areas within and adjacent to the annual range that caribou may or may not use, but where habitat disturbance will affect caribou through far-reaching effects on predator/prey dynamics.

Because complete information on caribou range use was lacking for northern ranges, we categorised the thresholds as follows: 1) for low elevation areas where large-scale natural disturbances such as fire play a significant role in driving overall habitat disturbance, we adopted the 35% maximum disturbance threshold and 2) for high elevation areas where fire plays a minor role we adopted the minimal (close to 0%) threshold. Matrix range was then assigned to either group based on elevation.

Although these levels of disturbance are not an absolute threshold (i.e., caribou may struggle at lower levels of disturbance or may tolerate higher levels), they are a good guide to the point at which disturbance should trigger concerns for individual caribou ranges.

For each caribou range, we summarized the extent of: each individual type of habitat disturbance; all anthropogenic habitat disturbance combined; and, total habitat disturbance (all types of anthropogenic habitat disturbance combined, plus fire).

Total habitat disturbance (low plus high elevation ranges) makes up about 15% of the combined area of all 17 ranges, with nine ranges above 10%. The three ranges with the highest level of disturbance (Pink Mountain, Muskwa, Liard Plateau) are the three easternmost caribou ranges in the study area, with the majority of habitat disturbance within them in their eastern halves.

Total habitat disturbance in low elevation range equals or exceeds the 35% threshold in five adjacent ranges, including the three easternmost ranges (Liard Plateau, Muskwa, Pink Mountain) and the two southernmost ranges (Finlay, Thutade). Total habitat disturbance in low elevation range is between 20% and 35% on three ranges: Horseranch, Little Rancheria, and Tsenaglode. (We discuss the sources of disturbance, which varies between ranges, on page 7.)

Total habitat disturbance in high elevation range exceeds the minimal (i.e. close to 0%) threshold in all 17 caribou ranges. However, in seven ranges it is less than 5% and in three it is less than 3%. The highest levels of total habitat disturbance in high elevation range are in the Muskwa, Pink Mountain and Tsenaglode ranges.

Total habitat disturbance is higher in the 20 km and 30 km matrices surrounding all 17 caribou ranges combined, than in the caribou ranges themselves. The surrounding 20 km and 30 km matrices include more low elevation range (where habitat disturbance is more prevalent) than in the caribou ranges themselves.

Caribou in low elevation habitat in the Muskwa caribou range in April. (Donald Reid)

Future trends in levels of habitat disturbance (particularly anthropogenic) for these ranges are difficult to predict. Mineral and coal claims and leases, environmental assessment applications, and timber supply reviews indicate that interest exists in resource extraction activities in the region. Where and to what extent this development will happen is more difficult to predict.

With climate change, wildfires and forest insect outbreaks are also expected to increase. Overall, climate change is expected to result in longer fire seasons and increased fire intensity for this region.

For each caribou range, we also summarized population size and trend information from available technical reports, using information from the 2014 COSEWIC status report as a baseline and updating population size and trend information where more recent information was available. (See Appendix 3 for summaries of population information for individual caribou ranges.) We were only able to determine long-term population trends for four of the 17 populations. Two were increasing (Atlin and Carcross), and two were decreasing (Liard Plateau and Pink Mountain).

Of the two populations that are experiencing known long-term declines in numbers, Pink Mountain had the highest level of anthropogenic habitat disturbance and Liard Plateau had the highest level of fire disturbance across the total range. Those two populations were also two of the three with the highest levels of total habitat disturbance over the whole range, and among the five with the highest levels of total habitat disturbance in the low elevation portions of their ranges. This is consistent with studies that have linked federally-listed Boreal Caribou population condition to habitat disturbance, and with greater impacts on ranges where habitat disturbance was primarily due to anthropogenic habitat disturbance.

Our study points to the need for proactive action for caribou ranges in northern BC, to avoid the precarious situation that caribou in the southern part of the province are in. This will require a coordinated approach across all ranges in northern BC, making caribou conservation a priority and restricting anthropogenic disturbance from core areas. We know from experience in southern BC and other areas that recovering caribou populations once they are declining is very difficult and expensive, requires the application of multiple coordinated recovery actions, and has so far resulted in limited success. Recovery to self-sustaining population status as a result of recovery efforts in caribou ranges in southern BC has yet to be achieved. Further, habitat recovery, even with restoration, can take decades. In northern BC, we still have the ability to take simpler and much more effective steps to conserve caribou if we act now.

We provide the following recommendations to help shift the existing regulatory and policy regimes to ones that provide stronger limits on the amount and spatial extent of landscape disturbances generally and thereby lessen the risk of Northern Mountain Caribou becoming threatened or endangered. All eight recommendations will need to be implemented in keeping with the *BC Declaration on the Rights of Indigenous Peoples Act* (2020) and the Declaration on the Rights of Indigenous Peoples Act Action Plan.

1. Make caribou conservation a priority in northern BC.

2. To better ensure persistence of Northern Mountain Caribou in northern BC, manage all 17 populations and ranges together as a unit.

3. Develop and implement a better system for tracking and sharing data of anthropogenic habitat disturbance (and habitat recovery) for all natural resource extraction sectors to support cumulative effects analysis and management.

4. Protect caribou habitat to provide deliberate and sustained protection of key seasonal ranges and connectivity between populations.

5. Improve our understanding of seasonal range and habitat use, and seasonal range and habitat requirements for Northern Mountain Caribou in northern BC.

6. Develop and implement priorities for habitat restoration across all 17 ranges.

7. Improve monitoring of caribou population status.

8. Revise caribou range boundaries with best available information.

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Abbreviations

BC CDC: BC Conservation Data Centre
BC MFLNRORD: BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development
COSEWIC: Committee on the Status of Endangered Wildlife in Canada
DU: Designatable Units (from COSEWIC)
EC: Environment Canada (presently ECCC)
ECCC: Environment and Climate Change Canada (previously EC)
IWMS: Integrated Wildlife Management Strategy
NEA: National Ecological Area
NMNEA: Northern Mountain National Ecological Area
NMP: Northern Mountain Population (as defined by the NMNEA in EC 2012a)
SARA: *Species at Risk Act* (Canada)
SMNEA: Southern Mountain National Ecological Area

Biogeoclimatic zones:
BAFA: Boreal Altai Fescue Alpine
BWBS: Boreal White and Black Spruce
ESSF: Engelmann Spruce-Subalpine Fir
SBS: Sub-Boreal Spruce
SWB: Spruce-Willow-Birch

Introduction

Most attention on caribou (*Rangifer tarandus*) in British Columbia (BC) has been focused in the southern part of the province, where many populations have undergone dramatic declines, especially in the last 10-20 years, with seven of 31 populations in southern BC currently considered extirpated, and another ten populations having fewer than 50 individuals (BC Caribou Recovery Program 2021). Considerably less is known about the condition of caribou populations and ranges in the mountainous region of northern BC (EC 2012a, COSEWIC 2014, BC Caribou Recovery Program 2021). Northern BC represents one of the last remaining landscapes in the province where the cumulative pressures from natural resource development remain relatively low. Yet continued interests in mineral development, oil and gas, and forestry, together with proposals for protection by Indigenous communities, demand better understanding of the status of sensitive and culturally-important wildlife like caribou, which can serve as barometers of change.

Landscape in the west-central portion of the Rabbit caribou range. (© Garth Lenz)

Together with a number of populations in Yukon and the Northwest Territories (NWT), caribou in northern BC are known as Northern Mountain Caribou – one of 11 caribou "designatable units"[1] recognized federally (COSEWIC 2014); in BC, they belong to the "northern" ecotype of caribou (IWMS 2004). These caribou live in areas where the snow is shallow enough during winter that they can dig through the snow, either in low elevation forests or on windswept alpine slopes, to feed on lichens and other forage growing on the ground (IWMS 2004). They may also eat lichens that grow on trees, both in low elevation forests and in higher elevation subalpine forests. During summer, these caribou prefer to use high elevation alpine and subalpine habitats, but also use low elevation habitat, especially when travelling between winter and summer ranges.

[1] Designatable Units are recognized by COSEWIC as discrete and evolutionarily significant units of a taxonomic species.

Caribou in northern BC in the Northern Mountain National Ecological Area (NMNEA) are currently listed as Special Concern in Schedule 1 of the *Species at Risk Act*, while caribou in southern BC in the Southern Mountain National Ecological Area (SMNEA) are currently listed as Threatened (Table 1). In 2014, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) grouped mountain-dwelling caribou in western Canada into three Designatable Units (DUs): Northern Mountain (DU7), Central Mountain (DU8), and Southern Mountain (DU9) (COSEWIC 2014). The population numbers and trends for the Central Mountain and Southern Mountain DUs met the criteria for Endangered status, while Northern Mountain DU caribou were assessed as Special Concern (COSEWIC 2014, Ray et al. 2015). As of this writing, the Minister of Environment and Climate Change Canada (ECCC) had not yet implemented COSEWIC's recommendations. The 2014 assessments were recently referred back to COSEWIC for further information or consideration due to uncertainties relating to DU delineation (including lack of inclusion of Indigenous Knowledge in delineating DUs), insufficient genetic information, and recent changes in population sizes of some herds (Government of Canada 2022). Therefore, current listings and designatable units for mountain-dwelling caribou on the *Species at Risk Act* (SARA) public registry do not reflect the latest COSEWIC assessments (Table 1). Regardless of when Schedule 1 of the *Species at Risk Act* is updated with COSEWIC's 2014 status recommendations, the current status of mountain-dwelling caribou in the northern part of BC will remain Special Concern, which indicates that they "may become a threatened or an endangered species because of a combination of biological characteristics and identified threats". As such, they are not subject to general prohibitions under the Act, nor is there any obligation to identify or protect critical habitat.

While there is ample evidence for predation as the main direct cause of boreal and mountain caribou population declines in Canada and of extirpation of many caribou populations (Seip 1992, Wittmer et al. 2005, Serrouya et al. 2011), habitat disturbance and loss from a combination of industrial activities and fire, which result in changes to predator/prey dynamics and to energy budgets, is considered the ultimate cause (Festa-Bianchet et al. 2011, Nagy-Reis et al. 2021). Increased habitat loss on caribou ranges has been linked to: reduced spatial separation between caribou and other prey or predators (Peters 2010);

Table 1. Current and recommended designations for caribou in British Columbia.

<table>
<tr><th>Area</th><th>Ecotype (IWMS 2004)[1]</th><th>Nationally Significant Population (COSEWIC 2002)/ Current SARA Designation[1]</th><th>Designatable Unit (COSEWIC 2014)/ 2014 COSEWIC Recommended Designation[1]</th><th>BC CDC population and Status (2017)[1]</th></tr>
<tr><td>Northeastern BC</td><td>Boreal</td><td>Boreal (Threatened)</td><td>Boreal (Threatened)</td><td>Boreal (Red)</td></tr>
<tr><td>Northern BC</td><td rowspan="4">Northern</td><td>Northern Mountain (Special Concern)</td><td rowspan="3">Northern Mountain (Special Concern)</td><td rowspan="3">Northern Mountain (Blue)</td></tr>
<tr><td>North central BC</td><td rowspan="3">Southern Mountain (Threatened)</td></tr>
<tr><td>West central BC</td></tr>
<tr><td>East central BC</td><td>Central Mountain (Endangered)</td><td>Central Mountain (Red)</td></tr>
<tr><td>Southeastern BC</td><td>Mountain</td><td>Southern Mountain (Endangered)</td><td>Southern Mountain (Red)</td></tr>
</table>

[1] CDC = Conservation Data Centre; COSEWIC = Committee on the Status of Endangered Wildlife in Canada; IWMS = Integrated Wildlife Management Strategy; SARA = *Species at Risk Act* (Canada)

reduced occupancy by caribou (Smith et al. 2000, Apps and McLellan 2006, Wittmer et al. 2007); reduced calf recruitment (McCarthy et al. 2011); displacement of caribou (Chubbs et al. 1993, Schaefer and Mahoney 2007, Weir et al. 2007); reduced adult caribou survival (Smith 2004, Wittmer et al. 2007); caribou population declines (Wittmer et al. 2007); and effects on caribou health (Ewacha et al. 2017, Bondo et al. 2018). Industrial activities can also affect caribou directly through impacts on forage lichens (Kranrod 1996, Sulyma 2001, Miège et al. 2001, Stevenson and Coxson 2007). For Boreal Caribou ranges, the degree of habitat disturbance (i.e., physical change to vegetation/land) on a range caused by human activities negatively affects the viability of caribou populations (EC 2011, Johnson et al. 2020).

Current survey information available on the status of caribou populations and their ranges in northern BC is limited, given the remoteness of the region and the relative infrequency of aerial surveys (EC 2012a, COSEWIC 2014). Although current population sizes are typically larger than those in southern BC, recent estimates (<5 years old) are available for only 3 out of 17 populations of Northern Mountain Caribou in northern BC (BC Caribou Recovery Program 2021). For the other 14 populations, estimates are more than 5 years old or not available (surveys were conducted for purposes other than estimating population size). Habitat disturbance due to industrial activities and corresponding risk levels are assumed to be lower for caribou ranges in northern BC than in the south. This report provides a compilation of the recent available information on levels of habitat disturbance and population status for 17 Northern Mountain Caribou ranges in northern BC, covering an area of approximately 16 million hectares.

Little Rancheria caribou in low elevation winter range. (Hilary Cooke)

The management plan for the Northern Mountain Caribou population (in the NMNEA) recommends mapping and evaluating current habitat availability in relation to habitat disturbance (human footprint, fire, forest disease outbreaks, access and development), hunting activity, and habitat connectivity, and also recommends conserving key habitats (EC 2012a). Because Special Concern species are not legally required to have critical habitat identified under SARA, the management plan does not provide specific direction related to habitat protection. By contrast, the federal recovery strategy for the threatened Southern Mountain Caribou "population" in southern BC does identify critical habitat for all herds, including nine herds that are members of the revised Northern Mountain Caribou designatable unit (EC 2014). For those "Northern Group" herds, effective protection of critical habitat includes a requirement to maintain a minimum of 65% undisturbed area within low elevation winter range and matrix (see Range categories and thresholds in Methods).

Our objectives with this technical report are:

1. to assess the levels of both fire and anthropogenic (human-caused) habitat disturbance on caribou ranges in northern BC using available GIS datasets;

2. to identify information gaps, data issues and potential future habitat trends; and,

3. to provide updated population information for caribou herds in northern BC where new survey data are available since the COSEWIC (2014) status assessment.

This report is a summary of available technical information only. A much broader understanding of caribou in northern BC would be gained by the addition of Indigenous Knowledge.

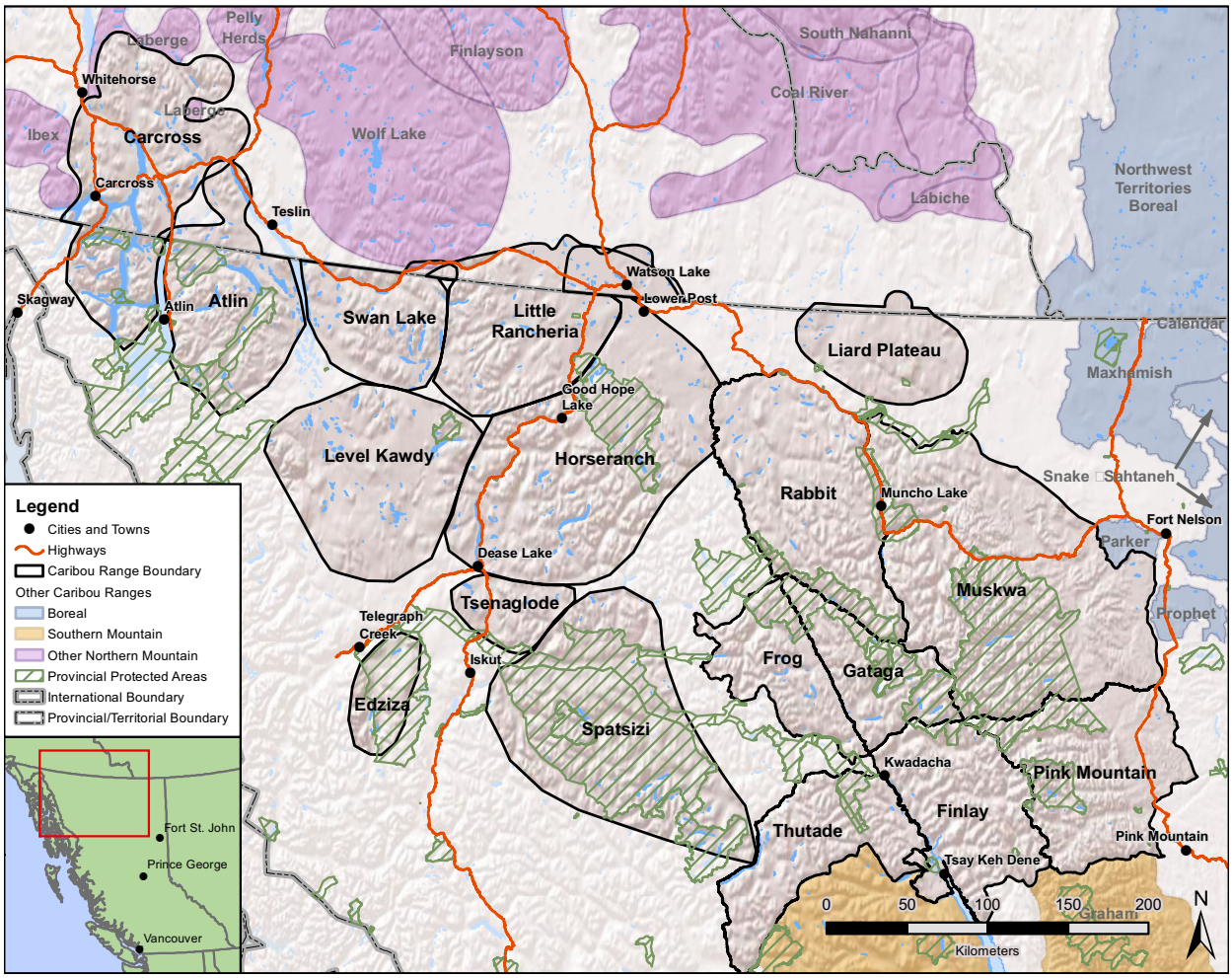
Study Area

The study area includes 17 caribou ranges in the mountainous portion of northern BC north of approximately 57° latitude to the Yukon border and west of Fort Nelson, six of which overlap with Yukon (Figure 1):

- Carcross,
- Atlin,
- Swan Lake,
- Little Rancheria,
- Horseranch,
- Level Kawdy,
- Edziza,
- Tsenaglode,
- Spatsizi,
- Liard Plateau,
- Rabbit,
- Muskwa,
- Frog,
- Gataga,
- Pink Mountain,
- Finlay, and,
- Thutade.

Low elevation areas throughout the study area lie within the Boreal White and Black Spruce (BWBS) biogeoclimatic zone, other than in the southernmost portions of the Finlay, Atlin and Carcross ranges where low elevations are made up of the Sub-Boreal Spruce (SBS) zone (Meidinger and Pojar 1991). The Spruce-Willow-Birch (SWB) zone lies above the BWBS in most of the study area except in portions of the Finlay, Thutade, Frog, Gataga, Spatsizi, Mt Edziza, and Carcross ranges, where higher elevation forested areas consist of the Engelmann Spruce-Subalpine Fir (ESSF) zone. The Boreal Altai Fescue Alpine (BAFA) zone covers the highest elevation areas throughout the study area.

Figure 1. Location of caribou ranges that are wholly or partially in northern British Columbia. The northwestern boundary of the Muskwa range and the northeastern boundary of the Rabbit range are partially overlain by the Alaska Highway.



Methods

Caribou population and range use characteristics

We conducted interviews with regional Fish and Wildlife biologists and/or caribou specialists with the BC Ministry of Forests, Lands, Natural Resource Operations and Rural Development (BC MFLNRORD) and the Yukon Ministry of Environment to: assemble technical information collected on population size or trend for caribou in northern BC (including populations/ranges shared with Yukon) since the COSEWIC status report (2014); identify potential short-term (0-10 years) and long-term (10-50 years) industrial developments on and adjacent to caribou ranges to estimate potential future risks; and, identify seasonal ranges where possible. We also reviewed available reports and published literature to summarize existing technical information on caribou seasonal range use, population size and population trend. Our interpretations of this information are our own, and have not been reviewed in depth by government biologists.

Caribou range boundaries

We talked to BC MFLNRORD regional biologists to assess whether any caribou range boundaries required adjusting prior to the analysis. Although regional biologists felt that new information merited some adjustments, they were unable to provide us with revised boundaries at this time, other than the addition of the Thutade range that covered a portion of the area between currently delineated ranges that had previously been considered to contain few caribou (see Sittler et al. 2015). Consequently, we used currently available BC caribou range boundaries, which were finalized in 2008, and the Thutade range boundary provided by BC MFLNRORD. For the Yukon portion of the ranges, we used range boundaries defined by Yukon (Hegel and Russell 2013).

Calculating habitat disturbance within caribou ranges to estimate range condition

Habitat disturbance categories and datasets

To assess range condition as a function of levels of habitat disturbance on caribou ranges in northern BC, we used the following procedure, which is based on methods used by ECCC for Boreal Caribou (EC 2011), and for the identification of critical habitat for Boreal Caribou (EC 2012b) and Southern Mountain Caribou (EC 2014):

1. We categorized habitat disturbance (using provincially-available data layers) into categories that were consistent with those used by ECCC (Table 2, EC 2011, EC 2014).

2. For anthropogenic habitat disturbance, we applied a 500 m buffer around both area-based disturbances (e.g., clearcuts, mines) and linear disturbances (e.g., roads, seismic lines) (EC 2011, 2014). The 500 m buffer was not applied to reservoirs (e.g., Williston Lake).

3. For all types of anthropogenic habitat disturbance, we dissolved the buffer around each individual type of habitat disturbance with adjoining overlapping buffers of the same type of disturbance to eliminate "double-counting" of areas within overlapping buffers (see Appendix 1). Similarly, for all anthropogenic habitat disturbance combined, we dissolved the footprints of all types of anthropogenic habitat disturbance and buffers to eliminate double-counting overlapping disturbances and their buffers.

4. To calculate total habitat disturbance, we merged the total combined anthropogenic habitat disturbance layer with the total area of fires that were less than 40 years old. Any area that was subjected to both disturbance types was dissolved to prevent "double-counting" the area in the calculation of the total area affected by habitat disturbance. Consistent with ECCC methods, areas affected by forest insects were not included in the calculation of total habitat disturbance.

Other than forest harvesting, most anthropogenic habitat disturbance is considered permanent or semi-permanent, where vegetation has been permanently removed and is not undergoing "natural" vegetation succession or has not been actively restored (Table 2). Forest harvesting and "natural" disturbances are considered temporary habitat disturbances, where vegetation eventually recovers naturally or is actively restored following the initial disturbance.

Table 2. Categories of habitat disturbance used for assessing levels of habitat disturbance on caribou ranges that are wholly or partially in northern British Columbia.

Habitat disturbance category	Habitat disturbance type	
	Permanent/ semi-permanent[1]	Temporary[2]
Anthropogenic habitat disturbance		
Settlement	X	
Agriculture	X	
Recreation	X	
Airstrip	X	
Reservoir	X	
Dam	X	
Powerline	X	
Road/trail	X	
Railroad	X	
Mine	X	
Oil/gas facility	X	
Pipeline	X	
Oil/gas well		X
Seismic line		X
Forest harvesting		X
Natural disturbance		
Fire		X
Mountain pine beetle		X
Spruce bark beetle		X
Balsam bark beetle		X

[1] The disturbed area is maintained as a permanent or long-lasting feature on the landscape where vegetation has been permanently removed and is not undergoing "natural" vegetation succession or has not been actively restored.

[2] The disturbed area is not maintained as a permanent or long-lasting feature; therefore, vegetation can re-establish following the initial disturbance either naturally or through restoration activities. Although we classified wells sites and seismic lines as temporary habitat disturbances, some of those disturbed sites are likely to require active restoration.

We assessed habitat disturbance levels by type within caribou ranges in northern BC using spatial data layers that were publicly available through the BC data warehouse and the BC Oil and Gas Commission's data portal. An additional spatial dataset that was collected for a cumulative effects project in northwestern BC that included mine footprints and mining roads, was provided by BC MFLNRORD. For the six ranges that overlapped Yukon (Carcross, Atlin, Swan Lake, Little Rancheria, Horseranch, Liard Plateau), we accessed spatial habitat disturbance data for the Yukon portion of those ranges through the Geomatics Yukon FTP site. A detailed listing of data sources is included in Appendix 2. Apart from forest harvest, dates of most anthropogenic disturbances are not available.

For determining the occurrence of anthropogenic habitat disturbance, our methods differed from those of ECCC (EC 2011, 2012b, 2014) in that ECCC mapped anthropogenic habitat disturbances that could be detected using 1:50,000 scale Landsat satellite imagery (from 2008 to 2010) and using other sources of data to aid in categorizing the type of disturbance (EC 2011). On the other hand, our methods for assessing natural disturbances were similar to those of ECCC (2011) in using provincial spatial data layers to map fires. ECCC

(2011) limited the age of fires to less than 40 years because fire data were only available for a maximum of 40 years in some provinces. We also used fires up to 40 years of age in the calculation of total habitat disturbance (consistent with EC (2011)), but there was sufficient information to assess fires up to 50 years of age, so our summary tables included both fires less than 40 years (used by EC 2011) and fires less than 50 years.

Although we used spatial data layers to quantify and delineate anthropogenic habitat disturbance while ECCC (EC 2011, 2012b, ECCC 2014) identified anthropogenic habitat disturbance from 1:50,000 scale satellite photos, we expect that the distribution and relative levels of anthropogenic habitat disturbance on the landscape would be very similar using both methods.

We accessed spatial datasets in 2017. As a result, the 40-year fire dataset includes fires from 1978 to 2017, and the 50-year fire dataset includes fires from 1968 to 2017.

In addition, we calculated the area affected by mountain pine beetles (*Dendrotonus ponderosae*) and spruce beetles (*Dendroctonus rufipennis*) from 2000 to 2017 from spatial layers that were publicly available from the BC data warehouse. Area of forest insect attack is not included as part of the overall habitat disturbance calculation by ECCC (2014) and therefore we also do not include it in our calculation of habitat disturbance. However, we report it in our summary of levels of individual types of habitat disturbances because extensive mountain pine beetle attack is present in low elevation areas in the southeastern portion of the study area.

Range categories and thresholds

To assess the significance of the level of habitat disturbance on caribou ranges in northern BC, we used the habitat disturbance thresholds identified for critical habitat that applied to the "Northern Group" of caribou in the federal recovery strategy for Southern Mountain Caribou (EC 2014) as a surrogate and adapted them to fit data that were available in our study. Of the four critical habitat attributes required by caribou to carry out life processes, three included habitat disturbance thresholds and one included a predator density threshold (Table 3). Matrix range consists of areas either within (Type 1) or surrounding (Type 2) caribou ranges where predator/prey dynamics influence predation on caribou within their annual range (EC 2014). Although caribou may not use these areas regularly, or use them less often than they use other parts of their range (such as during travel between seasonal ranges), habitat disturbance in matrix range will affect caribou through effects on predator/

Table 3. Habitat disturbance thresholds associated with critical habitat attributes for Southern Mountain Caribou that are applicable to "Northern Group" caribou (from EC 2014).

Critical habitat attribute	Habitat disturbance threshold[1]
High elevation winter and/or summer range	Minimal (i.e. close to 0%)
Low elevation summer range	Minimal (i.e. close to 0%)
Low elevation winter range + Type 1 matrix range	35%
Type 2 matrix range[3]	NA[4]

[1] Total habitat disturbance = anthropogenic habitat disturbance (including a 500 m buffer) + fire (no buffer)
[2] Type 1 matrix range = matrix range within the annual range (from EC 2014)
[3] Type 2 matrix range = matrix range surrounding annual range (from EC 2014)
[4] Threshold is a wolf density of < 3 wolves/1000 km (from EC 2014)

prey dynamics. Overall, critical habitat in the recovery strategy has been defined as minimal to no habitat disturbance in high elevation winter and/or summer range and in low elevation summer range, and a maximum of 35% habitat disturbance in low elevation winter range and matrix (Table 3).

Top: Example of Horseranch and Little Rancheria caribou low elevation winter range with extensive mature coniferous forests. Bottom: During winter, caribou use open mature coniferous stands with an abundant ground cover of lichens (light colour). (Donald Reid)

The 35% habitat disturbance threshold for low elevation winter range + Type 1 matrix range is based on a meta-analysis that was conducted for Boreal Caribou ranges in Canada (EC 2011, EC 2014). Although a similar analysis for Southern Mountain Caribou is not available, the 35% habitat disturbance threshold was chosen as a reference level because low elevation winter ranges and matrix range in "Northern Group" caribou ranges are ecologically similar to Boreal Caribou ranges (EC 2014). That is, fire plays a significant role in natural disturbance dynamics in low elevation winter ranges and adjacent matrix range for "Northern Group" caribou, which is similar to the role of fire in natural disturbance dynamics in Boreal Caribou ranges (EC 2014).

It is, however, important to stress that the threshold applied originally to identify critical habitat in the Boreal Caribou recovery strategy (EC 2012b) and then used to characterize Southern Mountain Caribou critical habitat (EC 2014) is a "management threshold" informed by science, i.e., an empirical relationship between landscape disturbance and population health, as indicated by recruitment (EC 2011). Because the "disturbance-recruitment relationship" is in reality characterized by a continuum of risk, and not an inflection point (Johnson and Ray 2021), the management threshold associated with critical habitat identification reflects a social decision accepting a 60% probability of persistence. In this report, we use habitat disturbance levels within caribou ranges relative to these thresholds to relate recent habitat conditions to the likelihood of population persistence derived from the critical habitat model (EC 2011).

To apply ECCC's (EC 2014) habitat disturbance thresholds as a management indicator, we required information on individual critical habitat attributes for each range in northern BC. However, there was insufficient information for most caribou ranges in BC for MFLNRORD regional biologists to provide us with seasonal or matrix ranges. Therefore, we simplified the categories into "high elevation range" and "low elevation range" and applied habitat disturbance thresholds from ECCC (2014) that reflected natural disturbance dynamics (Table 4). That is, we used the 35% threshold for low elevation range where large

Table 4. Range categories and habitat disturbance thresholds used for analysis of habitat disturbance on caribou ranges that are wholly or partially in northern British Columbia, adapted from EC (2014).

Range category	Maximum habitat disturbance[1]
High elevation range[2]	Minimal (i.e. close to 0%)
Low elevation range[3]	35%

[1] Habitat disturbance = anthropogenic habitat disturbance (including a 500 m buffer) + fire (no buffer)
[2] Includes high elevation Type 1 matrix range
[3] Includes low elevation Type 1 matrix range

scale natural disturbances such as fire play a significant role in driving overall habitat disturbance, and used the minimal (i.e. close to 0%) threshold for high elevation ranges where fire plays a minor role. Low elevation Type 1 matrix range is included in the "Low elevation range" category and High elevation Type 1 matrix range is included in the "High elevation range" category.

High elevation alpine habitat in the Horseranch caribou range. (© Garth Lenz)

In the absence of previously delineated high and low elevation ranges, we used the BAFA, ESSF and SWB biogeoclimatic zones to represent high elevation range, and the remaining area (BWBS and SBS zones) to represent low elevation range. We considered these reasonable ecological approximations that could be applied consistently across all ranges. High elevation ranges include areas above about 800-1200 m (depending on location within the study area), based on the lower boundary of the high elevation biogeoclimatic zones (Banner et al. 1993, DeLong 2004). For the Yukon portions of the six transboundary ranges, we estimated the extent of high elevation range using Yukon Territory's Bioclimate Zones data set. We considered any area covered by the Boreal Alpine Tundra, Boreal High, or Boreal Subalpine zones to be high elevation range with the remainder (i.e. Boreal

Low) classed as low elevation range. Initially, for the Yukon portion of the caribou ranges, we attempted to approximate high elevation range by determining the average elevation of the boundary between the BWBS and SWB zones at the BC/Yukon boundary, but this approach did not capture the biogeoclimatic variability of the landscape as well as the bioclimate zone data did. Additionally, a small portion of the 30 km matrix (see below) extends into the state of Alaska (~40 850 ha). In that case, we approximated the high and low elevation zones using manual digitization based on Bing Maps imagery using the adjacent BC biogeoclimatic mapping as a guide. This was only feasible due to the small size of the area that needed to be mapped.

In addition to assessing habitat disturbance levels within currently-delineated caribou range boundaries in northern BC, we conducted similar assessments in areas surrounding each range within 20 km and within 30 km of each range boundary. The two distances provide options for assessing the level and types of habitat disturbance in matrix range that surrounds individual caribou ranges. The surrounding area also provides spatial context for where habitat disturbance is located if adjustments are made to caribou range boundaries in the future.

Range condition summaries

For each caribou range, for both high elevation and low elevation portions, we summarized:

- the extent of habitat disturbance due to: each type of anthropogenic habitat disturbance; and, each type of natural disturbance (fires <40 years, fires <50 years, forest insect attack);
- the extent of anthropogenic habitat disturbance for all types combined;
- the extent of total habitat disturbance (all types of anthropogenic habitat disturbance combined plus fires less than 40 years old); and,
- within 20 km and 30 km surrounding each caribou range, the extent of habitat disturbance due to: each type of habitat disturbance; all types of anthropogenic habitat disturbance combined; and, total habitat disturbance (including fire).

For the six transboundary caribou ranges, we summarized the habitat disturbance information described above for the BC portion of each range, and for the total area of each range (BC + Yukon).

We also summarized the information described above for individual ranges and for the aggregated area of all caribou ranges combined, including the extent of habitat disturbance within 20 km and 30 km surrounding each range and the aggregated area.

The results section contains roll-ups of information across all caribou ranges in the study area. Maps and summaries of information for individual caribou herds and their ranges are provided in Appendix 3.

Population status

For each caribou herd, we summarized population information from available technical reports. We used information from the 2014 COSEWIC status report (COSEWIC 2014) as a baseline and updated population size and trend information where more recent information was available. Detailed summaries for each caribou herd are provided in Appendix 3.

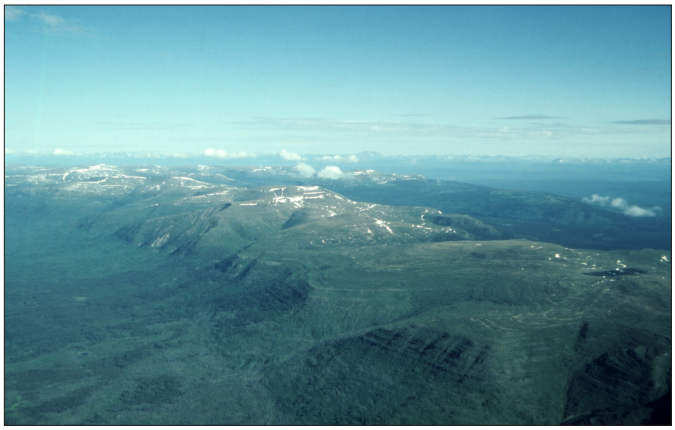
Where possible, we assessed population trend, based on consecutive population surveys or measures of calf recruitment (see detailed methods in Appendix 3). We explored the relationship between habitat disturbance levels on individual ranges to their corresponding population trends. Subsequent to our initial compilation of population information, the BC Caribou Recovery Program developed a summary of population size and trend information for all caribou populations in BC (BC Caribou Recovery Program 2021), which we checked against the estimates we derived. For population trend, we used long-term population trend information summarized from Appendix 3.

Caribou ranges

We identified several potential issues with range boundaries in the study area (Table 5) including:

- the BC and Yukon boundaries for the six transboundary ranges did not line up, as they were derived independently in each jurisdiction;
- most range boundaries in northwestern BC were coarsely drawn, resulting in gaps between ranges that likely do not reflect actual gaps in distribution;
- discussions with BC MFLNRORD biologists, and telemetry and observation data suggest that:
    - some ranges may need to be expanded into areas that are currently not included in any caribou ranges;
    - distribution of several caribou populations overlap and therefore range boundaries should overlap in those areas;
- the large gap between caribou ranges in the centre of the study area is known to contain caribou (see Appendix 3: Range Summaries – Low density area) and may need to be incorporated into adjacent ranges, or added as new range(s); and,
- the Edziza caribou range is offset from the known range, excluding the eastern portion of the Mt Edziza mountain block.

We could not address these boundary issues at this time (see Caribou range boundaries); therefore, we used the currently available caribou boundaries.



High elevation plateaus, such as the Spatsizi Plateau, are used by caribou during both summer and winter. (Deborah Cichowski)

Approximately two-thirds of the combined area in currently-delineated caribou ranges in northern BC consists of high elevations as defined by the SWB, ESSF or BAFA biogeoclimatic zones (Table 6, Figure 2). The other third consists of low elevations, primarily in the BWBS. Within individual caribou ranges, the extent of high elevation range varies from 47% in the Little Rancheria range to 89% in the Frog, Thutade and Tsenaglode ranges.

Table 5. Potential boundary issues for caribou ranges that are wholly or partially in northern British Columbia.

Potential boundary issue	Carcross	Atlin	Swan Lake	Little Rancheria	Horseranch	Level Kawdy	Edziza	Tsenaglode	Spatsizi	Liard Plateau	Rabbit	Muskwa	Pink Mountain	Gataga	Frog	Finlay	Thutade
BC/Yukon caribou range boundaries do not line up	X	X	X	X	X					X							
Range boundaries coarsely drawn resulting in gaps between ranges	X	X	X	X	X	X		X	X								
Telemetry and observation data suggest boundaries should be expanded into some areas that are currently not included in any caribou ranges									X						X		
Telemetry data suggest overlap between adjacent ranges			X	X	X	X		X	X				X			X	
The large gap between caribou ranges in the centre of the study area is known to contain caribou					X			X	X		X				X		
Boundaries coarse and offset from known range use							X										
Available information insufficient to evaluate issues with boundaries											X			X	X		

Table 6. High and low elevation proportions (%), and total area of each caribou range and of the 20 km and 30 km matrix surrounding ranges for caribou ranges that are wholly or partially in northern British Columbia.

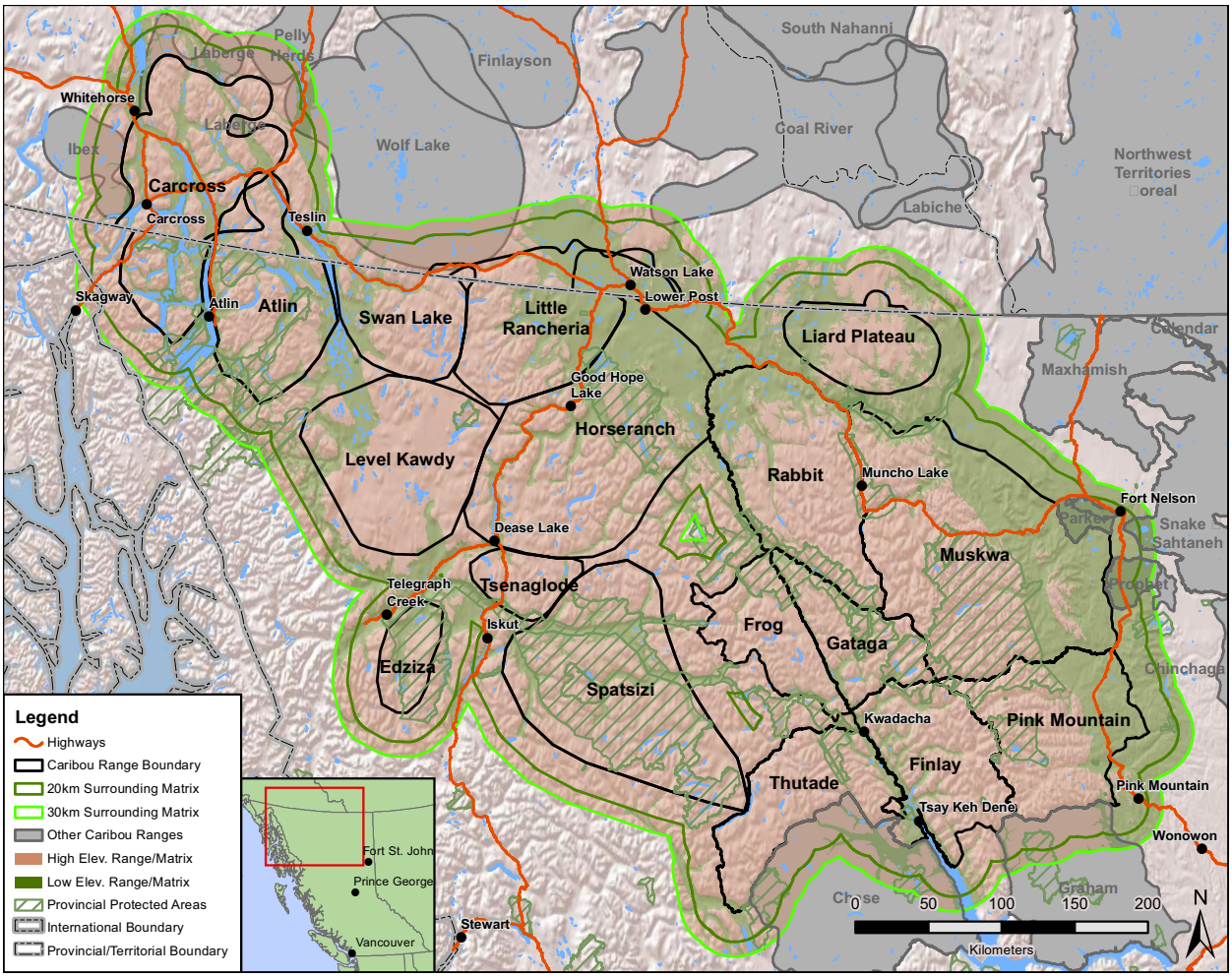
	Range			0-20 km matrix surrounding range				0-30 km matrix surrounding range			
	Low elevation[1]	High elevation[2]	Total Range (ha)	Low elevation[1]	High elevation[2]	Total Range (ha)	% of matrix in adjacent range[3]	Low elevation[1]	High elevation[2]	Total Range (ha)	% of matrix in adjacent range[3]
Atlin (Total)	40.3	59.7	858 401	54.2	45.8	959 801	35.7 (NM)	53.0	47.0	1 516 826	41.0 (NM)
Atlin (BC only)	41.9	58.1	695 385	62.8	37.2	566 293	30.7 (NM)	59.9	40.1	893 837	37.2 (NM)
Carcross (Total)	40.7	59.3	1 273 592	32.7	67.3	1 203 133	41.2 (NM)	29.5	70.5	1 870 606	41.6 (NM)
Carcross (BC only)	49.0	51.0	324 060	36.2	63.8	413 599	20.4 (NM)	30.7	69.3	632 286	25.6 (NM)
Edziza	27.3	72.7	235 185	36.4	63.6	514 300	0	39.6	60.4	865 688	0.2 (NM)
Finlay	24.1	75.9	817 094	23.8	76.2	982 244	62.7 (NM) 22.1 (SM)	20.9	79.1	1 525 168	60.4 (NM) 25.6 (SM)
Frog	11.3	88.7	504 069	22.9	77.1	885 050	41.0 (NM)	21.5	78.5	1 392 243	63.1 (NM)
Gataga	22.3	77.7	500 703	18.7	81.3	845 787	92.3 (NM)	16.4	83.6	1 352 795	90.6 (NM)
Horseranch (Total)	47.3	52.7	1 945 173	51.4	48.6	1 473 971	57.2 (NM)	48.5	51.5	2 272 285	57.3 (NM)
Horseranch (BC only)	42.9	57.1	1 779 688	45.8	54.2	1 195 352	63.3 (NM)	43.8	56.2	1 807 609	65.7 (NM)
Level Kawdy	14.3	85.7	1 135 902	36.8	63.2	921 841	36.6 (NM)	36.5	63.5	1 477 004	41.5 (NM)
Liard Plateau (Total)	48.9	51.1	520 304	74.2	25.8	690 962	8.9 (NM)	76.2	23.8	1 128 170	15.8 (NM)
Liard Plateau (BC only)	49.1	50.9	475 350	91.5	8.5	435 358	14.2 (NM)	89.9	10.1	696 906	25.6 (NM)
Little Rancheria (Total)	53.4	46.6	1 055 816	45.3	54.7	1 054 289	58.5 (NM)	42.7	57.3	1 662 553	60.6 (NM)
Little Rancheria (BC only)	46.0	54.0	698 569	41.2	58.8	612 209	83.3 (NM)	41.6	58.4	957 387	85.7 (NM)
Muskwa	41.8	58.2	2 158 213	56.6	43.4	1 481 104	54.4 (NM) 9.9 (Boreal)	56.0	44.0	2 281 006	56.4 (NM) 8.4 (B)
Pink Mountain	34.8	65.2	957 542	45.7	54.3	1 067 608	53.3 (NM) 15.2 (SM)	44.1	55.9	1 669 138	51.4 (NM) 15.0 (SM) 0.1 (Boreal)
Rabbit	31.7	68.3	1 179 409	47.9	52.1	1 093 947	64.7 (NM)	45.1	54.9	1 721 485	67.5 (NM)
Spatsizi	17.7	82.3	1 565 613	9.3	90.7	1 169 526	22.6 (NM)	9.5	90.5	1 848 437	27.1 (NM)
Swan Lake (Total)	23.2	76.8	585 080	26.1	73.9	748 067	68.7 (NM)	25.0	75.0	1 212 853	73.7 (NM)
Swan Lake (BC only)	24.3	75.7	557 190	32.0	68.0	472 321	71.6 (NM)	30.5	69.5	753 031	77.4 (NM)
Thutade	11.2	88.8	711 930	27.0	73.0	1 033 466	30.6 (NM) 27.9 (SM)	25.2	74.8	1 619 076	33.2 (NM) 26.7 (SM)
Tsenaglode	11.2	88.8	247 008	35.0	65.0	521 447	58.8 (NM)	35.0	65.0	876 415	61.9 (NM)
All Ranges (Total)	32.1	67.9	16 049 860	44.5	55.5	7 214 147	–	44.2	55.8	9 919 904	–
All Ranges (BC only)	30.8	69.1	14 537 257	46.3	53.7	5 557 502	–	46.0	54.0	7 383 130	–

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Figure 2. The extent of low and high elevation ranges within each caribou range and within the 20-km and 30-km surrounding matrix for caribou ranges that are wholly or partially in northern British Columbia.



The matrix range surrounding the combined area of caribou ranges in northern BC contains more low elevation areas than the caribou ranges themselves (Table 6). High elevations make up 56% of the surrounding matrix range within both 20 km and 30 km of the combined range boundary, and vary from 9-10% for the BC portion of the Liard Plateau range to 91% for the Spatsizi range.

Most caribou ranges in northern BC lie adjacent to other caribou ranges and overlap in some areas (Figure 2). The Edziza range is the only caribou range where the 20 km and 30 km surrounding matrices do not overlap with any other caribou ranges, although they overlap 20 km and 30 km surrounding matrices of other ranges (Table 6).

Otherwise, between 9% and 92% of the 20 km surrounding matrix, and between 16% and 91% of the 30 km surrounding matrix overlap adjacent ranges. The majority of the overlap occurs with other Northern Mountain National Ecological Area (NEA) ranges, but some also occurs with Boreal NEA and Southern Mountain NEA ranges (Table 6, see Figure 1).

Results

Range condition

Total habitat disturbance (anthropogenic + 500 m buffer, and fires <40 years old) makes up about 15% of the area in all 17 caribou ranges combined (Table 7). Nine of the 17 ranges each contain more than 10% habitat disturbance. The three caribou ranges with the highest levels of habitat disturbance (Pink Mountain, Muskwa, Liard Plateau) are the three easternmost caribou ranges in the study area, with the majority of habitat disturbance located in the eastern portions of their ranges (Figure 3). The lowest levels of total habitat disturbance (<8% disturbance) are in the Frog, Gataga, Level Kawdy, Rabbit and Spatsizi ranges, and in the BC portion of the Carcross range (Table 7).

The amount of anthropogenic habitat disturbance is greater than the amount of fire in most (8/9) ranges with >10% habitat disturbance (Table 7). Fire plays a larger role in driving total habitat disturbance levels in ranges with <10% habitat disturbance, where half (4/8) of the ranges contain more fire than anthropogenic habitat disturbance (Table 7).

Figure 3. Distribution of fire and anthropogenic habitat disturbance on caribou ranges that are wholly or partially in northern British Columbia.

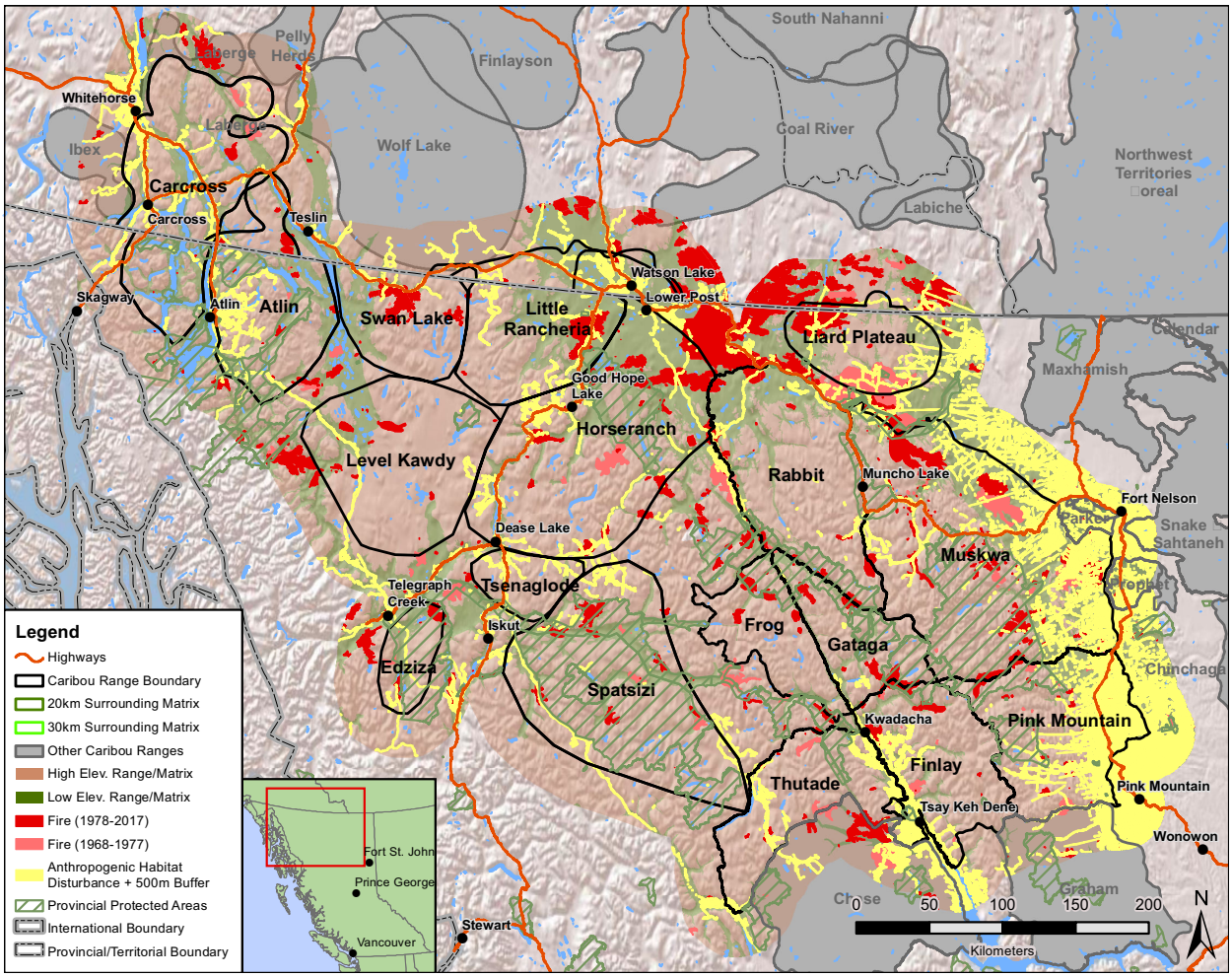


Table 7. Proportion (%) of each caribou range, and of the 20 km and 30 km matrix surrounding ranges, consisting of fires <40 years old, total anthropogenic habitat disturbance, and total habitat disturbance (fires <40 years old + anthropogenic habitat disturbance), for caribou ranges that are wholly or partially in northern British Columbia.

