Species Status Report

Boreal Caribou

Rangifer tarandus caribou

Mbedzih (Dene Zhatié)
Tǫdzı (K'áhsho, Sahtú/Délı̨nę, Shúhta, Tłı̨chǫ Yatıì)
Tuktut (Siglitun)
Tuttut (Uummarmiutun)
Vadzaih (Gwichya Gwich'in, Teetł'it Gwich'in)

IN THE NORTHWEST TERRITORIES

NORTHWEST TERRITORIES
SPECIES AT RISK COMMITTEE

RE-ASSESSMENT – THREATENED

May 2022

Species at Risk Committee status reports are working documents used in assigning the status of species suspected of being at risk in the Northwest Territories (NWT).

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ABOUT THE SPECIES AT RISK COMMITTEE

The Species at Risk Committee was established under the *Species at Risk (NWT) Act*. It is an independent committee of experts responsible for assessing the biological status of species at risk in the NWT. The Committee uses the assessments to make recommendations on the listing of species at risk. The Committee uses objective biological criteria in its assessments and does not consider socio-economic factors. Assessments are based on species status reports that include the best available Indigenous knowledge, community knowledge, and scientific knowledge of the species. The status report is approved by the Committee before a species is assessed.

ABOUT THIS REPORT

This species status report is a comprehensive report that compiles and analyzes the best available information on the biological status of boreal caribou in the NWT, as well as existing and potential threats and positive influences. Full guidelines for the preparation of species status reports, including a description of the review process, may be found at www.nwtspeciesatrisk.ca.

Environment and Natural Resources, Government of the Northwest Territories, provides full administrative and financial support to the Species at Risk Committee.

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RE-ASSESSMENT OF BOREAL CARIBOU

The Northwest Territories Species at Risk met on May 2-5, 2022 and assessed the biological status of boreal caribou in the Northwest Territories. The assessment was based on this approved status report. The assessment process and objective biological criteria used by the Species at Risk Committee are based on Indigenous and Community Knowledge (ICK) and Scientific Knowledge (SK) and are available at: www.nwtspeciesatrisk.ca.

Assessment: Threatened in the Northwest Territories

Threatened – The species is likely to become Endangered in the NWT if nothing is done to reverse the factors leading to its extirpation or extinction.

Reasons for the assessment: Boreal caribou fit criterion ICK (e) and SK (C2)(a)(ii) for Threatened.

Criterion	**Threatened**
ICK(e)	There is concern expressed by knowledge holders that the species is *likely to experience severe declines* in the NWT, in its abundance, habitat quality/quantity, movements, and/or range, within their grandchildren's lifetimes.
SK(C2)(a)(ii)	SK(C2) An observed, projected, or inferred *continuing decline* in the number of mature individuals **AND** (ii) % of mature individuals *in one subpopulation* = 100%

Main factors (ICK):

- Boreal caribou need access to all seasonal habitat types within their range to maintain a healthy population. Boreal caribou may adapt to certain types of disturbances, but they are known to be sensitive to disturbances.
- The main threats to boreal caribou in the NWT include habitat loss, fragmentation, and disturbance. Areas burned by fire or disturbed by industry are generally not used by boreal caribou until the habitat recovers. Habitat recovery is complex and full habitat recovery takes many decades.
- Changes in the abundance of boreal caribou are local and variable; limited new information was available to update population trends.
- Climate change is increasing the size and severity of fires, which may result in a larger effect as habitat takes longer to recover. Other key concerns include changes in snow,

ice and permafrost, which contribute to continuing habitat fragmentation and degradation.

- The cumulative effects of these factors are an important concern to many communities in the NWT. Knowledge holders are concerned that disturbance will increase in the future.

Main factors (SK):

- Boreal caribou in the NWT are found in one continuous population. Due to their ecology and the need to spread out, densities are low. The current population has been estimated at just over 6,000 mature individuals.
- Boreal caribou populations declined in the past and are anticipated to decline in the future due to continued habitat fragmentation and degradation.