	Range				0-20 km matrix surrounding range				0-30 km matrix surrounding range			
	Area	Fire <40 years	Total Anthro. Disturbance	Total[1] Habitat Disturbance	Area	Fire <40 years	Total Anthro. Disturbance	Total[1] Habitat Disturbance	Area	Fire <40 years	Total Anthro. Disturbance	Total[1] Habitat Disturbance
Atlin (Total)	858 401	1.9	9.6	11.5	959 801	1.7	5.0	6.6	1 516 826	1.8	4.3	6.0
Atlin (BC only)	695 385	0.8	10.7	11.5	566 293	2.5	3.3	5.7	893 837	2.4	2.8	5.2
Carcross (Total)	1 273 592	0.4	8.4	8.8	1 203 133	1.9	10.7	12.5	1 870 606	1.6	9.6	11.1
Carcross (BC only)	324 060	0	2.6	2.6	413 599	0.2	10.4	10.5	632 286	0.1	10.4	10.5
Edziza	235 185	4.8	5.1	9.5	514 300	4.2	6.4	9.9	865 688	3.3	7.7	10.6
Finlay	817 094	3.3	13.3	16.1	982 244	5.7	15.5	20.8	1 525 168	5.4	13.3	18.4
Frog	504 069	4.2	0.1	4.3	885 050	3.5	2.0	5.3	1 392 243	3.7	2.4	5.6
Gataga	500 703	5.1	1.7	6.8	845 787	5.8	1.2	6.9	1 352 795	6.1	2.3	8.0
Horseranch (Total)	1 945 173	5.7	9.2	14.4	1 473 971	12.1	10.4	21.0	2 272 285	12.5	8.6	19.7
Horseranch (BC only)	1 779 688	5.9	7.0	12.5	1 195 352	12.7	10.4	21.4	1 807 609	12.0	8.6	19.0
Level Kawdy	1 135 902	1.4	1.6	3.0	921 841	4.4	5.1	9.4	1 477 004	3.6	6.5	9.9
Liard Plateau (Total)	520 304	11.6	11.0	20.9	690 962	21.8	14.4	33.2	1 128 170	23.6	13.4	33.7
Liard Plateau (BC only)	475 350	10.4	11.1	19.9	435 358	16.1	20.0	32.3	696 906	17.8	19.2	32.5
Little Rancheria (Total)	1 055 816	5.4	11.7	16.1	1 054 289	6.7	10.3	16.4	1 662 553	10.8	8.3	18.4
Little Rancheria (BC only)	698 569	6.7	7.0	12.5	612 209	5.7	11.0	15.9	957 387	9.1	8.5	16.7
Muskwa	2 158 213	8.4	19.4	25.8	1 481 104	5.1	29.1	32.7	2 281 006	4.4	29.3	32.5
Pink Mountain	957 542	2.2	33.9	35.4	1 067 608	3.2	34.1	36.7	1 669 138	4.7	34.7	37.9
Rabbit	1 179 409	3.6	3.6	6.7	1 093 947	13.2	8.4	19.7	1 721 485	15.6	7.2	20.8
Spatsizi	1 565 613	2.4	3.3	5.5	1 169 526	0.8	6.6	7.2	1 848 437	0.8	5.8	6.4
Swan Lake (Total)	585 080	6.2	3.5	9.4	748 067	0.7	6.0	6.7	1 212 853	0.8	4.8	5.5
Swan Lake (BC only)	557 190	6.5	3.0	9.2	472 321	0.9	2.8	3.7	753 031	1.0	1.9	2.9
Thutade	711 930	1.8	10.1	11.3	1 033 466	4.7	13.1	17.3	1 619 076	3.0	11.6	14.3
Tsenaglode	247 008	0	11.4	11.4	521 447	3.3	12.3	15.2	876 415	3.4	10.3	13.4
All Ranges (Total)	16 049 860	4.2	9.9	13.6	7 214 147	6.5	15.7	21.5	9 919 904	7.1	16.3	22.5
All Ranges (BC only)	14 537 257	4.4	9.7	13.5	5 557 502	6.0	17.7	22.8	7 383 130	6.0	19.5	24.4

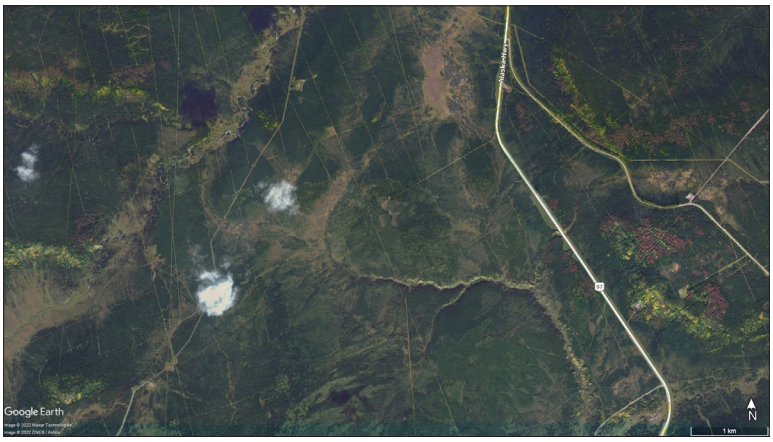
[1] Total habitat disturbance takes into account overlap between fire and anthropogenic habitat disturbance (anthropogenic habitat disturbance includes a 500 m buffer). Therefore, the amount of total habitat disturbance is less than the sum of the two types of habitat disturbance on ranges where overlaps between fire and anthropogenic habitat disturbance occur. Grey shading indicates ranges with >10% total habitat disturbance.

Total habitat disturbance is higher in the surrounding 20 km and 30 km matrices than in the caribou ranges themselves for all 17 caribou ranges combined (Table 7). Overall, the surrounding 20 km and 30 km matrices include more low elevation range than the caribou ranges (see Table 6).

In all 17 caribou ranges, the level of total and anthropogenic habitat disturbance is higher in low elevation range than in high elevation range (Table 8). The percent of area affected by fires <40 years is higher in low elevation range than in high elevation range in most (13/17) caribou ranges (Table 8). The extent of anthropogenic habitat disturbance is higher than the extent of fire disturbance in low elevation range in 10 of 17 ranges, and in high elevation range in 11 of 17 ranges (Table 8).

In all 17 caribou ranges combined, total habitat disturbance is 30% in low elevation range, and 8% in high elevation range (Table 8). Total habitat disturbance in high elevation range exceeds the "Minimal (i.e. close to 0%)" threshold in all 17 caribou ranges; in seven ranges it is less than 5%, and in three less than 3%. The highest level of total habitat disturbance in high elevation range is in the Muskwa, Pink Mountain and Tsenaglode ranges (Table 8). Total habitat disturbance in low elevation range equals or exceeds the 35% threshold in five adjacent ranges including the three easternmost ranges (Liard Plateau, Muskwa, Pink Mountain) and the two southernmost ranges (Finlay, Thutade; Table 8, Figure 3, Figure 4). Total habitat disturbance in low elevation range is between 20% and 35% on three ranges: Horseranch, Little Rancheria, and Tsenaglode.

For most caribou ranges, the majority of fires were <40 years of age, except in the Liard Plateau range where over half of the fires <50 years of age were 40-50 years old (Table 9, Figure 3). Forest insect disturbance levels were most prominent in the Finlay and Thutade ranges (Table 9, Figure 5), most of which was due to mountain pine beetles (*Dendroctonus ponderosae*). Disturbances caused by forest insects were also present in the Pink Mountain, Frog and Gataga ranges, but to a lesser extent. Although we do not provide information on balsam bark beetles (*Dryocoetes confusus*), they are present throughout the study area.



Seismic lines in the eastern portion of the Pink Mountain caribou range. (Satellite image from Google Earth)

Linear features (e.g., roads, trails, seismic lines and pipelines), primarily roads/trails, were the most prominent anthropogenic habitat disturbance on all caribou ranges (Table 9), at both high and low elevations (Table 10, Table 11). From the spatial data layers we were using, there was a high degree of overlap between roads and trails, therefore we were unable to distinguish between those two types of linear features using spatial layers. Also, roads and trails varied from hiking/horse trails to paved highways, resulting in a wide range of types of access that we were not able to distinguish between. There was also overlap between seismic lines and roads/trails.

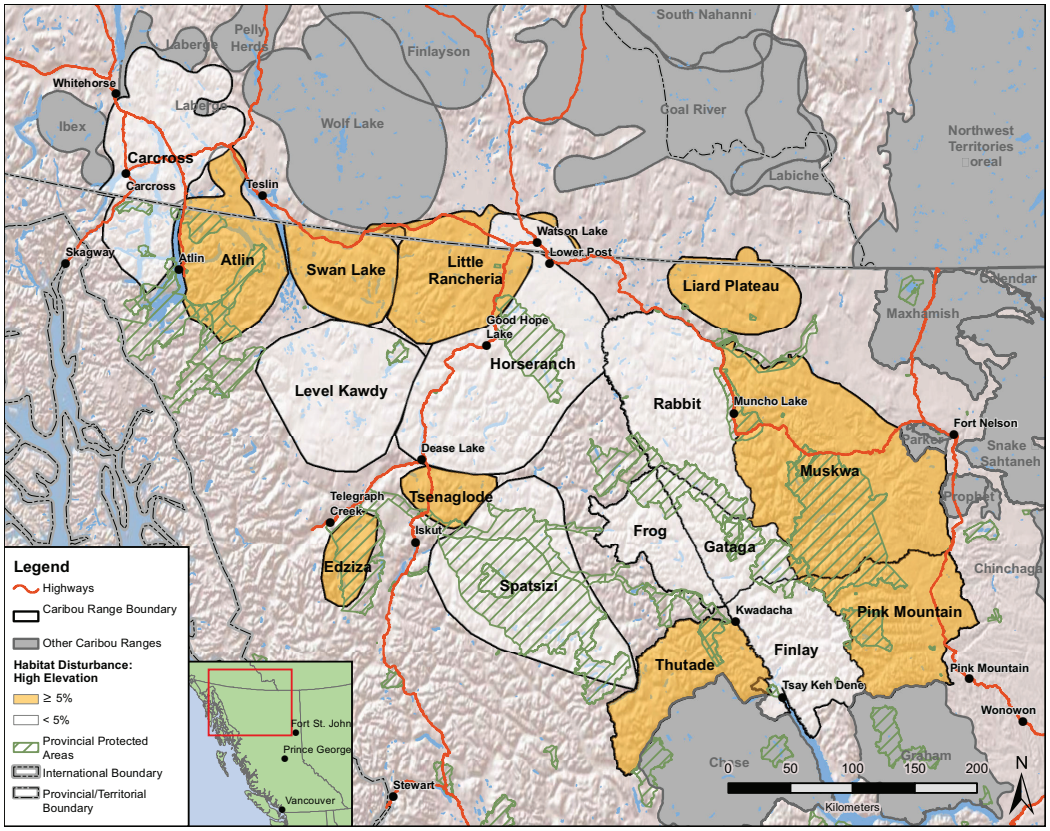
Table 8. Proportion (%) of total range, low elevation range, and high elevation range consisting of fires <40 years old, total anthropogenic habitat disturbance, and total habitat disturbance (due to fires <40 years old + anthropogenic disturbance) on caribou ranges that are wholly or partially in northern British Columbia.

	Total[1]				Low elevation[1]				High elevation[1]			
	Area (ha)	Fire <40 years	Total Anthro. Habitat Disturbance	Total[2] Habitat Disturbance	Area (ha)	Fire <40 years	Total Anthro. Habitat Disturbance	Total[2] Habitat Disturbance	Area (ha)	Fire <40 years	Total Anthro. Habitat Disturbance	Total[2] Habitat Disturbance
Atlin (Total)	858 401	1.9	9.6	11.5	346 303	4.0	14.2	18.2	512 097	0.5	6.5	7.0
Atlin (BC only)	695 385	0.8	10.7	11.5	291 045	1.6	14.3	15.9	404 341	0.2	8.1	8.3
Carcross (Total)	1 273 592	0.4	8.4	8.8	518 781	0.2	17.9	18.1	754 811	0.5	2.0	2.5
Carcross (BC only)	324 060	0	2.6	2.6	158 865	0	5.0	5.0	165 196	0	0.2	0.2
Edziza	235 185	4.8	5.1	9.5	64 255	10.5	7.3	17.8	170 929	2.7	4.2	6.4
Finlay	817 094	3.3	13.3	16.1	197 112	7.1	46.7	51.9	619 983	2.1	2.7	4.8
Frog	504 069	4.2	0.1	4.3	57 099	10.9	1.1	12.0	446 969	3.4	0	3.4
Gataga	500 703	5.1	1.7	6.8	111 491	10.7	5.3	16.0	389 212	3.6	0.6	4.2
Horseranch (Total)	1 945 173	5.7	9.2	14.4	920 489	10.7	15.2	24.9	1 024 684	1.1	3.8	4.9
Horseranch (BC only)	1 779 688	5.9	7.0	12.5	762 958	12.3	11.4	22.7	1 016 730	1.2	3.7	4.9
Level Kawdy	1 135 902	1.4	1.6	3.0	161 995	3.4	3.8	7.1	973 907	1.1	1.2	2.3
Liard Plateau (Total)	520 304	11.6	11.0	20.9	254 275	22.6	15.1	34.3	266 029	1.1	7.2	8.2
Liard Plateau (BC only)	475 350	10.4	11.1	19.9	233 434	20.1	15.6	32.5	241 916	1.0	6.9	7.8
Little Rancheria Total)	1 055 816	5.4	11.7	16.1	563 685	9.7	15.9	23.8	492 131	0.5	6.8	7.2
Little Rancheria (BC only)	698 569	6.7	7.0	12.5	321 110	14.5	8.0	19.7	377 459	0.2	6.2	6.4
Muskwa	2 158 213	8.4	19.4	25.8	901 281	11.3	39.4	46.2	1 256 932	6.3	5.1	11.1
Pink Mountain	957 542	2.2	33.9	35.4	332 894	2.2	71.8	72.3	624 647	2.2	13.7	15.7
Rabbit	1 179 409	3.6	3.6	6.7	374 007	8.4	8.2	15.2	805 402	1.4	1.4	2.8
Spatsizi	1 565 613	2.4	3.3	5.5	277 677	7.4	4.2	11.0	1 287 936	1.3	3.1	4.4
Swan Lake (Total)	585 080	6.2	3.5	9.4	135 756	6.4	8.2	13.9	449 324	6.1	2.1	8.1
Swan Lake (BC only)	557 190	6.5	3.0	9.2	135 228	6.5	8.0	13.9	421 963	6.5	1.4	7.8
Thutade	711 930	1.8	10.1	11.3	79 848	7.3	47.6	50.4	632 082	1.1	5.4	6.3
Tsenaglode	247 008	0	11.4	11.4	27 740	0	29.5	29.5	219 268	0	9.1	9.1
All Ranges (Total)	16 049 860	4.2	9.9	13.6	5 158 612	8.5	22.4	29.3	10 891 248	2.2	4.0	6.1
All Ranges (BC only)	14 537 257	4.4	9.7	13.5	4 482 822	9.2	22.3	29.6	10 045 117	2.3	4.1	6.3

[1] Total range, low elevation range and high elevation range include only the area within a caribou herd's range and do not include the 20 km or 30 km surrounding matrix.

[2] Total habitat disturbance takes into account overlap between fire and anthropogenic habitat disturbance (anthropogenic habitat disturbance includes a 500 m buffer). Therefore, the amount of total habitat disturbance is less than the sum of the two types of habitat disturbance on ranges where overlaps between fire and anthropogenic habitat disturbance occur. For low elevation range, orange shading indicates ranges with ≥35% total habitat disturbance and yellow shading indicates ranges with 20-34% total habitat disturbance. For High elevation range, orange shading indicated ranges with ≥5% total habitat disturban

Figure 4. Caribou ranges that are wholly or partially in northern British Columbia with total habitat disturbance in high elevation range ≥5% (orange) and <5% (white) (top), and in low elevation range ≥35% (orange), 20-34% (yellow) and <20% (white) (bottom).



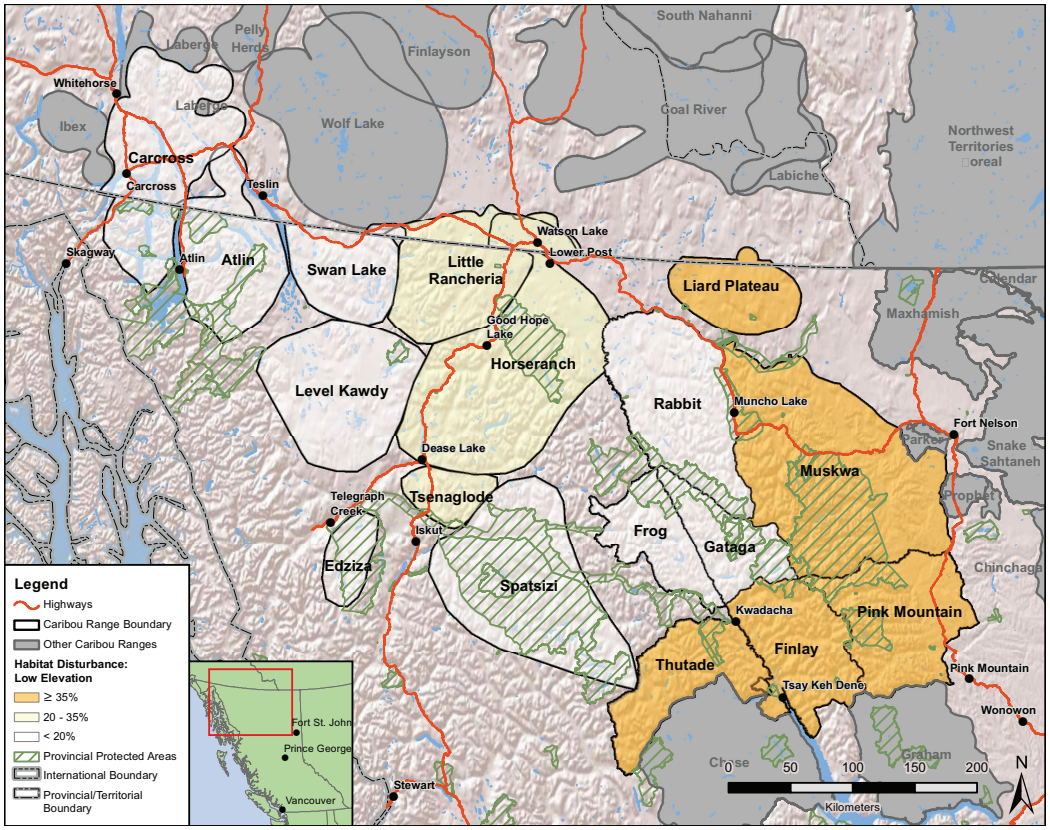


Table 9. Proportion (%) of total area in each habitat disturbance category in caribou ranges that are wholly or partially in northern British Columbia.

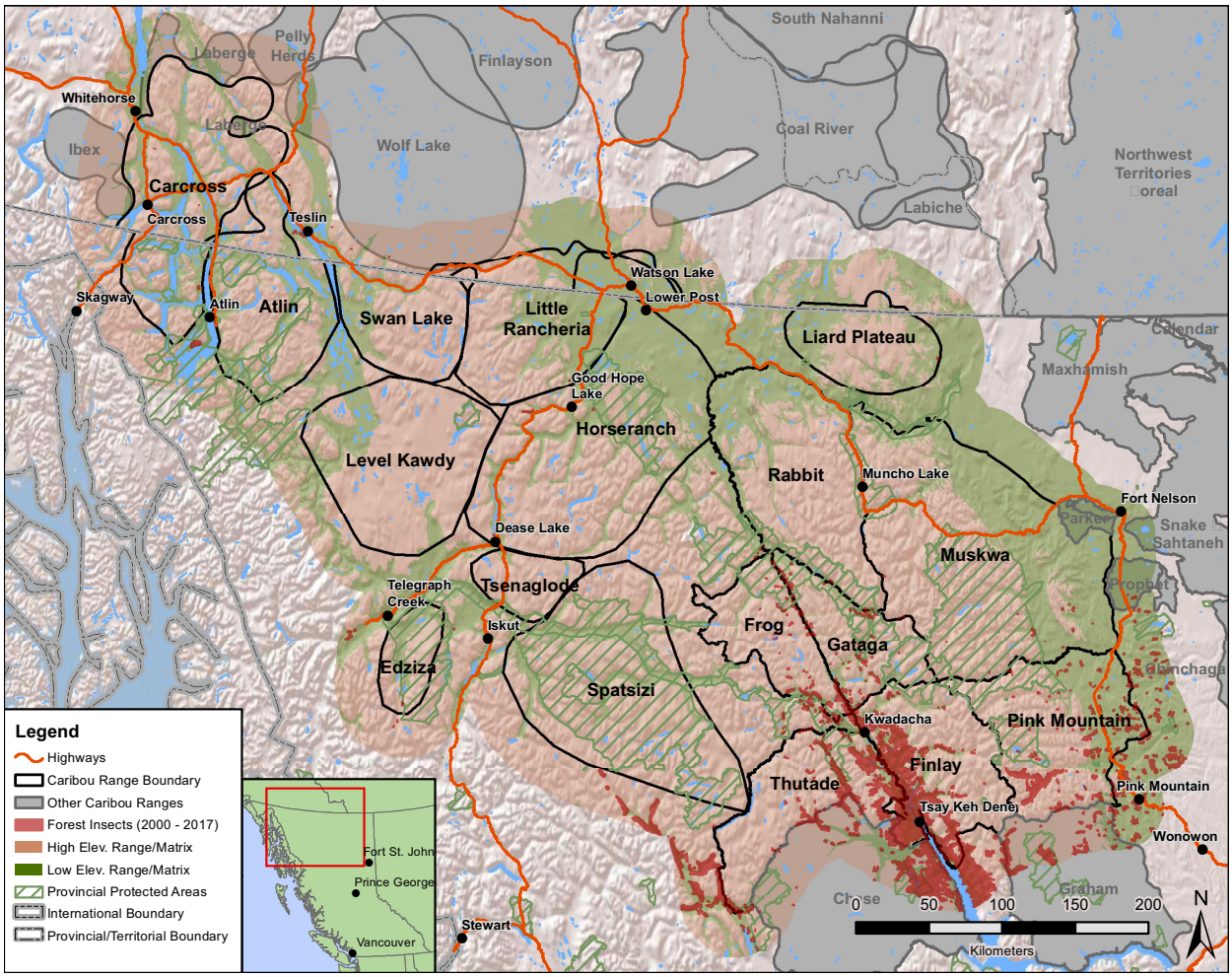
	Caribou Range Area (ha)	Habitat disturbance category[1,2]																			
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Forest harvesting	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road/Trail[3]
Atlin (Total)	858 401	1.9	2.0	0	0	0	0	0.2	0	1.7	0	0	0	0	0	8.7	0.1	0.1	3.8	3.2	9.3
Atlin (BC only)	695 385	0.8	0.9	0	0	0	0.1	0.2	0	2.1	0	0	0	0	0	10.1	0.1	0.1	3.6	3.3	10.4
Carcross (Total)	1 273 592	0.4	0.9	0	0	0.1	0	0.8	0	0.4	0	0	0.7	0.6	0.7	4.5	0.1	1.1	7.3	4.1	7.7
Carcross (BC only)	324 060	0	0	0.1	0	0	0	0.1	0	0.1	0	0	0	0	0	2.3	0	0	2.0	1.8	2.5
Edziza	235 185	4.8	5.7	0	0	0	0.1	0	0	0	0	0	0	0	0	5.1	0	0.1	0	0	5.1
Finlay	817 094	3.3	4.3	16.6	0	0	0.1	9.5	0	0	0	0	0	0	0	12.1	0	0.1	0	0	12.1
Frog	504 069	4.2	4.4	2.3	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1
Gataga	500 703	5.1	5.3	1.4	0	0	0	0	0	0	0	0	0	0	0	1.7	0	0	0	0	1.7
Horseranch (Total)	1 945 173	5.7	6.8	0	0	0	0	1.8	0	0.6	0	0	0	0	0	6.8	0.1	0.4	2.5	1.3	8.0
Horseranch (BC only)	1 779 688	5.9	7.2	0	0	0	0	0	0	0.6	0	0	0	0	0	6.5	0.1	0.3	1.0	0.6	6.9
Level Kawdy	1 135 902	1.4	1.5	0	0	0	0	0	0	0	0	0	0	0	0	1.2	0	0	0.9	0.6	1.6
Liard Plateau (Total)	520 304	11.6	23.4	0	0	0	0	0	0	0	0	0	0	0.3	0	7.2	2.6	0.2	4.8	2.6	9.3
Liard Plateau (BC only)	475 350	10.4	23.4	0	0	0	0	0	0	0	0	0	0	0.4	0	7.9	2.8	0.3	4.3	2.9	9.2
Little Rancheria (Total)	1 055 816	5.4	5.4	0	0	0.1	0	3.8	0	0.3	0	0	0	0	0	6.9	0.2	0.3	7.2	4.7	9.4
Little Rancheria (BC only)	698 569	6.7	6.7	0	0	0	0	0.2	0	0.2	0	0	0	0	0	6.6	0.1	0	4.0	3.7	6.9
Muskwa	2 158 213	8.4	11.2	0	0	0.1	0	2.1	0	0	0.4	0.5	0.1	0	0	14.5	7.4	0.1	1.1	0.8	14.8
Pink Mountain	957 542	2.2	3.5	3.2	0	0.2	0	0.9	0	0	3.7	2.6	2.6	0	0	25.7	20.4	0.2	1.4	1.3	25.8
Rabbit	1 179 409	3.6	4.0	0	0	0	0.1	0	0	0	0	0	0	0	0	3.4	0	0	0.5	0.4	3.5
Spatsizi	1 565 613	2.4	3.0	0	0	0	0	0	0	0.3	0	0	0	0	0	3.2	0.1	0.1	0	0	3.2
Swan Lake (Total)	585 080	0.7	1.1	0	0	0.2	0	0	0	0.1	0	0	0	0	0	3.0	0.1	0.1	5.4	2.5	5.9
Swan Lake (BC only)	557 190	6.5	6.5	0	0	0	0	0	0	0.1	0	0	0	1.0	0	2.6	0	0.1	1.9	1.6	2.9
Thutade	711 930	1.8	3.1	7.9	0	0.1	0.1	4.8	0	0	0	0	0	0.6	0.1	9.5	0	0.1	0	0	9.5
Tsenaglode	247 008	0	0	0	0.3	0	0	0	0.1	0.1	0	0	0	0	0	11.0	0	0.4	0	0	11.0
All Ranges (Total)	16 049 860	4.2	4.2	1.5	0	0	0	1.3	0	0.3	0.3	0.2	0.2	0.1	0.1	7.8	2.3	0.2	1.9	1.3	8.4
All Ranges (BC only)	14 537 257	4.4	4.4	1.6	0	0	0	1.1	0	0.2	0.3	0.2	0.2	0.1	0	8.0	2.6	0.1	1.1	0.9	8.2

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic habitat disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbance (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

Figure 5. Distribution of forest insect attack (mountain pine beetles, spruce beetles) from 2000 to 2017 in the British Columbia portion of caribou ranges that are wholly or partially in northern British Columbia.



Seismic lines contributed to anthropogenic habitat disturbance in the Pink Mountain and Muskwa ranges, and to a lesser extent in the Liard Plateau range (Table 9, Figure 3). Only the Pink Mountain and Muskwa ranges contained oil facilities and wells, while pipeline right-of-ways were located in the Pink Mountain, Muskwa and Carcross ranges (Table 9).

The proportion of the total caribou range affected by forest harvesting was highest in the Finlay and Thutade ranges, and covered one-third of the low elevation range in both caribou ranges (Table 9, Table 10). After linear features, forest harvesting was the next highest contributor of anthropogenic habitat disturbance in the Finlay, Thutade, Horseranch and Little Rancheria ranges (Table 9). Forest harvesting in the Horseranch and Little Rancheria ranges is primarily located in the Yukon portion of their ranges.

The footprint from mining activity was the next highest contributor of anthropogenic habitat disturbance in the Atlin range, after linear disturbances, and contributed to anthropogenic habitat disturbance to a lesser extent in the Carcross, Horseranch, Little Rancheria, Swan Lake, Spatsizi and Tsenaglode ranges (Table 9). Although we were not able to distinguish between roads/trails that were constructed for mining and those constructed for other purposes using our dataset, mining activity was commonly associated with road networks, especially in the Atlin caribou range.

Table 10. Proportion (%) of total low elevation range area in each habitat disturbance category in caribou ranges that are wholly or partially in northern British Columbia.

	Low Elevation Range Area (ha)	Habitat disturbance category[1,2]																			
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Forest harvesting	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road/Trail[3]
Atlin (Total)	346 303	4.0	4.2	0	0	0	0.1	0.5	0	1.6	0	0	0	0	0	12.5	0.2	0.2	6.9	5.6	13.9
Atlin (BC only)	291 045	1.6	1.8	0	0	0	0.1	0.5	0	1.8	0	0	0	0	0	13.4	0.3	0.2	5.8	5.3	13.9
Carcross (Total)	518 781	0.2	0.8	0	0	0.3	0	1.9	0	0.9	0	0	1.7	1.5	1.7	10.5	0.1	2.7	15.3	9.6	16.3
Carcross (BC only)	158 865	0	0	0.1	0	0	0	0.3	0.1	0.3	0	0	0	0	0	4.6	0	0	3.9	3.6	5.0
Edziza	64 255	10.5	10.7	0	0	0	0	0	0	0	0	0	0	0	0	7.3	0	0	0	0	7.3
Finlay	197 112	7.1	9.6	41.5	0.1	0	0.5	32.7	0	0	0	0	0	0	0	43.2	0	0.4	0	0	43.2
Frog	57 099	10.9	11.5	12.5	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0	0	1.1
Gataga	111 491	10.7	11.2	4.1	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	5.3
Horseranch (Total)	920 489	10.7	11.4	0	0	0.1	0.1	3.7	0	0.7	0	0	0	0	0	10.3	0.3	0.8	5.3	2.7	12.9
Horseranch (BC only)	762 958	12.3	13.0	0	0	0	0.1	0.1	0	0.6	0	0	0	0	0	10.2	0.2	0.6	2.3	1.3	11.3
Level Kawdy	161 995	3.4	3.6	0	0	0	0	0	0	0	0	0	0	0	0	3.0	0	0	3.3	2.6	3.8
Liard Plateau (Total)	254 275	22.6	33.7	0	0	0	0	0	0	0	0	0	0	0.7	0	11.0	3.2	0.4	6.4	4.4	12.9
Liard Plateau (BC only)	233 434	20.1	32.2	0	0	0	0	0	0	0	0	0	0	0.7	0	11.9	3.4	0.5	6.2	4.8	13.2
Little Rancheria (Total)	563 685	9.7	9.7	0	0	0.1	0	6.9	0	0.3	0	0	0	0	0	8.2	0.4	0.5	9.8	6.2	11.8
Little Rancheria (BC only)	321 110	14.5	14.5	0	0	0	0	0.5	0	0.1	0	0	0	0	0	7.3	0.2	0	5.0	4.4	7.9
Muskwa	901 281	11.3	16.9	0	0	0.2	0.1	5.0	0	0	1.0	1.2	0.2	0	0	28.1	17.3	0.1	1.4	0.7	28.8
Pink Mountain	332 894	2.2	3.6	2.7	0	0.7	0.1	2.5	0	0.1	9.8	6.5	7.6	0	0	57.6	46.5	0.4	1.0	0.9	57.6
Rabbit	374 007	8.4	9.1	0.1	0	0.1	0.1	0	0	0	0	0	0	0	0	7.9	0	0.1	1.2	1.0	8.2
Spatsizi	277 677	7.4	9.5	0	0	0	0	0.1	0	0.2	0	0	0	0	0	4.1	0	0.3	0	0	4.1
Swan Lake (Total)	135 756	1.7	3.2	0	0	0	0	0.2	0	0.3	0	0	0	0	0	2.5	0	0.1	3.8	2.4	3.9
Swan Lake (BC only)	135 228	6.5	6.5	0	0	0	0	0	0	0.4	0	0	0	3.8	0	7.2	0	0.2	6.1	5.5	7.8
Thutade	79 848	7.3	8.3	33.0	0	0	0.2	33.5	0	0	0	0	0	0	0.8	44.5	0	0.4	0	0	44.5
Tsenaglode	27 740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28.9	0	3.9	0	0	28.9
All Ranges (Total)	5 158 612	8.5	8.5	2.5	0	0.1	0.1	3.8	0	0.4	0.8	0.6	0.7	0.3	0.2	17.2	6.3	0.6	4.4	2.9	18.7
All Ranges (BC only)	4 482 822	9.2	9.2	2.8	0	0.1	0.1	3.3	0	0.3	0.9	0.7	0.6	0.2	0	18.2	7.2	0.3	2.3	1.8	18.7

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic habitat disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbance (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

Table 11. Proportion (%) of total high elevation range area in each habitat disturbance category in caribou ranges that are wholly or partially in northern British Columbia.

	High Elevation Range Area (ha)	Habitat disturbance category[1,2]																			
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Forest harvesting	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road/Trail[3]
Atlin (Total)	512 097	0.5	0.5	0	0	0	0	0	0	1.8	0	0	0	0	0	6.1	0	0	1.7	1.5	6.3
Atlin (BC only)	404 341	0.2	0.3	0	0	0	0	0	0	2.3	0	0	0	0	0	7.7	0	0	2.0	1.9	7.8
Carcross (Total)	754 811	0.5	1.0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.3	0.1	0	1.8	0.3	1.8
Carcross (BC only)	165 196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0.2	0.1	0.2
Edziza	170 929	2.7	3.8	0	0	0	0.1	0	0	0	0	0	0	0	0	4.2	0	0.1	0	0	4.2
Finlay	619 983	2.1	2.6	8.7	0	0	0	2.1	0	0	0	0	0	0	0	2.1	0	0	0	0	2.1
Frog	446 969	3.4	3.5	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gataga	389 212	3.6	3.6	0.7	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0.6
Horseranch (Total)	1 024 684	1.1	2.7	0	0	0	0	0.1	0	0.6	0	0	0	0	0	3.6	0	0.1	0	0	3.6
Horseranch (BC only)	1 016 730	1.2	2.8	0	0	0	0	0	0	0.6	0	0	0	0	0	3.7	0	0.1	0	0	3.7
Level Kawdy	973 907	1.1	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0.5	0.3	1.2
Liard Plateau (Total)	266 029	1.1	13.6	0	0	0	0	0	0	0	0	0	0	0	0	3.6	2.0	0	3.2	0.9	5.9
Liard Plateau (BC only)	241 916	1.0	14.9	0	0	0	0	0	0	0	0	0	0	0	0	4.0	2.2	0.1	2.4	1.0	5.4
Little Rancheria (Total)	492 131	0.5	0.5	0	0	0	0	0.1	0	0.3	0	0	0	0	0	5.4	0.1	0	4.3	3.1	6.6
Little Rancheria (BC only)	377 459	0.2	0.2	0	0	0	0	0	0	0.4	0	0	0	0	0	5.9	0.1	0	3.1	3.0	6.1
Muskwa	1 256 932	6.3	7.1	0	0	0	0	0	0	0	0	0	0	0	0	4.8	0.3	0.1	0.8	0.8	4.8
Pink Mountain	624 647	2.2	3.4	3.5	0	0	0	0	0	0	0.3	0.5	0	0	0	8.8	6.6	0.1	1.6	1.5	8.9
Rabbit	805 402	1.4	1.6	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0	0	0.3	0.2	1.4
Spatsizi	1 287 936	1.3	1.6	0	0	0	0	0	0	0.4	0	0	0	0	0	3.0	0.1	0.1	0	0	3.0
Swan Lake (Total)	449 324	0.4	0.4	0	0	0.3	0	0	0	0.1	0	0	0	0	0	3.2	0.1	0.1	5.9	2.6	6.6
Swan Lake (BC only)	421 963	6.5	6.5	0	0	0	0	0	0	0	0	0	0	0.1	0	1.1	0	0.1	0.6	0.3	1.3
Thutade	632 082	1.1	2.4	4.8	0.1	0.2	0.1	1.2	0	0	0	0	0	0.6	0	5.1	0	0	0	0	5.1
Tsenaglode	219 268	0	0	0	0.3	0	0	0	0.1	0.1	0	0	0	0	0	8.8	0	0	0	0	8.8
All Ranges (Total)	10 891 248	2.2	2.2	1.0	0	0	0	0.2	0	0.2	0	0	0	0	0	3.3	0.5	0	0.8	0.5	3.6
All Ranges (BC only)	10 045 117	2.3	2.3	1.1	0	0	0	0.2	0	0.2	0	0	0	0	0	3.5	0.5	0	0.6	0.5	3.6

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic habitat disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbance (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

The highest contribution of settlements to overall habitat disturbance levels was in the Yukon portion of the Carcross range, and the highest contribution of powerlines was in the Swan Lake range (Table 9). Agriculture, airstrips, railroads, reservoirs and dams played relatively minor roles in all caribou ranges (Table 9).

Roads/trails, mines and seismic lines were located in both low elevation and high elevation portions of the ranges, while forest harvesting, oil facilities, wells, pipeline right-of-ways, powerlines, settlements, agriculture, airstrips, and railroads were located primarily in low elevation ranges (Table 10, Table 11).

The main anthropogenic habitat disturbances in high elevation ranges other than roads/trails were seismic lines (Liard Plateau and Pink Mountain), mining (Atlin), and forest harvesting (Finlay, Thutade; Table 11).

Potential future habitat disturbance

Mineral exploration and mining activities, forest harvesting, oil and gas exploration and development, and road networks associated with industrial activities all have the potential to increase within Northern Mountain Caribou ranges assessed in this report. Natural resources in northern BC are viewed as key contributors to the provincial economy. Much employment and business activity in the region is driven, directly and indirectly, by natural resource extraction activities, and figures prominently in plans for future prosperity of the region (e.g., Initiatives Prince George Development Corporation and Northern Development Initiative Trust 2020). However, it is not always possible to predict where, and at what intensity, industrial activities are most likely to occur in the future. For example, while mining claims provide a good indication of areas of potential interest for mineral exploration activities (Figure 6), it is not possible to use this information to predict the location of viable ore deposits and which mines will ultimately be developed. While information on mining projects for which environmental assessment processes have been initiated can be used to predict potential location of mines, by the time projects enter these processes, they are already advanced in planning and feasibility studies.

The BC Environmental Assessment Office lists a number of mining projects that have initiated environmental assessment processes in caribou ranges and their surrounding matrix (Table 12). Two of the projects were withdrawn in 2016 and the certificate for one project expired in 2017. Two projects in the Spatsizi caribou range (Kutcho) and 20 km matrix (Arctos Anthracite) are listed as in the pre-application phase. The Arctos Anthracite (metallurgical coal) project is located just outside the southwestern boundary of the Spatsizi caribou range in the Klappan area, and includes a 147-km extension to an existing railway. In 2015, the Province of BC acquired the coal licenses in the Klappan to allow for time for the Province and the Tahltan Nation to develop a shared vision for the Klappan (Government of BC 2015). As part of the agreement, Fortune Minerals and POSCO Canada have a 10-year option to buy back the licenses after the Province and the Tahltan Nation have agreed on the shared vision. The Kutcho project lies within the northern portion of the Spatsizi caribou range and includes upgrading approximately 40 km and realigning approximately 80 km of the Jade-Boulder road (which currently supports seasonal use for industrial activities) to a one lane radio-controlled road supporting year-round use. One project in the Finlay caribou range was approved prior to the Environmental Assessment Act but development did not proceed. A certificate was issued for the Galore Creek open

Figure 6. Mineral and placer claims and leases, and coal licenses and leases, in and adjacent to the British Columbia portion of caribou ranges that are wholly or partially in northern British Columbia.

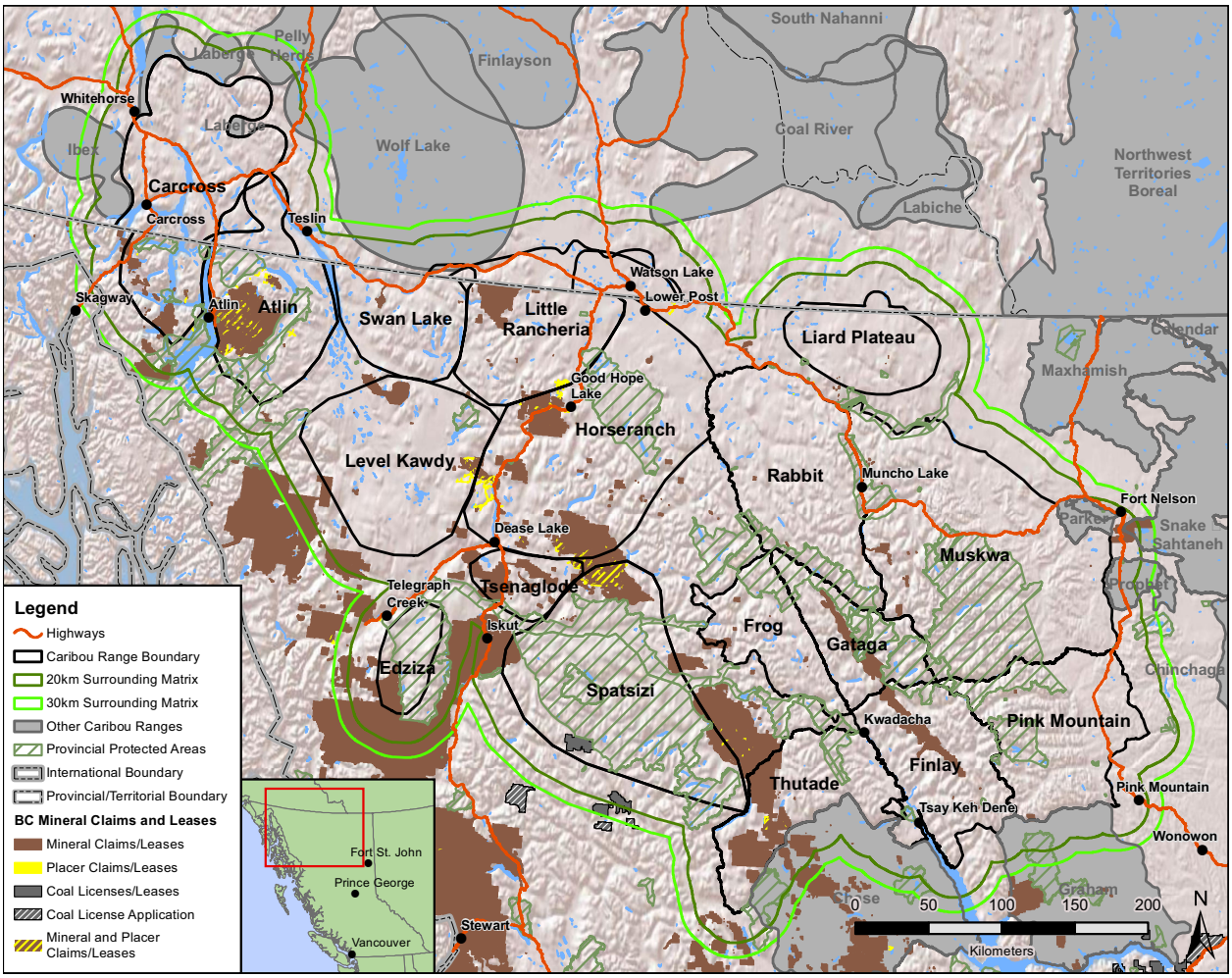


Table 12. Projects listed on the BC Environmental Assessment Office (EAO) website for caribou ranges that a wholly or partially in northern British Columbia.

Range	Zone	Project	Type	EAO Stage
Atlin	Range	Ruby Creek	Open pit molybdenum mine and mill	Certificate expired 2017
Edziza	Range	Schaft Creek	Open pit copper-gold-molybdenum-silver mine	Withdrawn 2016
	30 km matrix	Galore Creek	Open pit copper-gold-silver mine	Certificate issued 2007
Spatsizi	Range	Kutcho	Underground copper-zinc mine	Pre-application[1]
	20 km matrix	Arctos Anthracite	Open pit coal mine	Pre-application[1]
Finlay	Range	Stronsay	Open pit lead-zinc mine	Pre-EA Act approval
Thutade	Range	Sustut	Open pit copper mine	Withdrawn 2016

[1] There are no time limits on the pre-application phase (BC Environmental Assessment Office 2020)

pit copper-gold-silver mine in 2007, but the mine has not been developed yet. The Galore Creek project is located in the southwestern portion of the 30 km matrix surrounding the Edziza range. The Northwest Transmission Line from Terrace to the Iskut area, which was completed in 2014, is expected to support development of new mines in northwestern BC (BC Hydro 2014).

Forest harvest cutblocks in the Thutade caribou range, west of Kwadacha. (© Garth Lenz)

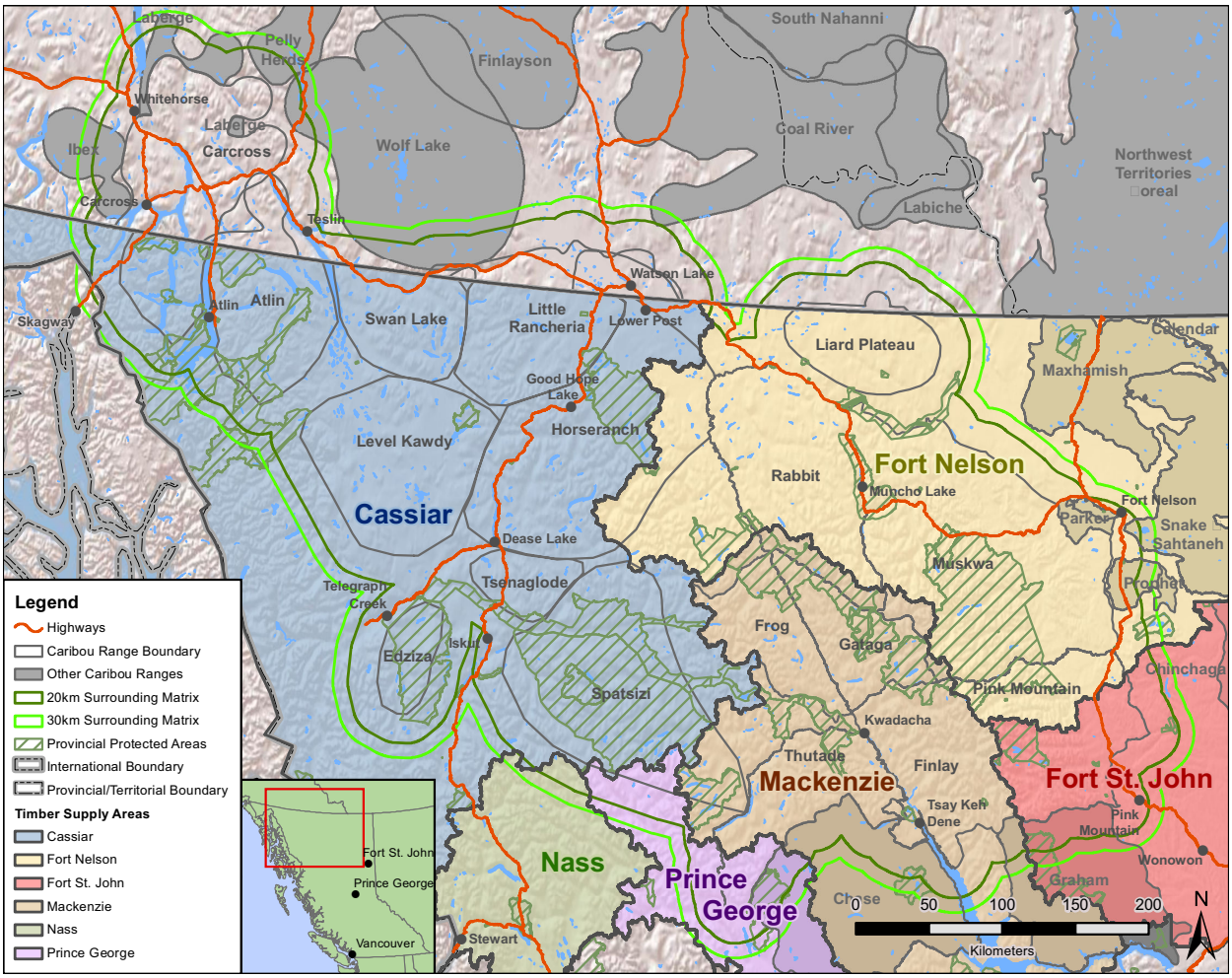
Future oil and gas and forestry development are both likely to be focused in and around areas of current or past activity. Oil and gas development (conventional and nonconventional) is currently concentrated in the Western Sedimentary Basin of northeastern BC, which overlaps the Liard Plateau, Muskwa and Pink Mountain caribou ranges; expansion of activities is expected to continue within that area (Government of BC 2022a). The Bowser Basin and Whitehorse trough are interior basins with identified coal, oil and gas potential in northwestern BC (Government of BC 2022a). In 2012, the Province of BC reached a tripartite agreement with the Tahltan Central Council and Shell Canada in which Shell Canada ceased exploration activities for natural gas and relinquished its tenures in the Klappan area within the Bowser Basin (Government of BC 2012), which overlaps the western portion of the Spatsizi caribou range. The Province of BC also committed to not issuing future petroleum and natural gas tenure in the area.

Natural gas pipelines that have been discussed or proposed in BC are all located outside the study area (Government of BC 2019), but potential routes for an "Alberta to Alaska Railway" freight rail line project have been proposed in the northerneastern part of the region near the Yukon border (Van Horne Institute 2015) in the Rabbit, Liard Plateau, Horseranch and Little Rancheria ranges and surrounding matrix.

The study area overlaps portions of six timber supply areas (TSAs) (Figure 7). In 2014, the allowable annual cut (AAC) in the Mackenzie TSA was increased, with the intent of targeting MPB-killed stands (Nicholls 2015a). Areas currently considered operable in the Mackenzie TSA include low elevation areas in the Thutade and Finlay caribou ranges (BC MFLNRORD 2020). In the recent AAC determination in the Fort St John TSA, the AAC remained unchanged, but a limit was set on the harvest level within the 'core' of the TSA, effectively directing more harvesting into the 'periphery' (Nicholls 2018), which includes the Pink Mountain caribou range. Forest harvesting has not yet occurred in the western part of the Pink Mountain caribou range because this area is in the Muskwa-Kechika Management Area and prior to harvesting requires approved landscape unit objectives, which have not yet been developed (Nicholls 2018). However, increased harvesting in the eastern portion of the range could occur as a result of increased harvesting pressure in the 'periphery'.

Most of the caribou ranges and surrounding matrix in the western part of the study area are located in the Cassiar TSA and to a lesser extent in the northern portions of the Nass and Prince George TSAs (Figure 7). The five operable areas in the Cassiar TSA are generally focused around existing road networks (BC MFLNRO 2013) and overlap portions of all caribou ranges in northwestern BC except Carcross. Commercial forest harvesting is not permitted in virtually all of the Carcross caribou range and portions of the Atlin caribou

Figure 7. Timber supply areas (TSAs) in British Columbia that overlap caribou ranges that are wholly or partially in northern British Columbia.



range in the BC portion of the ranges, outside of protected areas (Government of BC 2014). Although the more remote 'Iskut B' area, which includes parts of the Level Kawdy, Horseranch, Tsenaglode and Spatsizi caribou ranges, was not included in the timber harvesting landbase (THLB) in the current AAC determination, it could be reconsidered for inclusion in the next determination that is due to be completed in 2025 (Nicholls 2015b). Forest harvesting was recently deferred for 20 years in the Sacred Headwaters zone in the Klappan area (Tahltan Central Government and Province of BC 2019). Most of the portion of the Nass TSA that overlaps matrix that surrounds caribou ranges in our study area was excluded from the THLB in the recent timber supply review due to the high cost of access development into the area (BC MFLNRORD 2019). In the Prince George TSA, potential new connector roads could make forest harvesting more viable in more remote portions of the TSA (Nicholls 2017), such as in the northern portion that overlaps caribou ranges and surrounding matrix in our study area.

In addition to potential future anthropogenic habitat disturbance, with climate change, wildfires and forest insect outbreaks are expected to increase (Price et al. 2013, Wotton et al. 2016). In northern BC, mean summer and winter temperature are predicted to increase and mean summer and winter precipitation are expected to increase slightly with an overall decrease in precipitation falling as snow (Foord 2016, Wang et al. 2016, Zhang et al. 2019). However, the increase in precipitation is likely not sufficient to balance increased evaporation due to increased temperatures (Foord 2016, Wotton et al. 2016). Overall, climate change is expected to result in longer fire seasons and increased fire intensity (Wotton et al. 2016).

Climate change is also expected to result in changes to ecological conditions. In our study area, by 2100, climatic conditions in the high elevation Spruce-Willow-Birch and low elevation Boreal White and Black Spruce biogeoclimatic zones are expected to transition to climatic conditions associated with the Engelmann Spruce-Subalpine Fir and Sub-Boreal Spruce zones respectively, with some lower elevations in the southern and western portions of the study area transitioning to the Interior Cedar Hemlock zone and a potentially novel zone at some lower elevations in the northeast and north-central portions of the study area (Wang et al. 2016).

Population status

Table 13 summarizes population size and trends for caribou herds in northern BC. Current population trend assessed during this study (increasing, stable, declining) was based on three or more calf recruitment surveys conducted within the last 9 years (1 generation). Of the 17 currently-defined caribou herds in northern BC, current and long-term trend (over 2-3 generations) is unknown for most (13) herds, decreasing for two herds, and increasing for two herds (Table 13). Although numerous composition surveys (i.e., for sex and age) have been conducted for several herds since aerial surveys began in the late 1960s, information on current population size and current and long-term population trend is lacking because: 1) for most herds, few or no population surveys have been conducted that can be used to compare population size over time; 2) the majority of composition surveys for most herds were conducted in the 1970s and 1980s, and/or during 3-5 year duration radio-telemetry studies in the 1990s and early 2000s, making population trend inferred from calf recruitment indices from those surveys out of date; and 3) since 2010, very few or no surveys have been conducted for most herds although there has been an increase in effort for some herds in the last 3-5 years (see Appendix 3).

Table 13. Population estimates and trends for caribou herds that are wholly or partially in northern British Columbia.

Range[1]		Estimate[1]	Survey year	Current trend[2]	Long-term trend[2]	Total Habitat Disturbance[3] (Anthropogenic habitat disturbance with 500m buffer + fires <40 years)		
						Low elevation	High elevation	Total Range
Atlin	AT	1527[4]	2018	Stable or increase	Increase	18.2	7.0	11.5
Carcross	CA	775[5]	2007	Increase	Increase	18.1	2.5	8.8
Edziza	ED	151[6]	2006	Unknown	Unknown	17.8	6.4	9.5
Finlay	FI	96[7]	2020	Unknown	Unknown	51.9	4.8	16.1
Frog	FR	245[8,9]	2001	Unknown	Unknown	12.0	3.4	4.3
Gataga	GA	265[8,10]	2000	Unknown	Unknown	16.0	4.2	6.8
Horseranch	HO	800-1000[11]	2000	Unknown	Unknown	24.9	4.9	14.4
Level Kawdy	LK	1538	1998	Unknown	Unknown	7.1	2.3	3.0
Liard Plateau	LP	131	2020	Unknown	Decrease	34.3	8.2	20.9
Little Rancheria	LR	800-1600	1999	Unknown	Unknown	23.8	7.2	16.1
Muskwa	MU	917	2004	Unknown	Unknown	46.2	11.1	25.8
Pink Mountain	PM	533[12]	2021	Decrease	Decrease	72.3	15.7	35.4
Rabbit	RA	1300[13]	2007	Unknown	Unknown	15.2	2.8	6.7
Spatsizi	SP	2681	1994	Unknown	Unknown	11.0	4.4	5.5
Swan Lake	SL	600-800	2007	Unknown	Unknown	13.9	8.1	9.4
Thutade	TH	114[8]	2019	Unknown	Unknown	50.4	6.3	11.3
Tsenaglode	TS	450-650[14]	2022	Unknown	Unknown	29.5	9.1	11.4

1 All population estimates were derived from surveys (and extrapolated in most cases).
2 Recent trend based on evaluation of data collected during the most recent generation (9 years – see COSEWIC 2014); Long-term trend based on data collected over 2-3 generations (18-27 years); see data summarized in Appendix 3
3 For transboundary caribou ranges, total habitat disturbance is for the total range (BC + Yukon); see Table 8
4 From BC Caribou Recovery Program (2021); confidence interval: 1077-1927
5 2007 population estimate includes Yukon's Laberge herd (Caribou Recovery Program 2021); confidence interval: 642-935; Carcross population estimate based on a 2019 survey is currently being prepared (Thiessen, pers. comm.)
6 The most recent estimate was based on a survey conducted in March 2006; since then 23 caribou were counted in October 2017 (see Appendix 3) and less than 30 have been counted during surveys in the last few years (N. MacLean, pers. comm.)
7 From Klaczek and Anderson (2020); confidence interval: 65-127
8 Grey lettering indicates number of caribou counted during the survey and does not represent a population estimate
9 In March 2020, 114 caribou were counted during a composition survey (A. Pelletier pers. comm.; see Appendix 3)
10 In March 2007, 138 caribou were counted during a sheep survey in a portion of the Gataga range; see Appendix 3
11 Since 2000, 514 caribou were counted in Feb/Mar 2009 and 133 were counted during a composition survey in fall 2015; see Appendix 3
12 From BC Caribou Recovery Program (2021); confidence interval: 333-879
13 Since 2007, 362 caribou were counted in 2021 (BC Caribou Recovery Program 2021)
14 From Tahltan Wildlife Department (pers. comm. 2022); based on minimum counts during seasonal composition surveys from 2020 to 2022

There is some indication that historical numbers of caribou were larger in northern BC than they are today. Francis & Nishi (2015) mention oral history that indicates that caribou in southern Yukon prior to the Klondike Gold Rush were much more numerous (in the thousands) and widespread than today, and that there was a significant commercial harvest during the Klondike Gold Rush. Also, as a result of wide-scale wolf poisoning programs that were conducted in BC in the 1950s and early 1960s (Hoffos 1987, BC MFLNRO 2014), caribou populations were likely higher in the 1960s and 1970s than they are currently.

Total habitat disturbance (anthropogenic + natural) was highest in the two caribou ranges with declining populations over the long term (Pink Mountain, Liard Plateau) and in the Muskwa range with an unknown population trend (Figure 8). The same general pattern was evident in the low elevation portion of caribou ranges, except that the Muskwa, Thutade and Finlay ranges (all with unknown population trends) were also included in the five ranges with the highest levels of habitat disturbance. Total habitat disturbance in high elevation range was also highest in the two ranges with declining populations and in the Muskwa range (Figure 8). Levels of total habitat disturbance in the total, low and high elevation ranges for the two populations with increasing long-term trends were intermediate relative to other ranges (Figure 8).

Of the two populations that are experiencing known long-term declines in numbers, Pink Mountain had the highest level of anthropogenic habitat disturbance and Liard Plateau had the highest level of fire disturbance across the total range (Figure 9). The Pink Mountain caribou range also had the highest level of anthropogenic habitat disturbance in its low elevation and high elevation ranges of all 17 ranges in northern BC (Figure 9). Levels of both fire and anthropogenic habitat disturbances were much lower in high elevation range, with both declining populations included in three ranges with the highest levels of anthropogenic disturbance (Figure 9).

Muskwa caribou near Muncho Lake in April. (Donald Reid)

Discussion

Our study represents the latest effort to bring together various sources of information to provide an updated status assessment of range and population condition for 17 Northern Mountain Caribou herds in BC. The picture that emerges is one whereby most caribou ranges in the region are affected to some degree by various agents of human and natural habitat disturbance. Meanwhile, our knowledge of population trends in the face of changing circumstances is largely unknown.

Further, some range boundaries did not fully or accurately represent the distribution of caribou. For example, the currently delineated Edziza caribou range is offset in a way that it does not contain the entire mountain block that the Edziza caribou herd occupies. Also, for a number of herds there is insufficient information to delineate range-specific seasonal

Figure 8. Total habitat disturbance (fire<40 years + anthropogenic habitat disturbance) in the total range (top), low elevation portion of the range (centre) and high elevation portion of the range (bottom), for caribou ranges that are wholly or partially in northern British Columbia. See Table 13 for codes for caribou ranges. Symbol colours indicate population trend: green = stable or increasing; red = declining; grey = unknown.

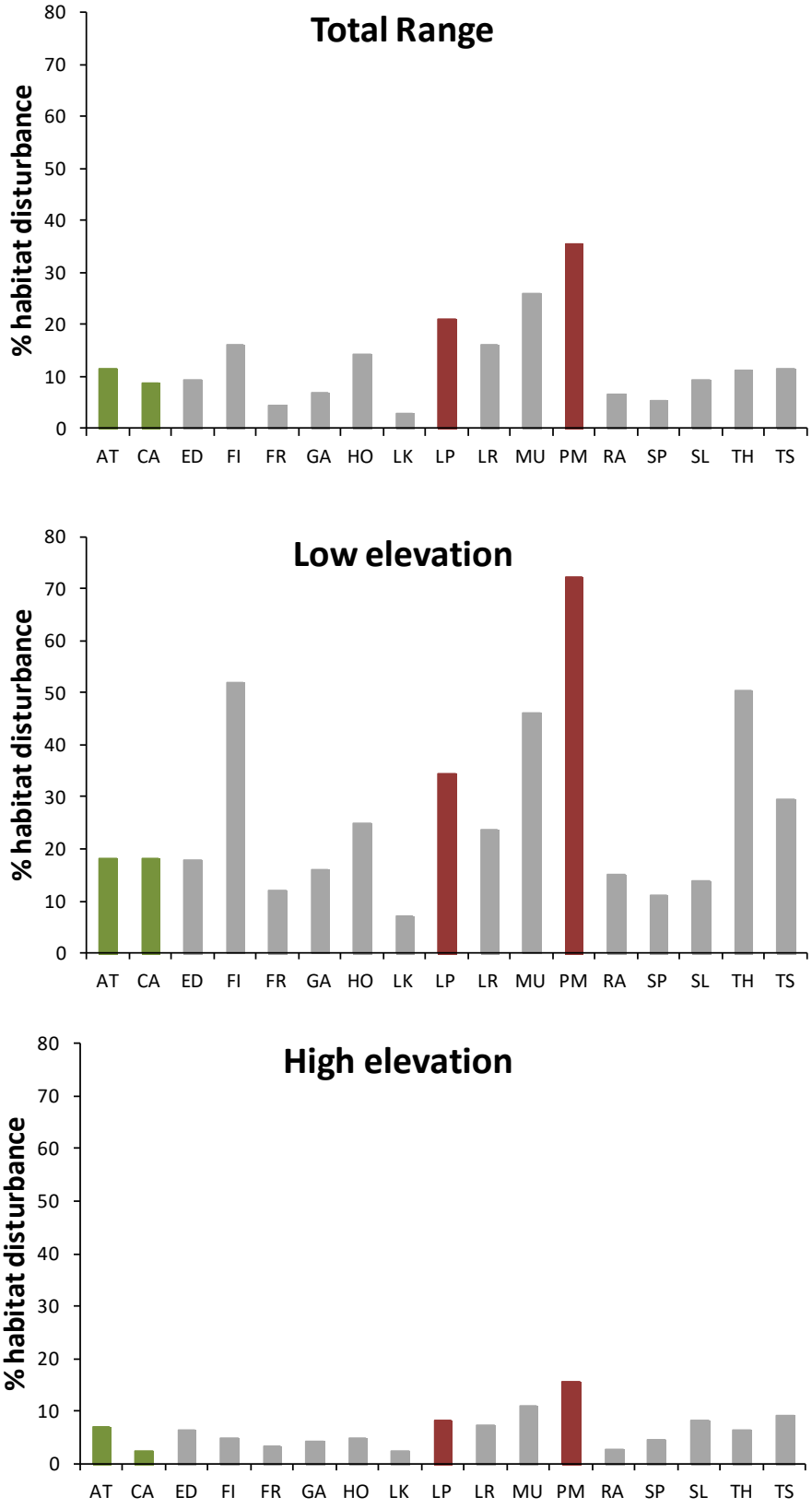
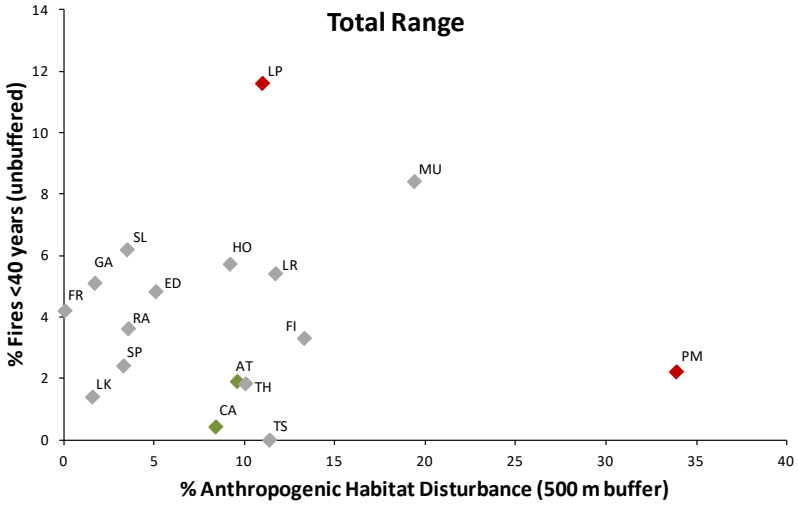
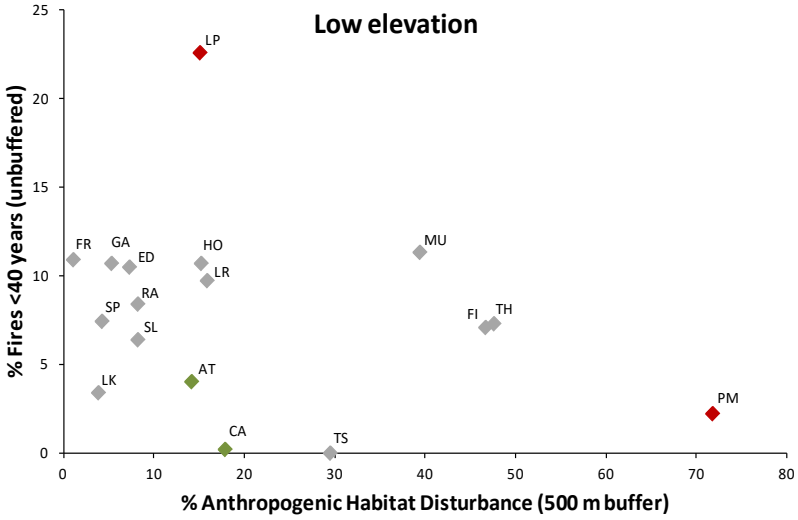
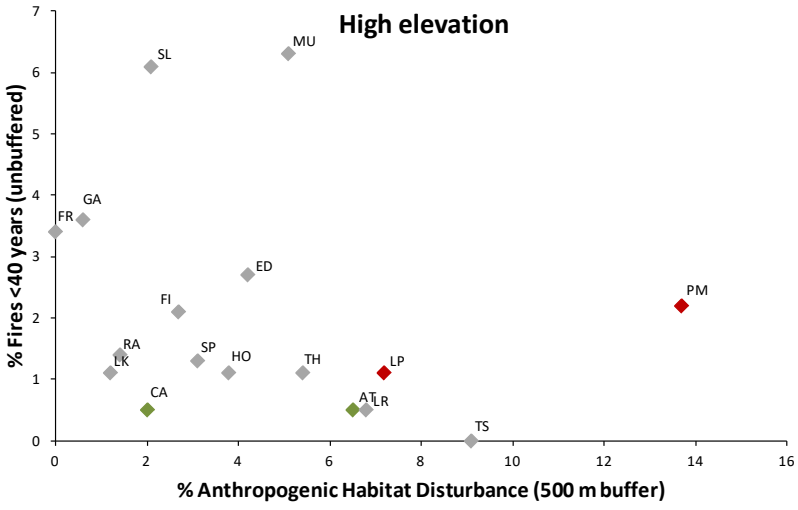


Figure 9. Contribution of fires <40 years (unbuffered) and anthropogenic disturbance (500 m buffer) to total habitat disturbance on the whole range (top), low elevation portion of the range (centre) and high elevation portion of the range (bottom), for caribou ranges that are wholly or partially in northern British Columbia. See Table 13 for codes for caribou ranges. Symbol colours indicate population trend: green = stable or increasing; red = declining; grey = unknown.







ranges. Instead, we used biogeoclimatic zones as a coarse filter approach for distinguishing between low elevation and high elevation ranges, which could potentially result in overestimation of the extent of one or the other.

Accurate range boundaries are necessary to tailor management actions to individual herds and to address their annual and seasonal needs. Range boundaries should not necessarily be expected to remain static, and regular monitoring will be needed to make appropriate amendments to caribou range boundaries, a number of which currently require revisions. Although revised range and seasonal range boundaries would result in different habitat disturbance levels for individual ranges than those presented in this report, the distribution of existing habitat disturbance would not change, nor do we expect the relative levels of habitat disturbance across individual ranges to change. That is, the ranges that currently contain the highest levels of habitat disturbance would still contain the highest levels of habitat disturbance even if boundaries are adjusted. With the inclusion of 20 km and 30 km matrices around each range and around the total area of all the ranges, we have a complete picture of the current distribution of habitat disturbance across all ranges that should also encompass most, if not all, boundary adjustments within the area.

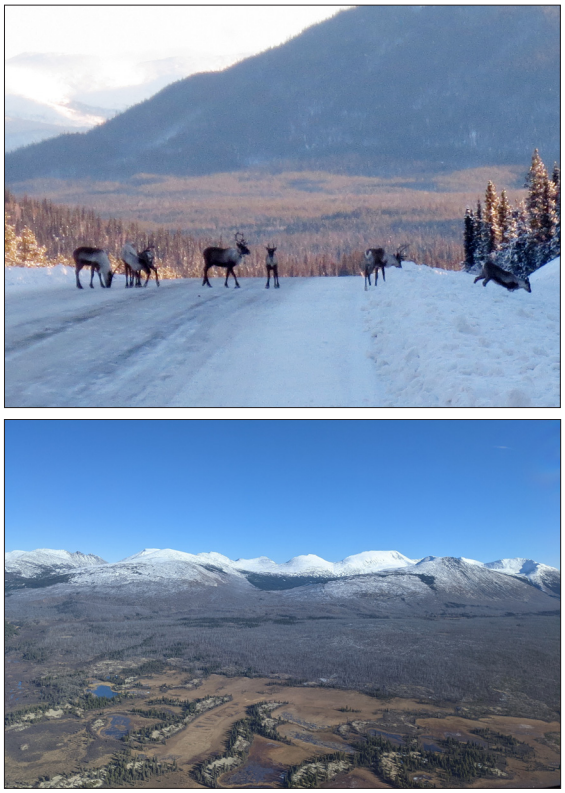
Patterns of habitat disturbance and population status

Although we encountered uncertainties with caribou range boundaries (see above) and other data limitations (see Appendix 4), some distinct patterns of habitat disturbance across the 17 caribou ranges were evident:

- the highest levels of habitat disturbance across the total range were in the Pink Mountain (35%), Muskwa (26%), and Liard Plateau (21%) ranges;
- the lowest levels of habitat disturbance across the total range were in the Frog (4%), Gataga (7%), Level Kawdy (3%), Rabbit (7%) and Spatsizi (6%) ranges;
- total habitat disturbance levels equal or exceed the 35% management threshold on low elevation ranges in five ranges: Liard Plateau, Muskwa, Pink Mountain, Finlay, and Thutade;
- roads and trails were the dominant type of anthropogenic habitat disturbance on all ranges in both high and low elevation ranges;
- other types of anthropogenic habitat disturbance were important in individual ranges including:
    - forest harvesting in the Finlay, Thutade, Horseranch, and Little Rancheria ranges;
    - mines in the Atlin range;
    - seismic lines in the Pink Mountain, Muskwa, and Liard Plateau ranges; and,
    - oil facilities and wells in the Pink Mountain and Muskwa ranges;
- mines and seismic lines were located in both low elevation and high elevation portions of ranges, although seismic lines were more abundant at low elevations than at high elevations;

- forest harvesting, oil facilities, wells, pipelines, powerlines, settlements, agriculture, airstrips and railroads were located primarily in low elevation portions of ranges; and,
- in caribou ranges with <10% total habitat disturbance, fire was the dominant type of habitat disturbance on the landscape, while anthropogenic habitat disturbance played a larger role in caribou ranges with >10% total habitat disturbance.

The role of potential future habitat disturbance must also be considered when assessing the current level of habitat disturbance on caribou ranges in northern BC. Given the reality of a warming climate, wildfires and forest insect outbreaks will also increase. Caribou avoid burns, especially during winter, and therefore increased fire frequency and severity will result in increased levels of winter habitat loss in the short to medium term (Palm et al. 2022). Fire could also potentially contribute to ecological changes. For example, in boreal forests, regeneration following fire in some black spruce (*Picea mariana*) stands has been found to favour deciduous canopy species because of complete or partial failure of black spruce to regenerate soon after the fire (Baltzer et al. 2021). Following fire, any permanent changes to ecosystem condition that negatively affects the ability of the ecosystem to support lichens, the primary winter food source for caribou, may effectively remove portions of caribou habitat from the range.



Top: Roads and other linear features increase mortality risk from predation, collisions, and hunting. (Maria Leung) Bottom: Example of a wildfire that burned 30,212 ha in the Swan Lake caribou range in 2004 (Oliver Holt).

Planning for increases in natural disturbances will be important when considering potential future cumulative habitat disturbance from anthropogenic activities, especially for ranges where disturbance levels already exceed or are nearing habitat management thresholds. Although strategic land use plans cover most of the study area, they are focused on resource management rather than conservation outcomes. Regulatory processes related to the management of natural resources have generally occurred on a sector or project-specific basis (Council of Canadian Academies 2019). This makes it challenging to implement a cumulative effects approach that will be necessary to safeguard caribou and other wide-ranging and sensitive species in the face of environmental change.

While amount of habitat disturbance is an important indicator for assessing the level of potential impacts on caribou, spatial distribution of habitat disturbance also needs to be considered. Even low levels of habitat disturbance could result in significant impacts if they occur in sensitive habitats. For example, an active mine or large exploration camp that is located in important calving range, even if it is serviced by a single road, could lead to increased mortality risk if access to calving range is improved for predators and/or caribou are displaced into habitats with higher predation risk. Due to limited information available on seasonal ranges in many of the caribou ranges, we were not able to assess the significance of spatial distribution of habitat disturbance in each range.

Although population size and trend data are limited for the 17 caribou ranges in northern BC, the two populations that were identified as declining over the long term were two of the three with the highest levels of habitat disturbance over the whole range, and among the five with the highest levels of habitat disturbance in the low elevation portions of their ranges. These results are consistent with studies that have linked Boreal Caribou population condition to habitat disturbance (e.g. EC 2011, Rudolph et al. 2017, Johnson et al. 2020). Reid et al. (2013) found that population growth rate models based on habitat disturbance developed for Boreal Caribou reasonably approximated population status of the Carcross caribou population, but were limited by their inability to deal with seasonal ranges and permanent shrub or sparsely vegetated habitats. Johnson et al. (2020) found that Boreal Caribou populations were more vulnerable on ranges where habitat disturbance was primarily due to anthropogenic habitat disturbance. Although Boreal Caribou models may not be useful in predicting population growth rates for Northern Mountain Caribou, our results suggest that where population trend information is available, that higher levels of habitat disturbance, especially anthropogenic, are associated with declining population trends.

Both herds with increasing population trends (i.e. Carcross and Atlin) are part of the Southern Lakes Caribou Recovery Program, which, since 1993, in Yukon, has included elimination of licensed hunting and a voluntary cessation of hunting by First Nations. The Southern Lakes area is the most densely populated portion of Yukon, and overhunting was thought to be the main cause of caribou declines (Farnell 2009). Following the elimination of Yukon harvests, and along with continued intense fire suppression in Yukon, populations increased (Farnell 2009), and appear to have continued to increase (see Table 13). Levels of anthropogenic disturbance and access in most of the other caribou ranges in our study area (except for the northeastern and southeastern ranges) is currently lower than in the Southern Lakes area, and therefore current potential for overhunting in those ranges is also likely lower.

Management actions focused on mountain-dwelling caribou in western Canada have often been initiated once populations have already declined or been reduced to small numbers, necessitating intensive measures (Ray et al. 2015, Johnson et al. 2015, Palm et al. 2020). Many Northern Mountain Caribou ranges in northern BC remain in relatively intact condition, but habitat disturbance is higher on some ranges, especially the southern and eastern-most ranges. Habitat disturbance in the five caribou ranges in the eastern and southeastern portion of the study area (Liard Plateau, Muskwa, Pink Mountain, Finlay, Thutade) is already at high levels, which increases the importance of ranges with currently lower levels of habitat disturbance and strengthens the case for proactive attention. Special

Concern species are defined under SARA as those that "may become threatened or endangered because of a combination of biological characteristics and identified threats". One of three purposes of the Act is "to manage species of special concern to prevent them from becoming endangered or threatened".

In southern BC, many caribou populations are declining, in some places dramatically, and becoming increasingly isolated as habitat disturbance continues to increase in and adjacent to their ranges (Palm et al. 2020; Nagy-Reis et al. 2021). By contrast, there is a unique opportunity to conserve caribou in northern BC while large areas of intact range with minimal or no anthropogenic habitat disturbances still remain. In this region, conserving caribou will require a coordinated approach across all ranges; making caribou conservation a priority; and, restricting anthropogenic habitat disturbance from core areas. The existing system of provincial protected areas protects portions of a number of the 17 caribou ranges in this study, but important habitat for Northern Mountain Caribou is not well represented in the eastern portion of the study area (Weaver 2019).

Dune Za Keyih Provincial Park in northern BC includes portions of the Frog, Gataga and Rabbit caribou ranges, and a portion of the low density area. (© Garth Lenz)

We know from experience that recovering caribou populations once they are declining is very difficult and expensive, requires the application of multiple coordinated recovery actions, and so far has resulted in limited success. In BC, recovery efforts involving two or more recovery actions (i.e. predator management, maternity penning, primary prey management, habitat restoration) have helped to avoid extirpation of some herds (BC Caribou Recovery Program 2019; Serrouya et al. 2019), but recovery to self-sustaining populations has yet to be achieved. Complete restoration of caribou habitat will take decades even with concerted effort because of the lag time between when restoration activities occur, and when disturbed (and even subsequently restored) areas are mature enough to become

less attractive to other ungulates, and to start exhibiting characteristics of preferred caribou habitat (e.g., lichens for forage, canopies for snow interception). Therefore, not disturbing habitat in the first place is the most effective method for conserving caribou and their habitat in both the short and long terms.

Recommendations

The federal Special Concern status of Northern Mountain Caribou (including those in Yukon and the NWT) required the development of a management plan under SARA, which was issued 10 years ago (EC 2012a). That plan recommended a series of management actions under eight objectives that called for coordinated actions with a goal "to prevent the NMP[2] from becoming threatened or endangered, by having responsible agencies cooperatively work together to care for caribou and their habitat." Although the federal Minister of the Environment is obliged under SARA to monitor the implementation of this plan and formally assess progress every five years, to our knowledge this has not occurred to date. Although the BC government acknowledges growing concerns with the condition of Northern Mountain Caribou populations (Government of BC 2022b), the conservation of these herds remains to be reliant only on sector-specific habitat management "tools".

Within this context, we offer the following recommendations to help shift the existing regulatory and policy regimes to ones that provide stronger limits on the amount and spatial extent of landscape disturbances generally (Yahey v British Columbia, 2021) and thereby lessen the risk of Northern Mountain Caribou becoming threatened or endangered (EC 2012a). In view of the BC *Declaration on the Rights of Indigenous Peoples Act* (2020) and the province's Declaration on the Rights of Indigenous Peoples Act Action Plan (Government of BC 2022c), all First Nations having Traditional Territories overlapping the ranges of Northern Mountain Caribou in northern BC will need to be consulted to garner input of knowledge about caribou and on how Indigenous-led conservation efforts could improve future conditions for Northern Mountain Caribou in northern BC.

1. **Make caribou conservation a priority.** Among wildlife species in northern BC, caribou are one of the most sensitive to the cumulative impacts of anthropogenic and natural habitat disturbances. Caribou habitat is defined by extensive areas of mature and undisturbed landscapes (COSEWIC 2014) and many areas in northern BC are relatively undisturbed. Monitoring, managing and protecting habitat for caribou today will be essential if we want to avoid the need to conduct intensive and expensive recovery actions in the future, which may result in only limited success and require a long-term commitment. While there are important information gaps, caribou are well-studied relative to other less-visible elements of biodiversity, and management efforts that successfully maintain caribou populations should also better preserve animal assemblages (Bichet et al. 2016).

[2] NMP = Northern Mountain Population as defined by the Northern Mountain National Ecological Area (see EC 2012a)

2. **To better ensure persistence of Northern Mountain Caribou in northern BC, manage all 17 populations and ranges together as a unit**, such that the land management and habitat disturbances on one caribou range are considered in terms of their implications to the whole system, rather than just to the individual caribou population and range. Managing all populations as one unit will also foster a stronger focus on maintaining connectivity between ranges.

3. **Develop and implement a better system for tracking and sharing data of anthropogenic habitat disturbance (and habitat recovery) for all natural resource extraction sectors, to support cumulative effects analysis and management**. Currently, availability and accuracy of spatial and temporal data for anthropogenic habitat disturbances varies among natural resource sectors and among different types of habitat disturbances. As a result of Yahey v British Columbia (2021), requirements for conducting cumulative effects assessments are potentially expanding beyond only those for Environmental Assessments for major projects. A reliable source of consistent and readily available information on anthropogenic habitat disturbances will be essential for enabling all industrial sectors to assess cumulative effects on caribou in northern BC.

4. **Protect caribou habitat to provide deliberate and sustained protection of key seasonal ranges and connectivity between populations**. There are a number of existing Indigenous-led, and other proposals for protected areas (e.g., Kaska Dena Council 2019, Weaver 2019) that address protection of important caribou habitat. Where feasibility of protected areas is limited, use areas of temporary (e.g., 30 years) deferrals from industrial use to conserve sufficient habitat (e.g., 300,000 ha) to maintain caribou herds in a self-sustaining condition. Temporary deferral areas could be opened to industrial interests once adjacent disturbed areas have been fully restored to conditions suitable for use by caribou.

5. **Improve our understanding of caribou seasonal range and habitat use, and seasonal range and habitat requirements.** A better understanding of seasonal range and habitat use and requirements is essential to clarify understanding of the implications of habitat disturbances on those seasonal ranges and for assessing and managing cumulative effects. Information should be gathered in an approach that considers all forms of available knowledge and information together. The approach should include two phases: 1) immediately compile all currently available information to update our understanding; and, 2) collect and analyze more technical information and/or more Indigenous Knowledge as needed.

6. **Develop and implement priorities for habitat restoration across all 17 ranges** using results from this study. To determine priorities, an approach could be used similar to that used in the tactical plans for restoration of habitat for the Northern and Southern Groups of Southern Mountain Caribou (Cichowski et al. 2021a,b).

7. **Improve monitoring of caribou population status** through more extensive and regular population surveys to support assessment of habitat disturbance effects on populations.

    - Develop a monitoring strategy for all 17 ranges that enables consistent survey efforts so that trends can be evaluated over time.

    - Adopt standards and a protocol for collecting population data, including methods for calculating population estimates, data that should be included in reports (e.g. survey composition numbers, adult mortality rates for radio-collared caribou studies [including information on how they were calculated]), and a schedule for data collection and reporting.

8. **Revise caribou range boundaries** where needed to better reflect currently available information on caribou distribution and re-run habitat disturbance analyses using the updated range boundaries.

    - Revise total range boundaries (where needed) and delineate seasonal ranges using both technical information and Indigenous Knowledge.

    - If knowledge gaps still exist, revise portions of boundaries where information is sufficient to do so based on best available information and acknowledge that additional boundary revisions may be needed once additional information is collected.

    - Once caribou range boundaries and range-specific seasonal ranges have been updated, compare the spatial dataset to satellite imagery to identify any potential missing habitat disturbances.

9. **Enhance the spatial dataset collected for this study** so that linear features can be measured by length. We were unable to do so because the data, collected from multiple sources, did not distinguish among types of linear features, not all features were represented in their entirety, and some features were duplicated many times. Having a measure of length would help in tactical plans for habitat restoration.

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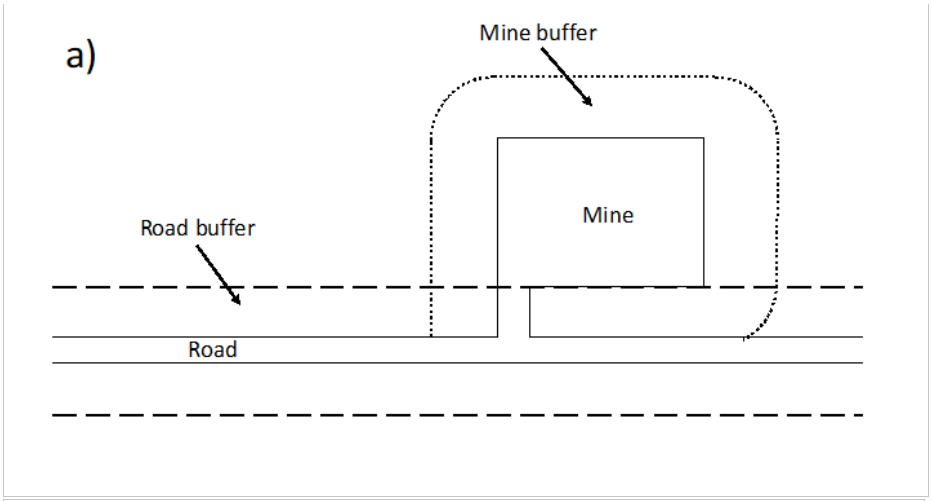
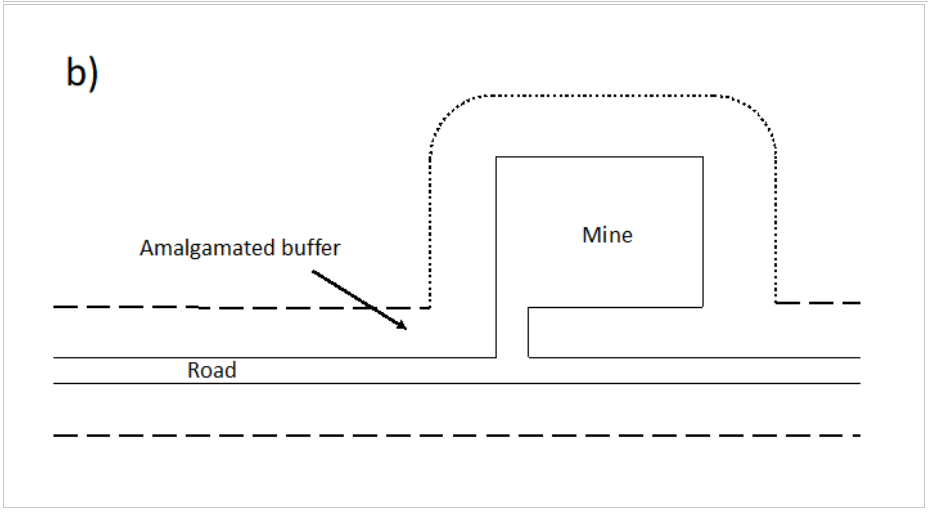
Appendix 1. Amalgamating overlapping buffers

The following two illustrations show a) individual buffers around individual anthropogenic habitat disturbances resulting in overlaps of portions of those buffers, and b) the amalgamated buffer, which is the result of dissolving the portions of the boundaries of individual buffers that lie within the combined buffer area.





Appendix 2. Summary of spatial layers used in the habitat disturbance analysis

Table A1. Spatial data sources for low versus high elevation range lines.

Name	Notes	Source
u_bc_bec_v10_170412_Clip_Dissolve2	High Elevation zones were selected: BAFA, CMA, ESSF, MH, SWB	https://catalogue.data.gov.bc.ca/dataset/biogeoclimatic-ecosystem-classification-bec-map
u_AK_HighLow	Small portion of the study area 30km buffer is in Alaska (40,847ha, 0.16%), high and low elevation areas were approximated with hand-digitization based on Bing Maps imagery using the adjacent BEC mapping as a guide	digitized from Bing Maps imagery
u_YT_HighLow_S05_erase	Good partner to BEC for areas north of 60N, selected Boreal High, Boreal Subalpine, and Boreal Alpine Tundra classes to approximate high-elevation range	ftp://ftp.geomaticsyukon.ca/GeoYukon/Biophysical/Bioclimate_Zones_and_Subzones/

Table A2. Spatial data sources for habitat disturbances.

Layer	Class	Data Type	Used in Project	Description	Source
Raw_YT_Agriculture_Land_Dispositions	Agriculture	Polygon	Yes	Agricultural footprints in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Land_Tenure/Agriculture_Land_Dispositions/
Raw_BC_btm_agriculture	Agriculture	Polygon	Yes	Agricultural footprints in BC	https://catalogue.data.gov.bc.ca/dataset/baseline-thematic-mapping-present-land-use-version-1-spatial-layer
Raw_BC_airports_point	Airstrip	Point	For Reference	Locations of airstrips in BC	https://catalogue.data.gov.bc.ca/dataset/bc-airports/resource/03fdc03b-5487-4a2e-b7e3-a82e53d-b9ea1
Raw_BC_airports_point	Airstrip	Point	Yes	Locations of airstrips in BC	features are either digitized from Bing Maps imagery or copied from 'urban' features in BTM mapping
Raw_YT_Forest_Openings_Pre_1990	Cutblocks	Polygon	Yes	Cutblocks pre-1990 in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Forestry/Forest_Openings_Pre_1990/
Raw_YT_Forest_Openings	Cutblocks	Polygon	Yes	post-1990 cutblocks in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Forestry/Forest_Openings/
Raw_BC_consolidated_cutblocks_171123	Cutblocks	Polygon	Yes	Harvested areas in BC	https://catalogue.data.gov.bc.ca/dataset/harvested-areas-of-bc-consolidated-cutblocks-
Raw_YT_dams	Dam	Line	Yes	Locations of dams in YT	2 features digitized from Bing maps imagery
Raw_BC_dams	Dam	Line	Yes	Locations of dams in BC	https://catalogue.data.gov.bc.ca/dataset/b-c-dams/resource/c361739f-5514-457f-866a-b832ebaf06b3
Raw_YT_Placer_Land_Use_Permits_50k	Mining	Polygon	Yes	Placer mining land permits, active and expired	ftp://ftp.geomaticsyukon.ca/GeoYukon/Mining/Placer_Land_Use_Permits_50k/
Raw_YT_Gravel_Pits_25k	Mining	Point	No	Locations of gravel pits associated with roads, not polygonal and doesn't add a lot of area, might not contribute much over roads alone	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Gravel_Pits_25k/
Raw_YT_Cultural_Features_Mining_Areas_50k	Mining	Polygon	Yes	Mining perimeters on the landscape, mostly gravel pits	ftp://ftp.geomaticsyukon.ca/GeoYukon/Culture_and_Heritage/Cultural_Features_Polygon_50k/
Raw_BC_SKE_MineFP_Jan2018	Mining	Polygon	Yes	Mine footprints in NW BC digitized by Blair Ells BC FLNRO	N/A
Raw_BC_btm_mining	Mining	Polygon	Yes	Mine footprints in BC	https://catalogue.data.gov.bc.ca/dataset/baseline-thematic-mapping-present-land-use-version-1-spatial-layer
u_veg_comp_lyr_r1_poly_abiotic_disturbance_only	NaturalAbiotic	Polygon	Yes	VRI derived abiotic disturbance	https://catalogue.data.gov.bc.ca/dataset/vri-forest-vegetation-composite-polygons-and-rank-1-layer
Raw_YT_Forest_Health_Abiotic_Disturbance	NaturalAbiotic	Polygon	Yes	Abiotic forest disturbance in YT (e.g. flooding, windthrow, etc.)	https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/2016/
Raw_YT_Forest_Health_Aerial_Overview_Pest_Disturbance	NaturalPest	Polygon	Yes	Forest pest disturbance in YT (records go back to 1994, none in our area before 2009 for bark beetles with a severe or very severe infestation rating)	ftp://ftp.geomaticsyukon.ca/GeoYukon/Forestry/Forest_Health_Aerial_Overview_50k/
Raw_BC_Forest_Health_Aerial_Overview_Pest_Disturbance	NaturalPest	Polygon	Yes	Forest pest disturbance in BC, annual layers combined and any bark beetle polygon (FHF = IBB, IBM, or IBS) with a severe or very severe infestation level was considered a disturbance, records go back to 1999, no records meeting criteria show up in the study area before 2000	https://www.for.gov.bc.ca/ftp/HFP/external/!publish/Aerial_Overview/
Raw_YT_Utilities_Pipelines_50k	Oil and Gas	Line	Yes	Pipelines in YT, buffered by 15m (30m width) to closely simulate right-of-way to allow combination into single layer with BC data	ftp://ftp.geomaticsyukon.ca/GeoYukon/Utilities_and_Communication/Utilities_Line_50k/
Raw_YT_Oil_and_Gas_Wells_50k	Oil and Gas	Point	Yes	Locations of oil and gas well heads, points buffered by 50m to approximate clearings as per EC well site procedure	ftp://ftp.geomaticsyukon.ca/GeoYukon/Oil_and_Gas/Oil_and_Gas_Wells_50k/
Raw_BC_well_surface_hole_locations_permitted	Oil and Gas	Point	Yes	Oil and gas well surface hole locations, points buffered by 50m to approximate clearings as per EC well site procedure	https://data-bcogc.opendata.arcgis.com/datasets/9149cb556e694617970a5774621af8be_0
Raw_BC_sump_locations	Oil and Gas	Point	Yes	Oil and gas sump locations in BC, points buffered by 50m to approximate clearings as per EC well site procedure	https://data-bcogc.opendata.arcgis.com/datasets/01df1e822ff84ddc8d4808e68b322101_0
Raw_BC_Pipeline_Rights_of_Way_Permitted	Oil and Gas	Polygon	Yes	Oil and gas pipelines in BC	https://data-bcogc.opendata.arcgis.com/datasets/6434890915cd4d25817037c0600040b1_1
Raw_BC_Geophysical_Ancillary_Points	Oil and Gas	Point	No	Oil and gas ancillary geophysical point locations (e.g. clearings)	https://data-bcogc.opendata.arcgis.com/datasets/7fd246f6c212469eb07acf6467b2f8bd_0
Raw_BC_Facility_Locations_Pre2016	Oil and Gas	Point	Yes	Oil and gas facility point locations in BC, points buffered by 50m to approximate clearings as per EC well site procedure	https://data-bcogc.opendata.arcgis.com/datasets/e2014a76454545abb0509afa2444876b_0
Raw_BC_Associated_and_Ancillary_Areas_Permitted	Oil and Gas	Polygon	Yes	Oil and gas ancillary features in BC (e.g. campsites, workspaces, deck sites, etc.)	https://data-bcogc.opendata.arcgis.com/datasets/bbd11f8029a949fb9ce6012f32111e31_1
Raw_YT_Railroads_50k_Canvec	Railway	Line	Yes	Railroads in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Railroads_50k_Canvec/
Raw_BC_NRWN_tracks_bc_Clip	Railway	Line	Yes	Railroads in BC	http://ftp.geogratis.gc.ca/pub/nrcan_rncan/vector/geobase_nrwn_rfn/bc/
Raw_YT_Reservoirs	Reservoir	Polygon	Yes	Locations of man-made water reservoirs in YT	2 features digitized from Bing maps imagery
Raw_BC Reservoirs	Reservoir	Polygon	Yes	Locations of man-made water reservoirs in BC	https://catalogue.data.gov.bc.ca/dataset/freshwater-atlas-lakes/resource/9595d129-03cc-40bb-b216-6ce3a1337143
Raw_YT_Vegetation_Inventory_Roads_40k	Roads	Line	Yes	Forestry roads in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Forestry/Vegetation_Inventory_Roads_40k/
Raw_YT_Roads_National_Road_Network	Roads	Line	Yes	Federal NRN road network in YT and BC	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Roads_National_Road_Network/
Raw_YT_Bridges_25k	Roads	Point	No	point location of bridges in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Bridges_25k/
Raw_YT_Blocked_Road_Passages_National_Road_Network	Roads	Point	No	impassable points on existing roads in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Blocked_Road_Passages_National_Road_Network/
Raw_BC_u_FTN_RD_SGM_line_Clip	Roads	Line	Yes	Forest tenure road segments in BC	https://catalogue.data.gov.bc.ca/dataset/forest-tenure-road-segment-lines
Raw_BC_SKE_Roads_Jan2018	Roads	Line	Yes	Mining Roads digitized by Blair Ells BC FLNRO	N/A
Raw_BC_Petroleum_Development_Roads_Pre2006_Clip	Roads	Line	Yes	Petroleum development roads in BC approved pre-20061030	https://data-bcogc.opendata.arcgis.com/datasets/5861465cbe5649de93d521117cdf3a6a_0
Raw_BC_OGC_Road_Segments_Permitted_Clip	Roads	Line	Yes	Road centre-lines associated with oil and gas approved after 20061030	https://data-bcogc.opendata.arcgis.com/datasets/b073031723eb44578e1e881939757fe2_0
Raw_BC_DRA_Transport_Line_Clip	Roads	Line	Yes	Roads in BC	https://catalogue.data.gov.bc.ca/dataset/digital-road-atlas-dra-master-partially-attributed-roads
Raw_YT_Oil_and_Gas_Seismic_Lines	Seismic	Line	Yes	Seismic lines in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Oil_and_Gas/Oil_and_Gas_Seismic_Lines/
Raw_YT_Cut_Lines_50k_Canvec	Seismic	Line	Yes	Cut lines in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Cut_Lines_50k_Canvec/
Raw_BC_Geophysical_Plans_20022006	Seismic	Line	Yes	Seismic lines in BC	https://data-bcogc.opendata.arcgis.com/datasets/c27b9f1a3754436cb7816b27ece5cb28_0
Raw_BC_Geophysical_Plans_19962004	Seismic	Line	Yes	Seismic lines in BC	https://data-bcogc.opendata.arcgis.com/datasets/81d619920b6848e9a3f0f0201d126cae_0
Raw_BC_Geophysical_Lines_Permitted	Seismic	Line	Yes	Seismic lines in BC	https://data-bcogc.opendata.arcgis.com/datasets/bd0a685c1f614b4b89ace6564e5e3cc4_0
Raw_YT_Yukon_Communities	Settlements	Point	For Reference	Locations of Yukon Communities	ftp://ftp.geomaticsyukon.ca/GeoYukon/Reference/Yukon_Communities/
Raw_YT_Places_1M	Settlements	Point	For Reference	Locations of communities across the study area	ftp://ftp.geomaticsyukon.ca/GeoYukon/Base/Places_1M/
Raw_YT_Municipal_Boundaries	Settlements	Polygon	No	Municipal boundaries in YT, poor reflection of developed area	ftp://ftp.geomaticsyukon.ca/GeoYukon/Land_Planning/Municipal_Boundaries/
Raw_YT_Cultural_Features_Camps_50k	Settlements	Polygon	Yes	Camps in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Culture_and_Heritage/Cultural_Features_Polygon_50k/
Raw_YT_Cultural_Features_BuiltUp_Areas_50k	Settlements	Polygon	Yes	Built up areas in YT e.g. dumps, buildings, runways, etc., digitized 29 missing features noticed in the vicinity of Whitehorse	ftp://ftp.geomaticsyukon.ca/GeoYukon/Culture_and_Heritage/Cultural_Features_Polygon_50k/
Raw_YT_Community_Boundaries	Settlements	Polygon	For Reference	Community boundaries in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Land_Planning/Community_Boundaries/
Raw_YT_Communities_and_Subdivisions_Surveyed	Settlements	Polygon	Yes	Built up areas in YT e.g. subdivisions	ftp://ftp.geomaticsyukon.ca/GeoYukon/Land_Tenure/Communities_and_Subdivisions_Surveyed/
Raw_BC_btm_urban	Settlements	Polygon	Yes	Footprint for human occupation	https://catalogue.data.gov.bc.ca/dataset/baseline-thematic-mapping-present-land-use-version-1-spatial-layer
Raw_YT_Whitehorse_Trails_10k	Trails	Line	Yes	Trails in and around Whitehorse	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Whitehorse_Trails_10k/
Raw_YT_Trails_50k_Canvec	Trails	Line	Yes	Trails in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Trails_50k_Canvec/
Raw_YT_Trails_50k	Trails	Line	Yes	Trails in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Transportation/Trails_50k/
RAW_BC_Trails_FTN_REC_LN	Trails	Line	Yes	Trails in BC	https://catalogue.data.gov.bc.ca/dataset/forest-tenure-recreation-lines
Raw_YT_Utilities_Transmission_Line_50k	Transmission Lines	Line	Yes	Electricity transmission lines in YT	ftp://ftp.geomaticsyukon.ca/GeoYukon/Utilities_and_Communication/Hydro_Energy/
Raw_YT_Utilities_Polygon_50k	Transmission Lines	Polygon	No	Transformer station outside of Whitehorse, only one feature in a residential area, inconsequential	ftp://ftp.geomaticsyukon.ca/GeoYukon/Utilities_and_Communication/Utilities_Polygon_50k/
RAW_BC_u_bc_transmission_lines_Clip	Transmission Lines	Line	Yes	Electricity transmission lines in BC	https://catalogue.data.gov.bc.ca/dataset/bc-transmission-lines
Raw_YT_Fire_History	Wildfire	Polygon	Yes	Wildfire boundaries in YT <=40 years old, and <=50 years old (evaluated separately)	ftp://ftp.geomaticsyukon.ca/GeoYukon/Biophysical/Fire_History/
Raw_BC_u_mofr_fire_polygons	Wildfire	Polygon	Yes	Wildfire boundaries in BC <=40 years old, and <=50 years old (evaluated separately)	https://catalogue.data.gov.bc.ca/dataset/fire-perimeters-historical
Raw_BC_C_FIRE_PLY_2017_clip	Wildfire	Polygon	Yes	Current wildfire boundaries in BC from 2017	https://catalogue.data.gov.bc.ca/dataset/bc-wildfire-fire-perimeters-current-internal

Appendix 3. Range summaries

Range summaries are provided for each of the 17 caribou ranges and the low density area, and include the following information:

- range use summary;
- population size;
- population trend;
- boundary issues; and,
- range condition (habitat disturbance).

The intent of the range use summary is to provide some context for interpreting the significance of low elevation and high elevation portions of the range. Where available, information on population size and trend is summarized to aid in estimating population condition in order to compare range condition (i.e. level of habitat disturbance) with population condition.

Range use summary

The range use summary includes seasonal range use, location of seasonal ranges, and, for transboundary ranges, percent of range in BC. Where possible, summaries of seasonal range location and use were based on information from radio-collared caribou studies. We also used information from aerial surveys and interviews with local biologists, especially for ranges where there was no or limited radio-collared caribou information available.

Population size

Population size estimates provided in this summary include only population estimates that were based on survey data (see individual range summaries for a description of methods for determining each population estimate). In the past, due to a lack of information on caribou distribution and numbers, many population estimates were based on expert opinion. We do not include those estimates here.

Population trend

Three potential methods can be used to assess population trend based on:

- estimated population size from surveys;
- population growth rate based on additions into the population (calf recruitment) and losses (adult mortality); and,
- calf recruitment.

For ranges with two or more population estimates, population trend can be inferred from the difference between the two population size estimates.

Another method is to calculate the population growth rate using data collected on calf recruitment (usually based on surveys) and adult mortality (usually based on mortality rate of radio-collared caribou).

The third method is based on calf recruitment data. Bergerud (1996) recommends a late winter calf recruitment rate of 15% calves to achieve population stability. In Yukon, although additional calf mortality is expected through the winter, an average fall calf survival ratio of 20 to 25 calves/100 cows is considered sufficient to support a stable population growth rate (Environment Yukon 2016). In the Spatsizi caribou range, Hatler (1987) found that fall counts in traditional alpine rutting grounds were biased against calves, and possibly bulls. In west-central BC, Cichowski (1990) found some evidence of the bias against calves for the Tweedsmuir-Entiako caribou population, but not for the Itcha-Ilgachuz-Rainbow population. Consequently, it may be possible that this bias exists for some populations in northern BC in addition to the Spatsizi population. But, because Yukon assesses calf recruitment based on calf/cow ratios from fall surveys, fall calf/100 cow ratios should

be a reliable measure of calf recruitment at least for the transboundary populations. We assess and discuss calf recruitment data for each range individually.

Where we had access to data sheets or data summaries that provided composition for each group, we used only those groups where all, or at least a significant portion of the group was classified when calculating calf/100 cow ratios from surveys. Where we did not have access to group-specific data, we used the classified caribou portion of the total survey to calculate ratios. For surveys where ratios were calculated using methods other than using numbers counted during the survey (e.g. stratified random block surveys), we provide the ratios presented in the original report. In some cases, where there were errors in addition or in numbers used to calculate ratios in an original report, we recalculated ratios and footnoted any difference from the original report.