Additional factors:

- Boreal caribou habitat in the NWT takes longer to recover after disturbance than it does in southern Canada. Thus, despite apparently low levels of disturbance in the NWT, there is a concern that the amount and impact of disturbance may be underrepresented. It is anticipated that continued or increased habitat fragmentation will directly impact population numbers.
- Climate change will limit the effectiveness of conservation and recovery actions.
- Knowledge holders from one First Nation of the NWT shared that the loss of hunting practice is threatening their traditional way of life and transmission of cultural practices, values, and knowledge to current and future generations.

Positive influences to boreal caribou and their habitat:

- Range planning for boreal caribou is ongoing across all five regions in the NWT with a target to have one third of the range under intensive management class, which limits human disturbance and protects important boreal caribou habitat.
- Total annual harvest of boreal caribou in the NWT is limited for resident hunters and General Hunting Licence holders and ranges between 1-3% of the estimated population. Traditional stewardship practices that include rules and guidance for a respectful relationship with caribou in both harvest and research activities can also have a positive influence.
- Conservation planning, monitoring and research efforts have accelerated the acquisition of the information required to better understand and conserve boreal caribou and their habitats in the NWT.

- Indigenous-led monitoring and research initiatives have also created networks of information sharing to better inform boreal caribou management and range planning.

Assessment History:

- The NWT Species at Risk Committee met in December 2012 and assessed boreal caribou as Threatened in the NWT because of concerns about population declines and habitat loss, degradation and fragmentation from human-caused and natural disturbances that were thought to result in increased predation risk.
- In 2014, boreal caribou were listed Threatened in the NWT under the *Species at Risk (NWT) Act.*
- In 2017, the Conference of Management Authorities (CMA) developed and published the *Recovery Strategy for the Boreal Caribou (*Rangifer tarandus caribou*) in the Northwest Territories*.
- In 2019, a Conservation Agreement for the conservation of boreal caribou was signed between the Government of Canada and the GNWT under Section 11 of the federal *Species at Risk Act*. In 2019, *A Framework for Boreal Caribou Range Planning* was completed, which will guide the development of five regional caribou range plans that will address habitat alteration at the regional level.

Recommendations:

- Effective range management is required to support self-sustaining population growth rates. Promote habitat protection by continuing to work with traditional knowledge holders to identify and protect important boreal caribou habitat.
- Promote the use of Indigenous guardianship to continue to maintain the cultural practices, languages and knowledge transmission that supports the relationship between people and boreal caribou.
- Encourage harvest reporting and health monitoring.
- Continue monitoring the status of the NWT boreal caribou population especially in areas without current population information.
- Investigate the impacts to biocultural relationships.
- Fill other knowledge gaps identified in the status report.
- Canada and the NWT must uphold and, if possible, exceed international climate change agreements including reducing greenhouse gas emissions at the local level. Climate change in the NWT must be addressed by implementing the *2030 NWT Climate Change Strategic Framework* and Action Plan.

Executive Summary

Indigenous and Community Knowledge	Scientific Knowledge
About the Species	
Description Boreal caribou are a medium-sized member of the deer family, larger than barren-ground caribou but smaller than northern mountain caribou. Size may vary in different regions of the Northwest Territories (NWT). They are generally distinguishable from other caribou based on size, but markings, tracks (and hoof shape), location, and behaviour can also be used to identify them. Colouring, markings, and antlers vary by seasons and sex. Boreal caribou are considered intelligent, secretive, fast, elusive animals that startle easily and are difficult to hunt. **Life Cycle and Reproduction** Boreal caribou give birth about one month earlier than barren-ground caribou in the Sahtú Settlement Area (SSA), and between May and June in the Tłı̨chǫ region. The rut takes place in late September-early October. Males may gather a small harem of females for overwintering. Cows do not disperse or move as much as bulls over their lifetimes. Calf survival is an important influence on boreal caribou numbers. Factors affecting calf survival include mid- and late-winter environmental conditions, condition of the mothers, disturbances in calving habitat, and predators.	**Description** Boreal caribou (Woodland Caribou [Boreal population]; *Rangifer tarandus caribou*) are a medium-sized member of the deer family. Many of their physical and behavioural traits are adaptations to living in a cold climate and in the boreal forest. **Life Cycle and Reproduction** Female boreal caribou disperse and are solitary during pre-calving and calving. Females produce their first calves at age three and may reproduce up to at least 21 years of age. The generation time (average age of parents of newborn individuals) is approximately 9 years. Calf mortality is high during the first six weeks of life. **Physiology and Adaptability** Boreal caribou are adapted to feeding on lichens, and to travelling on and foraging in snow. Unlike other members of the deer family, both males and females grow antlers. **Interactions** Boreal caribou feed primarily on lichens during winter, and on a wider variety of forage in the snow-free months. Wolves are the primary predators of adult female boreal caribou in the Northwest Territories (NWT). Although the causes of calf mortalities in the NWT are largely unknown,