We provide three measures of calf recruitment: % calves, calves/100 adults and calves/100 cows. Although there is no specified threshold for calves/100 adults, many surveys, especially those conducted in late winter, did not distinguish between adult females and adult males. One limitation of the calves/100 adults ratio is that it does not account for the variation in the proportion of adult females and males among surveys. To calculate calf:100 cow ratios, we used only data where caribou were classified at a minimum as bulls, cows and calves. To calculate % calves and calves/100 adults, we used only data where caribou were classified at a minimum as adults and calves. We also provide the number of classified caribou that each ratio is based on.

Boundary issues

Known boundary issues were described for ranges where boundary issues were identified.

Range condition (habitat disturbance)

To characterize each caribou range, we summarized:

- the percent of each caribou range, 20 km matrix and 30 km matrix consisting of the low elevation and high elevation portions; and,
- the percent of the 20 km matrix and 30 km matrix surrounding the range that overlaps adjacent ranges.

For habitat disturbance in each caribou range, we summarized:

- the extent of habitat disturbance due to each category of anthropogenic habitat disturbance, fires <40 years, fires <50 years, and forest insect attack;
- the extent of habitat disturbance due to all types of anthropogenic habitat disturbance combined; and,
- the extent of total habitat disturbance (all types of anthropogenic habitat disturbance combined and fires less than 40 years old).

The extent of each type of habitat disturbance, all anthropogenic habitat disturbance combined, and total habitat disturbance were calculated for:

- total range, high elevation portion of the range, and low elevation portion of the range; and,
- 20 km matrix and 30 km matrix surrounding the range.

For the six transboundary caribou ranges, we also summarized the habitat disturbance information described above for the BC portion of each range, and for the total area of each range (BC + Yukon).

Note on a previous summary of Peace caribou range population data

Population data for the caribou ranges in the Peace Region portion of our study area (Liard Plateau, Rabbit, Muskwa, Pink Mountain, Gataga, Frog) had been summarized previously by Duncan (2009). During the data compilation phase of the COSEWIC status report (COSEWIC 2014) and this current review, a number of errors were found in these data summaries.

We recommend that the population size and calf recruitment data presented in Duncan (2009) not be used.

Carcross

Range use summary

During winter, caribou are found primarily in low elevation mature pine and pine/spruce forests, with the core of the winter range located in Yukon. During summer, caribou move into high elevation habitats in both the Yukon and BC portions of the range. The BC portion of the range is used primarily during summer.

Season	Overview of Habitat and Range Use	Source
Winter	• Primarily low elevation forests (<1200 m) • Primarily mature lodgepole pine and pine/spruce habitats with open tree canopies with abundant terrestrial lichens • Most of the low elevation winter range is located in Yukon • There has been some radio-collared caribou use during winter in the northern portion of the BC portion of their range	Francis and Nishi (2015) Florkiewicz (2008) Florkiewicz et al. (2007)
Summer	• Primarily high elevation alpine/subalpine habitat (>1200 m) • The BC portion of the Carcross caribou range is used primarily during summer	Francis and Nishi (2015) Florkiewicz (2008) Florkiewicz et al. (2007)
Migration	• Primarily low elevation routes	Francis and Nishi (2015)
Total Range	• 25% of the range is located in BC • 75% of the range is located in Yukon	

Population size

Population surveys conducted between 1997 and 2007 indicate an increasing population trend (Florkiewicz 2008). A population survey was conducted in 2019 but preliminary results have not yet been released (C. Thiessen, pers. comm.). Prior to that, the most recent survey was in October 2015; 720 caribou were counted during a fall composition survey of all alpine areas within the Yukon and BC portions of the range (Jessup and Drury 2015) suggesting population stability.

Year	Population estimate	Number counted	Method	Reliability	Source
2007	775[1]	429	Distance sampling	High[2]	Environment Yukon unpub. data; Florkiewicz (2008)
2003	750[1]	474	Distance sampling	Moderate[2]	Environment Yukon unpub. data; Florkiewicz (2008)
1997	403[1]	272	Stratified Random Block	High[2]	Environment Yukon unpub. data; Florkiewicz (2008)

[1] From COSEWIC (2014)
[2] From Florkiewicz 2008

Population trend

Environment Yukon has conducted fall composition surveys annually in the Carcross caribou range since 1992.

Between 1992 and 2018, ratios of calves/100 cows were below 20 to 25 calves/100 cows (the level considered sufficient to support a stable population growth rate [Environment Yukon 2016]), during only six of the 27 years (2000, 2002, 2004, 2005, 2009, 2010). It is unknown whether fall surveys of rutting areas in the Carcross caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratio suggests at least a stable population even if the surveys were biased against calves. Calf/100 cows ratios were at or above 20 to 25 calves/100 cows for the last eight years (2011 to 2018).

Calf recruitment tends to be higher in the southern part of the range, but a mechanism for this difference has not yet been determined (Jessup and Drury 2015).

The annual adult female survival rate for 49 radio-collared caribou in the Carcross caribou population averaged 89% over a 12-year period, and the annual growth rate averaged 5.8% per year from 1997 to 2008 (Florkiewicz 2008).

Data from population surveys and fall composition counts suggest that the population is currently stable or increasing, and that it has increased since the 1990s.

Boundary issues

- The BC portion of the boundary is coarsely drawn and does not necessarily incorporate physical features where relevant.
- The BC and Yukon boundaries do not line up on the western side of the range.

Range condition

Within the current BC and Yukon Carcross caribou range boundaries, habitat disturbance covers 9%, 3% and 18% of the total, high elevation and low elevation portions of the range, respectively. In the BC portion of the range, habitat disturbance covers 3%, <1% and 5% of the total, high elevation and low elevation portions of the range respectively, indicating that most habitat disturbance is in the Yukon portion of the range. The primary disturbance in the whole range is roads/trails, followed by settlements (Carcross, and the areas surrounding Whitehorse and Carcross), forest harvesting, infrastructure associated with supporting settlements (pipeline right-of ways, powerlines, railroads), and mines. Most habitat disturbance in the Yukon portion of the range is concentrated around the settlement areas in the western portion of the range. Fires <40 years make up a very small component of the disturbance footprint (<1%) in the total range, and the BC portion of the range contains no fires <40 years.

The 20 km and 30 km surrounding matrix contain slightly higher levels of habitat disturbance, primarily due to additional settlement areas (Whitehorse and the surrounding area to the north) and some additional wildfires.

Although our analysis does not include fires from 2018 to 2021, the only fire in the BC portion of the Carcross caribou range or surrounding matrix during this period was a 1,200 ha fire at the south end of Tagish Lake in 2019, which was located partially in the caribou range and partially in the surrounding matrix.

Carcross

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/ 100 cows[2]	Total Counted[3]	Total classified[4]		Source[5]
						Calves+ Adults	Calves+ Cows+Bulls	
Fall								
2018	Fall[6]	12	14	20	378	376	376	Environment Yukon, unpub. data
2017	Fall[6]	13	15	23	598	585	585	Environment Yukon, unpub. data
2016	Fall[6]	17	20	28	657	657	657	Environment Yukon, unpub. data
2015	Fall[7]	12	13	20	600	600	600	Environment Yukon, unpub. data
2015	Oct 2-11	16	19	26	120	120	120	Williams and Dixon (2016)
2015	*Oct 2-5[7]*	*12*	*14*	*21*	*720*	*720*	*720*	*Jessup and Drury (2016)*
2014	Fall[6]	16	19	27	461	461	461	Environment Yukon, unpub. data
2013	Fall[6]	15	17	23	490	489	489	Environment Yukon, unpub. data
2012	Fall[6]	16	20	28	304	304	304	Environment Yukon, unpub. data
2011	Fall[6]	15	17	26	250	250	250	Environment Yukon, unpub. data
2010	Fall[6]	12[2]	14	16	199	145	145	Environment Yukon, unpub. data
2009	Fall[6]	9	10	14	278	278	278	Environment Yukon, unpub. data
2008	Fall[6]	13	14	22	151	151	151	Environment Yukon, unpub. data
2007	Fall[6]	14	16	25	472	466	466	Environment Yukon, unpub. data
2006	Fall[6]	20	26	37	309	305	305	Environment Yukon, unpub. data
2005	Fall[6]	12	13	18	399	397	397	Environment Yukon, unpub. data
2004	Fall[6]	11	13	19	457	457	457	Environment Yukon, unpub. data
2003	Fall[6]	13	15	23	424	424	424	Environment Yukon, unpub. data
2002	Fall[6]	11	13	17	332	332	332	Environment Yukon, unpub. data
2001	Fall[6]	15	18	30	323	320	320	Environment Yukon, unpub. data
2000	Fall[6]	11	13	19	641	641	641	Environment Yukon, unpub. data
1999	Fall[6]	18	21	33	443	440	440	Environment Yukon, unpub. data
1998	Fall[6]	15	18	27	502	498	498	Environment Yukon, unpub. data
1997	Fall[6]	17	20	29	452	452	452	Environment Yukon, unpub. data
1996	Fall[6]	15	18	26	255	255	255	Environment Yukon, unpub. data
1995	Fall[6]	18	23	33	442	440	440	Environment Yukon, unpub. data
1994	Fall[6]	22	29	42	439	435	435	Environment Yukon, unpub. data
1993	Fall[6]	18	22	38	33	33	33	Environment Yukon, unpub. data
1992	Fall[6]	13	14	22	144	144	144	Environment Yukon, unpub. data
Calving/summer								
1990	July	34	50	-	(179)	179		Schultze (1990)

1 % calves and calves/100 adults calculated based on data in Environment Yukon, unpubl. data

2 Calves/100 cows from Environment Yukon, unpubl. data

3 Numbers in parentheses indicate surveys where caribou were not a primary focus

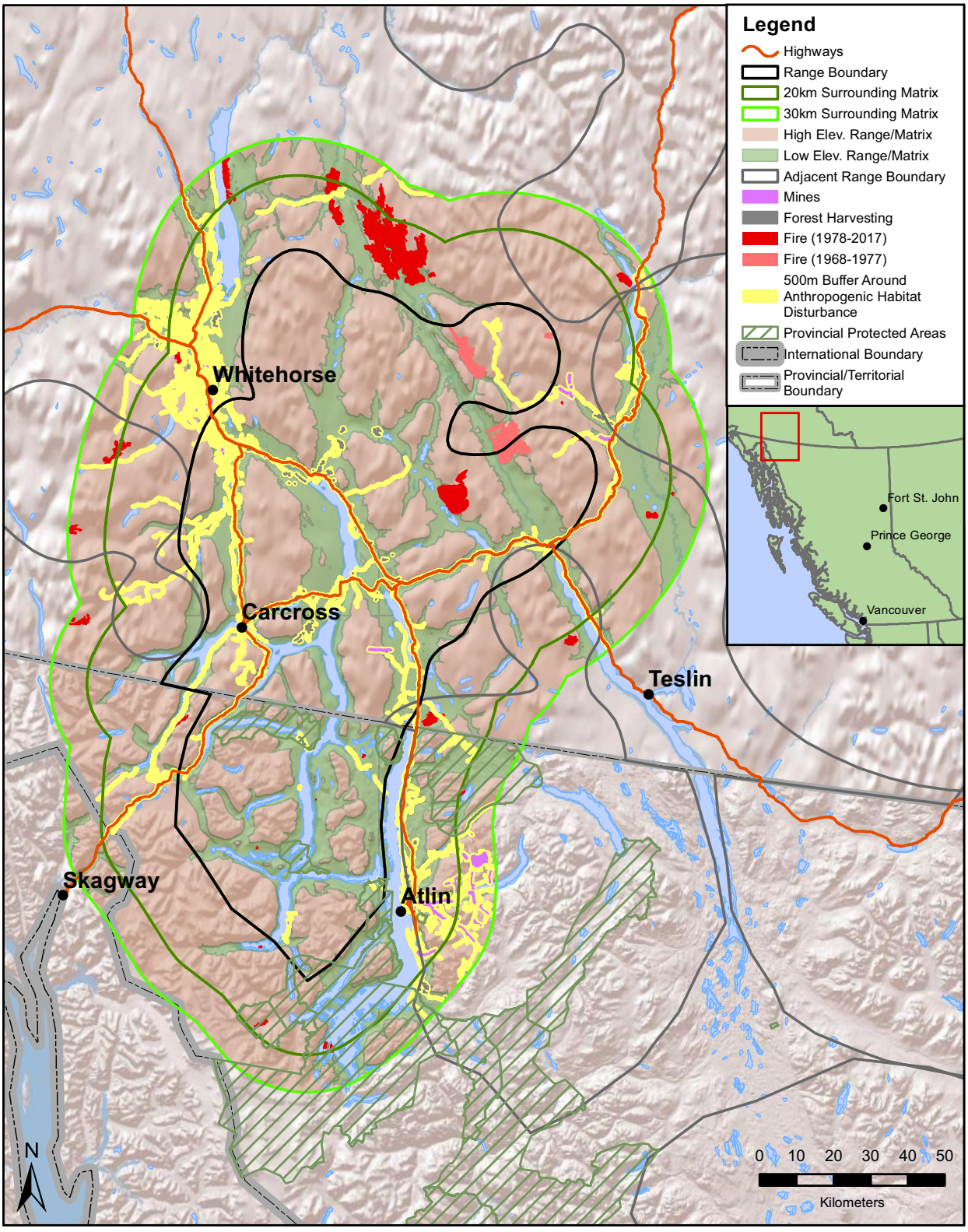
4 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

5 All surveys conducted by helicopter

6 Surveys were conducted in the Yukon portion of the range in the fall but exact dates were not provided

7 In 2015, the survey area in Yukon was expanded to include the entire range. In addition, the BC portion of the range was also surveyed and another 120 caribou were counted for a total of 720 caribou across their whole range (Jessup and Drury 2016). The expanded survey area has not been consistently surveyed since 2015 (K. Russell, pers. comm. 2019)

Carcross


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Whitehorse
Carcross
Teslin
Skagway
Atlin
N
0 10 20 30 40 50
Kilometers

Carcross

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 273 592	40.7	59.3	-
0-20 km matrix surrounding range	1 203 133	32.7	67.3	41.2 (NM)
0-30 km matrix surrounding range	1 870 606	29.5	70.5	41.6 (NM)
BC only				
Range	324 060	49.0	51.0	-
0-20 km matrix surrounding range	413 599	36.2	63.8	20.4 (NM)
0-30 km matrix surrounding range	632 286	30.7	69.3	25.6 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Carcross: Total Range (BC + Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road/Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**1 273 592**	**0.4**	**0.9**	**0**	**0**	**0.1**	**0**	**0.8**	**0**	**0.4**	**0**	**0**	**0.7**	**0.6**	**0.7**	**4.5**	**0.1**	**1.1**	**7.3**	**4.1**	**7.7**	**8.4**	**8.8**
High elevation	754 811	0.5	1.0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.3	0.1	0	1.8	0.3	1.8	2.0	2.5
Low elevation	518 781	0.2	0.8	0	0	0.3	0	1.9	0	0.9	0	0	1.7	1.5	1.7	10.5	0.1	2.7	15.3	9.6	16.3	17.9	18.1
Matrix 0-20 km																							
Total	**1 203 133**	**1.9**	**2.2**	**0.1**	**0**	**0.4**	**0**	**0.3**	**0**	**0.8**	**0**	**0**	**0.4**	**0.7**	**0.5**	**6.1**	**0.8**	**1.2**	**8.1**	**4.1**	**10.1**	**10.7**	**12.5**
High elevation	810 008	1.3	1.5	0.1	0	0.2	0	0	0	0.3	0	0	0.1	0	0.3	2.1	0.2	0	3.7	1.1	4.6	4.8	6.0
Low elevation	393 125	3.2	3.7	0.2	0	0.9	0.1	1.0	0.1	1.8	0	0	0.9	2.0	0.9	14.4	2.1	3.6	17.4	10.3	21.5	22.7	25.8
Matrix 0-30 km																							
Total	**1 870 606**	**1.6**	**1.8**	**0.1**	**0**	**0.3**	**0**	**0.3**	**0**	**0.9**	**0**	**0**	**0.2**	**0.6**	**0.3**	**5.8**	**0.5**	**0.8**	**6.7**	**3.5**	**9.1**	**9.6**	**11.1**
High elevation	1 318 771	1.2	1.3	0.1	0	0.1	0	0	0	0.7	0	0	0.1	0	0.2	2.6	0.1	0	2.9	0.9	4.6	4.8	5.9
Low elevation	551 642	2.6	3.0	0.1	0	0.8	0.1	0.9	0	1.6	0	0	0.7	1.9	0.6	13.5	1.6	2.6	15.8	9.5	19.7	21.0	23.5

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Carcross: BC only

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Distrubance[4]
Range																							
Total	**324 060**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0.1**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**2.3**	**0**	**0**	**2.0**	**1.8**	**2.5**	**2.6**	**2.6**
High elevation	165 196	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0.2	0.1	0.2	0.2	0.2
Low elevation	158 865	0	0	0.1	0	0	0	0.3	0.1	0.3	0	0	0	0	0	4.6	0	0	3.9	3.6	5.0	5.0	5.0
Matrix 0-20 km																							
Total	**413 599**	**0.2**	**0.2**	**0.4**	**0**	**0**	**0.1**	**0.3**	**0**	**1.2**	**0**	**0**	**0.8**	**0**	**1.2**	**9.6**	**0.3**	**0.4**	**4.8**	**4.3**	**10.1**	**10.4**	**10.5**
High elevation	263 797	0.2	0.2	0.4	0	0	0	0	0	0.5	0	0	0.3	0	1.0	4.0	0	0.1	1.7	1.2	4.5	4.6	4.8
Low elevation	149 803	0.1	0.2	0.4	0	0	0.2	0.7	0	2.5	0	0	1.7	0	1.7	19.4	0.6	0.8	10.3	9.6	20	20.5	20.6
Matrix 0-30 km																							
Total	**632 286**	**0.1**	**0.1**	**0.3**	**0**	**0**	**0.1**	**0.3**	**0**	**1.9**	**0**	**0**	**0.5**	**0**	**0.8**	**9.6**	**0.2**	**0.2**	**3.9**	**3.5**	**10**	**10.4**	**10.5**
High elevation	437 918	0.1	0.1	0.2	0	0	0	0	0	1.7	0	0	0.2	0	0.6	5.8	0	0.1	1.6	1.2	6.2	6.4	6.5
Low elevation	194 359	0.1	0.2	0.3	0	0	0.2	1.0	0	2.5	0	0	1.3	0	1.3	18.1	0.5	0.6	9.2	8.6	18.7	19.3	19.4

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Atlin

Range use summary

During summer, Atlin caribou are found mostly at high elevations throughout the range. During winter, habitat use can range from high elevation windswept alpine slopes to low elevation forests, where they use primarily lodgepole pine/lichen complexes and spruce/fir forests. Most of the range lies in BC, including most of the winter range and summer range. The Yukon portion of the range is used primarily during winter.

Season	Overview of Habitat and Range Use	Source
Winter	• Low elevation forests • High elevation windswept alpine slopes • At low elevations, primarily lodgepole pine/lichen complexes, spruce/fir forests, low elevation river valleys • Most of the winter range is located in BC • Known wintering areas include the area west of Gladys Lake and the area around the Silver Salmon River • The Yukon portion of the range is primarily used during winter	Polfus et al. (2011) M. Williams, pers. comm. (2018)
Summer	• Primarily high elevation alpine/subalpine habitat • Most of the summer range is located in BC	Polfus et al. (2011) M. Williams, pers. comm. (2018)
Total Range	• 81% of the range is located in BC • 19% of the range is located in Yukon	

Population size

The current population estimate of 1527 caribou was based on a mark-resight survey conducted in the Atlin caribou range in October 2018 (Thiessen 2018). The Atlin caribou range was surveyed three times and the proportion of the radio-collared caribou seen during the survey was used to estimate the total population size. The two previous surveys were stratified random block surveys that were conducted on the winter range in 2007 and 1999. Marshall (2007a) suggested that in 2007 (and potentially in 1999) the population size may have been under-estimated based on distribution of caribou during the survey.

The current population estimate is higher than the estimates in 2007 and 1999, suggesting that the population is increasing (Thiessen 2018).

Date	Population estimate	Number counted	Method	Reliability	Source
2018	1527	642[1]	Mark/Re-sight	High	Thiessen pers. comm[1]
2007	777[2]	463	Stratified Random Block (SRB)	High	Marshall (2007a)
1999	809[3]	486	Stratified Random Block	High	Marshall (1999a)

[1] Mark/Re-sight using the proportion of the 26 radio-collared caribou seen during the survey to correct for total caribou not seen during the survey; three surveys were conducted with 507, 621 and 642 caribou counted during each survey

[2] The estimate generated by the SRB survey was 555, then a sightability correction factor of 1.4 was applied to correct for caribou not seen during the survey, resulting in a total population estimate of 777

[3] The estimate generated by the SRB survey was 508, then a sightability correction factor of 1.4 was applied to correct for caribou not seen during the survey, resulting in a total population estimate of 809

Population trend

A radio-collared caribou study was conducted on the Atlin caribou population from 1995 to 2001. Many of the spring (June), fall (October/November) and late winter (March/April) composition surveys were conducted as part of that study. Composition information prior to and subsequent to the radio-collared caribou study was sometimes collected during surveys for other species.

Although the calf/100 cows ratio from the October 2018 composition survey was below 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016), the previous fall survey in 2015 and all seven of the fall surveys with sufficient samples sizes conducted between 1984 and 2007 were within or above the 20 to 25 calves/100 cows range. It is unknown whether fall surveys of rutting areas in the Atlin caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987).

Of the six late winter surveys with sufficient sample sizes conducted between 1995 and 2007, the last four (1997, 1999, 2003, 2007) had calf recruitment estimates that were at or above 15% calves recommended by Bergerud (1996) to achieve population stability.

No information on adult survival or population growth rate (based on adult mortality and calf recruitment) was readily available from the radio-collared caribou study.

Both the fall and winter calf recruitment data suggest that the Atlin caribou population was stable or increasing between at least 1997 and 2007, and in 2015, which supports the increase in estimated population size derived from population surveys. However, the most current ratio of 19 calves/100 cows ratio from the October 2018 survey suggests that calf recruitment may not have been sufficient to support a stable or increasing population that year.

Boundary Issues

- The BC portion of the boundary is coarsely drawn resulting in gaps between the Atlin and Swan Lake caribou ranges. It is unclear whether the gap between the Atlin and Level Kawdy caribou ranges is due to the coarsely drawn boundaries or to an actual gap in distribution.
- The BC and Yukon boundaries do not line up.

Range condition

Within the current BC and Yukon Atlin caribou range boundaries, habitat disturbance covers 12%, 7% and 18% of the total, high elevation and low elevation portions of the range respectively. The primary disturbance is roads/trails, followed by fire and mining activity. Most of the habitat disturbance from roads/trails and mining activity is located in the BC portion of the range. Roads/trails include the Alaska Hwy, the Atlin Road, and industrial roads associated primarily with mining activities in BC. Within the current range boundary, fire disturbance <40 years (up to and including 2016) is largely absent. Habitat disturbance is lower in the 20 km and 30 km matrix surrounding the range, primarily due to less disturbance from roads/trails.

Although our analysis does not include fires from 2018 to 2021, there were no fires >1 ha in the BC portion of the Atlin caribou range and surrounding matrix during those four years.

Atlin

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted[2]	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2008	Apr				22			Marshall (2008)
2007	Feb	15	16	21[5]	463	462	462	Marshall (2007a) (SRB)[6]
2006	Mar	13[7,8]	15[7,8]	17[7,8]	96	94	94	Marshall (2006)
2003	Mar	20	25	32	401	401	401	Marshall (2003)
2000	Mar	8[7,9]	9[7,9]	-	258	258[8]		Marshall (2000a)
1999	Mar	16	19	29[5]	486	486	460	Marshall (1999a) (SRB)[6]
1998	Mar	12[7]	13[7]	20[7]	110	110	107	Marshall (1998)
1997	Mar	16	19	22	210	210	206	Marshall (1997a)
1996	Mar	7	7	8	196	196	196	Marshall (1996)
1995	Mar	13	15	17	109	109	109	Marshall (1995a)
1980	Mar	12	13	-	257	257	257	Hodson (1980a)
1979	Mar				346			Hodson (1979a)
1977	Dec				64	9	9	Stephen (1977)[10]
1977	Feb				45			Hatler (1977a)
Fall								
2018	Oct	9[11]	12[11]	19[11]	514	N/A		Thiessen (2018) (MR)[6]
2015	Oct	14	16	26	446	446	446	Williams and Dixon (2016)
2007	Oct	14	16	23	366	360	360	Marshall (2007b)
2001	Oct	19	23	33	601	601	528	Marshall (2001)
2000	Nov	14	16	24	542	542	542	Marshall (2000c)
1999	Oct	19	24	37	676	676	641	Marshall (1999b)
1998	Oct	20	26	40	672	672	630	Marshall (1999a)
1997	Nov	11[7]	12[7]	15[7]	66	66	65	Marshall (1997d)
1997	Oct				93			Marshall (1997c) (FW)
1995	Oct	14	16	24	476	475	475	Marshall (1995b)
1984	Sep	14	16	25	196	196	196	Marshall (1984)
1979	Oct	31[12]	45[12]	55[12]	56	55	55	Hodson (1979b)
1977	Nov	19[12]	24[12]	25[12]	36	36	36	Hatler (1977b)
1977	Oct	19[12]	23[12]	-	86	86		Bergerud (1978) (FW)
1974	Nov	16[12]	18[12]	27[12]	111	58	58	Hatler (1974)
Calving/summer								
2000	June	22[7]	29[7]	57[7]	130	130	85	Marshall (2000b)
1998	June	28	40	60	306	306	285	Marshall (1999a)
1997	June	25	33	91	160	160	105	Marshall (1997b)
1982	July				(10)	10		Jones (1982)[10]
1980	June	40	67	68	(287)	285	283	Hodson (1980b)
1977	Aug	17	20	-	148	148		Bergerud (1978) (GR)
1975	Aug				(6)			Hazelwood (1975)

1 Calf ratios are based on totals in each age/sex class because data detailing composition of groups were not available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 The calf/100 cows ratio was derived from the SRB strata and therefore differs slightly from just dividing the total calves by total cows; the other two ratios were based on totals counted

6 Surveys conducted to estimate population size: MR=Mark/Re-sight; SRB=Stratified Random Block

7 Marshall recommends caution when assessing numbers and ratios due to sample size limitations

8 Poor survey conditions

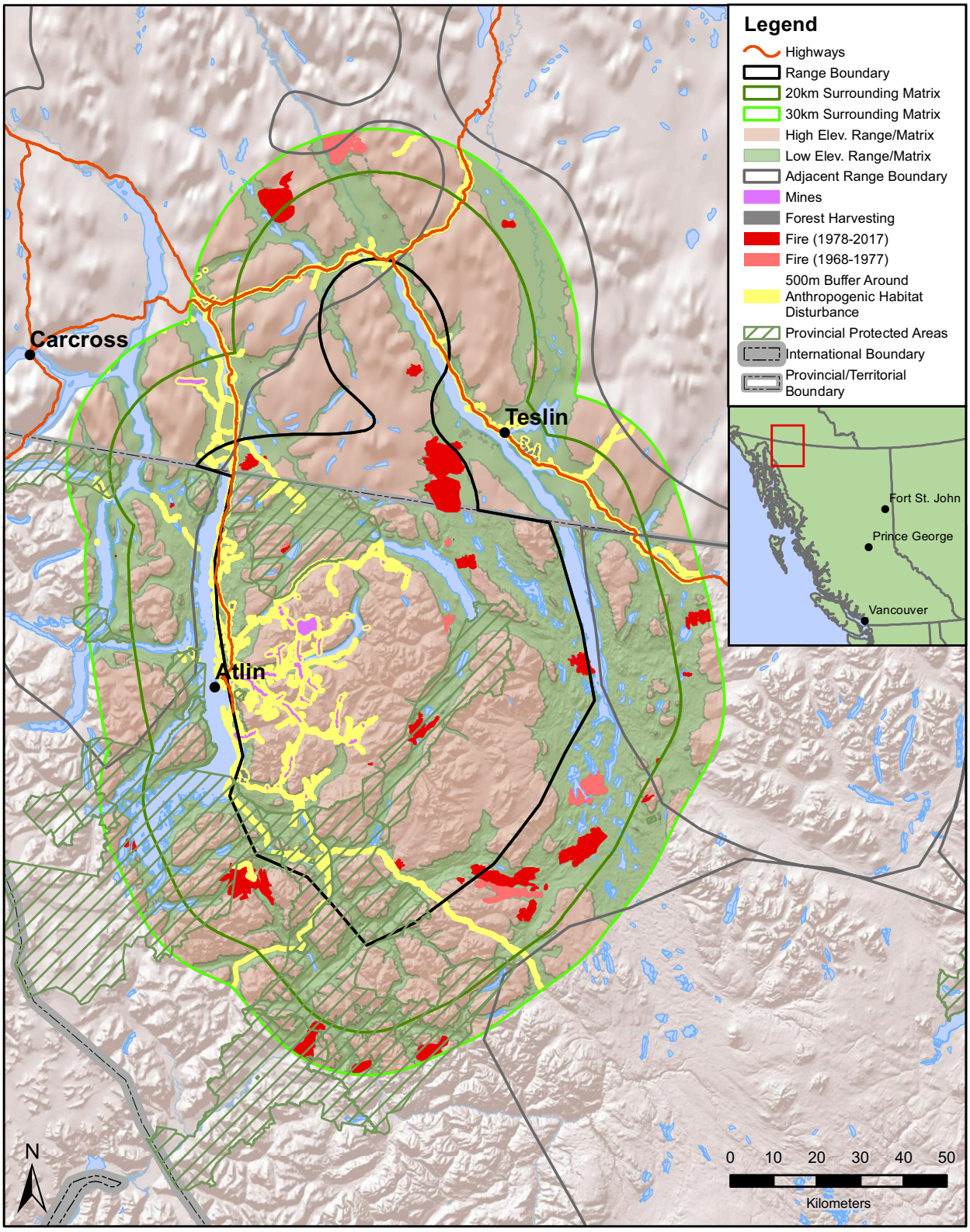
9 Ratios assume that 233 unclassified animals were unclassified adults.

10 Calf ratios not included due to low sample size.

11 % calves, calves/100 adults and # caribou counted from C. Thiessen (pers. comm.)

12 Ratios should be interpreted cautiously due to small sample sizes of classified caribou.

Atlin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Carcross
Teslin
Atlin
Fort St. John
Prince George
Vancouver
N
0 10 20 30 40 50
Kilometers

Atlin

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	858 401	40.3	59.7	-
0-20 km matrix surrounding range	959 801	54.2	45.8	35.7 (NM)
0-30 km matrix surrounding range	1 516 826	53.0	47.0	41.0 (NM)
BC only				
Range	695 385	41.9	58.1	-
0-20 km matrix surrounding range	566 293	62.8	37.2	30.7 (NM)
0-30 km matrix surrounding range	893 837	59.9	40.1	37.2 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Atlin Total Range (BC + Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**858 401**	**1.9**	**2.0**	**0**	**0**	**0**	**0**	**0.2**	**0**	**1.7**	**0**	**0**	**0**	**0**	**0**	**8.7**	**0.1**	**0.1**	**3.8**	**3.2**	**9.3**	**9.6**	**11.5**
High elevation	512 097	0.5	0.5	0	0	0	0	0	0	1.8	0	0	0	0	0	6.1	0	0	1.7	1.5	6.3	6.5	7.0
Low elevation	346 303	4.0	4.2	0	0	0	0.1	0.5	0	1.6	0	0	0	0	0	12.5	0.2	0.2	6.9	5.6	13.9	14.2	18.2
Matrix 0-20 km																							
Total	**959 801**	**1.7**	**2.3**	**0.2**	**0**	**0**	**0**	**0.3**	**0**	**0.3**	**0**	**0**	**0**	**0.1**	**0**	**3.7**	**0**	**0.3**	**3.9**	**2.9**	**4.8**	**5.0**	**6.6**
High elevation	439 383	0.8	1.0	0.3	0	0	0	0	0	0.2	0	0	0	0	0	1.1	0	0	1.2	0.8	1.4	1.6	2.3
Low elevation	520 417	2.4	3.4	0.2	0	0	0	0.5	0	0.4	0	0	0	0.1	0	5.9	0.1	0.5	6.3	4.6	7.6	8.0	10.2
Matrix 0-30 km																							
Total	**1 516 826**	**1.8**	**2.5**	**0.1**	**0**	**0**	**0**	**0.2**	**0**	**0.2**	**0**	**0**	**0**	**0.2**	**0**	**3.0**	**0**	**0.2**	**3.4**	**2.4**	**4.1**	**4.3**	**6.0**
High elevation	712 146	1.2	1.5	0.2	0	0	0	0	0	0.1	0	0	0	0	0	0.8	0	0	1.3	0.6	1.5	1.6	2.8
Low elevation	804 675	2.3	3.3	0.1	0	0	0	0.4	0	0.3	0	0	0	0.3	0	5.1	0.1	0.4	5.3	4.0	6.3	6.7	8.9

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Atlin: BC Only

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**695 385**	**0.8**	**0.9**	**0**	**0**	**0**	**0.1**	**0.2**	**0**	**2.1**	**0**	**0**	**0**	**0**	**0**	**10.1**	**0.1**	**0.1**	**3.6**	**3.3**	**10.4**	**10.7**	**11.5**
High elevation	404 341	0.2	0.3	0	0	0	0	0	0	2.3	0	0	0	0	0	7.7	0	0	2.0	1.9	7.8	8.1	8.3
Low elevation	291 045	1.6	1.8	0	0	0	0.1	0.5	0	1.8	0	0	0	0	0	13.4	0.3	0.2	5.8	5.3	13.9	14.3	15.9
Matrix 0-20 km																							
Total	**566 293**	**2.5**	**3.6**	**0.4**	**0**	**0**	**0**	**0.1**	**0**	**0.1**	**0**	**0**	**0**	**0.1**	**0**	**3.1**	**0**	**0.1**	**2.0**	**1.8**	**3.2**	**3.3**	**5.7**
High elevation	210 390	1.2	1.5	0.5	0	0	0	0	0	0	0	0	0	0	0	1.2	0	0	0.8	0.7	1.3	1.3	2.4
Low elevation	355 903	3.4	4.9	0.2	0	0	0	0.1	0	0.1	0	0	0	0.2	0	4.2	0	0.2	2.7	2.5	4.4	4.4	7.7
Matrix 0-30 km																							
Total	**893 837**	**2.4**	**3.1**	**0.2**	**0**	**0**	**0**	**0.1**	**0**	**0.1**	**0**	**0**	**0**	**0.2**	**0**	**2.7**	**0**	**0.1**	**1.8**	**1.7**	**2.8**	**2.8**	**5.2**
High elevation	358 775	1.3	1.5	0.3	0	0	0	0	0	0	0	0	0	0	0	0.8	0	0	0.5	0.5	0.8	0.8	2.1
Low elevation	535 057	3.1	4.2	0.2	0	0	0	0.2	0	0.1	0	0	0	0.4	0	3.9	0	0.2	2.7	2.5	4.1	4.2	7.2

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Swan Lake

Range use summary

During winter, caribou can be found in low elevation forests and on windswept alpine slopes, and during summer caribou mostly use high elevation habitats. Distribution of Swan Lake caribou overlaps with neighbouring ranges with evidence of winter use in the Little Rancheria low elevation winter range, and evidence of summer use in the Level-Kawdy range.

Season	Overview of Habitat and Range Use	Source
Winter	• Low elevation forests • High elevation windswept alpine slopes • Known wintering areas include one along the Alaska Highway • Some caribou winter in the Little Rancheria low elevation winter range	Williams (2009) M. Williams, pers. comm. (2014)
Summer	• Mostly high elevation habitats • One caribou moved into the Level-Kawdy caribou range for calving and summer	Williams (2009) M. Williams, pers. comm. (2014)
Total Range	• 95% of the range is located in BC • 5% of the range is located in Yukon	

Population size

The only population estimate for the Swan Lake caribou population based on survey data is from 2007. Based on 442 caribou counted during a fall composition survey in October 2007, the Swan Lake caribou population was estimated at 600-800 caribou (Williams 2009). Although the minimum count and population estimate were considered reliable at the time, they are now out of date. Since 2007, 333 caribou were counted during a fall composition survey in 2015 (C. Thiessen, pers. comm. 2020).

Year	Population estimate	Number counted	Method	Reliability	Source
2007	600-800	442	Minimum count + extrapolation	Mod-High	Williams (2009)

Population trend

Fall (October) and late winter (March/April) composition surveys were conducted from 2005 to 2008 as part of a study of radio-collared caribou (Williams 2009).

Three of the four fall calf/100 cow ratios from 2005 to 2015, including the most recent survey in 2015, were above 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016). It is unknown whether fall surveys of rutting areas in the Swan Lake caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987); however, the calves/100 cows ratio suggests a stable population in three of the four years even if the surveys were biased against calves.

Only one of the three late winter calf recruitment estimates from 2006 and 2008 were at or above 15% calves recommended by Bergerud (1996) to achieve population stability.

No information on adult survival or population growth rate (based on adult mortality and calf recruitment) was readily available from the radio-collared caribou study.

Of the most recent composition surveys conducted, evidence from October surveys suggests that calf recruitment may support a stable or increasing population trend, but data from March surveys suggests that it may be declining. However, other than the 2015 survey, these indicators of population trend are at least 13 years old and are too old to use for inferring current population trend.

There is not enough information to determine a current or long-term population trend.

Swan Lake

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted	Total classified[2]		Source[3]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2008	Apr	14	16	19	236	236	236	Williams (2009)
2007	Mar	14	17	24	468	359	359	Williams (2009)
2006	Mar	23	30	42	129	129	129	Williams (2009)
Fall								
2015		16	19	27	333	NA[4]	NA[4]	C. Thiessen, pers. comm.
2007	Oct	16	19	27	442	442	442	Williams (2009)
2006	Oct	12	13	18	340	340	340	Williams (2009)
2005	Oct	17	21	28	247	247	247	Williams (2009)
1977	Oct	13	14	–	56	56	–	Bergerud (1978) (FW)

1 Calf ratios based on groups where all caribou were classified to the degree required for the calculation of the ratio
2 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows
3 All surveys conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey
4 Not available

Boundary Issues

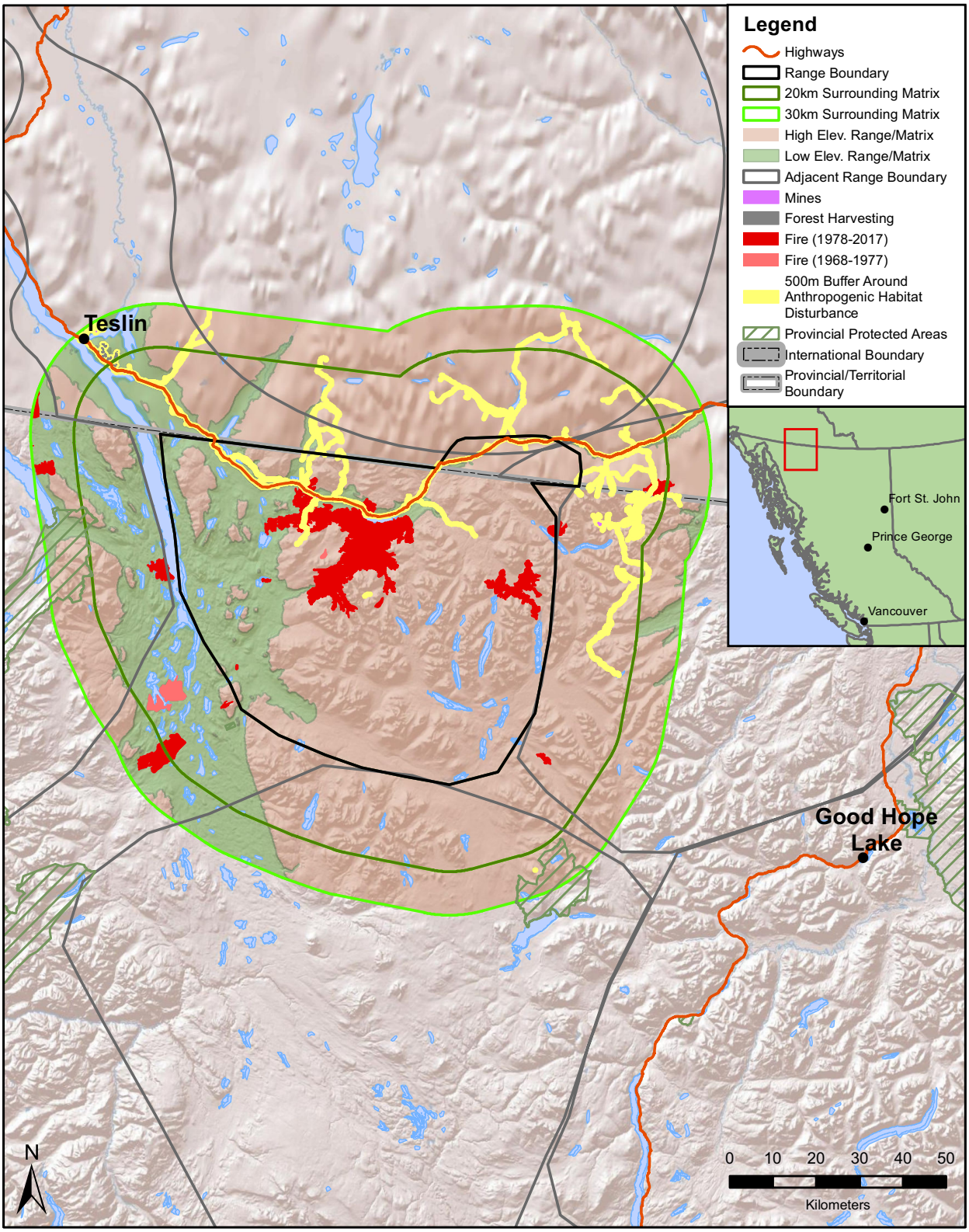
- The range boundary is coarsely drawn resulting in gaps between the Swan Lake caribou range and the Atlin, Level Kawdy and Little Rancheria caribou ranges.
- The BC/Yukon range boundaries do not line up.
- Telemetry data suggest that Swan Lake caribou also use areas within the Horseranch caribou range.

Range condition

Within the current BC and Yukon Swan Lake caribou range boundaries, habitat disturbance covers 9%, 8% and 14% of the total, high elevation and low elevation portions of the range respectively. The primary habitat disturbance is fire, followed by roads/trails and powerlines. The main road/trail in the Swan Lake caribou range is the Alaska Highway. Most of the area burned within the range was due to a 30,000 ha fire along and south of the Alaska Highway in 2004. Roads/trails is the primary habitat disturbance in the 20 km and 30 km matrix surrounding the range.

Although our analysis does not include fires from 2018 to 2021, there were no fires >1 ha in the BC portion of the Swan Lake caribou range and surrounding matrix during those four years.

Swan Lake


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Teslin
Good Hope Lake
Fort St. John
Prince George
Vancouver
N
0 10 20 30 40 50
Kilometers

Swan Lake

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	585 080	23.2	76.8	-
0-20 km matrix surrounding range	748 067	26.1	73.9	68.7 (NM)
0-30 km matrix surrounding range	1 212 853	25.0	75.0	73.7 (NM)
BC only				
Range	557 190	24.3	75.7	-
0-20 km matrix surrounding range	472 321	32.0	68.0	71.6 (NM)
0-30 km matrix surrounding range	753 031	30.5	69.5	77.4 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Swan Lake: Total Range (BC and Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**585 080**	**6.2**	**6.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**1.0**	**0**	**2.9**	**0**	**0.1**	**2.5**	**2.0**	**3.4**	**3.5**	**9.4**
High elevation	449 324	6.1	6.1	0	0	0	0	0	0	0.1	0	0	0	0.1	0	1.6	0	0.1	1.3	0.9	2.1	2.1	8.1
Low elevation	135 756	6.4	6.4	0	0	0	0	0	0	0.4	0	0	0	3.8	0	7.3	0	0.3	6.2	5.6	7.9	8.2	13.9
Matrix 0-20 km																							
Total	**748 067**	**0.7**	**1.1**	**0**	**0**	**0.2**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**3.0**	**0.1**	**0.1**	**5.4**	**2.5**	**5.9**	**6.0**	**6.7**
High elevation	553 034	0.4	0.4	0	0	0.3	0	0	0	0.1	0	0	0	0	0	3.2	0.1	0.1	5.9	2.6	6.6	6.6	7.0
Low elevation	195 033	1.7	3.2	0	0	0	0	0.2	0	0.3	0	0	0	0	0	2.5	0	0.1	3.8	2.4	3.9	4.1	5.8
Matrix 0-30 km																							
Total	**1 212 853**	**0.8**	**1.0**	**0**	**0**	**0.2**	**0**	**0.1**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**2.2**	**0.1**	**0.1**	**4.2**	**1.8**	**4.6**	**4.8**	**5.5**
High elevation	909 855	0.3	0.3	0	0	0.2	0	0	0	0	0	0	0	0	0	2.1	0	0.1	4.5	1.6	4.9	5.0	5.2
Low elevation	302 993	2.4	3.4	0	0	0	0	0.5	0	0.3	0	0	0	0	0	2.5	0.1	0.2	3.5	2.4	3.6	4.1	6.4

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Swan Lake: BC only

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Distrubance[4]
Range																							
Total	**557 190**	**6.5**	**6.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**1.0**	**0**	**2.6**	**0**	**0.1**	**1.9**	**1.6**	**2.9**	**3.0**	**9.2**
High elevation	421 963	6.5	6.5	0	0	0	0	0	0	0	0	0	0	0.1	0	1.1	0	0.1	0.6	0.3	1.3	1.4	7.8
Low elevation	135 228	6.5	6.5	0	0	0	0	0	0	0.4	0	0	0	3.8	0	7.2	0	0.2	6.1	5.5	7.8	8.0	13.9
Matrix 0-20 km																							
Total	**472 321**	**0.9**	**1.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.7**	**0.1**	**0**	**2.2**	**2.1**	**2.8**	**2.8**	**3.7**
High elevation	321 120	0.3	0.3	0	0	0	0	0	0	0.1	0	0	0	0	0	3.9	0.1	0	3.2	3.0	4.1	4.1	4.4
Low elevation	151 201	2.2	4.2	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0	0.1	0.1	0.1	0.1	2.3
Matrix 0-30 km																							
Total	**753 031**	**1.0**	**1.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.8**	**0.1**	**0**	**1.4**	**1.4**	**1.9**	**1.9**	**2.9**
High elevation	522 997	0.2	0.2	0	0	0	0	0	0	0	0	0	0	0	0	2.6	0.1	0	2.1	1.9	2.7	2.7	2.9
Low elevation	230 034	2.9	4.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.0

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Little Rancheria

Range use summary

During summer, caribou are found mostly at high elevations in the Cassiar Mountains between the Little Rancheria and Blue rivers in BC. The Little Rancheria River and Blue River valleys are used during spring and fall migration. During winter, caribou use low elevation forests with the main core winter range centred in the Liard River/Little Rancheria River area in Yukon, and they also use winter range in the area around the Dease River in BC. Portions of the low elevation winter range in Yukon and BC overlap with the Horseranch caribou low elevation winter range. Little Rancheria, Swan Lake and Level Kawdy caribou may also use the low elevation wintering area in BC.

Season	Overview of Habitat and Range Use	Source
Winter	• Low elevation forests • Open pine/lichen forests, mixed conifer forests, black spruce bogs • Core wintering areas are located in both Yukon (main core wintering area) and BC • Shared winter range with Horseranch some years (also some Swan Lake and Level Kawdy caribou) • Use of the core of the low elevation winter range is higher during late winter than early winter	Farnell and McDonald (1990) Florkiewicz et al. (2003) M. Williams pers comm. (2014) Jex (2013) Marshall et al. unpubl. data MacLean, in prep.
Summer	• Mostly high elevation alpine habitat • Most summer range (calving, post-calving, rut) is in the Cassiar Mountains in BC between the Little Rancheria and Blue rivers	Farnell and McDonald (1990) Florkiewicz et al. (2003) Marshall et al. unpubl. data MacLean, in prep.
Migration	• Stream and river courses and associated wetlands • Closed-canopy stands along highway corridors as caribou travel to key highway crossing points • Main travel corridor parallels the Little Rancheria River • Spring migration primarily in the Little Rancheria and Blue River valleys • Fall migration primarily in the Little Rancheria valley	Florkiewicz et al. (2003) Marshall et al. unpubl. data MacLean, in prep.
Total Range	• 66% of the range is located in BC • 34% of the range is located in Yukon	

Population size

The current population estimate of 800-1600 caribou was based on a stratified random block survey conducted on the Horseranch and Little Rancheria caribou low elevation winter ranges in March 1999 (Marshall et al., unpubl. data). A total of 1109 caribou were counted during the survey and the population estimate in the survey area was 1262 ± 13% (Marshall 1999). Based on two estimates of the proportion of radio-collared caribou seen during the survey, sightability correction factors (SCFs) of 1.44 and 1.48 were calculated resulting in a total survey estimate of 1817 and 1866. Based on SCFs calculated for this survey and for surveys in Yukon, Marshall (1999) concluded that an SCF of 1.4 was appropriate and conservative, which resulted a total population estimate of 1767. However, the estimate included both Horseranch and Little Rancheria caribou and it was difficult to determine what proportion of the total estimate belonged to the Horseranch or Little Rancheria populations (Marshall 1999). Because there were no other reliable population estimates for the Little Rancheria caribou population at the time, the portion of the total population estimate that belonged to the Little Rancheria caribou population was estimated using the radio-collared caribou sample.

Date	Population estimate	Number counted	Method	Reliability	Source
1999	800-1600[1]	–	Stratified Random Block	Moderate[2]	Marshall (1999)
1988	681[3]	339	Stratified Random Block	High	Farnell and MacDonald (1990)

[1] A stratified random block survey was conducted on the winter range in March 1999. The total estimate was 1817-1836 with +/-13% (90% CI). Radio-collared caribou from both the Horseranch and Little Rancheria subpopulations were present in the survey area so the estimates for each subpopulation were based on the radio-collared sample.

[2] Although reliability of a population estimate from a stratified random block survey is high, there was less certainty around the calculation of the proportion of caribou in that survey that belonged to the Little Rancheria population, reducing the reliability of the population estimate to moderate

[3] The survey area in 1988 was smaller than the survey area in 1999

In 1988, the Little Rancheria caribou population was estimated at 681 caribou based on a stratified random block survey (Farnell and MacDonald 1990). However the survey area was smaller than those in 1999 and it is unknown whether there were Horseranch caribou present. It is unclear whether the difference between the 1999 estimate and the 1988 estimate was due to a change in numbers, differing survey areas or differences in caribou distribution and populations using the survey area (Marshall 1999). Therefore, we are unable to infer population trend based on the two population estimates.

The most recent population estimate for the Little Rancheria caribou population of 800-1600 caribou based on the March 1999 survey is now over 20 years old. Since 1999, the highest number of caribou counted during a survey was 842 in fall 2004 (Marshall 2004, see Population trend below), although that information is now 17 years old.

Population trend

Spring (June), fall (October/November) and late winter (March/April) composition surveys were conducted from 1996 to 2002 as part of a study of radio-collared caribou (Marshall et al., unpubl. data). Spring (July) and Fall (October) composition surveys were also conducted in 1985 and 1986 as part of an earlier study on radio-collared caribou (Farnell and MacDonald 1990).

The most recent calves/100 cows ratio from fall 2015 was within the 20 to 25 calves/100 cows considered sufficient to support a stable population growth rate (Environment Yukon 2016). However, the sample size was low relative to the estimated population size (C. Thiessen, pers. comm.), and may not adequately represent the calves/100 cows ratio for the whole population. All nine fall calves/100 cows ratios from 1985 to 2004 were also above 20 to 25 calves/100 cows. It is unknown whether fall surveys of rutting areas in the Little Rancheria caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratios suggested a stable population even if the surveys were biased against calves.

Although all six fall surveys from 1996 to 2001 suggested a stable or potentially increasing population trend, only three of the six late winter calf recruitment estimates were at or above 15% calves recommended by Bergerud (1996) to achieve population stability.

Early calf survival based on surveys conducted during calving and early summer is not appropriate for use in estimating population trend because it does not account for late summer and winter mortality. For the Little Rancheria caribou, calf ratios in 1985 and 1985 were generally lower than those from 1997 to 2001, presumably because they were based on surveys conducted in July rather than June, and would have accounted for more calf mortality.

Little Rancheria

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted	Total classified[2]		Source[3]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2001	Mar	12	13	-	172	172		Marshall et al, unpubl. data
2000	Mar	19	23	-	240	240		Marshall et al, unpubl. data
1999	Mar	14	16	-	501	501		Marshall et al, unpubl. data
1998	Apr	10	11	-	168	168		Marshall et al, unpubl. data
1997	Apr	17	21	-	153	153		Marshall et al, unpubl. data
1988	Mar/Apr	19[4]		30[4]	338	338	326	Farnell and McDonald (1990)
Fall								
2015	Fall	15	18	23	189	NA	NA	C. Thiessen, pers. comm.[5]
2004	Fall	17	21	30	842	842	842	Marshall (2004)
2001	Nov[6]	29	-	52[7]	229			Marshall et al, unpubl. data
2000	Oct[6]	18	-	30[7]	502			Marshall et al, unpubl. data
1999	Oct[6]	25	-	44[7]	470			Marshall et al, unpubl. data
1998	Nov[6]	26	-	51[7]	321			Marshall et al, unpubl. data
1997	Oct[6]	17	-	28[7]	259			Marshall et al, unpubl. data
1996	Oct[6]	15	-	27[7]	293			Marshall et al, unpubl. data
1986	Oct	17	21	28	233	233	233	Farnell and McDonald (1990)
1985	Oct	17	20	28	145	145	145	Farnell and McDonald (1990)
1977	Oct	4	4	-	384	384		Bergerud 1978 (FW)[8]
Calving/Summer								
2001	June	34	52	59	150	150	150	Marshall et al, unpubl. data
2000	June	35	54	56	177	177	173	Marshall et al, unpubl. data
1999	June	33	49	74	292	292	240	Marshall et al, unpubl. data
1998	June	27	37		63	63	40	Marshall et al, unpubl. data
1997	June	16	19		80	80	64	Marshall et al, unpubl. data
1986	July	18	21	28	170	170	170	Farnell and McDonald (1990)
1985	July	24	31	41	115	115	115	Farnell and McDonald (1990)

[1] Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not available so we could not eliminate groups where some animals were unclassified

[2] Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

[3] All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

[4] Calf ratios provided; classification data not available; note low sample size relative to population size

[5] Reported % calves and calves/100 cows are based on stratified random block survey calculations and not on the number of caribou in each sex/age class counted during the survey

[6] No age/sex class data provided in the unpublished report; calf/100 cow ratios calculated using Jacknife analysis (Marshall et al. unpubl data)

[7] calf/100 cow ratios were calculated using Jacknife analysis and were based on only groups where all caribou were classified (Marshall et al. unpubl data)

[8] Also counted 60 caribou (of which 2 were calves) on September 28; he assumed this group was not counted both days but suggested it could be a possibility; if not double-counted, total = 444 of which 16 are calves (4% calves)

From the radio-collared caribou study from October 1996 to March 2002, annual survival rate of adult female caribou (N=35) ranged from 81% to 94% and annual survival rate of adult males (N=7) ranged from 53% to 100% (Marshall et al., unpubl. data). Survival rate of adult females during the 1985-87 radio-collared caribou study was 81% (N=11) but the authors felt that the sample size was too small to draw any conclusions (Farnell and MacDonald 1990). No data on population rate of change (lambda) were summarized in either study.

Indicators of population trend based on calf recruitment may not adequately represent the current condition due to small sample size (2015) and length of time since earlier surveys were conducted. For the composition surveys conducted between 1996 and 2004, evidence from October surveys suggests that calf recruitment may have supported a stable or increasing population trend, but data from March surveys is less conclusive. Regardless, these indicators of population trend are at least 17 years old and are too old to use for inferring current population trend.

Boundary Issues

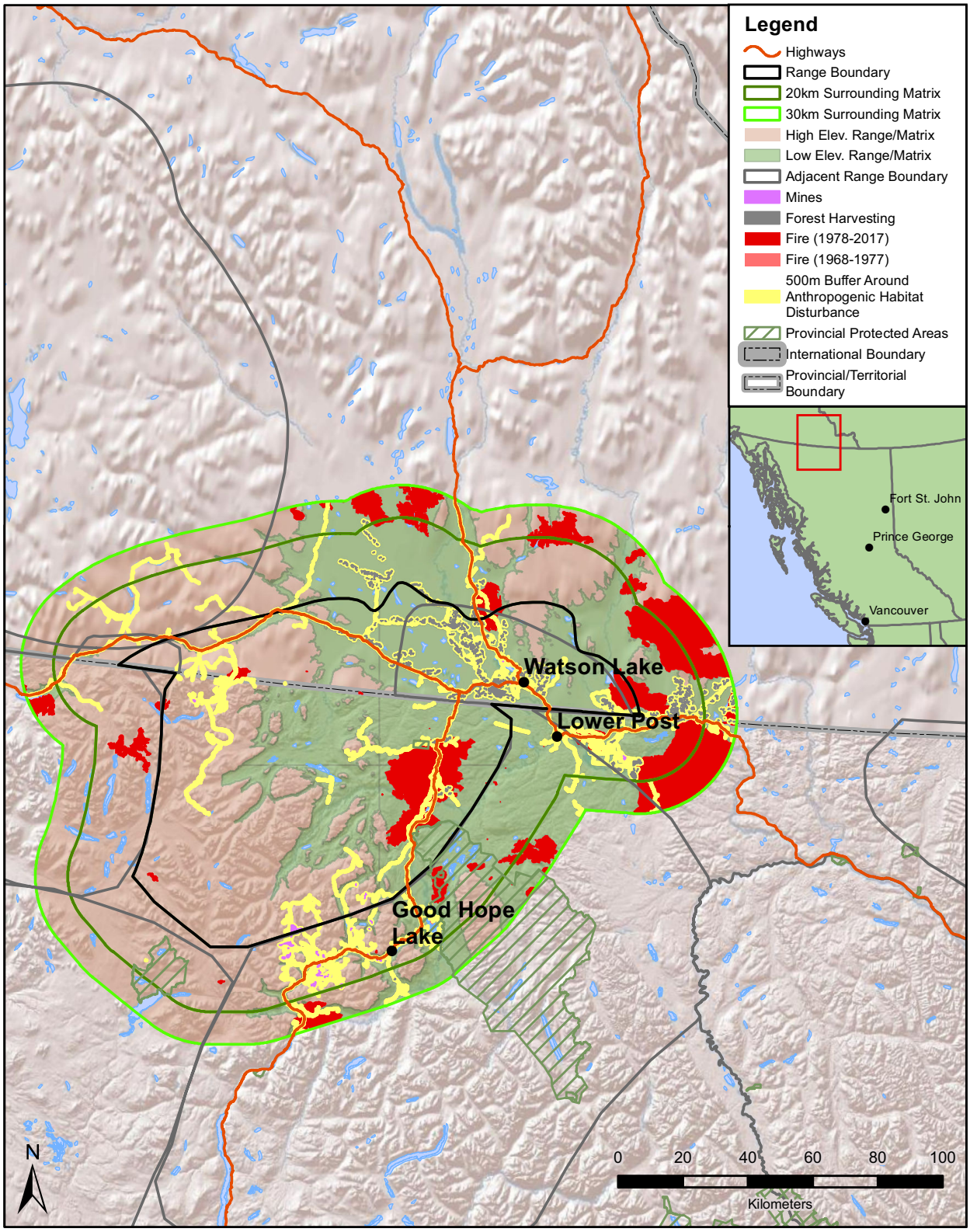
- The range boundary is coarsely drawn resulting in gaps between the Little Rancheria caribou range and the Swan Lake and Level Kawdy caribou ranges.
- The BC/Yukon range boundaries do not line up.
- Telemetry data suggest overlap between the Little Rancheria and Horseranch caribou ranges.

Range condition

Within the current BC and Yukon Little Rancheria caribou range boundaries, habitat disturbance covers 16%, 7% and 24% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails, fire and forest harvesting, all three of which are more prevalent at low elevations than at high elevations. Forest harvesting is located primarily in the Yukon portion of the range, with 54% of the harvested area > 30 years old. Roads/trails include the Stewart-Cassiar Highway in BC, the Alaska Hwy and Robert Campbell Highway in Yukon, and industrial roads associated primarily with mining activities in BC and forest harvesting in Yukon. Within the current range boundary, fire disturbance (up to and including 2016) is largely due to the 2010 and 2011 fires along the Stewart-Cassiar Highway. Habitat disturbance is slightly higher in the 20 km and 30 km matrix surrounding the range, with a greater contribution of fire in the area east of Watson Lake and Lower Post, and additional habitat disturbance due to roads and mining activity in the area west of Good Hope Lake.

Our analysis does not include fires from 2018 to 2021. Although fire disturbance was minimal in most caribou ranges in northern BC during those years, in 2018, there was a 2,500 ha fire in the caribou range, and in 2018 there were two large fires and one smaller fire totalling about 263,000 ha which partially overlapped the portion of the 20 km and 30 km surrounding matrix in the area south of the Liard River and southeast of the Dease River.

Little Rancheria



Little Rancheria

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 055 816	53.4	46.6	-
0-20 km matrix surrounding range	1 054 289	45.3	54.7	58.5 (NM)
0-30 km matrix surrounding range	1 662 553	42.7	57.3	60.6 (NM)
BC only				
Range	698 569	46.0	54.0	-
0-20 km matrix surrounding range	612 209	41.2	58.8	83.3 (NM)
0-30 km matrix surrounding range	957 387	41.6	58.4	85.7 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Little Rancheria: Total Range (BC and Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Distrubance[4]
Range																							
Total	**1 055 816**	**5.4**	**5.4**	**0**	**0**	**0.1**	**0**	**3.8**	**0**	**0.3**	**0**	**0**	**0**	**0**	**0**	**6.9**	**0.2**	**0.3**	**7.2**	**4.7**	**9.4**	**11.7**	**16.1**
High elevation	492 131	0.5	0.5	0	0	0	0	0.1	0	0.3	0	0	0	0	0	5.4	0.1	0	4.3	3.1	6.6	6.8	7.2
Low elevation	563 685	9.7	9.7	0	0	0.1	0	6.9	0	0.3	0	0	0	0	0	8.2	0.4	0.5	9.8	6.2	11.8	15.9	23.8
Matrix 0-20 km																							
Total	**1 054 289**	**6.7**	**6.7**	**0**	**0**	**0.2**	**0**	**2.1**	**0**	**0.7**	**0**	**0**	**0**	**0.2**	**0**	**6.8**	**0.6**	**0.3**	**4.1**	**2.3**	**8.6**	**10.3**	**16.4**
High elevation	576 889	2.5	2.5	0	0	0.3	0	0.4	0	0.7	0	0	0	0.1	0	3.6	0	0.2	2.6	0.9	5.3	5.8	8.4
Low elevation	477 400	11.8	11.8	0.1	0	0	0	4.1	0	0.8	0	0	0	0.3	0	10.6	1.3	0.5	5.9	4.0	12.5	15.6	26.0
Matrix 0-30 km																							
Total	**1 662 553**	**10.8**	**10.8**	**0**	**0**	**0.1**	**0**	**1.6**	**0**	**0.5**	**0**	**0**	**0**	**0.2**	**0**	**5.4**	**0.4**	**0.2**	**3.4**	**1.8**	**6.9**	**8.3**	**18.4**
High elevation	952 326	5.1	5.1	0	0	0.2	0	0.2	0	0.4	0	0	0	0	0	2.5	0	0.1	2.1	0.6	4.0	4.3	9.5
Low elevation	710 221	18.4	18.5	0	0	0	0	3.5	0	0.6	0	0	0	0.3	0	9.2	0.9	0.3	5.2	3.5	10.9	13.6	30.3

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Little Rancheria: BC only

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**698 569**	**6.7**	**6.7**	**0**	**0**	**0**	**0**	**0.2**	**0**	**0.2**	**0**	**0**	**0**	**0**	**0**	**6.6**	**0.1**	**0**	**4.0**	**3.7**	**6.9**	**7.0**	**12.5**
High elevation	377 459	0.2	0.2	0	0	0	0	0	0	0.4	0	0	0	0	0	5.9	0.1	0	3.1	3.0	6.1	6.2	6.4
Low elevation	321 110	14.5	14.5	0	0	0	0	0.5	0	0.1	0	0	0	0	0	7.3	0.2	0	5.0	4.4	7.9	8.0	19.7
Matrix 0-20 km																							
Total	**612 209**	**5.7**	**5.8**	**0.1**	**0**	**0**	**0**	**0.7**	**0**	**1.1**	**0**	**0**	**0**	**0.1**	**0**	**10**	**0.9**	**0.5**	**3.3**	**2.6**	**10.6**	**11.0**	**15.9**
High elevation	359 681	1.6	1.6	0	0	0	0	0	0	1.0	0	0	0	0.1	0	4.5	0	0.3	0.7	0.4	4.8	5.0	6.6
Low elevation	252 527	11.7	11.7	0.1	0	0	0.1	1.6	0	1.4	0	0	0	0.1	0	17.8	2.3	0.8	6.9	5.8	18.9	19.5	29.1
Matrix 0-30 km																							
Total	**957 387**	**9.1**	**9.1**	**0**	**0**	**0**	**0**	**0.5**	**0**	**0.8**	**0**	**0**	**0**	**0.2**	**0**	**7.9**	**0.6**	**0.3**	**2.6**	**2.1**	**8.3**	**8.5**	**16.7**
High elevation	559 140	1.6	1.6	0	0	0	0	0	0	0.6	0	0	0	0.1	0	3.0	0	0.2	0.5	0.2	3.2	3.3	5.0
Low elevation	398 241	19.7	19.7	0.1	0	0	0.1	1.1	0	1.0	0	0	0	0.3	0	14.7	1.4	0.5	5.5	4.8	15.4	15.8	33.2

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Horseranch

Range use summary

During summer, caribou are found mostly at high elevations in the Horseranch and Cassiar Mountains. During winter, caribou use low elevation forests with the core centred along the Dease River in BC, and high elevation alpine/subalpine habitat in the Horseranch Range. Horseranch caribou also winter in low elevation forests in the Liard River/Little Rancheria River area in Yukon, where they overlap with the Little Rancheria caribou winter range. Little Rancheria, Swan Lake and Level Kawdy caribou may also use the core low elevation wintering area in BC.

Season	Overview of Habitat and Range Use	Source
Winter	• In BC, primarily winter in low elevation forests along the Dease River, and at higher elevations in the Horseranch Range. • May also be wintering in northeastern portion of their range • Caribou also winter in low elevation areas in Yukon, south and west of Watson Lake, which overlaps with the Little Rancheria winter range • The main BC wintering area may also be used by Little Rancheria, Swan Lake and Level Kawdy caribou • Use of the core of the low elevation winter range in BC is higher during late winter than early winter	M. Williams, pers. comm. (2014) Marshall et al. unpubl. data MacLean, in prep.
Summer	• High elevation habitats in the Horseranch Range and Cassiar Mountains	M. Williams, pers. comm. (2014) Marshall et al. unpubl. data MacLean, in prep.
Migration	• Spring migration from winter range to Horseranch Mountain then onto alpine areas in the Cassiar Ranges ecosection • Fall migration from rutting habitats in the Cassiar Ranges ecosection to Horseranch Mountain then onto winter range in the Liard Basin	Marshall et al. unpubl. data MacLean, in prep.
Total Range	• 91% of the range is located in BC • 9% of the range is located in Yukon	

Population size

The current population estimate of 800-1000 caribou was based on a fall survey conducted in 2000, where 806 caribou were counted (Marshall et al., unpubl. data).

Year	Population estimate	Number counted	Method	Reliability	Source
2000	800-1000	806	Minimum Count + Extrapolation	High	Marshall et al., unpubl. data

A stratified random block survey was conducted on the Horseranch and Little Rancheria caribou low elevation winter ranges in March 1999. A total of 1109 caribou were counted during the survey and the population estimate in the survey area was 1262 ± 13% (Marshall 1999). Based on two estimates of the proportion of radio-collared caribou seen during the survey, sightability correction factors (SCFs) of 1.44 and 1.48 were calculated resulting in a total survey estimate of 1817 and 1866. Based on SCFs calculated for this survey and for surveys in Yukon, Marshall (1999) concluded that an SCF of 1.4 was appropriate and conservative, which resulted a final population estimate of 1767. However, the estimate includes both Horseranch and Little Rancheria caribou and it was difficult to determine what proportion of the total estimate belonged to the Horseranch or Little Rancheria populations (Marshall 1999). Therefore, the Horseranch caribou population estimate was based on the October 2000 survey instead.

Another stratified random block survey was conducted in the Horseranch range in October 1996. A total of 162 caribou were counted, but no population estimates or a confidence interval were provided in the original report (results summarized in Marshall 1996).

Neither the March 1999 nor October 1996 stratified random block surveys provided reliable population estimates specifically for the Horseranch caribou population.

The only population estimate for the Horseranch caribou population of 800-1000 caribou based on the October 2000 survey is now over 20 years old. Since 2000, the highest number of caribou counted during a survey in the Horseranch caribou range was 514 in February/March 2009 (see Population trend below), although the survey did not cover the whole range (Thiessen 2009, BC MFLNRORD unpubl. data).

Population trend

Spring (June), fall (October/November) and late winter (March/April) composition surveys were conducted from 1996 to 2002 as part of a study of radio-collared caribou (Marshall et al., unpubl. data). Fall composition surveys were also conducted from 1978 to 1987 as part of a study on effects of wolf predation on caribou and other ungulates (Elliott 1985, 1986, Bergerud and Elliott 1986, 1998). Wolves were removed: from the Horseranch Mountains area in late winter (March/April) in 1978, 1979, 1980 and 1985; from nearby areas in 1982 and 1983; and, from an area that partially overlapped with the Horseranch caribou range in 1984 (Bergerud and Elliot 1998).

From 1978 to 1987, fall calf/100 cow ratios were within or above 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016), only during years when full or partial wolf control was conducted (1978, 1979, 1980, 1984, 1985) and in 1986 and 1987, the two years following the end of the wolf control program. During the radio-collared caribou study from 1996 to 2001, fall calves/100 cows ratios were within or above 20-25 calves/100 cows in four of the six years. The four most recent fall ratios (2000, 2001, 2004, 2015) were all within or above that range. However, the sample size in 2015 was low relative to the estimated population size (C. Thiessen, pers. comm.), and may not adequately represent the calves/100 cows ratio for the whole population. It is unknown whether fall surveys of rutting areas in the Horseranch caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratios from the three most recent fall surveys with adequate sample sizes suggest that calf recruitment was sufficient to support a stable population growth rate in the early 2000s even if the surveys were biased against calves.

Horseranch

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted[2]	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2009	Feb/Mar	9	10	12	514[5]	507	507	MFLNRORD unpubl. data[5]
2001	Mar	15	18	-	278	278		Marshall et al. unpubl. data
2000	Mar	17	20	-	257	257		Marshall et al. unpubl. data
1999	Mar	7	8	-	471	471		Marshall et al. unpubl. data
1998	Apr	7	8	-	259	259		Marshall et al. unpubl. data
1997	Apr	11	12	-	120	120		Marshall et al. unpubl. data
1974	Mar				225			Bergerud 1978 (FW?)[6]
Fall								
2015	Fall	14	16	22	133	NA	NA	C. Thiessen, pers. comm.[7]
2004	Fall	14	17	26	266	266	266	Marshall 2004
2001	Nov[8]	19	-	30[9]	505			Marshall et al. unpubl. data
2000	Oct[8]	15	-	24[9]	806			Marshall et al. unpubl. data
1999	Oct[8]	9	-	13[9]	385			Marshall et al. unpubl. data
1998	Nov[8]	13	-	20[9]	580			Marshall et al. unpubl. data
1997	Oct[8]	13	-	18[9]	390			Marshall et al. unpubl. data
1996	Oct	20	26	40	162	162	162	Marshall 1996[10]
1987	Oct			44[11]				Bergerud and Elliott 1998
1986	Oct			24[11]				Bergerud and Elliott 1998
1985	Oct	26	35	51[12]	274	274	274	Elliott 1986
1984	Oct	16	19	24[12]	209	209	209	Elliott 1985
1983	Oct	6	6	8[12]	250	250	250	Bergerud and Elliott 1986
1982	Oct	4	4	7[12]	337	337	337	Bergerud and Elliott 1986
1981	Oct	11	12	18	329	329	329	Bergerud and Elliott 1986
1980	Oct	16	19	27[12]	311	311	311	Bergerud and Elliott 1986
1979	Oct	17	21	25[12]	274	274	274	Bergerud and Elliott 1986
1978	Oct	17	20	24[12]	263	263	263	Bergerud and Elliott 1986
1977	Oct	6	7	-	237	237		Bergerud 1978 (FW)
Calving/summer								
2001	June	27	37	71[9]	141	141	132	Marshall et al. unpubl. data
2000	June	26	35	39[9]	78	78	77	Marshall et al. unpubl. data
1999	June	20	25	42[9]	121	121	101	Marshall et al. unpubl. data
1998	June	7	8	-	43	43		Marshall et al. unpubl. data
1997	June	25	34		59	59		Marshall et al. unpubl. data
1963	July/Aug				(3)			Mundy 1963[13] (GR)

[1] Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not available so we could not eliminate groups where some animals were unclassified

[2] Numbers in parentheses indicate surveys where caribou were not the primary focus

[3] Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

[4] All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

[5] Total number differs from COSEWIC (2014) because an error was discovered and the correct total included here; data for total survey was presented in Thiessen (2009) but did not include a summary of the Horseranch-only portion

[6] Bergerud (1978) reported that D. Spalding observed 225 caribou on Horseranch Mtn on March 22, 1974 but does not provide information on what type of survey was conducted; we presume it may have been from a fixed-wing

[7] Calf ratios provided; classification data not available; note low sample size relative to population size

[8] No age/sex class data provided in the unpublished report; calf/100 cow ratios calculated using Jacknife analysis (Marshall et al. unpubl data)

[9] calf/100 cow ratios were calculated using Jacknife analysis and were based on only groups where all caribou were classified (Marshall et al. unpubl data)

[10] Marshall (1996) summary (Ca-8) of a report by J. Elliott. The survey was described as a stratified random block but no population estimate or confidence intervals were provided in the original report.

[11] No sample size or classification data provided

[12] Wolves were removed from the Horseranch Mountains area the previous winter (March/April) in 1978, 1979, 1980 and 1985; wolves were removed from nearby areas in 1982 and 1983; wolves were removed from an area with some overlap with the Horseranch caribou range in 1984 (Bergerud and Elliott 1998)

[13] Ground surveys conducted based at Eaglehead Lake

Of the six late winter surveys conducted, three were at or above 15% calves recommended to achieve population stability (Bergerud 1996). Calf recruitment from the most recent late winter survey in 2009 was 9% (Thiessen 2009). That survey was conducted for both caribou and Stone's sheep and did not include the whole Horseranch caribou range (Thiessen 2009).

From the radio-collared caribou study (October 1996 to March 2002), annual survival rate of adult female caribou (N=27) ranged from 78% to 100% and annual survival rate of adult males (N=10) ranged from 60% to 100% (Marshall et al., unpubl. data). No data on population rate of change (lambda) were summarized.

Indicators of population trend based on calf recruitment may not adequately represent the current condition due to small sample size (2015) and length of time since earlier surveys were conducted. For the four fall surveys conducted between 2000 and 2009, evidence suggests that calf recruitment may support a stable or increasing population trend (2000, 2001, 2004) or may not (2009). Regardless, these indicators of population trend are at least 12 years old and are too old to use for inferring current population trend.

Boundary Issues

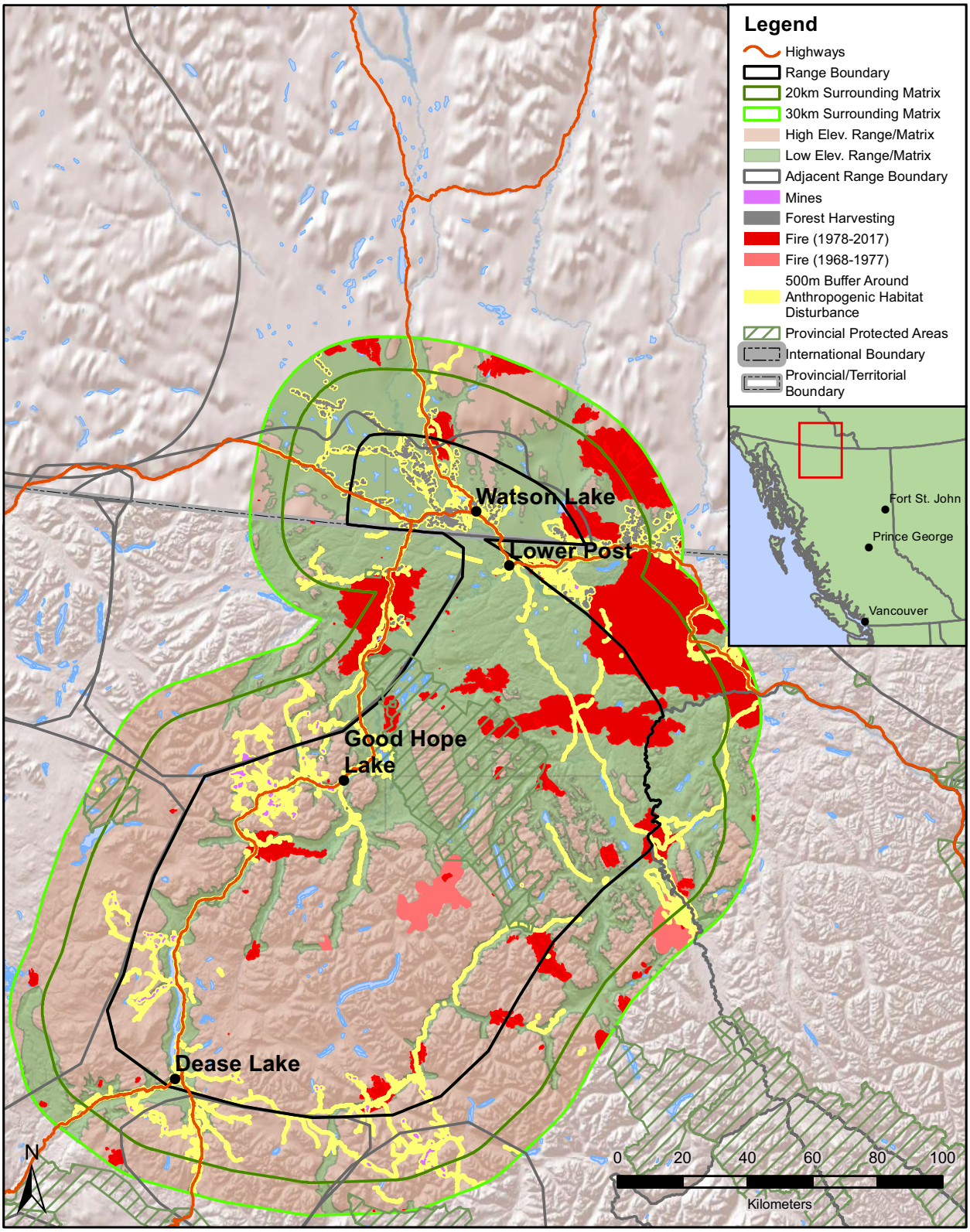
- The range boundary is coarsely drawn resulting in gaps between the Horseranch caribou ranges, and the Level Kawdy, Tsenaglode and Spatsizi caribou ranges.
- The BC/Yukon range boundaries do not line up.
- Telemetry data suggest overlap between adjacent ranges including Little Rancheria, Swan Lake, Level Kawdy and Tsenaglode.
- The large gap between caribou ranges in the centre of the study area (between the Horseranch, Spatsizi, Rabbit, Frog and Thutade caribou ranges) is known to contain caribou.
- For the Horseranch caribou range, the BC and Yukon portions of the range were connected by only a point on the BC side. We therefore widened the point on the BC side slightly to create a single polygon for the combined range.

Range condition

Within the current BC and Yukon Horseranch caribou range boundaries, habitat disturbance covers 14%, 5% and 25% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails and fire, both of which are more prevalent at low elevations than at high elevations. Forest harvesting also contributes to habitat disturbance at low elevations, primarily in the Yukon portion of the range. Roads/trails include the Stewart-Cassiar Highway in BC, the Alaska Hwy and Robert Campbell Highway in Yukon, and industrial roads associated primarily with mining activities in BC and forest harvesting in Yukon. Fire plays a slightly higher role in habitat disturbance in the 20 km and 30 km surrounding matrix, especially in the areas to the northwest and northeast of the Horseranch caribou range in BC.

Our analysis does not include fires from 2018 to 2021. Although fire disturbance was minimal in most caribou ranges in northern BC during those years, in 2018 there were two large wildfires and one smaller fire totaling about 263,000 ha that that were almost entirely contained within the northeastern portion of the Horseranch caribou range in the area south of the Liard River and southeast of the Dease River. Therefore, fire and total habitat disturbance in the caribou range are currently higher than what we have calculated in this report.

Horseranch


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Watson Lake
Lower Post
Good Hope Lake
Dease Lake
Fort St. John
Prince George
Vancouver
N
0
20
40
60
80
100
Kilometers

Horseranch

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 945 173	47.3	52.7	-
0-20 km matrix surrounding range	1 473 971	51.4	48.6	57.2 (NM)
0-30 km matrix surrounding range	2 272 285	48.5	51.5	57.3 (NM)
BC only				
Range	1 779 688	42.9	57.1	-
0-20 km matrix surrounding range	1 195 352	45.8	54.2	63.3 (NM)
0-30 km matrix surrounding range	1 807 609	43.8	56.2	65.7 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Horseranch: Total Range (BC and Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Distrubance[4]
Range																							
Total	**1 945 173**	**5.7**	**6.8**	**0**	**0**	**0**	**0**	**1.8**	**0**	**0.6**	**0**	**0**	**0**	**0**	**0**	**6.8**	**0.1**	**0.4**	**2.5**	**1.3**	**8.0**	**9.2**	**14.4**
High elevation	1 024 684	1.1	2.7	0	0	0	0	0.1	0	0.6	0	0	0	0	0	3.6	0	0.1	0	0	3.6	3.8	4.9
Low elevation	920 489	10.7	11.4	0	0	0.1	0.1	3.7	0	0.7	0	0	0	0	0	10.3	0.3	0.8	5.3	2.7	12.9	15.2	24.9
Matrix 0-20 km																							
Total	**1 473 971**	**12.1**	**12.5**	**0**	**0**	**0**	**0**	**1.7**	**0**	**0.4**	**0**	**0**	**0**	**0.1**	**0**	**8.5**	**0.4**	**0.1**	**2.9**	**2.3**	**9.1**	**10.4**	**21.0**
High elevation	716 138	0.7	0.8	0	0.1	0	0	0.3	0	0.7	0	0	0	0	0	7.1	0	0	0.1	0.1	7.1	7.6	8.3
Low elevation	757 833	22.8	23.4	0	0	0	0	2.9	0	0.2	0	0	0	0.2	0	9.9	0.7	0.1	5.5	4.4	11.0	13.0	32.9
Matrix 0-30 km																							
Total	**2 272 285**	**12.5**	**13.2**	**0**	**0**	**0**	**0**	**1.4**	**0**	**0.3**	**0**	**0**	**0**	**0.1**	**0**	**7.0**	**0.3**	**0.1**	**2.4**	**2.0**	**7.5**	**8.6**	**19.7**
High elevation	1 169 719	3.0	3.3	0	0.1	0	0	0.2	0	0.4	0	0	0	0	0	5.2	0	0	0.1	0.1	5.2	5.5	8.5
Low elevation	1 102 563	22.6	23.8	0	0	0	0	2.6	0	0.2	0	0	0	0.1	0	9.0	0.6	0.1	4.8	3.9	10	11.8	31.7

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Horseranch: BC only

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**1 779 688**	**5.9**	**7.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**0**	**0**	**6.5**	**0.1**	**0.3**	**1.0**	**0.6**	**6.9**	**7.0**	**12.5**
High elevation	1 016 730	1.2	2.8	0	0	0	0	0	0	0.6	0	0	0	0	0	3.7	0	0.1	0	0	3.7	3.7	4.9
Low elevation	762 958	12.3	13.0	0	0	0	0.1	0.1	0	0.6	0	0	0	0	0	10.2	0.2	0.6	2.3	1.3	11.3	11.4	22.7
Matrix 0-20 km																							
Total	**1 195 352**	**12.7**	**13.2**	**0**	**0.1**	**0**	**0**	**0.5**	**0**	**0.5**	**0**	**0**	**0**	**0**	**0**	**9.8**	**0.4**	**0.1**	**2.6**	**2.3**	**10.2**	**10.4**	**21.4**
High elevation	648 400	0.4	0.6	0	0.1	0	0	0	0	0.7	0	0	0	0	0	7.7	0	0	0.2	0.2	7.7	8.0	8.4
Low elevation	546 952	27.2	28.2	0	0	0	0	1.0	0	0.2	0	0	0	0	0	12.3	0.9	0.2	5.6	4.9	13.0	13.3	36.8
Matrix 0-30 km																							
Total	**1 807 609**	**12.0**	**13.0**	**0**	**0**	**0**	**0**	**0.3**	**0**	**0.4**	**0**	**0**	**0**	**0**	**0**	**8.2**	**0.3**	**0.1**	**2.2**	**2.0**	**8.4**	**8.6**	**19.0**
High elevation	1 015 426	0.7	1.1	0	0.1	0	0	0	0	0.5	0	0	0	0	0	5.7	0	0	0.1	0.1	5.7	5.8	6.6
Low elevation	792 180	26.6	28.2	0	0	0	0	0.7	0	0.2	0	0	0	0	0	11.4	0.7	0.2	4.9	4.4	11.9	12.1	35.0

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Level Kawdy

Range use summary

During summer, caribou are found mostly at high elevations in the Level Mountain and Kawdy ranges. Fidelity to rutting areas is high. During winter, caribou primarily use low elevation forests along the Kawdy and Teslin rivers, but some caribou use high elevation alpine/subalpine habitat and some caribou have wintered in the Little Rancheria, Horseranch and Swan Lake caribou low elevation winter ranges. Individual caribou may use different winter ranges in different years. Migration routes between winter and summer ranges include low elevation forested areas and appear to be well defined.

Season	Overview of Habitat and Range Use	Source
Winter	• Primarily in low elevation forests along the Kawdy and Teslin Rivers • Some wintering in Little Rancheria low elevation winter range • Some wintering at low elevation in the Swan Lake range • Some caribou used different winter ranges in different years • Some use of high elevation alpine/subalpine	Jex (2013) Kerckhoff (2013)
Summer	• High elevation habitats in the Level Mountain and Kawdy ranges • Some caribou calve in the Kawdy and rut on Level Mountain • Some caribou calve and rut in the Kawdy • Some calving/summer locations extend into the western portion of the Horseranch caribou range	Jex (2013)
Migration	• Consistently used travel routes including low elevation forested areas	Jex (2013)
Total Range	• radio-collared caribou have used portions of the Swan Lake, Little Rancheria and Horseranch caribou ranges	Jex (2013)

Population size

The current population estimate of 1538 caribou was based on a total count of the Level Mountain and Kawdy Plateau areas conducted in October 1998 (Marshall 1999). A total of 1398 caribou were counted, and it was assumed that 90% of the caribou were seen during the survey, resulting in the total population estimate of 1538 (Marshall 1999).

Date	Population estimate	Number counted	Method	Reliability	Source
1998	1538	1398	Minimum count + extrapolation	High	Marshall (1999)

Prior to 1998, a population estimate of 1250 caribou was based on a survey conducted in 1982 (see Marshall 1999). A total of 760 caribou were counted during the October 1982 survey (see Population trend below). However, we did not have any information about how the estimate of 1250 was calculated and therefore were not able to assess the reliability of the estimate, and have not included it in the list of population estimates.

Prior to the 1998 population survey, the most caribou counted during a survey was 1363 caribou counted during a fixed-wing survey in 1977 (see Population trend below). Since 1998, the most caribou counted during a survey was 1086 counted in October 2011 (see Population trend below).

Population trend

In the Level/Kawdy caribou range, most composition surveys were conducted in the fall, except for the two most recent surveys (2012, 2013) that were conducted in winter.

Four of the five fall calves/100 cows ratios between 1983 to 2011, and three of the four most recent fall calves/100 cows ratios (1998 to 2011) were at or above 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016). It is unknown whether fall surveys of rutting areas in the Level Kawdy caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratio suggests a stable population even if the survey is biased against calves.

Although adults were not classified during fall surveys prior to 1983, % calves ranged from 6% in 1977, 1981 and 1982 to 24% in 1978. Bergerud and Elliott (1986) suggest that calf survival was higher during years of early snow melt (1978, 1980), and during years with lower wolf numbers (1978, 1980).

One of the two most recent late winter calf recruitment surveys was at or above 15% calves recommended by Bergerud (1996) to achieve population stability.

No information on adult survival or population growth rate (based on adult mortality and calf recruitment) was readily available from the radio-collared caribou study.

Of the six most recent composition surveys conducted, four suggest that calf recruitment was sufficient to support a stable or increasing population trend, while calf recruitment in the other two surveys were close to levels considered sufficient.

Regardless, these indicators of population trend are at least 8 years old and are too old to use to infer current population trend.

Boundary Issues

- The range boundary is coarsely drawn resulting in gaps between the Level Kawdy range and Atlin, Little Rancheria, Horseranch and Tsenaglode ranges.
- Telemetry data suggest Level Kawdy caribou also use areas within Swan Lake, Little Rancheria and Horseranch caribou ranges.

Range condition

Within the current Level Kawdy caribou range boundaries, habitat disturbance covers 3%, 2% and 7% of the total, high elevation and low elevation portions of the range respectively. The only disturbances within the range boundary are roads/trails and fire, both of which are more prevalent at low elevations than at high elevations. The linear feature running through the western portion of the range is the old Telegraph Trail, which sees some snowmobile use. Habitat disturbance levels are slightly higher in the 20 km and 30 km matrix surrounding the range, with roads/trails and fire the primary disturbances. Other habitat disturbances in the matrix include settlement (Dease Lake) and mines.

Our analysis does not include fires from 2018 to 2021. Although fire disturbance was minimal in most caribou ranges in northern BC during those years, in 2018 there was a small (3,500 ha) fire in the caribou range, and a 120,000 ha fire that affected the southernmost portion of the 20 km and 30 km matrix.

Level Kawdy

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted[2]	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2013	Mar	17	20	30	272	272	272	Kerkhoff (2013)
2012	Feb	13	16	21	164	149	149	Jex (2012)
Fall								
2011	Oct	17	27	35	1086	1086	1086	Jex (2011)
2002	Nov	17	20	29	164	164	164	Marshall (2002)
1999	Oct	12	14	19	864	820	820	Marshall (1999)
1998	Oct	19	24	40	1398	1346	1346	Marshall (1999)
1983	Oct	15	17	24	312	312	312	van Drimmelen (1983)
1983	Sept				769			van Drimmelen (1983) (FW)
1982	Fall[5]	6	7	-	760	491		Bergerud & Elliott (1986) (FW)[6]
1981	Fall[5]	6[7]	6[7]	-	108[7]	108[7]		Bergerud & Elliott (1986) (FW)[6]
1980	Fall[5]	17	20	-	378	378		Bergerud & Elliott (1986) (FW)[6]
1979	Fall[5]	11	12	-	833	833		Bergerud & Elliott (1986) (FW)[6]
1978	Fall[5]	24	31	-	412	412		Bergerud & Elliott (1986) (FW)[6]
1977	Oct	6	6	-	228	228		Hatler in Bergerud (1978)
1977	Sept	5	5	-	1363	1155		Bergerud (1978) (FW)
Calving/summer								
1981	June	28	39	39	61	61	61	Bergerud & Elliott (1986) (GR)[8]
1980	June	42	73	73	69	69	69	Bergerud & Elliott (1986) (GR)[8]
1979	June	22	28	28	87	87	87	Bergerud & Elliott (1986) (GR)[8]
1978	June	33	49	49	55	55	55	Bergerud & Elliott (1986) (GR)[8]
1963	July	0	0		(63)	43		Mundy (1963)(GR)[9]

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 No information on month/day of survey were provided

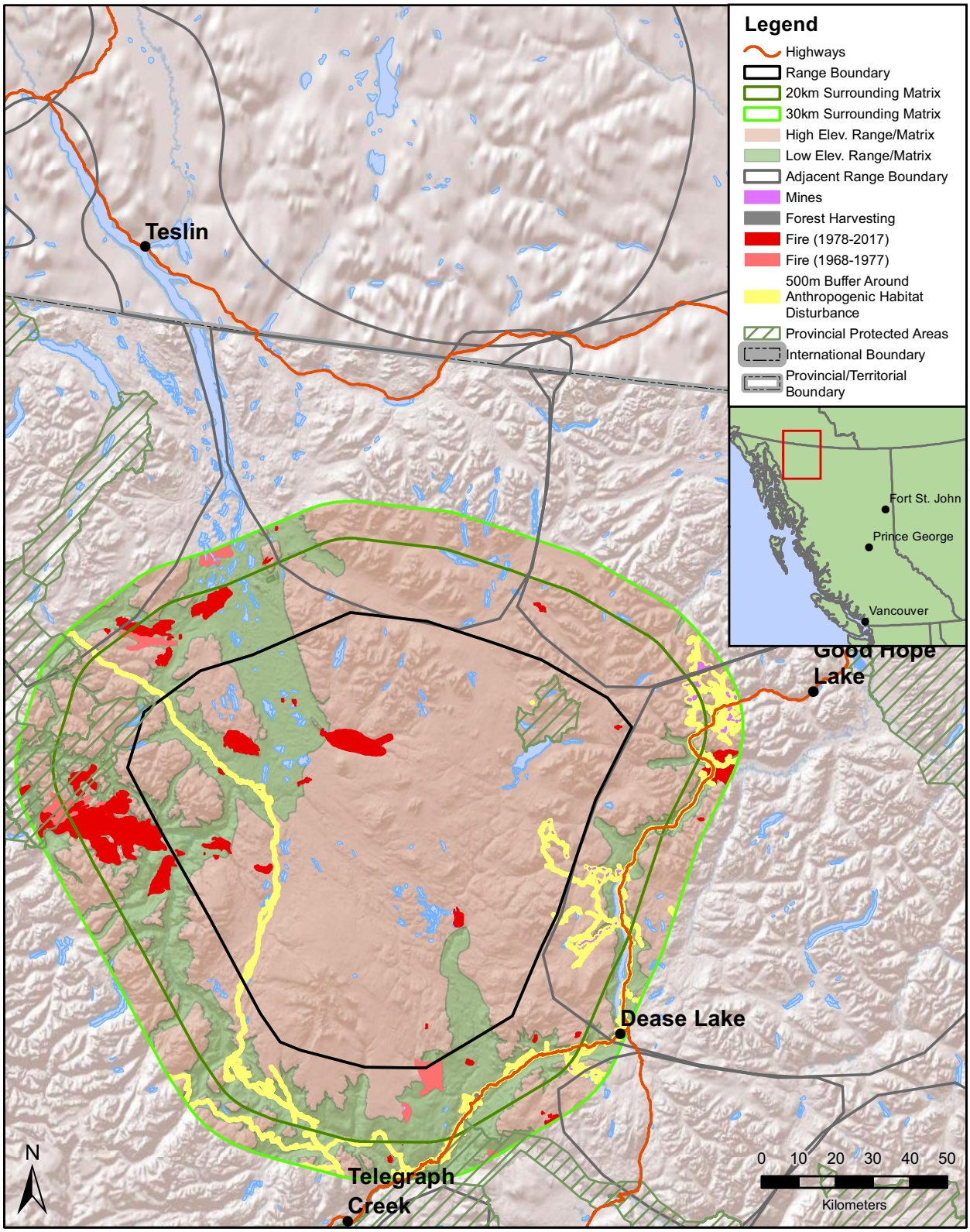
6 Aircraft assumed to be fixed-wing because methods indicated that adults were not sexed during fixed-wing surveys and all adults in these surveys were 'unclassified adults'

7 Level Mountain only

8 Ground surveys conducted June 9-15 each year on Level Mountain; only data for cows and calves were reported

9 Ground surveys around Pyrrhotite Lake and Ketchum Lake

Level Kawdy


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Teslin
Fort St. John
Prince George
Vancouver
Good Hope Lake
Dease Lake
Telegraph Creek
N
0 10 20 30 40 50
Kilometers

Level Kawdy

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 135 902	14.3	85.7	-
0-20 km matrix surrounding range	921 841	36.8	63.2	36.6 (NM)
0-30 km matrix surrounding range	1 477 004	36.5	63.5	41.5 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Level Kawdy

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**1 135 902**	**1.4**	**1.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.2**	**0**	**0**	**0.9**	**0.6**	**1.6**	**1.6**	**3.0**
High elevation	973 907	1.1	1.1	0	0	0	0	0	0	0	0	0	0	0	0	0.9	0	0	0.5	0.3	1.2	1.2	2.3
Low elevation	161 995	3.4	3.6	0	0	0	0	0	0	0	0	0	0	0	0	3.0	0	0	3.3	2.6	3.8	3.8	7.1
Matrix 0-20 km																							
Total	**921 841**	**4.4**	**5.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**0**	**0**	**4.9**	**0**	**0.1**	**0.9**	**0.8**	**4.9**	**5.1**	**9.4**
High elevation	582 435	1.1	1.5	0	0	0	0	0	0	0.4	0	0	0	0	0	2.9	0	0.1	0.6	0.5	3.0	3.0	4.1
Low elevation	339 406	10	12.0	0.1	0	0	0	0.1	0	0.5	0	0	0	0	0	8.2	0	0.1	1.4	1.3	8.3	8.5	18.5
Matrix 0-30 km																							
Total	**1 477 004**	**3.6**	**4.6**	**0**	**0**	**0**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**0**	**0**	**6.3**	**0**	**0.2**	**0.9**	**0.8**	**6.3**	**6.5**	**9.9**
High elevation	937 534	1.0	1.6	0	0.1	0	0	0	0	0.6	0	0	0	0	0	3.3	0	0.1	0.4	0.4	3.3	3.5	4.6
Low elevation	539 463	8.0	9.9	0.1	0	0	0.1	0.1	0	0.5	0	0	0	0	0	11.4	0	0.5	1.7	1.6	11.5	11.7	19.3

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Edziza

Range use summary

There is limited information about seasonal habitat and range use of Edziza caribou other than locations from surveys. During summer, caribou are found throughout alpine areas in Mt. Edziza Park. During winter, caribou are found primarily in the northern part of the park, both in alpine areas and in the forested areas around Buckley Lake. Relative use of alpine areas varies between winters (see Population trend below). Four caribou were collared with GPS radio-collars in 2002, which provided about 1 year of data.

Season	Overview of Habitat and Range Use	Source
Winter	• Limited information • Alpine areas or forested areas in the northern part of Mt. Edziza Park	Various flight reports
Summer	• Limited information • Alpine areas in Mt. Edziza Park	Various flight reports
Total Range		

Population size

The current population estimate of 151 caribou was based on a total count survey of alpine areas in Mt. Edziza Park in March 2006 (Marshall 2006). The only survey conducted since 2006 was in October 2017 when 23 caribou were seen (Grant 2018).

Date	Population estimate	Number counted	Method	Reliability	Source
2006	151	151	Minimum count	High	Marshall (2006)

Numerous surveys have been conducted in the Edziza caribou range, mostly in the 1970s and 1980s (see Population trend below). The highest number of caribou counted was during winter surveys in 1982 (106), 2002 (142) and 2006 (151). However, there have also been several winter surveys when no caribou were seen (e.g. 1978, 1983, 1984). In the Spatsizi caribou range, relative use of alpine areas varied between winters depending on snow conditions, with a large proportion of the population found above treeline during only one of four winters (Hatler 1986, 1987).

Number of caribou counted during fall surveys in the Edziza caribou range has also been variable, which may depend on survey timing. In 1983, Sather (1983) counted 66 caribou during a helicopter survey on October 7, but saw no caribou during fixed-wing surveys on September 27, September 30 and October 12. On October 28 that year, 50 caribou were seen during a fixed-wing survey (Osmond-Jones 1983). Weather conditions may influence caribou distribution during the fall (Hatler 1987).

Due to the lack of range-specific information on potential variability of Edziza caribou seasonal range use, we do not make any inferences about population size based on counts of high elevation areas, other than that there are no fewer caribou in the population than what was counted during the survey. A better understanding of seasonal range use based on radio-collared caribou would aid in interpreting differences in numbers counted during surveys.

The population estimate for the Edziza caribou population of 151 caribou based on the March 2006 survey is now over 15 years old.

Population trend

Although numerous surveys have been conducted in the Edziza caribou range, mostly in the 1970s and 1980s, caribou were classified in less than half of the surveys conducted, and sample sizes were low in many surveys.

Of the four fall surveys with calves/100 cows ratios available, calves/100 cows ranged from 0 in 1978 and 1979 to 30 calves/100 cows in 2017, although sample sizes were less than 40 caribou in all but the 1983 survey (18 calves/100 cows). It is unknown whether fall surveys of rutting areas in the Edziza caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987). However, the 30 calves/100 cows in the most recent survey in 2017 is above 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016), although the ratio is based on only 23 caribou.

Percent calves during winter surveys has also been highly variable. Calves made up 7% of the total caribou counted during the most recent winter survey in 2006, which is below 15% calves recommended by Bergerud (1996) to achieve population stability.

There are insufficient data to infer a current population trend for the Edziza caribou population based on calf recruitment. During the only recent survey, which was conducted in October 2017, only 23 caribou we counted and therefore the calves/100 cows ratio should be interpreted with caution (Grant 2018).

Boundary Issues

- The range boundary is coarsely drawn and offset from the known range.
- The known area of use by Edziza caribou centres around the Mt. Edziza mountain block. The current Edziza caribou range boundary is offset to the west such that it does not include the eastern portion of the Mt. Edziza mountain block, and the boundary extends west of Mess Creek to encompass high elevation areas west of Mess Creek that the caribou are not known to use.

Range condition

Within the current Edziza caribou range boundaries, habitat disturbance covers 10%, 6% and 18% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails and fire, both of which are more prevalent at low elevations than at high elevations. Roads/trails include the Telegraph Trail through the range, and access to Schaft Creek in the southwest portion of the currently-drawn range. Most of the fires in the range have occurred in the last 10 years, including a 9,300 ha fire in the northeastern part of the range and a 3,100 ha fire in the Mess Creek area. Roads/trails (including the Telegraph Creek Road) and fire are also the primary habitat disturbances in 20 km and 30 km matrix surrounding the range, although agriculture, settlements and mines also contribute.

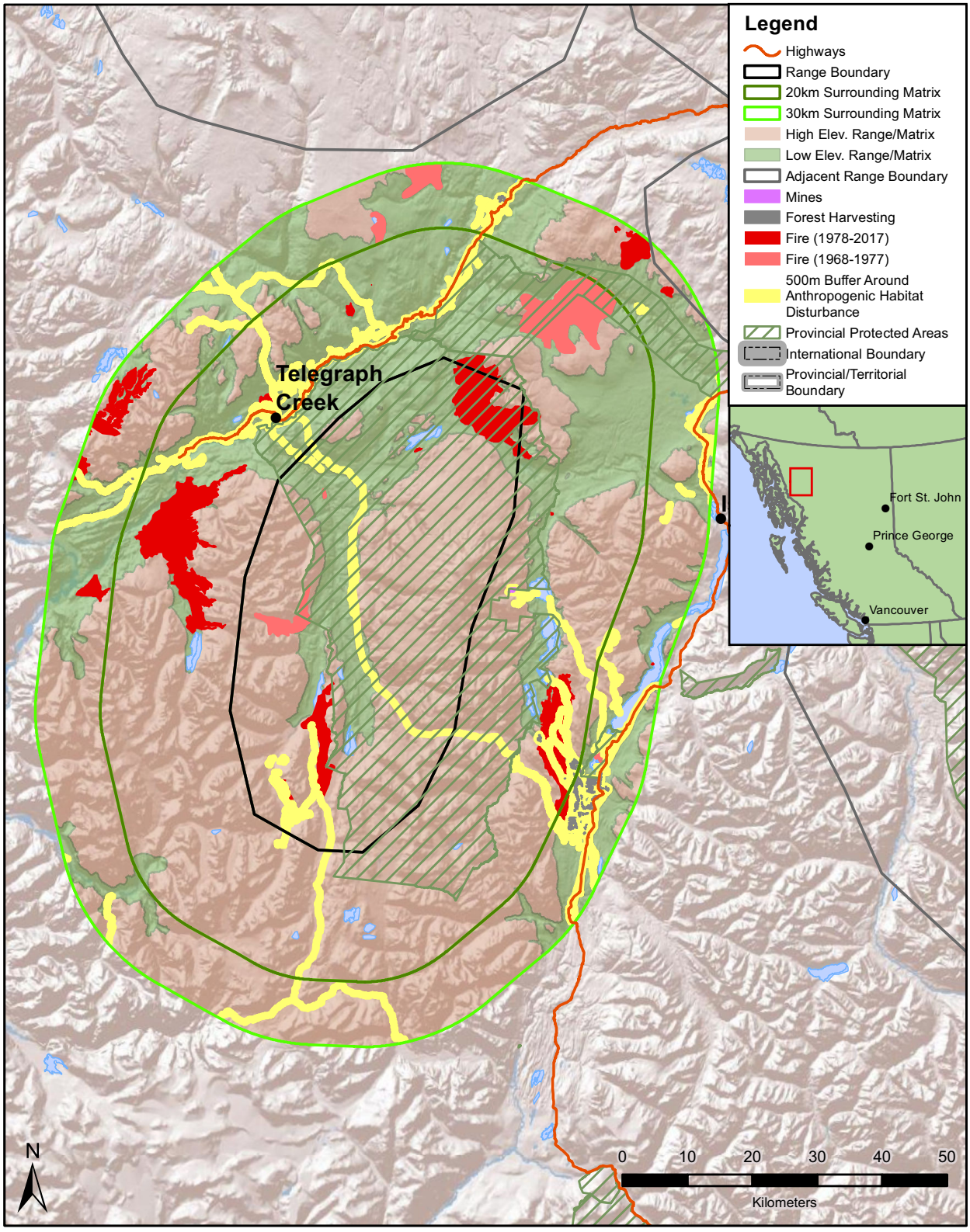
Our analysis does not include fires from 2018 to 2021. Several large fires in the Telegraph Creek area in 2018 burned portions of the Edziza caribou range and surrounding matrix. An 11,000 ha fire in the Mess Creek area and a 2,500 ha fire east of Buckley Lake are located entirely within the currently-delineated range. The largest 121,000 ha fire did not overlap much with the currently-delineated range, but did affect a large portion of the 20 km and 30 km matrix northwest of the range.

Edziza

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2006	Mar	7	8	11	151	151	151	Marshall (2006)
2002	Dec				142			Marshall (2002) in Grant (2018)
1996	Mar				(0)			Cichowski (1996)
1988	Jan				(3)			Jones (1988)
1984	Mar				(0)			Jones (1984)
1984	Feb				(0)[5]			Osmond-Jones (1984b)[5]
1983	Mar				13			Jones (1983)
1983	Feb				0			Hatler (1983) (FW)
1982	Mar 16				106			Hatler (1982) (FW)
1982	Mar 2	25	33		76	76	-	Jones (1982)
1982	Jan				(16)			Van Drimmelen (1982)
1980	Mar	12	14		50	50	-	Hatler (1980)
1979	Feb	2	2	-	(43)	43		Hatler (1979b)
1979	Jan	14	17	30	21	21	21	Hatler (1979a)
1978	Mar	0	0	-	18	18		Hatler (1978a)
1978	Feb				0			Hodson (1978)
1977	Mar				(58)			Hatler (1977a) (FW)
1976	Mar	8	9	-	(61)	61		Hatler (1976)
1973	Mar				(0)			Luckhurst (1973) (FW)
1972	Feb				(67)			Harper (1972)
Fall								
2017	Oct	13	15	30	23	23	23	Grant (2018)
1983	Oct 28				50			Osmond-Jones (1983) (FW)
1983	Oct 7	11	12	18	66[6]	66	66	Sather (1983)[6]
1979	Oct	0	0	0	34	34	34	Hazelwood (1979)
1978	Oct	0	0	0	(6)	6	6	Hatler (1978d) (FW)
1977	Oct	3	3	-	(37)	37		Hatler (1977c)
Spring/Summer								
1985	July				(4)			Hatler and Hazelwood (1985)
1981	Aug				(3)			Stewart (1981)
1979	May				0			Hatler (1979c)
1978	July	0	0	0	(24)	24	24	Hatler (1978c)[7]
1977	Sept				(0)			Hodson (1977) (GR)
1977	Jul/Aug	17	20	-	(12)	12		Hatler (1977b) (GR)
1975	Aug				(0)			Hazelwood (1975) (GR)

1 Calf ratios were based on groups where all caribou were classified to the degree required for the calculation of the ratio
2 Numbers in parentheses indicate surveys where caribou were not the primary focus
3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows
4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey
5 No caribou were seen during this Feb 14 helicopter survey for sheep or during fixed-wing surveys for caribou on Feb 13, Feb 26 or Mar 14 (Osmond-Jones 1984a,b,c,d)
6 66 caribou were seen during this Oct 7 helicopter survey but none were seen during fixed-wing surveys on Sept 27, Sept 30 or Oct 12
7 Two caribou were seen during ground observations July 31-August 5, 1978 (Hatler 1978b)

Edziza


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Telegraph Creek
Fort St. John
Prince George
Vancouver
N
0
10
20
30
40
50
Kilometers

Edziza

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	235 185	27.3	72.7	-
0-20 km matrix surrounding range	514 300	36.4	63.6	0
0-30 km matrix surrounding range	865 688	39.6	60.4	0.2 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Edziza

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**235 185**	**4.8**	**5.7**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5.1**	**0**	**0.1**	**0**	**0**	**5.1**	**5.1**	**9.5**
High elevation	170 929	2.7	3.8	0	0	0	0.1	0	0	0	0	0	0	0	0	4.2	0	0.1	0	0	4.2	4.2	6.4
Low elevation	64 255	10.5	10.7	0	0	0	0	0	0	0	0	0	0	0	0	7.3	0	0	0	0	7.3	7.3	17.8
Matrix 0-20 km																							
Total	**514 300**	**4.2**	**6.2**	**0**	**0**	**0.3**	**0.1**	**0.2**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**6.2**	**0**	**0.2**	**0.6**	**0.6**	**6.2**	**6.4**	**9.9**
High elevation	327 334	2.6	3.2	0	0	0	0	0.1	0	0.1	0	0	0	0	0	2.9	0	0	0.4	0.4	2.9	3.0	5.1
Low elevation	186 966	6.9	11.3	0	0	0.8	0.2	0.5	0	0	0	0	0	0	0	12.0	0	0.6	0.9	0.9	12.1	12.3	18.2
Matrix 0-30 km																							
Total	**865 688**	**3.3**	**4.9**	**0.1**	**0**	**0.2**	**0**	**0.7**	**0**	**0**	**0**	**0**	**0**	**0.5**	**0**	**7.4**	**0**	**0.2**	**0.7**	**0.6**	**7.4**	**7.7**	**10.6**
High elevation	523 271	2.4	2.8	0	0	0	0	0	0	0.1	0	0	0	0	0	3.4	0	0	0.3	0.3	3.4	3.5	5.6
Low elevation	342 409	4.8	8.0	0.3	0	0.5	0.1	1.6	0	0	0	0	0	1.2	0	13.5	0	0.6	1.2	1.2	13.5	14.2	18.3

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Tsenaglode

Range use summary

Tsenaglode caribou spend most of their time year-round in high elevation alpine habitat and subalpine habitat (Spruce-Willow-Birch biogeoclimatic zone) based on telemetry data from a study of radio-collared female caribou initiated in April 2019 (Tahltan Wildlife Department, pers. comm. 2022). During summer and rut, caribou are found primarily in high elevation alpine and subalpine habitats throughout the Dome Mountain, Dark Mountain, Three Sister Range, and Hotailuh Range areas. During winter, caribou are found in high elevation areas in the Dome Mountain, Dark Mountain, Three Sister Range, and Hotailuh Range areas and are often seen in the Gnat Pass area along the Stewart-Cassiar Highway. However, some individuals have been found wintering on Horseranch Mountain, in low elevation pine forests in the Liard Basin, and in the Spatsizi caribou winter range. During spring migration, caribou use habitats at all elevations. During calving, female caribou are found predominantly in alpine habitats. Previous radio-telemetry locations and observations for other caribou populations indicate overlap in range use by Tsenaglode, Horseranch and Spatsizi caribou.

Season	Overview of Habitat and Range Use	Source
Winter	• Primarily high elevation habitats in the Dome Mountain, Dark Mountain, Three Sister Range, and Hotailuh Range areas • Some individuals have mixed with other herds and have been found wintering on Horseranch Mountain, in open glacial fluvial pine forests in the Liard Basin in the Horseranch/Little Rancheria winter range, and in the Spatsizi caribou winter range	Tahltan Wildlife Department, pers. comm. (2020, 2022)
Summer	• Alpine and subalpine habitat throughout summer and fall throughout the Dome Mountain, Dark Mountain, Three Sister Range, and Hotailuh Range areas • The Dome Mountain, Dark Mountain and upper Turnagain River areas are located within the currently drawn Horseranch caribou range	Tahltan Wildlife Department, pers. comm. (2020) Thiessen and Grant (2020)
Spring and calving	• During spring, low elevation forested habitats in the upper Tanzilla, McBride, and upper Turnagain drainages • Calving is predominantly in alpine habitats	Tahltan Wildlife Department, pers. comm. (2020)
Total Range	• The core of the Tsenaglode caribou range is in the Dark Mountain, Dome Mountain, Three Sisters Range, Hotailuh Range, and Gnat Pass areas within the Upper Tanzilla, McBride, and Upper Turnagain drainages	Tahltan Wildlife Department, pers. comm. (2020)

Population size

The current population estimate of 450 to 650 caribou was based on minimum counts during composition surveys conducted from 2019 to 2022 (Tahltan Wildlife Department, pers. comm. 2022). A mark-resight population survey was conducted in October 2021, but analyses of results are still preliminary (Tahltan Wildlife Department, pers. comm. 2022).

Date	Population estimate	Number counted	Method	Reliability	Source
2022	450-650	–	Minimum counts during composition surveys	–	Tahltan Wildlife Department pers. comm. (2022)

Population trend

The calves/100 cows ratio from the October 2017 survey was within the range of 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016). It is unknown whether fall surveys of rutting areas in the Tsenaglode caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratio suggests a stable population even if the survey is biased against calves. Calf recruitment during the 2015 late winter survey was 15% calves, which was recommended by Bergerud (1996) to achieve population stability. However, that survey is more than five years old and may not represent the current condition.

During the post-calving survey in July 2020, the Tahltan Wildlife Department observed 26 calves/100 cows, but part of the survey was conducted in an area of overlap with the Horseranch caribou range and it is unknown how many of the caribou observed there belonged to the Tsenaglode or Horseranch populations (Tahltan Wildlife Department, pers. comm. 2020). Additional composition surveys have been conducted during post-calving (June/July), fall (October) and late winter (March) since the July 2020 survey but analyses of results are still preliminary.

In 1985, wolves were removed from the Horseranch caribou range in the area adjacent to the northeastern portion of the Tsenaglode caribou range (Bergerud and Elliott 1998), which may have potentially influenced population trend of the Tsenaglode caribou population that year.

There is insufficient technical information to determine current or long-term population trend for the Tsenaglode caribou population.

Tsenaglode

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted[2]	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2015	Feb	15[5]	17[5]	27	534[6]	274	174	Thiessen and Grant (2020)
Fall								
2017	Oct	15	18	25	227[7]	227	227	Thiessen and Grant (2020)
Calving/early summer								
2020	July		21	26	375[8]	375		Tahltan Wildlife Department, unpubl. data
1963	Jul/Aug	25	33	-	(28)	28		Mundy (1963) (GR)

1 Calf ratios were based on groups where all caribou were classified to the degree required for the calculation of the ratio
2 Numbers in parentheses indicate surveys where caribou were not the primary focus
3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows
4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey
5 Extrapolated from data presented in Thiessen and Grant (2020)
6 Area surveyed included a small portion of the alpine winter range as an extension of a moose survey
7 Survey area included only a portion of the range
8 Part of the survey was conducted in an area of overlap with the Horseranch caribou range and it is unknown how many of the caribou observed there belonged to the Tsenaglode or Horseranch populations

Boundary Issues

- The range boundary is coarsely drawn resulting in gaps between the Tsenaglode caribou range, and Horseranch and Spatsizi caribou ranges.
- Radio-telemetry data suggest that the Tsenaglode caribou range overlaps with at least the Horseranch and Spatsizi caribou ranges.

Range condition

Within the current Tsenaglode caribou range boundary, habitat disturbance covers 11%, 9% and 30% of the total, high elevation and low elevation portions of the range respectively. Habitat disturbance in the low elevation portion of the range is nearing the 35% disturbance threshold for critical habitat in the recovery strategy for southern mountain caribou (Environment Canada 2014). The primary habitat disturbance within the range is roads/trails with some contribution from settlements, mines, dams and reservoirs. Roads/trail and settlements are located primarily in the low elevation portion of the range, while mines, dams and reservoirs are located in the high elevation portion. The main roads/trails are the Stewart-Cassiar Highway, and portions of the Jade/Boulder Road and associated industrial roads. There are no fires <40 years in the range. Habitat disturbance makes up a higher proportion of the 20 km and 30 km surrounding matrix than the range, with roads/trails, fire, mines and settlements (Dease Lake, Iskut) also contributing.

Our analysis does not include fires from 2018 to 2021. A fire in 2018 affected a very small portion of the west end of the 30 km surrounding matrix. Otherwise there was no fire activity in the range or in the surrounding matrix during those years.

Tsenaglode

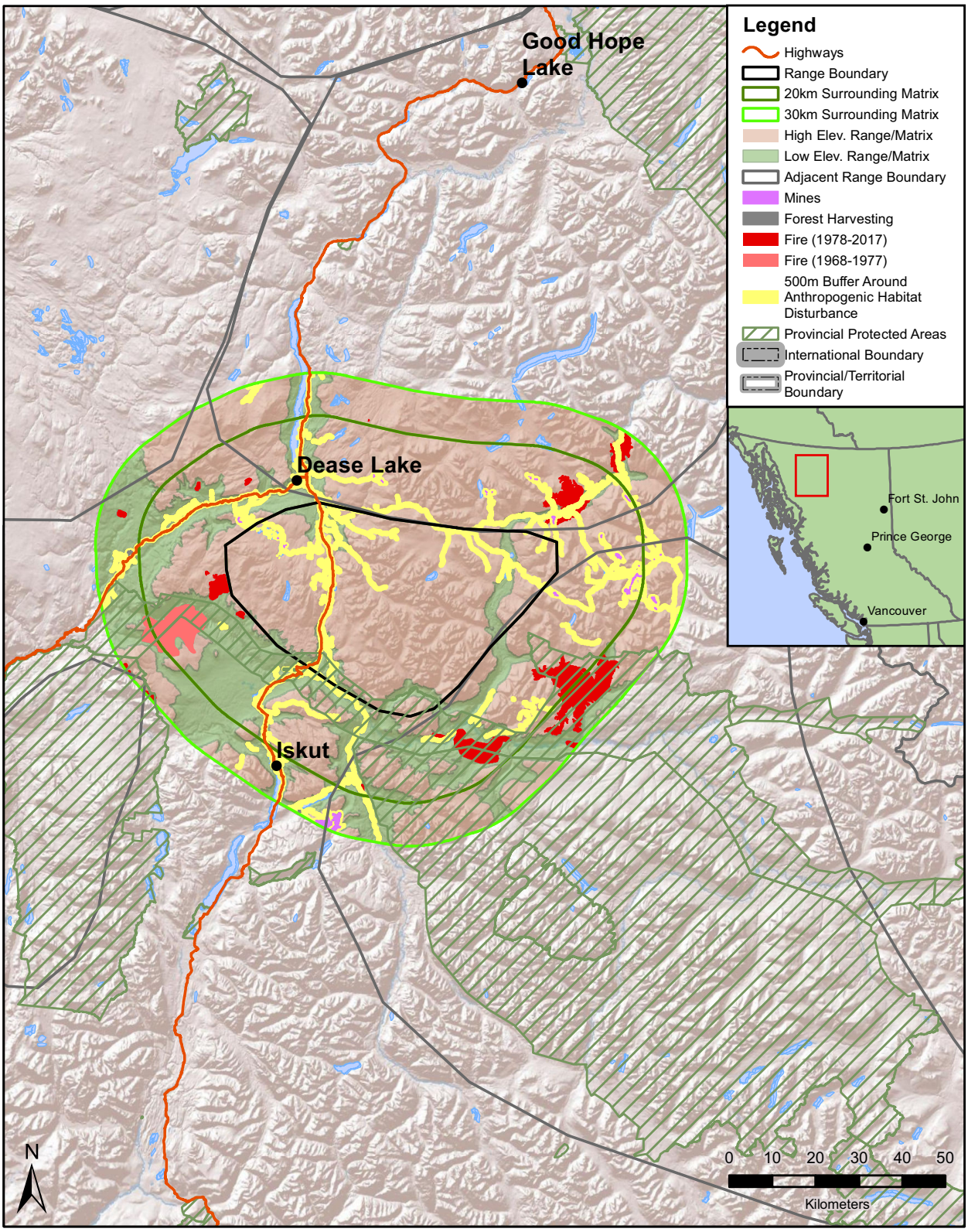
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	247 008	11.2	88.8	-
0-20 km matrix surrounding range	521 447	35.0	65.0	58.8 (NM)
0-30 km matrix surrounding range	876 415	35.0	65.0	61.9 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Tsenaglode


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Good Hope Lake
Dease Lake
Iskut
Fort St. John
Prince George
Vancouver
N
0 10 20 30 40 50
Kilometers

Tsenaglode

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**247 008**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**0.1**	**0.1**	**0**	**0**	**0**	**0**	**0**	**11.0**	**0**	**0.4**	**0**	**0**	**11.0**	**11.4**	**11.4**
High elevation	219 268	0	0	0	0.3	0	0	0	0.1	0.1	0	0	0	0	0	8.8	0	0	0	0	8.8	9.1	9.1
Low elevation	27 740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	28.9	0	3.9	0	0	28.9	29.5	29.5
Matrix 0-20 km																							
Total	**521 447**	**3.3**	**5.0**	**0**	**0**	**0**	**0.1**	**0.1**	**0**	**0.8**	**0**	**0**	**0**	**0**	**0**	**12.2**	**0**	**0.5**	**0.1**	**0.1**	**12.2**	**12.3**	**15.2**
High elevation	338 924	2.5	3.0	0	0	0	0	0	0	1.1	0	0	0	0	0	9.8	0	0	0	0	9.8	9.8	12.2
Low elevation	182 522	4.8	8.7	0	0	0	0.2	0.2	0	0.1	0	0	0	0	0	16.6	0	1.4	0.2	0.2	16.6	16.8	20.8
Matrix 0-30 km																							
Total	**876 415**	**3.4**	**4.6**	**0**	**0**	**0**	**0.1**	**0.2**	**0**	**0.8**	**0**	**0**	**0**	**0**	**0**	**10.1**	**0**	**0.4**	**0**	**0**	**10.1**	**10.3**	**13.4**
High elevation	569 638	2.2	2.6	0	0	0	0	0.1	0	1.1	0	0	0	0	0	7.8	0	0	0	0	7.8	7.9	10.1
Low elevation	306 776	5.5	8.2	0	0	0	0.2	0.4	0	0.2	0	0	0	0	0	14.5	0	1.2	0.1	0.1	14.5	14.7	19.5

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Spatsizi

Range use summary

During most winters, caribou use low elevation forested habitat primarily in the northern portion of their range along the Stikine River. In some winters, caribou use windswept alpine slopes on the Spatsizi Plateau, Eaglenest Mountains, Gladys Lake Ecological Reserve, and mountains around the Dawson River. During spring migration, caribou use mostly low elevation forested areas. Calving occurs at high elevations generally above 1500 m, but some caribou are also found below treeline during calving. Caribou are highly dispersed in summer with some caribou moving to areas in almost all directions beyond Spatsizi Plateau Wilderness Park boundaries. Although traditional high elevation rutting areas are located in the Caribou Mountain, Tomias Mountain and Edozadelly/ Lawyers Pass areas, many caribou rut in other areas throughout their range.

Season	Overview of Habitat and Range Use	Source
Winter	• Low elevation forested habitat primarily in the Stikine River and Kehlechoa River areas • During some winters, windswept alpine slopes on the Spatsizi Plateau, Eaglenest Mountains, Gladys Lake Ecological Reserve, and mountains around the Dawson River	Hatler (1986a) Cichowski (1994)
Summer	• Calving occurs primarily above 1500 m but some caribou are also found below treeline • Caribou are highly dispersed during calving and summer • Traditional high elevation rutting areas include the Caribou Mountain, Tomias Mountain and Edozadelly/Lawyers Pass areas • Rut occurs throughout the range at all elevations • Late fall use primarily in subalpine shrub zone	Hatler (1986a)
Migration	• Spring migration primarily in low elevation forested areas	Hatler (1986a)
Total Range		

Population size

The current population estimate of 2681 caribou was based on a total count survey in high elevation habitat in the Spatsizi caribou range in March 1994 (Cichowski 1994). During some winters, a large portion of the Spatsizi caribou population is found on windswept alpine slopes, presumably in response to snow conditions (Hatler 1986a), which appeared to be the case during the March 1994 survey. Because it is hard to predict when these conditions will occur, it is difficult to plan surveys to coincide with those conditions (Hatler 1987).

Date	Population estimate	Number counted	Method	Reliability	Source
1994	2681	2145	Minimum count + extrapolation	High	Cichowski (1994)

[1] The estimate was calculated assuming that 80% of the caribou were seen during the March 1994 survey.

Prior to 1994, the highest numbers of caribou counted during fall surveys were 1267 in 1976, 2469 in 1977, 1126 in 1980, 1075 in 1982 and 1041 in 1984 (see Population trend below). All surveys were conducted primarily in Spatsizi Plateau Wilderness Park except the 1977 survey, which also included areas to the northeast of the park (Hatler 1977).

From 1976 to 1986 (over a span of 11 years), 20 surveys were conducted in the Spatsizi caribou range, 16 of which focused specifically on caribou (see Population trend below). Hatler (1987) concluded that data collected on numbers and composition of caribou up to 1986 were not adequate to assess changes in population size. Since 1986 (over a span of 34 years), only 3 surveys have been conducted specifically for caribou in the Spatsizi caribou range (see Population trend below), with only the 1994 conducted to determine a population estimate.

The most recent population estimate for the Spatsizi caribou population of 2681 caribou based on the March 1994 survey is now over 27 years old. Since 1994, the highest number of caribou counted during a survey was 1336 in fall 2017 (Thiessen and Grant 2019, see Population trend below). The 2017 survey was a fall composition survey that included areas northeast of Spatsizi Park, and was not intended for estimating population size.

Population trend

From 1976 to 1982, all five fall surveys with calves/100 cows ratios were below the 20 to 25 calves/100 cows level that is considered sufficient to support a stable population growth rate (Environment Yukon 2016). The six most recent fall calf/cow ratios (1983-1986, 2010, 2017) were at or above 20 to 25 calves/100 cows.

In all six late winter surveys conducted (3 targeting caribou and 3 where caribou were not the target species) where caribou were classified to at least adults and calves, calf recruitment estimates were above 15% calves recommended by Bergerud (1996) to achieve population stability.

During the three years when survey data were available in both fall and late winter for the same cohort of calves (i.e. October 1978 and January/February 1979; October 1980 and January 1981; October 1981 and February/March 1982), percent calves was significantly higher during late winter surveys than during fall surveys (Hatler 1987), suggesting that either fall surveys were biased against calves or that winter surveys were biased for calves. Based on data from radio-collared caribou, Hatler (1987) concluded that fall surveys conducted between 1976 and 1986 were "biased in terms of population composition, and unreliable as indicators of population trend."

From the radio-collared caribou study from November 1980 to October 1984, annual survival rate of adult female caribou ranged from 57% to 96% and averaged 87% (Hatler 1986). No data on population rate of change (lambda) were summarized.

In 1985, wolves were removed from the Horseranch caribou range in the area adjacent to the northern portion of the Spatsizi caribou range (Bergerud and Elliott 1998), which may have potentially influenced population trend of the Spatsizi caribou population that year. Wolves were also removed from smaller areas slightly more distant to the northeastern portion of the Spatsizi caribou range in 1982, 1983 and 1984 (Bergerud and Elliott 1998).

Hatler (1986a; p. 146) suggested that the Spatsizi caribou population had likely increased at least in 1983 and 1984. Calves/100 cows ratios were at or above 20 to 25 calves/100 cows those two years. Despite potential biases against calves during fall surveys, calves/100 cows during the two most recent fall surveys (2010, 2018) were at or above 20 to 25 calves/100 cows, and percent calves during the three most recent late winter surveys (1988, 1994, 2003) were above 15% calves. Although the 2018 fall survey suggests a stable population, it is the only recent survey available to assess current population trend, and therefore there is not enough information to determine current population trend. Although calf survival was consistently high in all fall and late winter surveys conducted since 1988, there is not enough information to determine a long-term population trend.

Spatsizi

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2003	Mar	18	22	32	(725)	725	725	Marshall (2005)
1994	Mar	16	19	-	2145	2145		Cichowski (1994)
1993	Mar				(465)			Cichowski (1993)
1988	Jan/Feb	19	24	33	(105)	105	83	Jones (1988)
1983	Feb/Mar				(0)			Jones (1983)
1982	Feb/Mar	16	18	-	438	438		Jones (1982a)
1981	Jan	20	25	-	405	405		Hatler (1981a)
1979	Jan/Feb	24	31	31	(108)	88	48	Hatler (1979b)
1979	Jan				(44)	11	11	Hatler (1979a)
1973	Mar				(645)			Luckhurst (1973)
1972	Feb				(400)			Harper (1972)
1962	Mar				(110+)			Hartman (1962a) (FW)
Fall								
2017	Oct	15	19	25	1336	1334	1334	Grant and Thiessen (2018)
2010	Nov	13	15	20	671	671	671	Marshall and Williams (2010)
1986	Oct	15	17	25	884	884	802	Hatler (1986b)
1985	Oct	12	14	21	693	693	633	Jones (1985)
1984	Oct	13	15	27	1041	1041	713	Jones (1984)
1983	Oct	15	17	24	446	446	446	Sather (1983)
1982	Nov	15	17	-	206	196		Hatler (1982) in Hatler (1987)
1982	Oct	9	10	14	1075	1075	1075	Jones (1982b)
1981	Oct	8	8	12[5]	457	457	457	Jones (1981)
1980	Oct	13	14	-	1126	1126		Jones (1980)
1979	Oct	7	7	9	215	215	215	Eastman (1979)[6]
1979	Oct	10	11	15	438	438	284	Hazelwood (1979)
1978	Oct	13	15	-	820	526		Hatler (1978) (FW)
1977	Oct	8	9	-	2469	2318		Hatler (1977)
1976	Sept	6	7	9	1267	671	671	Hatler (1976c)
Spring/Summer								
1985	July	28	40		(226)	226		Hatler and Hazelwood (1985)
1984	July	24	32	53[7]	(188)	171	90	Hatler and Hazelwood (1984)
1976	Aug				(32)			Hatler (1976b)
1976	July	2	2	-	366	366		Hatler (1976a)
1963	Jul/Aug	25	32		(167)	147		Mundy (1963) (GR)
1962	Aug	25	33	-	(117)	117		Hartman (1962b) (FW)
1959	Jul/Aug	3	3	-	(151)	151		Guiguet (1959) (GR)

[1] Calf ratios were based on groups where all caribou were classified to the degree required for the calculation of the ratio

[2] Numbers in parentheses indicate surveys where caribou were not the primary focus

[3] Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

[4] All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

[5] Although Jones (1981) does not provide all classification data, Hatler (1981b) does. From Table 6 in Hatler (1987), calves/100 cows = 11.5 with N=305 cows. For that calculation, # of cows includes unclassified adults.

[6] We recalculated total numbers from Eastman's (1978) datasheet (Total= 215: 43 bulls, 156 cows, 2 UA, 14 calves), which differed from the numbers he summarized in the written part of the report

[7] Excludes unclassified adults which were mostly adult females and small bulls; Hatler and Hazelwood (1984) calculated % calves excluding bulls and including unclassified adults, as 30.2%

Boundary Issues

- The range boundary is coarsely drawn resulting in gaps between the Spatsizi caribou range and the Tsenaglode, Horseranch, and Thutade caribou ranges.
- Telemetry and other location data suggest that boundaries should be expanded into some areas that are not included in the Spatsizi caribou range.
- Radio-telemetry data (~ 1 year) suggest that the Tsenaglode caribou range overlaps with at least the Spatsizi and Horseranch caribou ranges.
- The large gap between caribou ranges in the centre of the study area (between the Spatsizi, Horseranch, Rabbit, Frog and Thutade caribou ranges) is known to contain caribou.

Sittler et al. (2015) recommended extending the southeastern portion of the Spatsizi caribou range based on data collected from caribou radio-collared in the area of low density just southeast of the Spatsizi caribou range.

Range condition

Within the current Spatsizi caribou range boundary, habitat disturbance covers 6%, 4% and 11% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails, fire and seismic lines, all three of which are more prevalent at low elevations than at high elevations. Roads/trails include the Klappan Rail Grade in the western portion of the range, and industrial roads associated with mining in the northern and southeastern portions of the range. Fires <40 years are distributed throughout the range. Habitat disturbance is slightly higher in the 20 km and 30 km matrix surrounding the range.

Our analysis does not include fires from 2018 to 2021. There were no substantial fires recorded in the Spatsizi caribou range or surrounding matrix in those four years other than a 7,500 ha fire in Spatisizi Plateau Wilderness Park just south of the Stikine River in the Cullivan Creek area.

Spatsizi

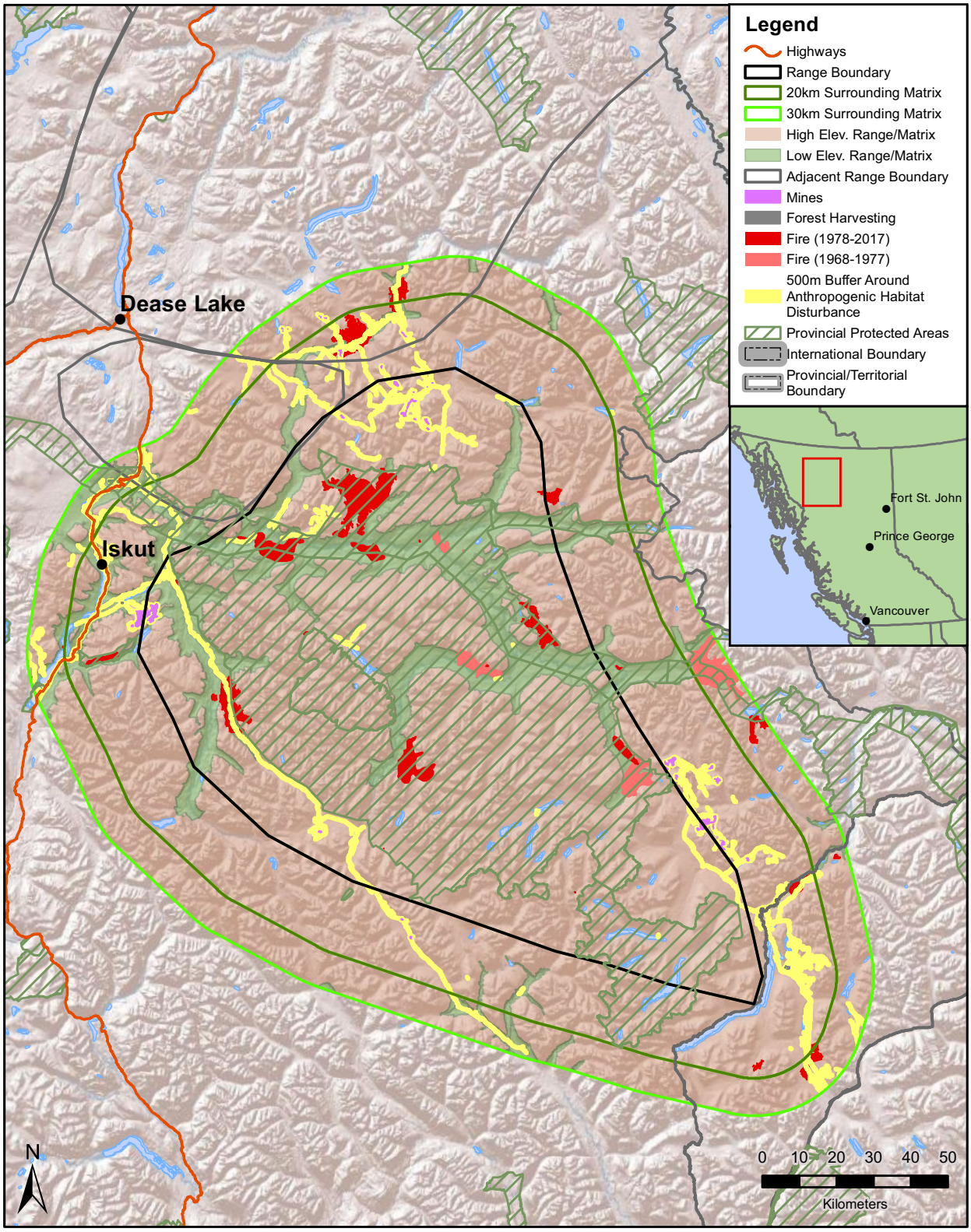
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 565 613	17.7	82.3	-
0-20 km matrix surrounding range	1 169 526	9.3	90.7	22.6 (NM)
0-30 km matrix surrounding range	1 848 437	9.5	90.5	27.1 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Spatsizi


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Dease Lake
Iskut
Fort St. John
Prince George
Vancouver
N
0 10 20 30 40 50
Kilometers

Spatsizi

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**1 565 613**	**2.4**	**3.0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0**	**0**	**0**	**0**	**0**	**3.2**	**0.1**	**0.1**	**0**	**0**	**3.2**	**3.3**	**5.5**
High elevation	1 287 936	1.3	1.6	0	0	0	0	0	0	0.4	0	0	0	0	0	3.0	0.1	0.1	0	0	3.0	3.1	4.4
Low elevation	277 677	7.4	9.5	0	0	0	0	0.1	0	0.2	0	0	0	0	0	4.1	0	0.3	0	0	4.1	4.2	11.0
Matrix 0-20 km																							
Total	**1 169 526**	**0.8**	**0.8**	**0.5**	**0**	**0**	**0.1**	**0**	**0**	**0.6**	**0**	**0**	**0**	**0.4**	**0**	**6.4**	**0**	**0.1**	**0**	**0**	**6.4**	**6.6**	**7.2**
High elevation	1 060 530	0.6	0.6	0.4	0	0	0	0	0	0.6	0	0	0	0.2	0	5.2	0	0.1	0	0	5.2	5.4	5.9
Low elevation	108 996	2.9	2.9	1.5	0	0.3	0.2	0.2	0	0.2	0	0	0	1.5	0	18.1	0	0.7	0	0	18.1	18.7	20.1
Matrix 0-30 km																							
Total	**1 848 437**	**0.8**	**1.3**	**0.8**	**0**	**0.1**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**0.4**	**0**	**5.6**	**0**	**0.2**	**0**	**0**	**5.6**	**5.8**	**6.4**
High elevation	1 672 770	0.6	1.0	0.5	0	0.1	0	0	0	0.4	0	0	0	0.2	0	4.2	0	0.1	0	0	4.2	4.3	4.8
Low elevation	175 662	2.6	4.8	3.8	0	0.2	0.1	0.2	0	0.1	0	0	0	1.7	0	19.7	0	1.0	0	0	19.7	20.2	21.6

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Liard Plateau

Range use summary

During winter, caribou use primarily high elevation alpine and high elevation mature forests close to alpine areas. Some use of low elevation forested habitat also occurs, especially during early winter. Calving occurs in alpine habitat but some caribou also calve below treeline. Most caribou rut in high elevation habitat. The core of the Liard Plateau caribou range is the Caribou Range plateau.

Season	Overview of Habitat and Range Use	Source
Winter	• High elevation windswept alpine slopes and high elevation mature forests • Some winter use in low elevation forested habitat, especially during early winter	Powell (2006) McNay et al. (2014)
Summer	• Mostly high elevation habitats • Some use of forested areas during calving	Powell (2006) McNay et al. (2014)
Migration	• Move from higher elevations in summer to lower elevation in early winter and back to higher elevation in late winter.	McNay et al. (2014)
Total Range	• 91% of the range is located in BC • 9% of the range is located in Yukon • The Caribou Range plateau is the core of the range (Powell 2006)	

Population size

The highest number of caribou counted in the Liard Plateau caribou range was 425 (± 50) during a Canada Land Inventory flight in February 1975 (McNay et al. 2014). In 2005, the population was estimated at less than 200 caribou, based on the number of caribou counted during a fall composition survey and during the capture session in 2002 (Powell 2006). In 2010 and 2011, the highest number of caribou counted during composition survey each year was 173 and 159 respectively (McNay et al. 2014). The highest recent count was 131 caribou in October 2020.

Date	Population estimate	Number counted	Method	Reliability	Source
2020	–	131	Minimum count		A. Pelletier, pers. comm.
2011	–	159	Minimum count		McNay et al. (2014)
2010	–	173	Minimum count		McNay et al. (2014)
2005	<200	141	Minimum count + Extrapolation	High	Powell (2006)
1975	–	425	Minimum count		McNay et al. (2014)

Population trend

In all four late winter surveys conducted where caribou were classified to at least adults and calves, calf recruitment estimates were below 15% calves recommended by Bergerud (1996) to achieve population stability.

Between 2005 and 2020, the calves/100 cows ratio for one of the four fall surveys was at the low end of the 20 to 25 calves/100 cows level that is considered sufficient to support a stable population growth rate (Environment Yukon 2016), while the other three, including the most recent in 2020, were well below that level. It is unknown whether fall surveys of rutting areas in the Liard Plateau caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987).

Liard Plateau

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2017	Mar	8	9	21	87[5]	87	52	A. Pelletier, pers. comm.
2011	Mar	7		10	159[6]			McNay et al. (2014)
2010	Feb	4	4	4	81	81	81	Thiessen (2010)
2002	Feb				<200[7]			Powell (2006)
1978	Feb	10	12	-	68[8]	68		Bergerud (1978) (FW)
1975	Feb				(425)[9]			CLI in McNay et al. (2014) (FW)
Fall								
2020	Oct	4	4	10	131	131	70	A. Pelletier, pers. comm
2011	Oct	5		7	120[6]			McNay et al. (2014)
2010	Oct	7		10	173[6]			McNay et al. (2014)
2005	Fall[10]	14	16	20	141	141	141	Powell (2006)
1977	Oct	10	11	-	93	93		Bergerud (1978) (FW)
Spring/Summer								
2011	July	17		24	117[6]			McNay et al. (2014)
2010	June	12			94[6]			McNay et al. (2014)
1977	Aug	18	22	29	22			Bergerud (1978) (GR)
1975	July				>200[11]			Bergerud (1978) (Unk)

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified
2 Numbers in parentheses indicate surveys where caribou were not the primary focus
3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows
4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey
5 Low cloud prevented classification of all caribou
6 No classification data provided; only ratios are provided
7 Estimated number of caribou seen by J. Adamczewski during the capture session
8 Plateau thoroughly searched; no information provided on weather or sighting conditions
9 Canada Land Inventory (CLI) flight summarized by McNay et al. (2014); map shows 3 groups (75, 250, 100); A. Stewart indicated the total number was likely 425±50 (McNay et al. 2014)
10 No survey date provided
11 Number of caribou seen by J. Elliott and B. Webster July 13-18 but no details provided on how the survey was conducted or on classification

However, late winter calf recruitment estimates are also low, consistent with the low fall calves/100 cows ratios. Although calf recruitment has been low, between December 2010 and October 2011 (22 months), survival rate of radio-collared adult female caribou was 95% (McNay et al. 2014). If adult female survival rate has continued to be high, there may have been sufficient calf recruitment to compensate for adult female mortality.

In the absence of recent information on adult survival, calf recruitment in 2017 and 2020 suggests that currently, the population may be declining.

Population trend based on the number of caribou counted during surveys is more difficult to interpret. The highest number of caribou counted was 425 in 1975, following a period of wolf control (McNay et al. 2014). Since then, numbers of caribou counted during surveys have all been less than 200. The number counted during late winter surveys has been variable and may not be useful for assessing population trend. In 2010, 81 caribou were counted in late winter and then 159 were counted in late winter the following year. The 2011 survey was based on caribou seen

with radio-collared caribou, which may have resulted in more caribou seen. Alternatively, 2011 may have been a year when a higher proportion of caribou were using habitats where they were more visible (e.g. high elevation open habitats). If either or both cases existed in 2011, the count of 87 caribou in 2017 may not be indicative of a decline. Counts during fall surveys have also been variable, but over 100 caribou were counted during the four most recent surveys.

The number of caribou counted during the CLI survey in 1975 and the number of caribou counted during surveys conducted since 2000, suggest a decrease in the population over the long term.

Boundary Issues

- The BC/Yukon range boundaries do not line up.

The width of the BC portion of the range boundary at the Yukon border is approximately 70 km, while the width of Yukon portion of the range is approximately 10 km.

Range condition

Within the current Liard Plateau caribou range boundary, habitat disturbance covers 20%, 8% and 34% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are fires, roads/trails, and seismic lines, all three of which are more prevalent at low elevations than at high elevations. Fires <40 years are most prevalent in the northwestern portion of the range, with one fire from 1982 covering 42,000 ha. Overall habitat disturbance is higher in the 20 km and 30 km matrix surrounding the range than in the range itself.

Our analysis does not include fires from 2018 to 2021, however, there were no substantial fires recorded in the BC portion of the Liard Plateau caribou range or the surrounding matrix in those four years.

Liard Plateau

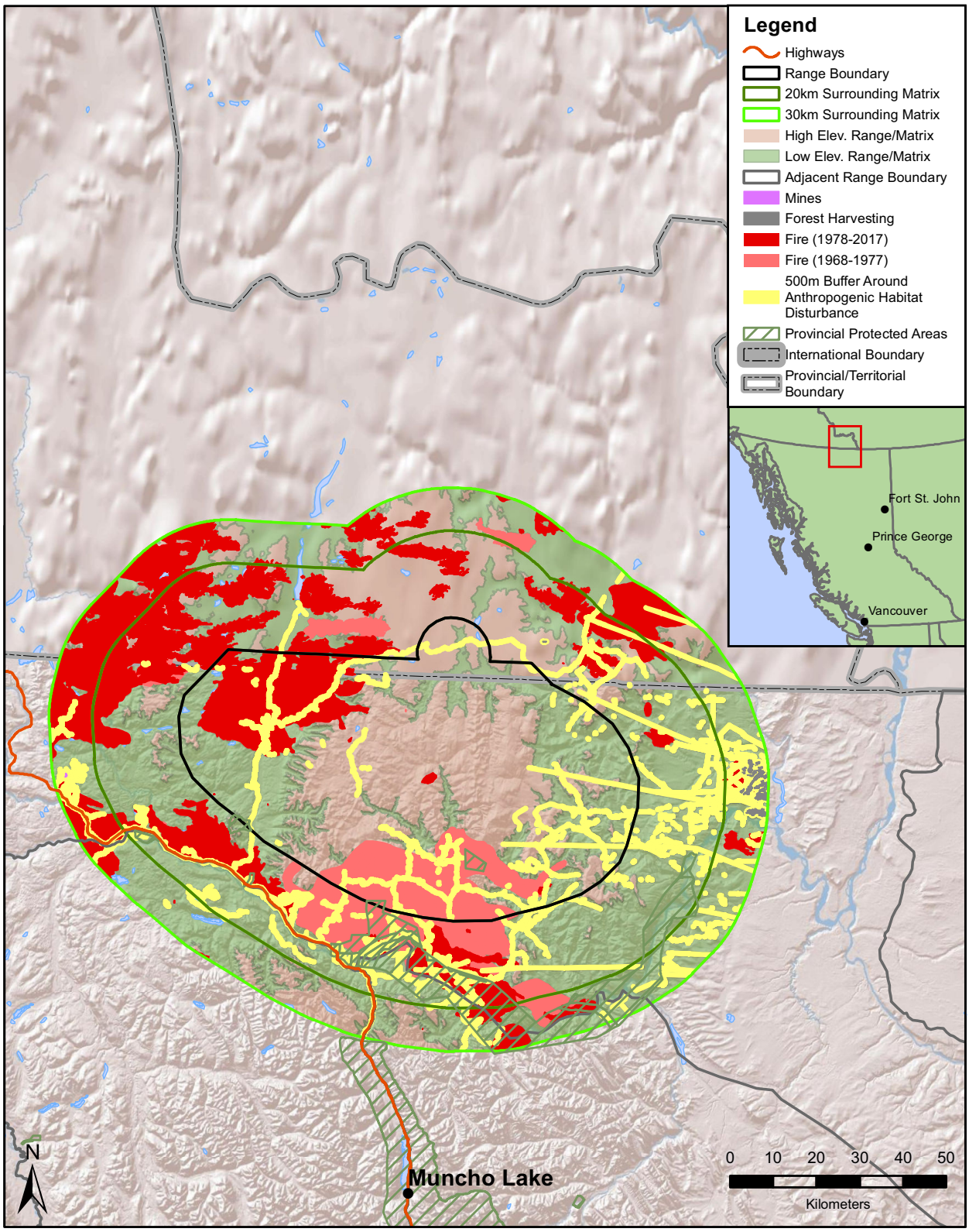
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	520 304	48.9	51.1	-
0-20 km matrix surrounding range	690 962	74.2	25.8	8.9 (NM)
0-30 km matrix surrounding range	1 128 170	76.2	23.8	15.8 (NM)
BC only				
Range	475 350	49.1	50.9	-
0-20 km matrix surrounding range	435 358	91.5	8.5	14.2 (NM)
0-30 km matrix surrounding range	696 906	89.9	10.1	25.6 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Liard Plateau



Liard Plateau: Total Range (BC and Yukon)

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**520 304**	**11.6**	**23.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0**	**7.2**	**2.6**	**0.2**	**4.8**	**2.6**	**9.3**	**11.0**	**20.9**
High elevation	266 029	1.1	13.6	0	0	0	0	0	0	0	0	0	0	0	0	3.6	2.0	0	3.2	0.9	5.9	7.2	8.2
Low elevation	254 275	22.6	33.7	0	0	0	0	0	0	0	0	0	0	0.7	0	11.0	3.2	0.4	6.4	4.4	12.9	15.1	34.3
Matrix 0-20 km																							
Total	**690 962**	**21.8**	**30.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**9.9**	**5.2**	**0.3**	**4.6**	**2.1**	**12.4**	**14.4**	**33.2**
High elevation	177 933	20.1	26.6	0	0	0	0	0.1	0	0	0	0.2	0	0	0	1.5	2.7	0	3.4	0.2	4.7	5.3	24.6
Low elevation	513 029	22.4	31.4	0	0	0	0	0	0	0	0	0.1	0	0	0	12.7	6.0	0.4	5.0	2.7	15.0	17.6	36.2
Matrix 0-30 km																							
Total	**1 128 170**	**23.6**	**29.5**	**0**	**0**	**0**	**0**	**0.6**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**8.9**	**5.5**	**0.2**	**4.2**	**2.2**	**11.0**	**13.4**	**33.7**
High elevation	268 985	20.3	25.1	0	0	0	0	0.1	0	0	0	0.1	0	0	0	1.0	2.2	0	2.3	0.1	3.1	4.0	23.6
Low elevation	859 182	24.6	30.9	0	0	0	0	0.7	0	0	0	0	0	0	0	11.4	6.5	0.3	4.9	2.8	13.5	16.3	36.8

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Liard Plateau: BC only

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**475 350**	**10.4**	**23.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.4**	**0**	**7.9**	**2.8**	**0.3**	**4.3**	**2.9**	**9.2**	**11.1**	**19.9**
High elevation	241 916	1.0	14.9	0	0	0	0	0	0	0	0	0	0	0	0	4.0	2.2	0.1	2.4	1.0	5.4	6.9	7.8
Low elevation	233 434	20.1	32.2	0	0	0	0	0	0	0	0	0	0	0.7	0	11.9	3.4	0.5	6.2	4.8	13.2	15.6	32.5
Matrix 0-20 km																							
Total	**435 358**	**16.1**	**27.8**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**15.6**	**6.4**	**0.5**	**4.8**	**3.3**	**17.1**	**20.0**	**32.3**
High elevation	36 801	6.8	29.4	0	0	0	0	0	0	0	0	0.3	0	0	0	7.1	3.2	0	1.2	0.8	7.4	9.1	15.2
Low elevation	398 557	16.9	27.7	0	0	0	0	0	0	0	0	0.1	0	0	0	16.4	6.7	0.5	5.1	3.5	18.0	21.0	33.9
Matrix 0-30 km																							
Total	**696 906**	**17.8**	**25.9**	**0**	**0**	**0**	**0**	**0.9**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**14.4**	**7.2**	**0.3**	**5.2**	**3.5**	**16.2**	**19.2**	**32.5**
High elevation	70 402	5.0	16.9	0	0	0	0	0	0	0	0	0.1	0	0	0	3.8	1.7	0	0.7	0.5	4.0	4.9	9.5
Low elevation	626 504	19.3	26.9	0	0	0	0	1.0	0	0	0	0.1	0	0	0	15.6	7.8	0.4	5.7	3.8	17.5	20.8	35.1

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Rabbit

Range use summary

The only information available about range use by Rabbit caribou is from aerial surveys. Caribou have been found in high elevation alpine habitat during both winter and summer during surveys. No information is available about use of other habitats.

Season	Overview of Habitat and Range Use	Source
Winter	• High elevation windswept alpine slopes	Thiessen (2008) BC MFLNRORD unpubl. data
Summer	• High elevation alpine	BC MFLNRORD unpubl. data
Migration		
Total Range		

Population size

The current population estimate of 1300 caribou was based on the number of caribou counted during a sheep survey in high elevation habitat in the Rabbit caribou range in March 2007 (Thiessen 2008). A total of 1133 caribou were counted and it was assumed that not all caribou in the range were seen during the survey, which resulted in an estimate of 1300 caribou.

Date	Population estimate	Number counted	Method	Reliability	Source
2007	1300	1133	Minimum count + Extrapolation	High	BC MFLNRORD unpubl data Thiessen (2008)

Prior to 2007, 636 caribou were counted during a survey in March 2000, and 265 caribou were counted during a mountain goat survey in June 1996 (see Population trend below). However, there was no information available on the area covered during either of those surveys and therefore it is unknown whether the number of caribou counted during those surveys was representative of the whole range. Also, the total number of caribou counted in the Rabbit range in June 1996 that we present here differs from the total reported elsewhere. In our total, we only include the 265 caribou that were counted in the Rabbit caribou range; the other 89 caribou counted during that survey were in the Muskwa caribou range. Since 2007, 362 caribou were counted during a composition survey in 2021 (Caribou Recovery Program 2021).

In the future, any potential differences between the number of caribou counted in future surveys and the 2007 survey need to be interpreted with caution. In the nearby Spatsizi caribou range, relative use of alpine areas varied between winters depending on snow conditions (Hatler 1986, 1987). A large proportion of the population was found above treeline during only one of four winters (Hatler 1986). It is unknown whether caribou in the Rabbit range exhibit winter habitat/range use patterns similar to those of Spatsizi caribou, and if they do, whether the 2007 survey was conducted in a year when most of the caribou were using alpine habitat. A better understanding of seasonal range use based on radio-collared caribou would aid in interpreting the number of caribou counted during future surveys.

The most recent population estimate of 1300 caribou for the Rabbit caribou range based on the March 2007 survey is now almost 15 years old and out of date.

Population trend

Few surveys have been conducted in the Rabbit caribou range from which to infer population trend from. Only three winter surveys have been conducted with reasonable sample sizes (2000, 2007, 2021). Of those three, calf recruitment was above 15% calves recommended by Bergerud (1996) to achieve population stability, during the two most recent survey in (2007, 2021). The 2007 survey was conducted almost 15 years ago and does not necessarily represent current population trend. Although the 2021 recruitment survey suggests at least a stable population, it is the only recent survey available to assess current population trend, and therefore there is not enough information to determine current population trend.

Bergerud (1978) indicated that "R. Sorensen reported that in 1965 he counted 423 animals in this herd." However, Bergerud (1978) did not provide any details about how (aerial vs ground), where (what portion of the range), when (summer, fall, winter), or over what period of time the count was conducted so it is difficult to make any inferences about population size or trend based on the information provided for this count.

Rabbit

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2021		19			362			Caribou Recovery Program 2021
2007	Mar	16	19		(1133)[5]	1036		BC MFLNRORD unpubl. data[5]
2001	Feb	19	23	32	54[6]	54	54	BC MFLNRORD unpubl. data
2000	Mar	11	13		636	636		BC MFLNRORD unpubl. data
1978	Feb	0	0		22	18		Bergerud (1978) (FW)[7]
1976	Jan-Feb	11	12		47	47		Elliott in Bergerud (1978) (FW)[8]
Summer								
1996	June	18	22		(265)[9]	265		BC MFLNRORD unpubl. data

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 Number of caribou counted during the Stone's sheep survey were reported in Thiessen (2008), but numbers in the report were not broken down by caribou range and therefore the number counted in the Rabbit caribou range was summarized from BC MFLNRORD unpublished data

6 These caribou were previously included in the number of caribou counted in the Gataga caribou range portion of this survey; however, a closer examination of the data during our project revealed that they were counted in the Rabbit caribou range; another 39 caribou were counted in the Gataga caribou range and 245 in the Frog caribou range

7 Includes caribou counted in the Muncho Lake Herd and Rabbit River Herd; in the Rabbit River area, an additional 31 caribou were seen by B. Webster MOE that winter in an area not searched by Bergerud (an additional 22 were seen by BC Hydro but may have been duplicates of those seen by B. Webster; and 17 including 1 calf were seen by B. Kjos but no details on where or when and potentially may have been some duplication of Bergerud's sightings)

8 Aircraft not specified – assumed FW

9 Caribou counted during a mountain goat survey; note: this total may differ from the total for this survey reported elsewhere because we only include the 265 caribou that were counted in the Rabbit caribou range; another 89 caribou were counted in the Muskwa caribou range during this survey (see Muskwa)

Boundary Issues

- The large gap between caribou ranges in the centre of the study area (between the Rabbit, Horseranch, Spatsizi, Frog and Thutade caribou ranges) is known to contain caribou.

Range condition

Within the current Rabbit caribou range boundary, habitat disturbance covers 7%, 3% and 15% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails and fire, both of which are more prevalent at low elevations than at high elevations. Roads/trails include the Alaska Highway, which forms the northeastern border of the range, and are located primarily near the range boundary. There are few fires <40 years in the range itself, but several large fires are located within the 20 km and 30 km surrounding matrix. The levels of both fires <40 years and anthropogenic habitat disturbance are higher in the 20 km and 30 km matrix surrounding the range than in the range itself.

Our analysis does not include fires from 2018 to 2021. There were two large fires in the northwestern portion of the surrounding matrix in 2018, but did not affect much area in the range itself. Part of the area covered by those fires overlaps another large fire from 2015.

Rabbit

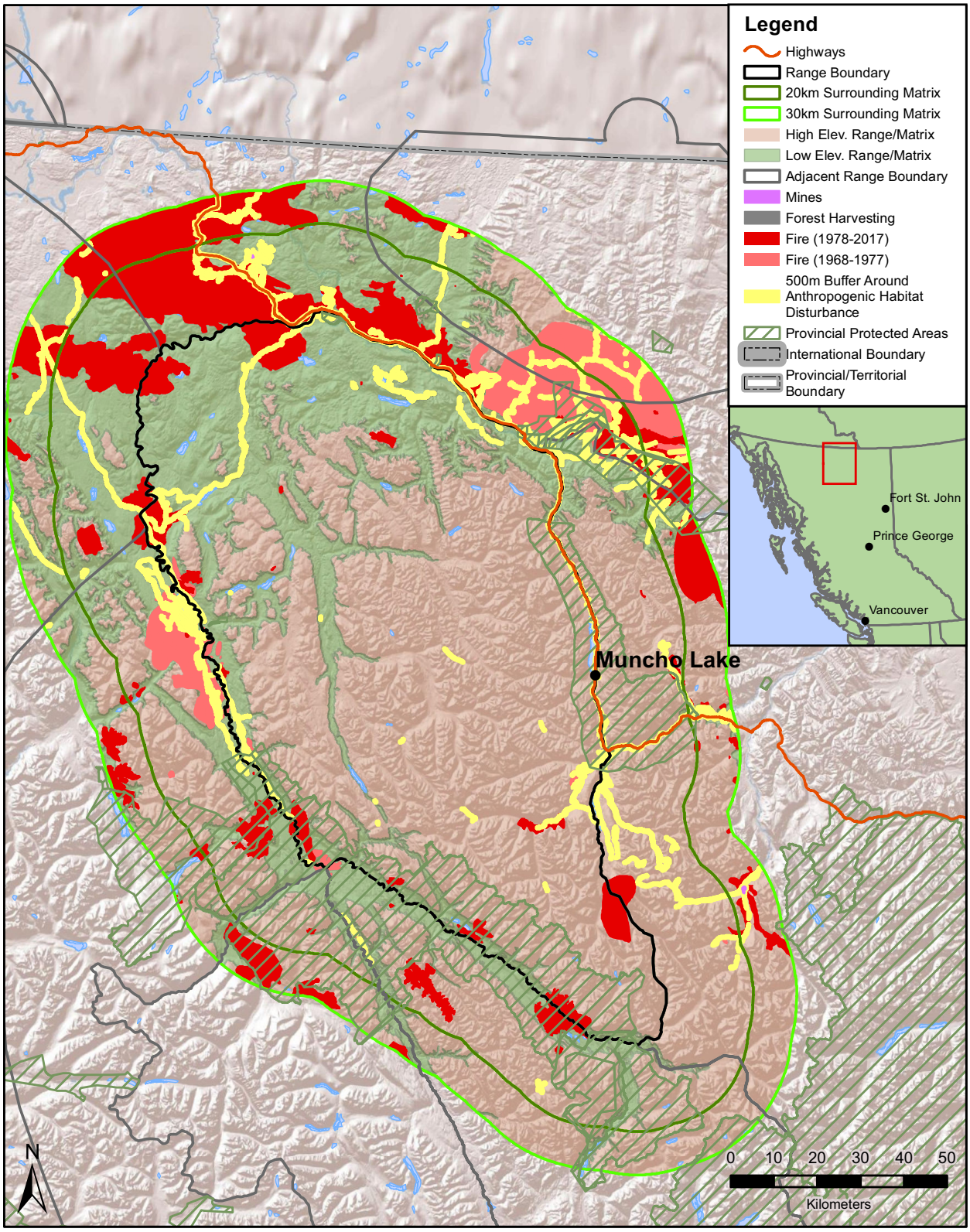
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	1 179 409	31.7	68.3	-
0-20 km matrix surrounding range	1 093 947	47.9	52.1	64.7 (NM)
0-30 km matrix surrounding range	1 721 485	45.1	54.9	67.5 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Rabbit


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Muncho Lake
N
0 10 20 30 40 50
Kilometers

Rabbit

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**1 179 409**	**3.6**	**4.0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3.4**	**0**	**0**	**0.5**	**0.4**	**3.5**	**3.6**	**6.7**
High elevation	805 402	1.4	1.6	0	0	0	0	0	0	0	0	0	0	0	0	1.3	0	0	0.3	0.2	1.4	1.4	2.8
Low elevation	374 007	8.4	9.1	0.1	0	0.1	0.1	0	0	0	0	0	0	0	0	7.9	0	0.1	1.2	1.0	8.2	8.2	15.2
Matrix 0-20 km																							
Total	**1 093 947**	**13.2**	**19.9**	**0.2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**7.7**	**0.4**	**0.1**	**2.2**	**1.7**	**8.3**	**8.4**	**19.7**
High elevation	570 481	2.4	5.4	0.1	0	0	0	0	0	0	0	0	0	0	0	4.3	0	0	0.9	0.9	4.4	4.4	6.7
Low elevation	523 466	25.0	35.7	0.4	0	0	0	0	0	0.1	0	0	0	0	0	11.5	0.9	0.1	3.7	2.6	12.5	12.7	34.0
Matrix 0-30 km																							
Total	**1 721 485**	**15.6**	**22.0**	**0.2**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0.1**	**0**	**6.6**	**0.5**	**0.1**	**2.0**	**1.6**	**7.0**	**7.2**	**20.8**
High elevation	944 682	4.4	8.5	0.1	0	0	0	0	0	0	0	0	0	0	0	3.1	0	0.1	0.7	0.7	3.2	3.2	7.4
Low elevation	776 801	29.2	38.4	0.3	0	0.1	0.1	0	0	0.1	0	0	0	0.2	0	10.8	1.1	0.2	3.6	2.6	11.8	12.1	37.1

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Muskwa

Range use summary

During calving, adult female caribou are found almost exclusively in high elevation alpine areas (Tripp et al. 2006, BC MFLNRORD in prep.). Caribou are also found primarily in high elevation habitat during summer and fall, but there is also some use of forested areas at lower elevations. During winter, caribou are found in both high elevation alpine habitat and to a lesser extent in forested areas (Tripp et al. 2006, BC MFLNRORD in prep.). The greatest use of high elevation alpine habitat is during calving and greatest use of forested habitat is during winter. Low elevation pine-lichen forests were limited in extent in the 2000-2004 study area (Tripp et al. 2006).

One caribou that was radio-collared in the Parker Boreal Caribou range in winter 2013, moved into the mountains in the Muskwa caribou range during calving in 2013 and 2015 but not in 2014 (Watters and DeMars 2016). It is unclear whether this was a Boreal Caribou that had calved in the Muskwa caribou range for two years, or a Muskwa caribou that wintered in the Parker caribou range each winter and calved in the Parker Boreal Caribou range during one of three years.

Season	Overview of Habitat and Range Use	Source
Winter	• Primarily high elevation windswept alpine slopes • Some winter use (up to 39%) in forested habitat adjacent to alpine	Tripp et al. (2006) BC MFLNRORD (in prep.)
Summer	• Calving is typically in high elevation alpine habitat • The highest use of alpine habitat is during calving • Summer and fall use is mostly in high elevation habitats and to a lesser extent in forested areas • Caribou moved in a generally northeasterly direction to fall ranges	Tripp et al. (2006) BC MFLNRORD (in prep.)
Migration		
Total Range		

Population size

For the Muskwa caribou, we include only the two population estimates based on the number counted during the October 2001 and July 2004 surveys. There have been other population estimates reported that we do not include, because the estimates were based on expert opinion or there was insufficient data to support the population estimates.

The most recent population estimate of 917 caribou for the Muskwa range was based on a survey conducted in 2004. The highest number of caribou counted in the Muskwa caribou range was 658 caribou during a fall caribou survey in 2001 from a study on radio-collared caribou between October 2000 and June 2004 (Tripp et al. 2006; see Population trend below). Prior to 2001, the highest number counted was 399 in 1978 (see Population trend below).

COSEWIC (2014) provided an estimate of 1000 caribou based on a 738 caribou counted during a sheep survey in 2007. However, since then an error was found in the database in which data for Muskwa was duplicated and the correct number of caribou seen during that survey was 369 and not 738 (BC MFLNRORD, unpubl. data). We therefore do not include the 2007 as a population estimate here.

In addition, we found an error in how population estimates were calculated in Tripp et al. (2006) report (see below). Subsequently, BC MFLNRORD used data from the July 2004 survey from that project and recalculated the population estimate as 917 (A. Pelletier, pers. comm.)

Date	Population estimate[1]	Number counted	Method	Reliability	Source
2004	917	516	Mark/re-sight	Moderate	A. Pelletier, pers. comm.

[1] COSEWIC (2014) provided an estimate of 1000 caribou based on a 738 caribou counted during a sheep survey in 2007. However, since then an error was found in the database in which data for Muskwa was duplicated; the correct number of caribou seen during that survey was 369 and not 738. We therefore do not include the 2007 as a population estimate here (see Population trend).

Tripp et al. (2006) used the proportion of radio-collared caribou seen during spring (June), fall (October) and late winter (February/March) surveys from October 2000 to June 2004 to calculate a relocation index that was then applied to the number of caribou counted during the survey. The relocation index was the proportion of caribou not seen during the survey, added to 1. For example, in June 2001, 23 of 26 radio-collared caribou were seen during the survey, which meant that 11% or a proportion of 0.11 were not seen. The relocation index was calculated as 1 + 0.11 or 1.11, which was multiplied by the total count of 471 to result in a population estimate of 522. The standard (and mathematically correct) method for mark/re-sight calculations is to apply the proportion of radio-collared caribou seen to the number counted during the survey (Krebs 1989). For June 2001, 23/26 or 89% of the radio-collared caribou were seen during the survey and therefore it is assumed that 89% of the population was counted during the survey. The number counted during the survey was 471, which is 89% of 532. Although the two estimates (522 vs 532) do not differ substantially, as the proportion of radio-collared caribou seen decreases, this difference increases. For example, in October 2001, when 7 of 26 radio-collared caribou were seen and 658 caribou were counted, the population estimates were 1138 using Tripp et al.'s (2006) calculations, and 2444 using the proportion method. As the proportion of radio-collared caribou seen during a survey decreases, so does the reliability of the estimate; that is the confidence limits around an estimate based only 27% of the marked animals seen will be very wide. Tripp et al. (2006) do not provide confidence limits around their estimates. Due to the error in calculating population estimates in Tripp et al. (2006), we do not include population estimates from that report but use MFLNRORD's estimate of 917 based on the recalculation of data from the June 2004 survey.

Bergerud and Elliott (1998) provide a population estimate of 3000 caribou in 1990, which appears to be based on a late winter survey in 1990. However, they do not provide any data from that survey to support the estimate. The only data provided on a late winter survey for caribou in 1990 show that 212 cows were classified and that there were 17.5 calves/100 cows based on the classified cow sample (Bergerud and Elliott 1998). Given insufficient information, we do not include the 1990 estimate in the list of population estimates here.

Population trend

Of the three most recent late winter surveys, the calf recruitment estimate from the March 2017 survey was below 15% calves recommended by Bergerud (1996) to achieve population stability, while the March 2018 and 2020 calf recruitment estimates were above 15%. However, the 2018 calf recruitment estimate is based on a small sample size and potentially may not represent calf recruitment for the whole population.

From 2001 to 2003, late winter calf recruitment was above 15% in one of three years (Tripp et al. 2006). From 1977 to 1987, calf recruitment was at or above 15% in four of six years with the highest level (21% in 1985) the year following wolf removal and the second highest level 2 years following wolf removal (20% in 1987), although calf recruitment estimates were also above 15% in 1979 and 1980, prior to wolf removal.

During fall surveys in 2002 and 2003, calves/100 cows ratios were within the 20 to 25 calves/100 cows range, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016). Calves/100 cows ratios were well above those levels in 1985 and 1987 after wolf control was conducted the previous winters. It is unknown whether fall surveys of rutting areas in the Muskwa caribou range are biased against calves as detected in the Spatsizi caribou range (Hatler 1987), however, even if that is the case, the two most recent fall surveys suggest that calf recruitment was sufficient to support a stable population growth rate in the early 2000s.

Muskwa

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2020	Mar	18	23	33	141	141	136	A. Pelletier, pers. comm.
2018	Mar	21	26	31	92	92	92	A. Pelletier, pers. comm.
2017	Mar	12	14	20	177	177	161	A. Pelletier, pers. comm.
2007	Mar	15	19	-	(369)[5]	176		BC MFLNRORD unpubl. data
2003	Mar	12	13	18	234	234	226	Tripp et al. (2006)
2002	Feb	14	17	26	210	210	201	Tripp et al. (2006)
2001	Mar	16	20	30	457	457	435	Tripp et al. (2006)
2001	Jan	12	14	-[6]	252	252		Tripp et al. (2006)
1990	Winter[7]			18[7]	249[7]		249[7]	Bergerud and Elliott (1998)
1987	Mar	20	25	31	331	331	331	Elliott (1987)
1985	Feb/Mar	21[8]	27[8]	-	324	324		Elliott (1985)
1980	Winter[9]	17	21	-	328	328		Elliott (1980)
1979	Winter[9]	18	22	-	71	71		Elliott (1980)
1978	Feb	11	12	-	399	369		Bergerud (1978) (FW)[10]
1977	Feb	13	15	-	219	179		Elliott in Bergerud (1978) (FW)[11]
Fall								
2003	Oct	14	16	25	411	411	395	Tripp et al. (2006)
2002	Oct	12	14	21	516	516	515	Tripp et al. (2006)
2001	Oct	-[12]	-[12]	-[12]	658			Tripp et al. (2006)
2000	Oct	-[12]	-[12]	-[12]	288			Tripp et al. (2006)
1987	Fall	-	-	65[7,8]	186[7]		186[7]	Bergerud and Elliott (1998)
1985	Oct	26[8]	35[8]	52[8]	192	192	192	Elliott (1986)
1983	Oct	20	26	-	123	123		Elliott (1984)
Calving/summer								
2017	July	22	28	33	(281)	281	277	A. Pelletier, pers. comm.
2004	June	22	28	42	516	516	506	Tripp et al. (2006)
2003	June	16	19	31	520	520	505	Tripp et al. (2006)
2002	June	25	34	-[6]	401	401		Tripp et al. (2006)
2001	June	27	37	-[6]	471	471		Tripp et al. (2006)
1996	June	20	25	47	(89)[13]	89	61	BC MFLNRORD unpubl. data

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 The total differs from COSEWIC (2014) because since then an error was found in the database in which data for Muskwa was duplicated; the correct number of caribou seen during that survey was 369; the number of caribou counted during the Stone's sheep survey were reported in Thiessen (2008) but numbers in the report were not broken down by caribou range and therefore the number counted in the Muskwa caribou range was summarized from BC MFLNRORD unpublished data

6 We did not calculate calves/100 cows because the proportion of unclassified adults was high

7 Sex/age class numbers were not reported in Bergerud and Elliott (1998). In this table, the number classified is the number of cows (reported) plus the number of calves (derived by multiplying the calf/100 cow ratio by the number of cows); no other survey data or the survey date were provided by Bergerud and Elliott (1998)

8 Wolves were removed from the Muskwa area the previous winter 1983/84 (partial; Elliott 1984), 1984/85 (total; Elliott 1985), and 1986/87 (total; Elliott 1987). (Note: there were no wolves removed in 1985/86 (Elliott 1986)).

9 No survey dates specified other than late winter; includes combined area of Macdonald-Racing and Toad River

10 Compiled from several areas including Muncho Lake, Racing River, Tuchodi River, Kluachesi Lake and Toad River

11 Toad River area only; aircraft not specified – assumed Helicopter

12 Calves were not distinguished from yearlings in October 2000 and October 2001

13 Caribou counted in the Muskwa caribou range portion of WMU7-51 during a mountain goat survey; these groups were previously lumped in with the Rabbit caribou range

It is not clear what the survey areas were for fall 1987 or winter 1990 based on information in Bergerud and Elliott (1998). The fall 1983, fall 1985 and winter 1987 survey areas were described in Elliott (1984), Elliott (1986) and Elliott (1987) respectively and lie entirely within the Muskwa caribou range. However, the map in Bergerud and Elliott (1998) shows the caribou survey area (presumably for all caribou surveys discussed) in what appears to be the Pink Mountain caribou range. We assumed that the fall 1987 and winter 1990 survey areas were the same as those for fall 1983, fall 1985 and winter 1987 and not as indicated on the map in Bergerud and Elliott (1998).

The numbers in our table do not necessarily match numbers in Bergerud and Elliott (1998). Bergerud and Elliott (1998) provided calves/100 cows ratios for Muskwa for 1979, 1980 and 1985. Although adults were not classified during those surveys, they assumed that cows made up two-thirds of the total adult count. Also, for the 1979 and 1980 surveys, it appears that they included surveys from the Prophet River area in their totals (based on data summarized in Elliott 1980), which were conducted the previous fall and therefore likely resulted in overestimates of the calves/100 cows ratios since over-winter mortality was not incorporated. This is especially problematic for late winter calf recruitment in 1979, which is based on 71 caribou counted in the Macdonald-Racing and Toad River areas in late winter, but the majority of caribou (219) were counted in the Prophet River area in fall 1978 (Elliott 1980). In our analysis, we only include the Macdonald-Racing and Toad River area surveys in the Muskwa caribou range, which were both conducted during winter, and we have included the Prophet River area in the Pink Mountain caribou range, where both surveys (Prophet River, Pink Mountain-Halfway) were conducted in the fall. Also, we do not include calves/100 cows ratios for the 1979, 1980 or 1985 Muskwa winter surveys because adults were not classified to bulls and cows, and we chose not to make assumptions about the proportion of cows in the adult sample.

Tripp et al. (2006) provide three full years of adult female mortality rates: 17% (Oct 2000 to Sept 2001); 22% (Oct 2001 to Sept 2002); and, 7% (Oct 2002 to Sept 2003). No data on population growth rate based on adult mortality and calf recruitment was readily available.

Of the three recent late winter calf recruitment surveys, one (2017) suggests and decreasing population trend, and two (2018, 2020) suggest a stable or increasing population, although sample size in 2018 was low. There is not enough information to determine a consistent recent population trend, nor a long-term population trend.

Boundary Issues

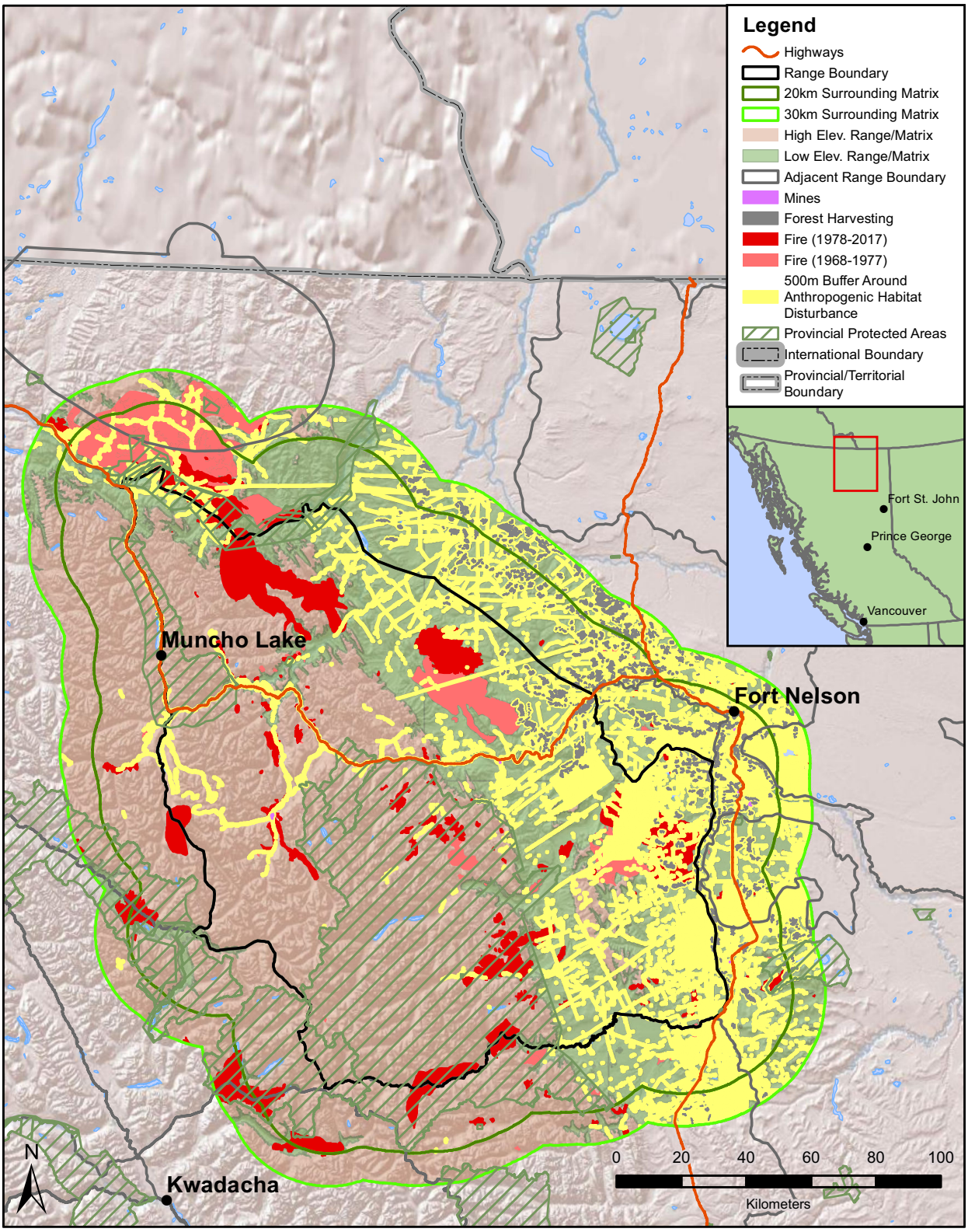
There were no boundary issues identified, however, the level of caribou use in the eastern portion of the range (e.g. east of the Muskwa and Dunedin rivers) may need to be assessed.

Range condition

Within the current Muskwa caribou range boundary, habitat disturbance covers 25%, 11% and 46% of the total, high elevation and low elevation portions of the range respectively. Habitat disturbance in the low elevation portion of the range is over the 35% disturbance threshold for critical habitat in the recovery strategy for southern mountain caribou (Environment Canada 2014). Primary disturbances are roads/trails, seismic lines, fire and forest harvesting, all four of which are more prevalent at low elevations than at high elevations. Roads/trails primarily include the Alaska Highway, and industrial roads associated with oil and gas and forest harvesting activity in the eastern and northeastern portions of the range. Fires <40 years are distributed throughout the range. Habitat disturbance is higher in the 20 km and 30 km matrix surrounding the range, especially in the area to the northeast of the range. The western portion of the range, where most of the caribou activity has been recorded, and the 20 km and 30 km matrices to the west of the range, contain low levels of anthropogenic habitat disturbance.

Our analysis does not include fires from 2018 to 2021, however, there were no significant fires recorded in the Muskwa caribou range or in the surrounding matrix in those four years.

Muskwa


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Muncho Lake
Fort Nelson
Kwadacha
N
0
20
40
60
80
100
Kilometers

Muskwa

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	2 158 213	41.8	58.2	-
0-20 km matrix surrounding range	1 481 104	56.6	43.4	54.4 (NM) 9.9 (Boreal)
0-30 km matrix surrounding range	2 281 006	56.0	44.0	56.4 (NM) 8.4 (Boreal)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Muskwa

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**2 158 213**	**8.4**	**11.2**	**0**	**0**	**0.1**	**0**	**2.1**	**0**	**0**	**0.4**	**0.5**	**0.1**	**0**	**0**	**14.5**	**7.4**	**0.1**	**1.1**	**0.8**	**14.8**	**19.4**	**25.8**
High elevation	1 256 932	6.3	7.1	0	0	0	0	0	0	0	0	0	0	0	0	4.8	0.3	0.1	0.8	0.8	4.8	5.1	11.1
Low elevation	901 281	11.3	16.9	0	0	0.2	0.1	5.0	0	0	1.0	1.2	0.2	0	0	28.1	17.3	0.1	1.4	0.7	28.8	39.4	46.2
Matrix 0-20 km																							
Total	**1 481 104**	**5.1**	**11.9**	**0.3**	**0**	**0.3**	**0**	**7.1**	**0**	**0.1**	**1.2**	**1.5**	**0.3**	**0.3**	**0.2**	**22.3**	**13.3**	**0.5**	**1.4**	**1.0**	**22.7**	**29.1**	**32.7**
High elevation	643 167	3.7	8.6	0.1	0	0	0	0	0	0	0	0	0	0	0	2.1	0	0.1	0.4	0.3	2.2	2.3	5.9
Low elevation	837 937	6.2	14.4	0.4	0	0.5	0	12.6	0	0.1	2.1	2.7	0.5	0.5	0.4	37.7	23.4	0.8	2.2	1.5	38.4	49.7	53.3
Matrix 0-30 km																							
Total	**2 281 006**	**4.4**	**10**	**0.4**	**0**	**0.2**	**0.1**	**7.2**	**0**	**0**	**1.1**	**1.5**	**0.4**	**0.2**	**0.2**	**22.5**	**13.5**	**0.4**	**1.4**	**1.0**	**22.9**	**29.3**	**32.5**
High elevation	1 003 803	3.0	7.4	0.1	0	0	0	0	0	0	0	0	0	0	0	1.8	0	0	0.4	0.4	1.8	1.9	4.8
Low elevation	1 277 194	5.4	12.1	0.6	0	0.4	0.1	12.9	0	0.1	2.1	2.7	0.7	0.4	0.4	38.9	24.0	0.6	2.1	1.5	39.4	50.9	54.3

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Pink Mountain

Range use summary

During winter, Pink Mountain caribou are found in high elevation alpine and high elevation forested habitat in the western portion of the range, and in low elevation forested habitat in the eastern portion of the range. Currently, there are no reports that discuss variability in winter habitat and winter range use between years with different winter conditions. Calving occurs primarily at higher elevations in the foothills in the eastern portion of the range, or in the higher mountains in the western portion. During summer, caribou use primarily high elevations but may move down in elevation in the fall.

Season	Overview of Habitat and Range Use	Source

Winter	• Two wintering strategies
	  • High elevation alpine or forests in the western portion of the range
	  • Low elevation forested habitat in the eastern portion of the range
	• At low elevations, caribou have been found in mature black spruce and pine stands, and mature black spruce bogs
		Parker and Gustine (2007)
		Gustine and Parker (2008)
		MFLNRORD (in prep.)
		Hansen (2017)

Summer	• Calving occurs primarily in high elevation alpine and subalpine habitat	Parker and Gustine (2007) BC MFLNRORD (in prep.)
Migration	• Lower elevations	BC MFLNRORD (in prep.)
Total Range		

Radio-collared caribou data suggests overlap between the Finlay and Pink Mountain caribou seasonal ranges (Zimmerman et al. 2002, Woods and McNay 2018, Klaczek and Anderson 2020). Based on 120 caribou collared in the Finlay and Pink Mountain caribou ranges from 1999 to 2005, 18 (11%) used both ranges (Woods and McNay 2018). Three caribou collared in the Finlay caribou range in March 2017 moved to the Pink Mountain area in June 2017 and remained in the Pink Mountain area the following winter (Klaczek 2018). A fourth radio-collared caribou also moved to the Pink Mountain area the following year (Klaczek and Anderson 2020).

Population size

The current population estimate of 1275 caribou is based on an aerial survey in high elevation habitat in the Pink Mountain caribou range in March 1993 (BC MFLNRORD, unpubl. data). This estimate is now over 25 years old. Since 1993, the highest numbers of caribou counted during surveys were 377 in 2000 and 323 in 2017 (see Population trend below). Many of the surveys conducted since 1993 were not intended as total count population surveys and did not include the whole caribou range. Also, most of the surveys were conducted in alpine habitat during winter, and because some caribou winter in lower elevation habitat in the eastern portion of their range, not all caribou would have been targeted during those surveys.

Date	Population estimate	Number counted	Method	Reliability	Source
1993	1275	1275	Minimum count	Moderate/ High	BC MFLNRORD unpubl. data

Population trend

Only two surveys have been conducted in the Pink Mountain caribou range during fall (1978, 1979). Because cows and bulls were lumped together as unclassified adults, we could not calculate calves/100 cows ratios to assess whether they were at or above 20 to 25 calves/100 cows, which is considered sufficient to support a stable population growth rate (Environment Yukon 2016).

Almost all of the surveys conducted in the Pink Mountain caribou range have been conducted during late winter. Of the 11 surveys conducted between 1976 and 2018 where calves were distinguished from adults, calf recruitment estimates for five surveys were above 15% calves recommended by Bergerud (1996) to achieve population stability. Calf recruitment estimates from the most recent survey (2018) suggests the population is likely stable, but estimates from the two previous surveys (2016, 2017) suggest that the population is declining.

It is not possible to evaluate population trend based on number of animals counted during surveys, given lack of information on effort for older surveys, and variability in seasonal range use. Bergerud (1978) suggested that the population decreased by 94% from 2675 in 1969 to 151 in 1978. However, the 1969 survey was from the Canada Land Inventory (CLI) survey in 1969 that included a much larger area; only 1125 caribou were counted during the CLI survey in 1969 in an area comparable to the area surveyed in 1978 (Bergerud 1978). Bergerud (1978) described conditions during the 1969 CLI survey as a period of extreme cold weather and temperature inversions, and deeper snow than the 1968 CLI survey, when 564 caribou were counted in the area comparable to the 1978 survey area. Any difference between the number counted during the 1968 CLI survey and 1969 CLI survey would have been more likely due to variation in winter conditions, and not to a doubling of the caribou population. The 1969 survey may have also been conducted during a winter with conditions that resulted in a large portion of the population using high elevation alpine areas. In the nearby Spatsizi caribou range, winter conditions resulted in most of the radio-collared caribou using windswept alpine slopes in only one of four years of the study (Hatler 1986). It is therefore possible that the 1969 CLI survey was conducted in a year when most of the caribou were using alpine habitat, while the 1978 survey may have been conducted during a year when many caribou were using lower elevation forested areas. Caribou in the Pink Mountain area use both high elevation alpine areas and lower elevation forested areas during winter (Parker and Gustine 2008, BC MFLNRORD in prep.). While we question the decline estimate of 94%, we can't rule out a decline. Also, there is a strong likelihood that populations were at higher levels then following wide-scale wolf poisoning programs in the 1950s and early 1960s (Hoffos 1987, BC MFLNRO 2014).

No information on adult survival or population growth rate (based on adult mortality and calf recruitment) was readily available from radio-collared caribou studies.

Two surveys (1994, 1995) included the area between the Halfway River and Cypress Creek, which is in the Graham caribou range. For those two surveys, we only included caribou groups that were counted in the Pink Mountain caribou range.

Pink Mountain

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2018	Mar	16	19	23	237	237	237	A. Pelletier, pers. comm.
2017	Mar	10	11	17	323	323	322	Hansen (2017)
2016	Feb	9	10	15	252	252	207	A. Pelletier, pers. comm.
2008	Feb	19	24	30	242	242	242	Goddard (2009)
2007	Mar				(266)[5]			BC MFLNRORD unpubl. data[5]
2002	Feb/Mar	11	12	–	133	131		Zimmerman et al. (2002)
2000	Mar	10	11	12	377	377	377	BC MFLNRORD unpubl. data[6]
1995	Feb	8	9	14	270[7]	261	260	BC MFLNRORD unpubl. data
1994	Jan/Feb	18	23	27	152[8]	152	152	BC MFLNRORD unpubl. data
1993	Feb	10	11	14	1275[9]	1275	1275	BC MFLNRORD unpubl. data
1978	Feb	16	20		151	151		Bergerud (1978) (FW)[10]
1976	Dec	16	19		186	186		Elliott in Bergerud (1978) (FW)[11]
1969	Jan				(2675)[12]			CLI in Bergerud (1978) (FW)[12]
1968	Feb/Mar				(1018)[13]			CLI in Bergerud (1978) (FW)[13]
Fall								
1979	Fall[14]	15	18		389	389		Elliott (1980)
1978	Fall[14]	24	32	–	430	430		Elliott (1980)

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 Number of caribou counted during the Stone's sheep survey were reported in Thiessen (2008), but numbers in the report were not broken down by caribou range and therefore the number counted in the Pink Mountain caribou range was summarized from BC MFLNRORD unpublished data

6 Aircraft not specified; assumed helicopter

7 MFLNRORD unpubl. data indicates that the survey was conducted in the Pink Mtn area; although not all groups have location data, of the ones that do, several groups totaling 63 caribou were counted in the Graham caribou range; based on location data, 270 caribou were counted in the Pink Mountain caribou range and 63 were counted in the Graham caribou range; aircraft not specified, assumed helicopter

8 MFLNRORD unpubl. data indicates that the survey was conducted between the Prophet River and Cypress Creek; based on location data, 152 caribou were counted in the Pink Mountain caribou range and 112 were counted in the Graham caribou range; aircraft not specified, assumed helicopter

9 MFLNRORD unpubl. data indicates that the survey was conducted between the Prophet and Halfway rivers (but there is no location data) so the whole survey was conducted within the Pink Mountain caribou range; aircraft not specified, assumed helicopter

10 Survey area included the area between the Sikanni Chief and Halfway rivers

11 Survey conducted by Elliott in the vicinity of Pink Mountain but no details of exact survey area other than it did not include the area west of Marion Lake; aircraft not specified - assumed FW

12 Canada Land Inventory (CLI) data summarized by Bergerud 1978; partial map included in that report - survey area appears to be within the current Pink Mountain caribou range boundary; 1125 caribou counted within the area comparable to the area covered during the February 1978 survey (Bergerud 1978)

13 Canada Land Inventory (CLI) data summarized by Bergerud 1978; survey area not specified; aircraft not specified – assumed FW; 564 caribou counted within the area comparable to the area covered during the February 1978 survey (Bergerud 1978)

14 No survey dates specified other than fall; includes combined area of Pink Mountain-Halfway and Prophet River

Boundary Issues

- Recent telemetry data suggest overlap between Pink Mountain and Finlay caribou ranges.

Radio-collared caribou data suggests overlap between the Finlay and Pink Mountain caribou seasonal ranges (Zimmerman et al. 2002, Woods and McNay 2018, Klaczek and Anderson 2020). However, Woods and McNay (2018) analyzed radio-telemetry data from 1999 to 2005 from caribou collared in both the Finlay and Pink Mountain ranges, and although some caribou used both ranges, they concluded that the current boundaries were biologically relevant and that no boundary refinements were needed.

Range condition

Within the current Pink Mountain caribou range boundary, habitat disturbance covers 35%, 16% and 72% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are seismic lines and roads/trails with the bulk of habitat disturbance in the lower elevation portion of the range. Roads/trails include the Alaska Highway, and industrial roads associated with petroleum exploration and development, and forest harvesting. Other habitat disturbance includes oil facilities, wells, pipelines, forest harvesting, fire, and forest insects. The eastern portion of the range is highly impacted by anthropogenic habitat disturbance. Fires <40 years are distributed throughout the range. Total habitat disturbance levels in the 20 km and 30 km matrix surrounding the range are similar to within the range, however, levels of petroleum infrastructure (facilities, wells, pipelines) and forest harvesting are higher.

Habitat disturbance in the low elevation portion of the range is well over the 35% disturbance threshold for critical habitat in the recovery strategy for southern mountain caribou (Environment Canada 2014).

Our analysis does not include fires from 2018 to 2021, however, there were only two small fires recorded in the Pink Mountain caribou range in 2021 (3,500 ha, 6,400 ha) and one in 2018 (1,600 ha). There were no substantial fires in the surrounding matrix in those four years.

Pink Mountain

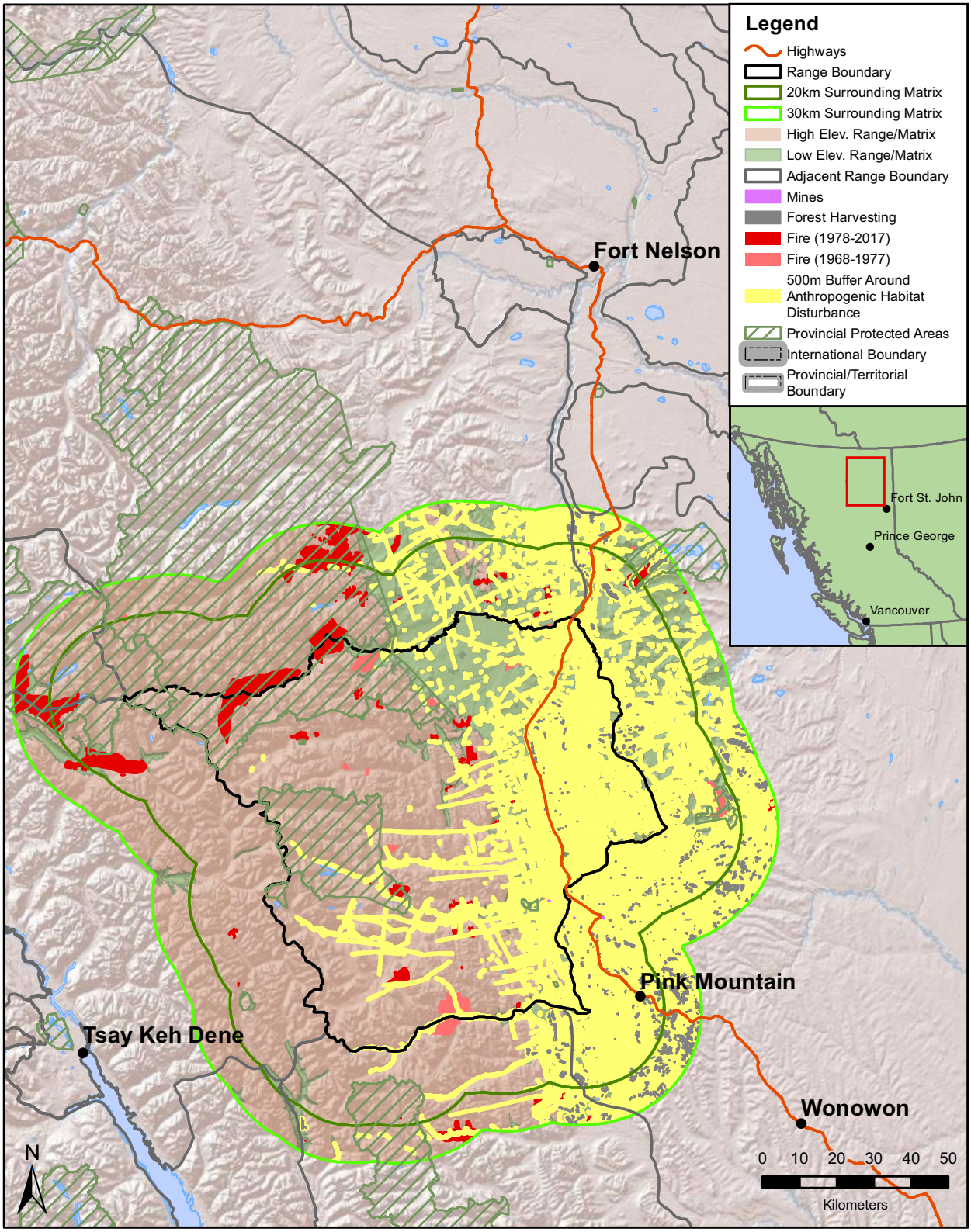
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	957 542	34.8	65.2	-
0-20 km matrix surrounding range	1 067 608	45.7	54.3	53.3 (NM) 15.2 (SM)
0-30 km matrix surrounding range	1 669 138	44.1	55.9	51.4 (NM) 15.0 (SM) 0.1 (Boreal)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Pink Mountain



Pink Mountain

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**957 542**	**2.2**	**3.5**	**3.2**	**0**	**0.2**	**0**	**0.9**	**0**	**0**	**3.7**	**2.6**	**2.6**	**0**	**0**	**25.7**	**20.4**	**0.2**	**1.4**	**1.3**	**25.8**	**33.9**	**35.4**
High elevation	624 647	2.2	3.4	3.5	0	0	0	0	0	0	0.3	0.5	0	0	0	8.8	6.6	0.1	1.6	1.5	8.9	13.7	15.7
Low elevation	332 894	2.2	3.6	2.7	0	0.7	0.1	2.5	0	0.1	9.8	6.5	7.6	0	0	57.6	46.5	0.4	1.0	0.9	57.6	71.8	72.3
Matrix 0-20 km																							
Total	**1 067 608**	**3.2**	**3.9**	**2.0**	**0**	**1.3**	**0.1**	**4.2**	**0**	**0.1**	**7.2**	**5.1**	**4.6**	**0**	**0**	**28.1**	**20.8**	**0.2**	**0.8**	**0.4**	**28.4**	**34.1**	**36.7**
High elevation	596 411	3.4	3.9	1.0	0	0	0	0.6	0	0	1.0	0.5	0.7	0	0	3.7	2.1	0	1.0	0.4	4.3	4.9	8.2
Low elevation	471 197	3.0	4.0	3.4	0	3.0	0.2	8.8	0	0.2	15.0	10.9	9.5	0	0	58.9	44.5	0.5	0.5	0.4	58.9	71.0	72.9
Matrix 0-30 km																							
Total	**1 669 138**	**4.7**	**5.2**	**2.6**	**0**	**1.1**	**0.1**	**6.2**	**0**	**0.1**	**7.7**	**6.1**	**4.8**	**0**	**0**	**29.1**	**27.1**	**0.2**	**0.6**	**0.4**	**29.3**	**34.7**	**37.9**
High elevation	906 888	4.3	4.6	1.6	0	0	0	0.5	0	0	0.7	0.4	0.5	0	0	3.7	10	0	0.8	0.5	4.1	5.0	8.9
Low elevation	762 233	5.1	5.9	3.8	0	2.4	0.2	13.0	0	0.2	16.1	12.9	10.0	0	0	59.3	47.3	0.4	0.3	0.3	59.3	70.0	72.4

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Gataga

Range use summary

During winter, caribou use high elevation alpine and subalpine habitat, and lower elevation spruce forests, then in spring use mainly lower elevation pine and spruce forests. During calving, summer, and rut, caribou are found primarily at high elevations.

Season	Overview of Habitat and Range Use[1]	Source[1]
Winter	• Use both high elevation alpine and subalpine habitat, and lower elevation spruce forests	BC Ministry of Water, Land and Air Protection (2004)
Summer	• From calving to rut (mid May to October), primarily use alpine and subalpine habitat, with highest use of alpine during summer and highest use of subalpine during rut	BC Ministry of Water, Land and Air Protection (2004)
Migration	• Primarily use lower elevation lodgepole pine and spruce forests during spring migration (April – mid May)	BC Ministry of Water, Land and Air Protection (2004)
Total Range		

[1] Habitat use information is based on radio-collared caribou data collected between summer 2000 and summer 2003 in the Gataga and Frog caribou ranges combined

Population size

The current population estimate of 265 caribou was based on a survey conducted in October 2000 in high elevation habitat in the Gataga caribou range. There is insufficient information available about the survey to determine whether it was a full count or a partial count, so this population estimate should be considered a minimum number present until a full survey can be conducted, and should not be used to assess trend when a full survey is conducted.

Date	Population estimate	Number counted	Method	Reliability	Source
2000	265[1]	265[1]	Minimum count	Moderate	BC MFLNRORD unpubl. data

[1] There is insufficient information available to determine whether this was a full count or a partial count so this estimate should be considered a minimum number present until a full survey can be conducted, and should not be used to assess trend when a full survey is conducted. Since 2000, 39 caribou and 138 caribou were counted on portions of the Gataga range in 2001 and 2007 respectively

Since 2000, 39 caribou were counted during a caribou survey in a portion of the Gataga caribou range in February 2001 (BC MFLNRORD unpubl. data) and 138 caribou were counted during a Stone's sheep survey in a portion of the Gataga caribou range in March 2007 (Thiessen 2008, BC MFLNRORD unpubl. data).

Prior to 2000, 40 caribou were seen during a late winter survey in 1980 and 15 caribou were seen during a survey in February 1978 (see Population trend).

The estimate of 265 caribou is now over 20 years old and out of date, and it is unclear how much of the range was surveyed.

Population trend

The calves/100 cows ratio during the October 2000 survey was above the 20 to 25 calves/100 cows level that is considered sufficient to support a stable population growth rate (Environment Yukon 2016). It is unknown whether fall surveys of rutting areas in the Gataga caribou range are biased against calves as detected in the nearby Spatsizi caribou range (Hatler 1987), however, the calves/100 cows ratio suggested a stable population in 2000 even if the survey was biased against calves.

Gataga

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2007	Mar	9	10	–	(138)[5]	138		BC MFLNRORD unpubl. data[5]
2001	Feb	21	26	31	39[6]	39	39	BC MFLNRORD unpubl. data
1980	Late winter	15	18	–	40	40		Elliott (1980)[7]
1978	Feb	13	15		15	15		Bergerud (1978) (FW)[8]
Fall								
2000	Oct	17	21	27	265	265		BC MFLNRORD unpubl. data

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 Number of caribou counted during the Stone's sheep survey was reported in Thiessen (2008), but numbers in the report were not broken down by caribou range and therefore the number counted in the Gataga caribou range was summarized from BC MFLNRORD unpublished data

6 This total may differ from the total for this survey reported elsewhere because we only include the 39 caribou that were counted in the Gataga caribou range; another 54 caribou were counted in the Rabbit caribou range and 245 caribou were counted in the Frog caribou range during this survey

7 No study area description was provided; the area was called Gataga-Kechika in the report so we assumed that it was in the Gataga caribou range

8 Includes sightings in the Upper Gataga and South Gataga rivers. Bergerud (1978) also saw some tracks near the lakes where the South Gataga and Gataga rivers join.

Only the most recent late winter survey in 2007 has a reasonable sample size to estimate calf recruitment, which was below 15% calves recommended by Bergerud (1996) to achieve population stability.

The most recent estimate of calf recruitment is now almost 15 years old and is out of date for assessing current population trend.

Of the 55 radio-collared adult female caribou in the Frog and Gataga caribou ranges at the start of the project, 41 were still alive at the end of the three years, resulting in an annual mortality rate of 10% (BC MWLAP 2004). No information was presented on how the mortality rate was calculated or whether there were any collar failures during this time. No calf recruitment data were presented but if the calves/100 cows ratio from the October 2000 survey was representative of calf recruitment for all three years of the study, then calf recruitment was likely sufficient to balance adult mortality.

Boundary Issues

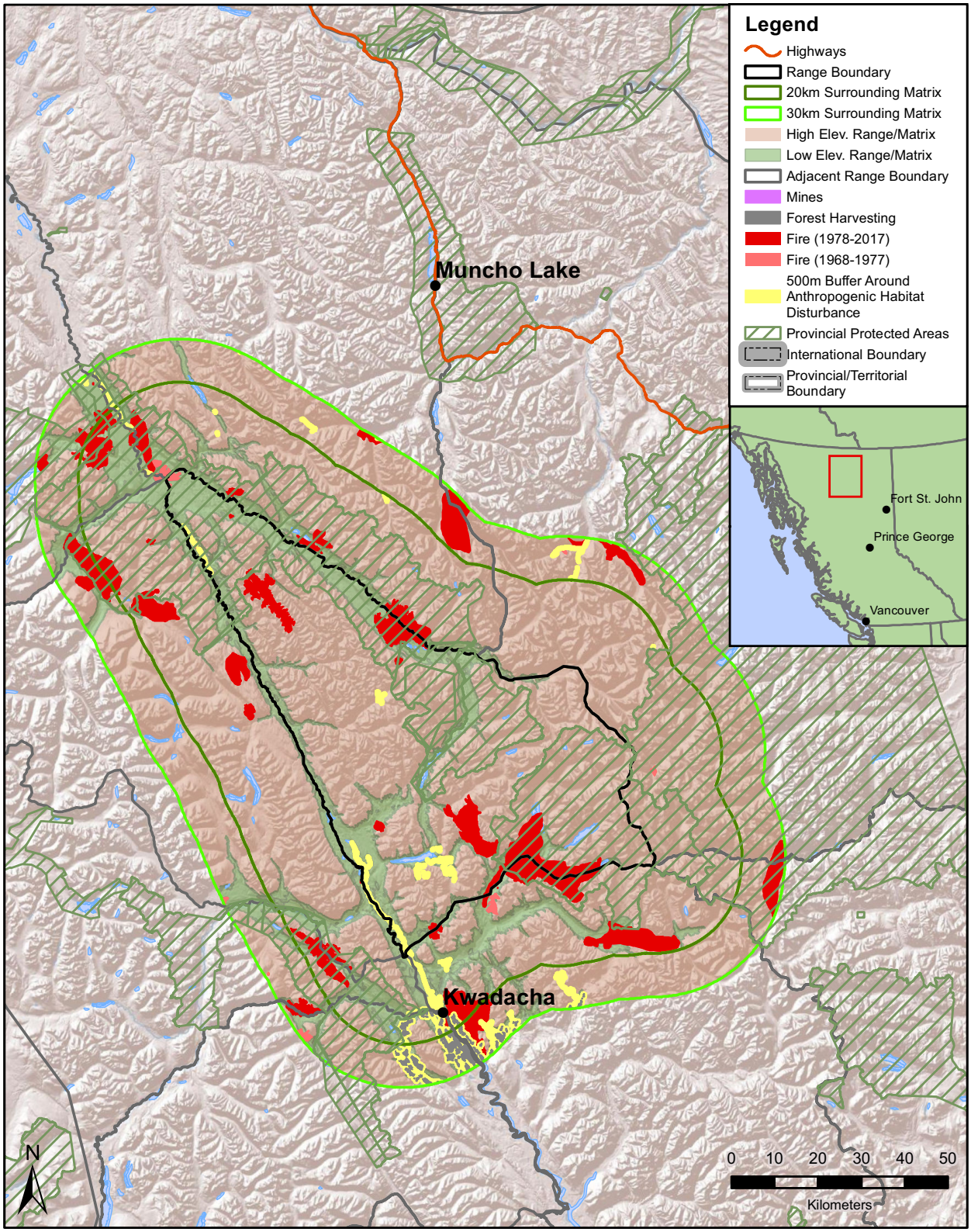
There is insufficient information available to assess whether there are any boundary issues.

Range condition

Within the current Gataga caribou range boundary, habitat disturbance covers 7%, 4% and 16% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are fire, forest insects, and roads/trails, all three of which are most prevalent in the lower elevation portion of the range. Roads/trails are the only recorded anthropogenic habitat disturbance within the range and are located primarily in the southwestern portion of the range. Habitat disturbance is slightly higher in the 30 km matrix surrounding the range, primarily due to more anthropogenic habitat disturbance in the form of roads/trails and cutblocks south of the range. Kwadacha is located south of the range within the 20 km and 30 km surrounding matrices.

Our analysis does not include fires from 2018 to 2021. During those four years, there were no substantial fires in the caribou range or surrounding matrix other than a small 7,000 ha fire in 2018 southwest of the Gataga caribou range in the 30 km surrounding matrix.

Gataga


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Muncho Lake
Kwadacha
Fort St. John
Prince George
Vancouver
N
0 10 20 30 40 50
Kilometers

Gataga

	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	500 703	22.3	77.7	-
0-20 km matrix surrounding range	845 787	18.7	81.3	92.3 (NM)
0-30 km matrix surrounding range	1 352 795	16.4	83.6	90.6 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub- Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Gataga

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**500 703**	**5.1**	**5.3**	**1.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.7**	**0**	**0**	**0**	**0**	**1.7**	**1.7**	**6.8**
High elevation	389 212	3.6	3.6	0.7	0	0	0	0	0	0	0	0	0	0	0	0.6	0	0	0	0	0.6	0.6	4.2
Low elevation	111 491	10.7	11.2	4.1	0	0	0	0	0	0	0	0	0	0	0	5.3	0	0	0	0	5.3	5.3	16.0
Matrix 0-20 km																							
Total	**845 787**	**5.8**	**6.1**	**3.2**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.1**	**0**	**0**	**0**	**0**	**1.1**	**1.2**	**6.9**
High elevation	687 709	4.0	4.1	1.3	0	0	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0.1	0.1	4.2
Low elevation	158 078	13.7	14.6	11.7	0	0	0.2	1.9	0	0	0	0	0	0	0	5.6	0	0.2	0	0	5.6	5.8	18.6
Matrix 0-30 km																							
Total	**1 352 795**	**6.1**	**6.3**	**3.1**	**0**	**0**	**0**	**1.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.2**	**0**	**0**	**0**	**0**	**2.2**	**2.3**	**8.0**
High elevation	1 130 671	4.3	4.4	1.5	0	0	0	0.2	0	0	0	0	0	0	0	0.6	0	0	0	0	0.6	0.7	4.9
Low elevation	222 124	15.1	16.0	11.5	0	0	0.1	6.6	0	0	0	0	0	0	0	10.4	0	0.1	0	0	10.4	10.9	23.6

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Frog

Range use summary

During winter, caribou use high elevation alpine and subalpine habitat, and lower elevation spruce forests, then in spring use mainly lower elevation pine and spruce forests. During calving, summer, and rut, caribou are found primarily at high elevations.

Season	Overview of Habitat and Range Use[1]	Source[1]
Winter	• Use both high elevation alpine and subalpine habitat, and lower elevation spruce forests	BC Ministry of Water, Land and Air Protection (2004)
Summer	• From calving to rut (mid May to October), primarily use alpine and subalpine habitat, with highest use of alpine during summer and highest use of subalpine during rut	BC Ministry of Water, Land and Air Protection (2004)
Migration	• Primarily use lower elevation lodgepole pine and spruce forests during spring migration (April – mid May)	BC Ministry of Water, Land and Air Protection (2004)
Total Range		

[1] Habitat use information is based on radio-collared caribou data collected between summer 2000 and summer 2003 in the Frog and Gataga caribou ranges combined

Population size

The current population estimate of 245 caribou was based on a survey conducted in February 2001 in high elevation habitat in the Frog, Gataga and Rabbit caribou ranges. A total of 338 caribou were counted in the three caribou ranges combined, 245 in the Frog caribou range, 39 in the Gataga caribou range and 54 in the Rabbit caribou range (BC MFLNRORD, unpubl. data). There is insufficient information available about the survey to determine whether it was a full count or a partial count, so this population estimate should be considered a minimum number present until a full survey can be conducted, and should not be used to assess trend when a full survey is conducted.

Date	Population estimate	Number counted	Method	Reliability	Source
2001	245[1]	245[1]	Minimum count	Moderate	BC MFLNRORD unpubl. data

[1] There is insufficient information available to determine whether this was a full count or a partial count so this estimate should be considered a minimum number present until a full survey can be conducted, and should not be used to assess trend when a full survey is conducted.

Since 2001, 82 caribou were counted during a sheep and caribou survey in northern portion of the Frog caribou range in 2009 (Thiessen 2009) and 114 caribou were seen during a survey in March 2020 (A. Pelletier, pers. comm.). Between 80 and 96 caribou were counted in the area just south of the southern Frog caribou range boundary between 2009 and 2013 (see Population trend below), which is an area that Sittler et al. (2015) recommended adding to the Frog caribou range based on radio-collared caribou data. In 2009, a total of 162 caribou were counted during two surveys conducted one week apart in northernmost portion of the range (Thiessen 2009: 82 caribou) and just outside the southeastern portion of the range (MacDonald et al. 2009: 80 caribou)

Bergerud (1978) found lots of tracks on Rainbow Creek, Johiah Mountain, Ludwig Creek and Flat Top Mountain on March 2, 1978, but did not report seeing any caribou.

The current estimate of 245 caribou is now over 20 years old and out of date, and the area surveyed did not include the area south of the current Frog caribou range boundary that Sittler et al. (2015) recommended for inclusion in the Frog caribou range.

Population trend

Neither of the two survey reports for fall surveys conducted in the area just south of the Frog caribou range in 2010 and 2012 presented data distinguishing bulls from cows, so we are unable to assess whether the calf/100 cow ratios were above or below the 20 to 25 calves/100 cows level that is considered sufficient to support a stable population growth rate (Environment Yukon 2016).

Calf recruitment based on caribou counted during the March 2020 Stone's sheep survey was higher than the 15% calves recommended by Bergerud (1996) to achieve population stability. In both winter surveys conducted in and adjacent to the Frog caribou range in 2009, calf recruitment estimates were below 15%, while calf recruitment in 2001 was over 15% calves. Sample size was low for the caribou counted during the March 2013 capture session and may not have been representative of calf recruitment. Percent calves during the two fall surveys was less than 15%. It is unknown whether fall surveys of rutting areas in the Frog caribou range are biased against calves as detected in the nearby Spatsizi caribou range (Hatler 1987). If so, the fall calf ratios may not be representative of calf recruitment. Sample sizes and the limited area covered may have also influenced calf ratios.

Of the 55 radio-collared adult female caribou in the Frog and Gataga caribou ranges at the start of the project, 41 were still alive at the end of the three years, resulting in an annual mortality rate of 10% (BC MWLAP 2004). No information was presented on how the mortality rate was calculated or whether there were any collar failures during this time. No calf recruitment data were presented but if calf recruitment from the February 2001 survey was representative of calf recruitment for all three years of the study, then calf recruitment would have been sufficient to balance adult mortality.

Frog

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2020	Mar	19	23	30	(114)	108	105	A. Pelletier pers. comm.
2013[5]	Mar	21	27	38	33[6]	28	28	MacDonald and McNay (2013)
2009[5]	Mar	9	10	18	80	80	80	MacDonald et al. (2009)
2009	Feb	7	8	10	82[7]	82	82	BC MFLNRORD unpubl. data[7]
2001	Feb	16	19	23	245[8]	245	245	BC MFLNRORD unpubl. data
Fall								
2012[5]	Oct	14	16		96	96[9]		Rudichuk et al. (2013)
2010[5]	Oct	12	14		92	92		McNay (2012)

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

2 Numbers in parentheses indicate surveys where caribou were not the primary focus

3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

4 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

5 Surveys shown in italics were conducted primarily in an area south of the Frog caribou range and outside of any caribou ranges, in an area that Sittler et al. (2015) recommended including in the Frog caribou range based on radio-collared caribou data

6 Includes 20 caribou counted in the Frog caribou range

7 Number of caribou counted during a Stone's sheep and caribou survey (Thiessen 2009)

8 The total number of caribou counted in the Frog caribou range in February 2001 that we present here differs from the total reported elsewhere. In our total, we only include the 245 caribou that were counted in the Frog caribou range (updated based on a closer examination of group locations); another 54 caribou were counted in the Rabbit caribou range and 39 caribou were counted in the Gataga caribou range.

9 Includes 21 caribou counted in the Frog caribou range

Boundary Issues

- Telemetry and other location data suggest that boundaries should be expanded into some areas that are not included in the Frog caribou range.
- The large gap between the Frog, Spatsizi, Horseranch, Rabbit, and Thutade caribou ranges is known to contain caribou.

Sittler et al. (2015) recommended extending the southern portion of the range to join up with the eastern portion of the Thutade range, based on data collected from caribou radio-collared in the area of low density just south of the Frog caribou range.

Range condition

Within the current Frog caribou range boundary, habitat disturbance covers 4%, 3% and 12% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are fire and forest insects, the majority of which have occurred in the lower elevation portion of the range. Roads/trails are the only recorded anthropogenic habitat disturbance, making up less than 1% of the range, and which are located in low elevations along the eastern boundary of the range. Habitat disturbance is slightly higher in the 20 km and 30 km matrices surrounding the range, primarily due to more anthropogenic habitat disturbance in the form of roads/trails and cutblocks southeast of the range. Kwadacha is located southeast of the range, within the 20 km and 30 km surrounding matrices.

Our analysis does not include fires from 2018 to 2021. During those four years, there were no substantial fires in the caribou range or surrounding matrix other than a small 7,000 ha fire in 2018 just southwest of the Frog caribou range within the 20 km and 30 km surrounding matrices.

Frog

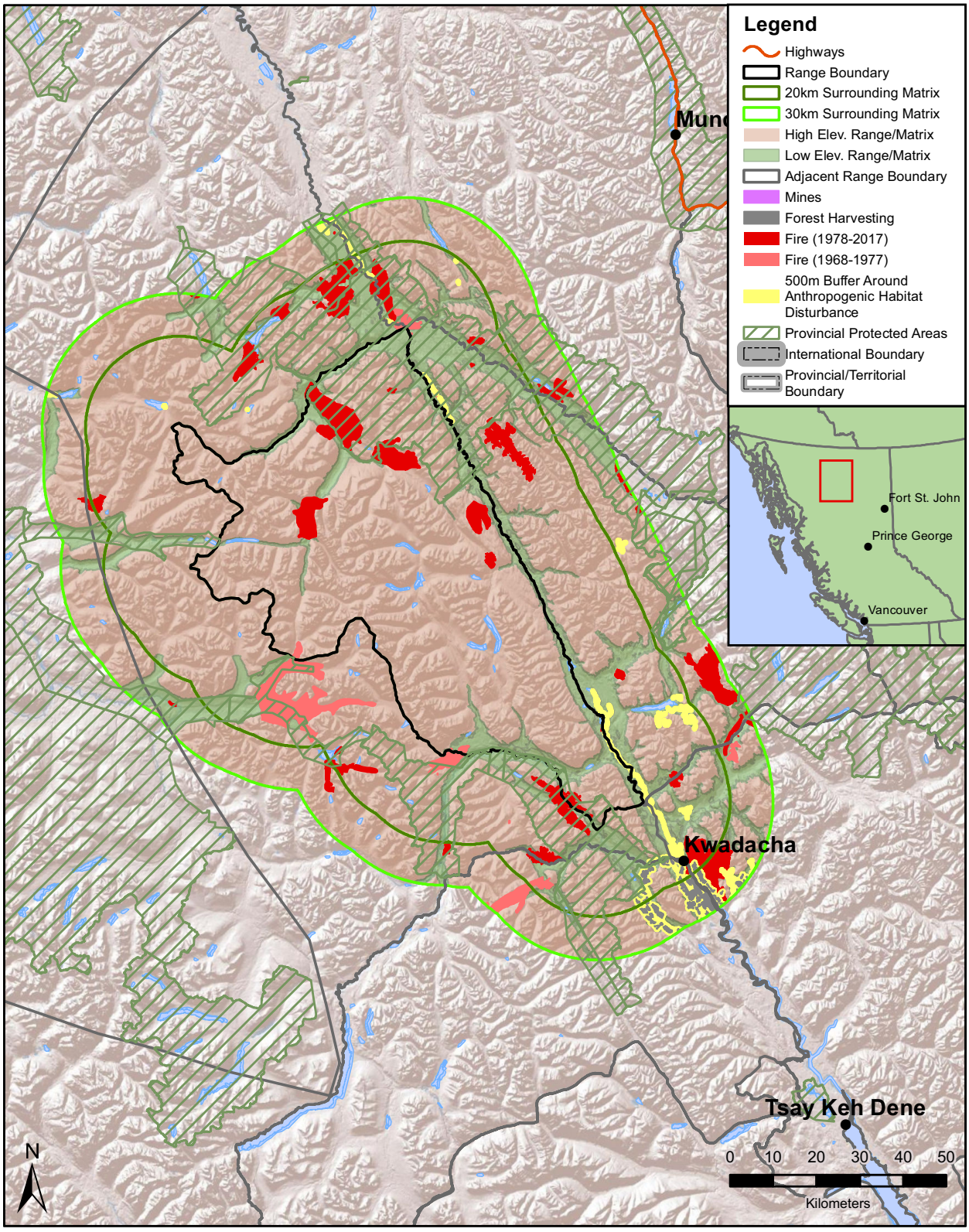
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	504 069	11.3	88.7	-
0-20 km matrix surrounding range	885 050	22.9	77.1	41.0 (NM)
0-30 km matrix surrounding range	1 392 243	21.5	78.5	63.1 (NM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Frog


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Kwadacha
Tsay Keh Dene
N
0 10 20 30 40 50
Kilometers

Frog

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**504 069**	**4.2**	**4.4**	**2.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0.1**	**0**	**0**	**0**	**0**	**0.1**	**0.1**	**4.3**
High elevation	446 969	3.4	3.5	1.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3.4
Low elevation	57 099	10.9	11.5	12.5	0	0	0	0	0	0	0	0	0	0	0	1.1	0	0	0	0	1.1	1.1	12.0
Matrix 0-20 km																							
Total	**885 050**	**3.5**	**5.8**	**2.5**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1.9**	**0**	**0**	**0**	**0**	**1.9**	**2.0**	**5.3**
High elevation	682 530	2.5	4.4	1.0	0	0	0	0.1	0	0	0	0	0	0	0	0.4	0	0	0	0	0.4	0.4	2.9
Low elevation	202 520	7.0	10.5	7.4	0	0	0.2	1.5	0	0	0	0	0	0	0	7.0	0	0.1	0	0	7.0	7.2	13.7
Matrix 0-30 km																							
Total	**1 392 243**	**3.7**	**5.4**	**2.6**	**0**	**0**	**0**	**1.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**2.2**	**0**	**0**	**0**	**0**	**2.2**	**2.4**	**5.6**
High elevation	1 092 846	2.5	4.0	1.3	0	0	0	0.2	0	0	0	0	0	0	0	0.4	0	0	0	0	0.4	0.5	2.9
Low elevation	299 392	8.0	10.5	7.2	0	0	0.1	4.3	0	0	0	0	0	0	0	9.0	0	0.1	0	0	9.0	9.3	15.5

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8 also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Finlay

Range use summary

There is limited information available on range use of caribou within the Finlay caribou range. Caribou have been counted in alpine habitat during several winter surveys (Wood 1994, Zimmerman et al. 2002, Klaczek and Anderson 2020), however, less information is available about use of low elevations during winter or range use during summer.

Season	Overview of Habitat and Range Use	Source
Winter	• High elevation windswept alpine slopes	Wood (1994) Zimmerman et al. (2002) Klaczek and Anderson (2020)
Summer	• No information	
Migration	• Mostly seasonal elevation shifts for sedentary caribou • Some caribou migrated to the Pink Mountain range	Klaczek and Anderson (2020)
Total Range		

Radio-collared caribou data suggests overlap between the Finlay and Pink Mountain caribou seasonal ranges (Zimmerman et al. 2002, Woods and McNay 2018, Klaczek and Anderson 2020). Based on 120 caribou collared in the Finlay and Pink Mountain caribou ranges from 1999 to 2005, 18 (11%) used both ranges (Woods and McNay 2018). Three caribou collared in the Finlay caribou range in March 2017 moved to the Pink Mountain area in June 2017 and remained in the Pink Mountain area the following winter (Klaczek 2018). A fourth radio-collared caribou also moved to the Pink Mountain area the following year (Klaczek and Anderson 2020).

Population size

The current population estimate is 96 caribou based the number of caribou counted during a census of the Finlay caribou range in March 2020 (see table below), which is similar to the 84 caribou estimated in the population in 2019 (Klaczek and Anderson 2020). The 2002 estimate of 26 caribou was based on the number of caribou counted during a stratified random block survey in February/ March 2002. The highest number of caribou counted in the Finlay caribou range and the area south of the range was 193 caribou in March 1994 during a survey of alpine areas.

Bergerud (1978) did not see any caribou during his flight on March 3, 1978 in the Mt. Del area or Ospika River areas, but saw tracks on the muskeg near Mt. Del and at Tobin Lake, Bevel Mountain and along the lower 15 miles of the Ospika River. He estimated possibly 50 caribou in the Mt. Del area and possibly 100+ caribou in the Ospika River area based on tracks seen.

Date	Population estimate	Number counted	Method	Reliability	Source
2020	96 (65-127)	96	Minimum count[1]	High	Klaczek and Anderson (2020)
2019	84	76	Minimum count + sightability correction[2]	High	Klaczek and Anderson (2020)
2002	26	26	Stratified Random Block + Incidental sightings	Unknown	Zimmerman et al. (2002)
1994	193	193	Minimum count[3]	High	Wood (1994)

[1] Minimum count includes the Finlay range but not the area south of the range on the east side of Williston Lake (due to Covid); the 95% confidence interval for the population estimate was calculated by applying a bootstrap estimator

[2] Minimum count includes caribou within the Finlay caribou range; a sightability correction factor of 0.90 (based on a sightability correction from collared caribou during mark-resight surveys in the adjacent Chase and Wolverine ranges) was used to calculate the population estimate; an additional 10 caribou were observed with radio-collared caribou south of the Finlay range on the east side of Williston Lake;

[3] Minimum count includes caribou within the Finlay caribou range and in the area south of the range on the east side of Williston Lake

Population trend

In 1994, the calf recruitment estimate was below 15% calves recommended by Bergerud (1996) to achieve population stability, while calf recruitment in 2002 was over 15% calves. In 2002, calf recruitment was above 15% calves but the number of caribou counted was low and may not have been representative of the total population. Calf recruitment estimates from the two most recent surveys (2019, 2020) suggest that the population currently may be stable or increasing.

Population trend inferred from the number of caribou counted during surveys suggests that the population has declined since 1994. Another factor to consider is that the 1994 survey may have been conducted during a winter with conditions that resulted in a large portion of the population using high elevation alpine areas. In the nearby Spatsizi caribou range, winter conditions resulted in most of the radio-collared caribou using windswept alpine slopes in only one of four years of the study (Hatler 1986). Also, a larger proportion of Pink Mountain caribou may have been wintering in the Finlay caribou range in 1994. However, the role that these two factors (winter conditions, Pink Mountain caribou distribution) may have played in differences in number of caribou counted during surveys in the Finlay caribou range does not mean that the population did not decline. A decline in the Finlay caribou population since 1994 would be consistent with the pattern of population declines observed in the nearby South Peace caribou herds (Seip and Jones 2014).

The sample size of caribou from the recent radio-collared caribou study (n=9) was too small to calculate adult survival or population growth rate (M. Klaczek, pers. comm.).

Finlay

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total Counted	Total classified[2]		Source[3]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2020	Mar	19	23	38	96[4]	96	82	Klaczek and Anderson (2020)
2019	Mar	17		32	76[5]	NA	NA	Klaczek and Anderson (2020)
2018	Feb/Apr				27[6]			Klaczek and Anderson (2020)
2002	Feb/Mar	21	27		26	19		Zimmerman et al. (2002)
1994	Mar	12	14	26[7]	193	193	107[7]	Wood (1994)

1 Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

2 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

3 All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

4 Due to Covid, the area south of the Finlay range was not included in the survey

5 Classification data were not included in report other than 14 calves and 8 unclassified adults; survey includes only the Finlay range; an additional 10 caribou (including 1 calf) were seen in the area south of the Finlay range during a telemetry tracking flight

6 Classification data were not included in the report; includes 18 caribou in the Finlay range and 9 caribou in the area south of the Finlay range; two GPS collared caribou were not seen during the survey in the area south of the Finlay range so the minimum number alive in that area was 11 (Klaczek and Anderson 2020)

7 The survey included 66 unclassified adults. Because some groups counted had a high number of unclassified adults, for the calves/100 cows ratio we only included the groups where all caribou were classified as bulls, cows or calves resulting in a sample of 107 caribou in just those groups combined

Boundary Issues

- Telemetry data suggest overlap between Pink Mountain and Finlay caribou ranges.

Radio-collared caribou data suggests overlap between the Finlay and Pink Mountain caribou seasonal ranges (Zimmerman et al. 2002, Woods and McNay 2018, Klaczek and Anderson 2020). However, Woods and McNay (2018) analyzed radio-telemetry data from 1999 to 2005 from caribou collared in both the Finlay and Pink Mountain ranges, and although some caribou used both ranges, they concluded that the current boundaries were biologically relevant and that no boundary refinements were needed.

Range condition

Within the current Finlay caribou range boundary, habitat disturbance covers 16%, 5% and 52% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails, forest harvesting, forest pests and fire, the majority of which has occurred in the lower elevation portion of the range. Other habitat disturbance includes airstrips, reservoirs and settlements (Kwadacha is located along the northwestern boundary), which together make up <1% of the range. Anthropogenic habitat disturbance within the range is concentrated in the area along the western boundary. Habitat disturbance levels in the 20 km and 30 km matrices surrounding the range are similar to those in the range and are located primarily in low elevations in the area just east and southeast of the range boundary.

Habitat disturbance in the low elevation portion of the range exceeds the 35% disturbance threshold for critical habitat in the recovery strategy for southern mountain caribou (Environment Canada 2014).

Our analysis does not include fires from 2018 to 2021, however, there were no fires of appreciable size recorded in the Finlay caribou range during those four years, a 7,000 ha fire in the 30 km surrounding matrix in 2018, and a 7,800 ha fire in the 20 km and 30 km surrounding matrices in 2021.

Finlay

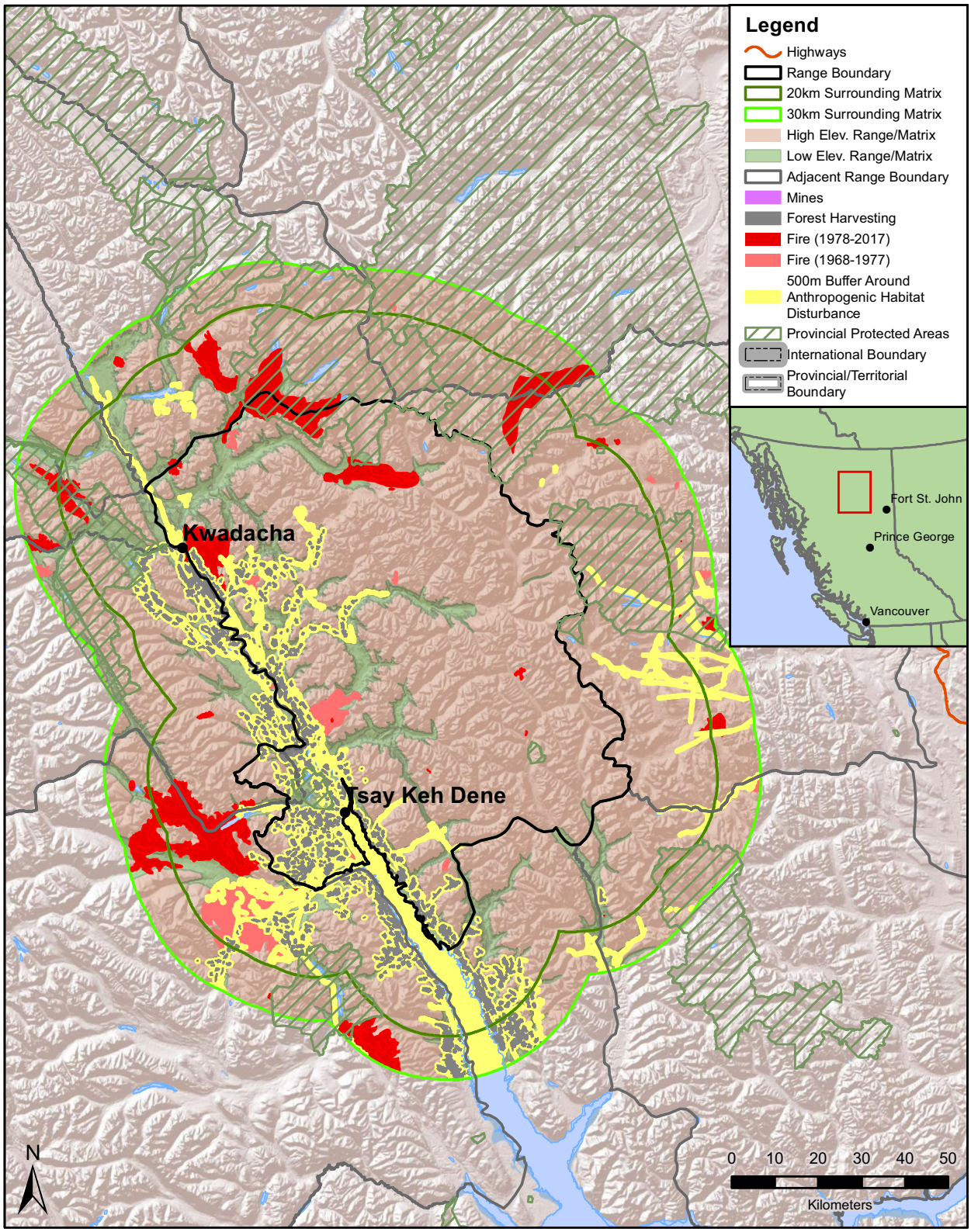
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	817 094	24.1	75.9	-
0-20 km matrix surrounding range	982 244	23.8	76.2	62.7 (NM) 22.1 (SM)
0-30 km matrix surrounding range	1 525 168	20.9	79.1	60.4 (NM) 25.6 (SM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Finlay


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Kwadacha
Tsay Keh Dene
N
0 10 20 30 40 50
Kilometers

Finlay

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**817 094**	**3.3**	**4.3**	**16.6**	**0**	**0**	**0.1**	**9.5**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**12.1**	**0**	**0.1**	**0**	**0**	**12.1**	**13.3**	**16.1**
High elevation	619 983	2.1	2.6	8.7	0	0	0	2.1	0	0	0	0	0	0	0	2.1	0	0	0	0	2.1	2.7	4.8
Low elevation	197 112	7.1	9.6	41.5	0.1	0	0.5	32.7	0	0	0	0	0	0	0	43.2	0	0.4	0	0	43.2	46.7	51.9
Matrix 0-20 km																							
Total	**982 244**	**5.7**	**8.1**	**13.8**	**2.8**	**0**	**0.1**	**8.1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**11.4**	**0.6**	**0.2**	**0.1**	**0.1**	**11.5**	**15.5**	**20.8**
High elevation	748 842	4.2	5.2	10.6	0	0	0	2.2	0	0	0	0	0	0	0	3.8	0.8	0.1	0.2	0.1	3.9	5.2	9.3
Low elevation	233 401	10.5	17.3	24.1	11.7	0	0.6	27.0	0	0	0	0	0	0	0	36.0	0	0.5	0	0	36.0	48.5	57.6
Matrix 0-30 km																							
Total	**1 525 168**	**5.4**	**7.2**	**13.1**	**2.3**	**0**	**0.1**	**6.3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**9.7**	**0.8**	**0.1**	**0.3**	**0.2**	**9.8**	**13.3**	**18.4**
High elevation	1 206 668	4.0	4.9	9.7	0	0	0	1.7	0	0	0	0	0	0	0	3.6	1.0	0	0.3	0.3	3.7	5.1	9.0
Low elevation	318 499	10.7	15.7	26.2	10.9	0	0.4	23.7	0	0	0	0	0	0	0	32.7	0	0.5	0	0	32.7	44.4	53.7

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Thutade

Range use summary

Caribou in the Thutade range are found primarily in high elevation habitat throughout the year at an average elevation of 1500 m or more. During winter, caribou use primarily windswept alpine slopes. On average, the highest elevations are used during summer and fall, although some caribou also use lower elevation forested areas during summer.

Season	Overview of Habitat and Range Use	Source
Winter	• Primarily high elevation windswept alpine	Sittler et al. (2015) K. Sittler, pers. comm. (2019)
Summer	• Primarily high elevation • Some low elevation forested habitat	Sittler et al. (2015) K. Sittler pers. comm. (2019)
Migration	• Primarily low elevation	Sittler et al. (2015) K. Sittler pers. comm. (2019)
Total Range		

Population size

The highest number of caribou counted during surveys in the Thutade caribou range was 114 in fall 2019, but the survey did not include the whole range (M. Klaczek, pers. comm.). The highest number of caribou counted during previous surveys in the Thutade caribou range in an area comparable to the area that was surveyed in 2019 (which included six of the 11 survey units in the range), was 97 in October 2010 (McNay 2012).

Date	Population estimate	Number counted	Method	Reliability	Source
2019		114[1]	Minimum count		M. Klaczek (pers. comm.)

[1] The highest number counted during surveys in the Thutade caribou range was 114 in fall 2019; this survey only covered a portion of the range

Population trend

The calves/100 cows ratio for the fall 2019 survey exceeded the 20 to 25 calves/100 cows level that is considered sufficient to support a stable population growth rate (Environment Yukon 2016). Although adult classification data were not available for the three fall surveys conducted from 2010 to 2013, the lowest possible values for the calf/100 cow ratios during those surveys would be the calves/100 adults ratios, which would assume that all adults were cows. Of the two of those three surveys with adequate sample sizes, one was within or above the 20 to 25 calves/100 cows level. It is unknown whether fall surveys of rutting areas in the Thutade caribou range are biased against calves as detected in the nearby Spatsizi caribou range (Hatler 1987), however, the calves/100 adults ratios suggest that the population may have been stable in 2010 and was at least stable in 2019, even if the surveys were biased against calves.

The most recent late winter count in 2013 had a reasonable sample size to estimate calf recruitment, which was above the 15% calves recommended by Bergerud (1996) to achieve population stability. However, this estimate is now almost 9 years old and is out of date.

Sample sizes and/or lack of classification data precluded assessing population trend based on calf survival or recruitment rates for other surveys conducted in the Thutade caribou range.

Although population estimates are not available for the whole Thutade caribou range, the number of caribou counted during fall surveys of comparable portions of the Thutade range in 2010 and 2019 were similar (97 and 114 respectively) suggesting the the short-term trend may be stable (M. Klaczek, pers. comm.).

Thutade

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2013	Mar	20	24	28	47[5]	46	46	MacDonald and McNay (2013)
1993	Mar	4	4	6	(26)[6]	26	26	Corbould (2001)
Fall								
2019		18		33	114	114	NA	M. Klaczek, pers. comm.
2013	Nov	17	20	-	6[5,7]	6		Sittler et al. (2014)
2012	Oct	13	15	-	90[5,7]	90		Rudichuk et al. (2013)
2010	Oct	23	29	-	97[5,7]	97		McNay (2012)
1991	Sept				53			Ritchie in McNay (2012)
1990	Oct				22			Ritchie in McNay (2012)

1 Calf ratios based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so could not eliminate groups where some animals were unclassified
2 Numbers in parentheses indicate surveys where caribou were not the primary focus
3 Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows
4 All surveys conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey
5 Totals include only the caribou counted in survey units that became part of the Thutade caribou range
6 Number of caribou counted during a Stone's sheep and mountain goat survey in the Russel Range
7 no classification provided other than number of calves

Of the 18 adult female caribou radio-collared with satellite collars in March 2012 (6) and March 2013 (12), three were confirmed mortalities and another two mortalities were detected as of December 31, 2013, but were not investigated (Sittler et al. 2015). Sittler et al. (2015) did not include a calculation of an annual mortality rate.

Boundary Issues

The Thutade caribou range was delineated based on recommendations from Sittler et al. (2015). Because the range boundaries were developed recently based on best available information, which included data from radio-collared caribou and surveys specifically designed to address range boundary questions, there are no identified issues with the current boundary.

Range condition

Within the current Thutade caribou range boundary, habitat disturbance covers 11%, 6% and 50% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are roads/trails, forest harvesting, forest pests and fire, the majority of which has occurred in the lower elevation portion of the range. Other habitat disturbances within the range include powerline, railroad, agriculture, settlements and reservoirs. Roads/trails include the Omineca Resource Road and associated industrial roads, which traverse through the middle of the caribou range, the BC railgrade and associated resource roads along the southwestern range boundary, and the Finlay-Russel Resource Road along the eastern boundary. Forest harvesting is located in the area along the eastern boundary, and along the southwestern boundary. Kwadacha is located at the northeastern tip of the range. Although our data do not show any habitat disturbance due to mining activity, Kemess mine (an underground mine) is located in the northwestern portion of the range. Habitat disturbance is higher in the 20 km matrix surrounding the range, primarily due to more anthropogenic habitat disturbance in the form of roads/trails and cutblocks, and more fire.

Habitat disturbance in the low elevation portion of the range exceeds the 35% disturbance threshold for critical habitat in the recovery strategy for southern mountain caribou (Environment Canada 2014).

Our analysis does not include fires from 2018 to 2021. There was a 7,000 ha fire in 2018 in the northern portion of the Thutade caribou range and in the surrounding matrix, and a 7,800 ha fire in the surrounding matrix in 2021.

Thutade

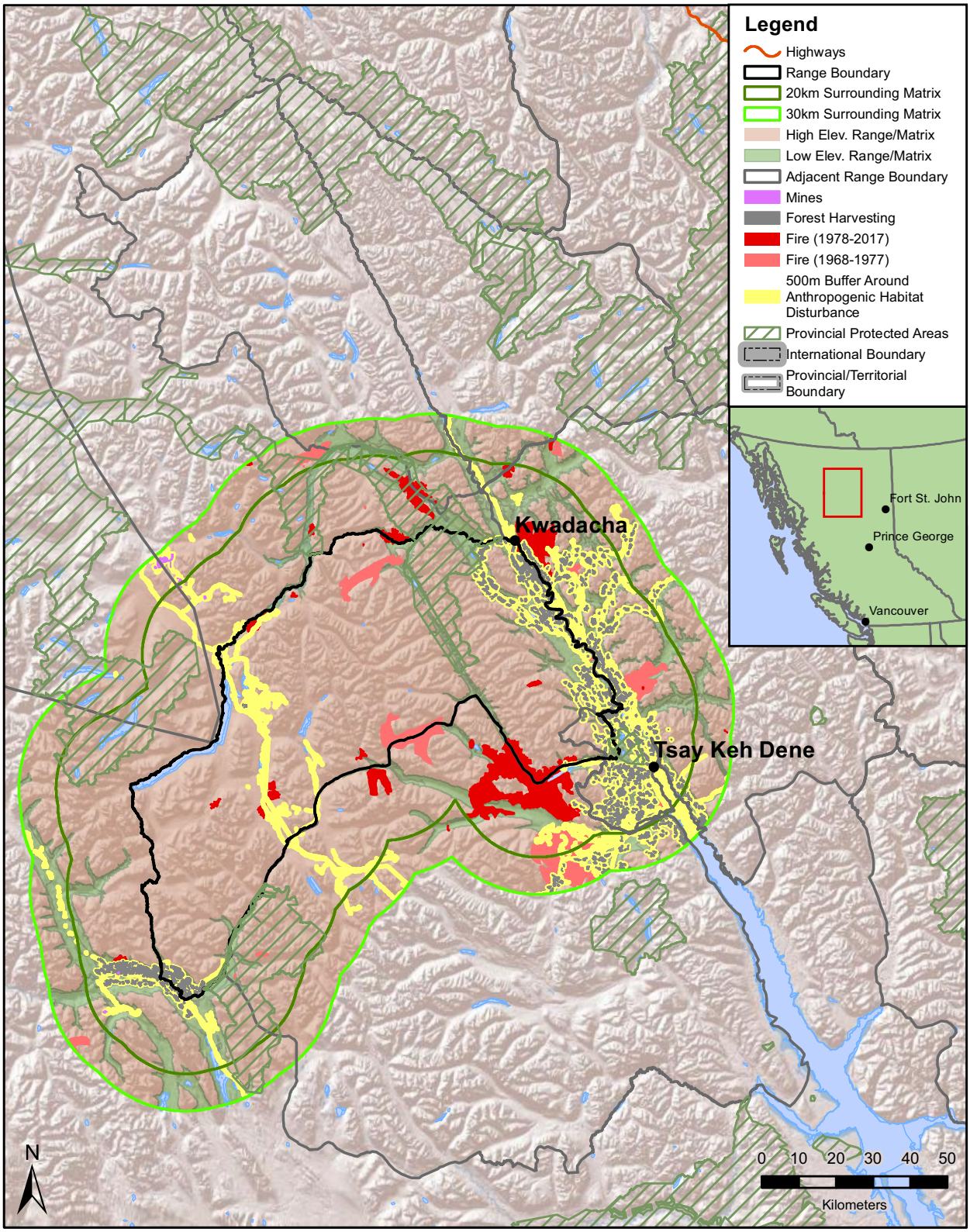
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Total Range				
Range	711 930	11.2	88.8	–
0-20 km matrix surrounding range	1 033 466	27.0	73.0	30.6 (NM) 27.9 (SM)
0-30 km matrix surrounding range	1 619 076	25.2	74.8	33.2 (NM) 26.7 (SM)

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Thutade


Legend
Highways
Range Boundary
20km Surrounding Matrix
30km Surrounding Matrix
High Elev. Range/Matrix
Low Elev. Range/Matrix
Adjacent Range Boundary
Mines
Forest Harvesting
Fire (1978-2017)
Fire (1968-1977)
500m Buffer Around Anthropogenic Habitat Disturbance
Provincial Protected Areas
International Boundary
Provincial/Territorial Boundary
Fort St. John
Prince George
Vancouver
Kwadacha
Tsay Keh Dene
N
0 10 20 30 40 50
Kilometers

Thutade

	Range Area (ha)	% habitat disturbance[1,2]																					
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Range																							
Total	**711 930**	**1.8**	**3.1**	**7.9**	**0**	**0.1**	**0.1**	**4.8**	**0**	**0**	**0**	**0**	**0**	**0.6**	**0.1**	**9.5**	**0**	**0.1**	**0**	**0**	**9.5**	**10.1**	**11.3**
High elevation	632 082	1.1	2.4	4.8	0.1	0.2	0.1	1.2	0	0	0	0	0	0.6	0	5.1	0	0	0	0	5.1	5.4	6.3
Low elevation	79 848	7.3	8.3	33.0	0	0	0.2	33.5	0	0	0	0	0	0	0.8	44.5	0	0.4	0	0	44.5	47.6	50.4
Matrix 0-20 km																							
Total	**1 033 466**	**4.7**	**6.8**	**15.0**	**0.4**	**0**	**0.1**	**6.0**	**0**	**0**	**0**	**0**	**0**	**0.3**	**0.4**	**11.9**	**0**	**0.2**	**0**	**0**	**11.9**	**13.1**	**17.3**
High elevation	754 663	3.0	4.3	9.0	0	0	0	1.3	0	0.1	0	0	0	0.3	0	3.6	0	0.1	0	0	3.6	4.0	6.9
Low elevation	278 803	9.1	13.7	31.2	1.5	0	0.5	18.7	0	0	0	0	0	0	1.4	34.6	0	0.5	0	0	34.6	38.0	45.5
Matrix 0-30 km																							
Total	**1 619 076**	**3.0**	**5.4**	**11.7**	**0.5**	**0**	**0.1**	**5.1**	**0**	**0.2**	**0**	**0**	**0**	**0.2**	**0.3**	**10.3**	**0**	**0.2**	**0**	**0**	**10.3**	**11.6**	**14.3**
High elevation	1 211 820	1.9	3.3	6.8	0	0	0	1.1	0	0.2	0	0	0	0.3	0	3.4	0	0.1	0	0	3.4	3.8	5.7
Low elevation	407 251	6.3	11.6	26.4	2.2	0	0.4	17.0	0	0	0	0	0	0	1.2	31.0	0	0.4	0	0	31.0	34.9	40.1

[1] The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

[2] As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

[3] "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

[4] Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Low density area

The low density area includes the area between the Spatsizi, Thutade, Frog, Rabbit and Horseranch and Tsenaglode caribou ranges.

Range use summary

There is limited information on range use of caribou within the low density area. Caribou were counted in alpine habitat in the northern portion of the low density area in February/March 2009 (Thiessen 2009), and therefore are known to use high elevation habitat during winter. Caribou were seen in the Rainbow Lakes area in the northwestern portion of the low density area during summer but no habitat information was provided (Mundy 1963).

Season	Overview of Habitat and Range Use[1]	Source
Winter	• high elevation alpine habitat in northern portion of the low density area	Thiessen (2009)
Summer		
Migration		
Total Range		

Population size and trend

There is no population estimate for caribou in the low density area. Prior to establishment of the Thutade caribou range, McNay (2012) estimated that a minimum of 301 caribou were observed in the low density area over the years during reconnaissance surveys, but did not suggest that this was an estimate.

The following table includes some observations of caribou in the low density area, excluding the newly delineated Thutade caribou range, and excluding observations in the area proposed as an extension to the Frog caribou range by Sittler et al. (2015). The caribou counted during surveys in the proposed extension to the Frog caribou range are included in the summary for the Frog caribou range.

Low density area

Year	Month	% calves[1]	Calves/ 100 adults[1]	Calves/100 cows[1]	Total[2] Counted	Total classified[3]		Source[4]
						Calves+ Adults	Calves+ Cows+Bulls	
Winter								
2013	Mar	29	40	40	7	7	7	MacDonald and McNay (2013)
2009	Feb/Mar	4	4	7	(125)[5]	124	124	BC MFLNRORD unpubl. data
Summer								
1991	Sept				41[6]			Ritchie in McNay (2012)
1963	July/Aug	19	24		47	47		Mundy (1963) (GR)[7]

[1] Calf ratios were based on totals in each age/sex class (except as otherwise indicated) because data detailing composition of groups were not always available so we could not eliminate groups where some animals were unclassified

[2] Numbers in parentheses indicate surveys where caribou were not the primary focus

[3] Caribou classified at a minimum to calves and adults apply to % calves and calves/100 adults; caribou classified at a minimum to calves, cows and bulls apply to calves/100 cows

[4] All surveys were conducted by helicopter unless indicated as a fixed-wing (FW) or ground (GR) survey

[5] Number of caribou were counted during a Stone's sheep and caribou survey (Thiessen 2009) but the number of caribou in the low density portion of the survey area (in the northeastern portion of the low density area) was not specified in the report and therefore the number counted in the low density area was summarized from BC MFLNRORD unpublished data

[6] These caribou were counted in the low density area west of the current Thutade caribou range and south of the current Spatsizi caribou range. Sittler et al. (2015) recommended extending the Spatsizi caribou range boundary to include this area

[7] Caribou counted during a summer ground survey in the Rainbow Lakes area in the area between the Spatsizi and Horseranch caribou ranges

A total of 7 and 41 caribou were seen in March 2013 and September 1991, respectively, in areas that Sittler et al. (2015) recommended for inclusion in the Spatisiz caribou range. The highest number of caribou counted in the low density area was 125 caribou during a Stone's sheep and caribou survey in the northeastern portion of the low density area in February/March 2009 (Thiessen 2009, BC MFLNRORD unpubl. data). The 47 caribou counted in the Rainbow Lakes area (Mundy 1963) are also located in the northern portion of the low density area.

Boundary Issues

In the southern portion of the low density area, Sittler et al. (2015) recommended boundary extensions to the Spatsizi and Frog caribou ranges in addition to the new Thutade caribou range.

Additional work needs to be conducted in the northern portion of the low density area to determine whether existing range boundaries need to be extended or new ranges created.

Range condition

Within the current low density area, habitat disturbance covers 10%, 6% and 22% of the total, high elevation and low elevation portions of the range respectively. Primary disturbances are fires and roads/trails. Roads/trail are located primarily along the outer margins of the low density area in the southwest (Omineca Resource Road and associated industrial roads), northwest (Jade/Boulder road) and northeast.

Our analysis does not include fires from 2018 to 2021, however, there were no fires of appreciable size recorded in the low density area during those four years other than a 2,500 ha fire in the northern portion of the area in 2021.

Low density area

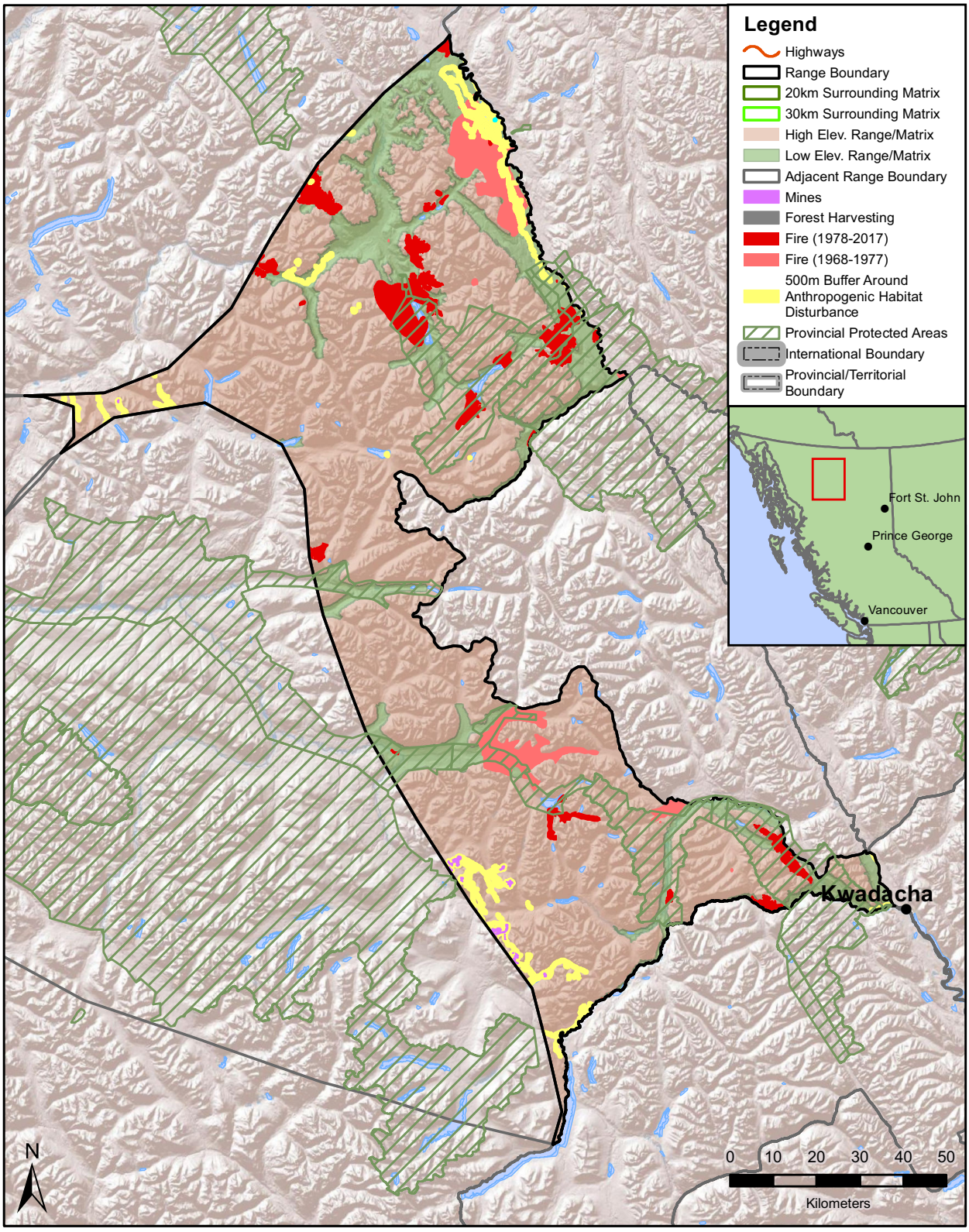
	Total Area (ha)	% of Area		% of matrix in adjacent range[3]
		Low elevation[1]	High elevation[2]	
Low density area				
Low density area	1 206 836	80.8	19.2	N/A

[1] Low elevation defined as that portion of the range that lies within the Boreal White and Black Spruce (BWBS) or Sub-Boreal Spruce (SBS) biogeoclimatic zones

[2] High elevation defined as that portion of the range that lies within the Spruce Willow Birch (SWB), Engelmann Spruce-Subalpine Fir (ESSF) or Boreal Altai Fescue Alpine (BAFA) biogeoclimatic zones

[3] Indicates how much of the surrounding matrix lies within neighbouring caribou ranges; Boreal = ranges in Boreal National Ecological Area (NEA); NM = ranges in Northern Mountain NEA; SM = ranges in Southern Mountain NEA

Low density area



Low density area

	Range Area (ha)	% habitat disturbance[1,2]																				
		Fire <40 years	Fire <50 years	Forest Insects	Reservoirs	Agriculture	Airstrip	Cutblock	Dam	Mine	Oil facility	Well	Pipeline	Powerline	Railroad	Road	Seismic	Settlement	Trail	Road and Trail[3]	Total Road or Trail[3]	Total Anthro.	Total Habitat Disturbance[4]
Low density area																							
Total	**1 206 836**	**2.9**	**6.5**	**0.5**	**0**	**0**	**0**	**0**	**0**	**0.4**	**0**	**0**	**0**	**0**	**0**	**3.2**	**0**	**0**	**0.4**	**0.3**	**3.2**	**3.3**	**6.1**
High elevation	962 484	1.9	3.8	0.3	0	0	0	0	0	0.4	0	0	0	0	0	2.2	0	0	0	0	2.2	2.3	4.1
Low elevation	229 127	7.3	18.0	1.2	0	0	0.1	0	0	0	0	0	0	0	0	7.8	0	0	1.9	1.7	7.9	7.9	15.1

1 The anthropogenic habitat disturbance footprint includes a 500 m buffer consistent with the 500 m buffer used for anthropogenic habitat disturbance in EC (2014).

2 As a result of overlapping types of habitat disturbance and overlapping buffers for anthropogenic habitat disturbance, some habitat disturbance polygons are identified as more than one type of habitat disturbance (e.g. a "settlement" polygon will overlap with a "road" polygon). As a result, one polygon could include the footprint of more than one type of habitat disturbance and therefore adding up the area of individual types of anthropogenic habitat disturbance will exceed the combined area of "Total anthropogenic disturbance" (see Tables 7 and 8), which merges all anthropogenic habitat disturbance and their buffers to eliminate overlaps. Similarly, "Total habitat disturbance" (see Tables 7 and 8) also merges the footprints of fires <40 years and anthropogenic habitat disturbance to eliminate double-counting overlapping habitat disturbances (e.g. a cutblock that was subsequently consumed in a fire).

3 "Road and trail" indicates the portions of the "Road" and "Trail" categories that were identified as both a road and a trail; "Total Road/Trail" is the combined total of roads and trails and accounts for overlap between the two categories.

4 Total habitat disturbance = combined area of total anthropogenic habitat disturbance (including a 500 m buffer) and fires <40 years.

Appendix 3 References

Preamble

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Low Density Area

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Appendix 4. Data limitations

In addition to issues with range boundaries, the spatial data layers for roads and trails resulted in duplication of data in some cases, and did not allow us to distinguish between roads and trails, which has bearing on use (e.g., motor vehicles vs. hiking and horses). Also, population size and trend information was limited, making it difficult to assess population status as it related to habitat disturbance.

For roads and trails, although some linear features were duplicated in the spatial layers we used, the application of the 500 m buffer around linear features eliminated double-counting of those features, since they were all incorporated into one amalgamated buffer. As a result, we could only represent the extent of linear features as an area-based metric, and we were not able to report extent of linear features as a distance. However, because the habitat disturbance thresholds that we were using also included linear features as an area-based metric, representing linear features this way did not compromise our analysis.

Another limitation for roads and trails was that we were unable to distinguish between roads and trails using the spatial datasets. Although some data distinguished between the two, it was not consistent across all data. As a result, we had to combine roads and trails into one category since it was beyond the scope of this project to investigate each linear feature to identify whether it was a road or a trail.

Although roads/trails are the dominant anthropogenic habitat disturbance on caribou ranges in northern BC, there are additional ATV/UTV trail networks that are not represented in the BC government's datasets, and therefore additional effort will be needed to identify and map them (B. Jex, pers. comm. 2019).

Ideally, we would have sufficient data to compare levels of habitat disturbance on individual ranges to population status. However, due to the limited information on population size and status, we were constrained in what inferences we could make from the data.

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