Physiology and Adaptability

In general, Boreal caribou are very sensitive to human disturbances such as noise and motorized vehicles. They flee from hunters, especially on snowmobiles. Boreal caribou use of disturbed habitat is variable and over time, they may adapt to disturbances of certain types, but there is a limit above which they will leave an area. Boreal caribou may move away from wildfires and burned areas to find suitable undisturbed habitat and vegetation elsewhere. They may also use burned areas to forage (for shrubs and mushrooms) and to seek refuge during calving (limiting predator access). Boreal caribou move easily through deep snow except when there is an ice crust. This may relate to the shape of their hooves, which also help them move across muskeg. They are generally healthy animals with a good fat layer, and parasites and disease are not indicated to be major threats.

Interactions

Predators can have a major impact on boreal caribou. Wolves are the most important predators, followed by bears. Other predators such as lynx, wolverine and potentially cougars have less impact. Predation can increase under certain conditions. Linear disturbances such as seismic lines can cause predation to increase because they open up travel corridors for predators and make it easier for them to hunt boreal caribou. Deep snow and ice crusts can also give wolves an advantage. Changes in the numbers of other ungulates can also influence predation rates on boreal caribou. wolves, black bears and lynx may also be important predators of calves. Moose and beavers are present across boreal caribou range in the NWT, while wood bison and muskox are localized. White-tailed deer and elk are sparsely distributed primarily in the southern portion of the range. Barren-ground caribou overlap the northeast portion of boreal caribou range in the NWT.

Linear features such as seismic lines are used by predators and may increase their hunting efficiency. Boreal caribou survival is known to be influenced by the diversity and density of predators and alternate prey species (such as deer). Where large numbers of wolves are supported by large numbers of alternate prey, there is an increased probability that more caribou will be killed.

The average estimated annual harvest of boreal caribou by NWT resident hunters from 2001 to 2019 was 19. The 2019 estimate of Indigenous annual harvest of boreal caribou in the NWT suggest it could be as low as 65 and as high as 190.

Exposure to the bacterium *Erysipelothrix rhusiopathiae*, which has been implicated in boreal caribou and other species' deaths elsewhere, was found in boreal caribou in the southern NWT. Winter tick has increased in prevalence on boreal caribou in the NWT. Chronic Wasting Disease (CWD) has not been recorded in the NWT, however it is a concern and ENR is working with hunters and neighbouring jurisdictions to prevent the spread of CWD into the NWT.

Predation is normal and important; however, populations of wolves and bears may be rising in some areas. Boreal caribou are sometimes seen to mix with barren-ground caribou in their fall and winter range. Boreal caribou also interact with northern mountain caribou along the eastern edges of the Mackenzie Mountains. Boreal caribou interact with moose, muskoxen, wood bison and white-tailed deer that share their range. In some cases, it is thought muskoxen and wood bison compete with and negatively impact boreal caribou. Boreal caribou are hunted intentionally by some communities (e.g., K'atl'odeeche First Nation) and opportunistically by other communities (e.g., Deninu Kue First Nation) throughout their range, particularly in winter due to easier access.	
Place	
Distribution Boreal caribou have a long-standing history and presence across the NWT and are a key species of cultural and ecological importance. Knowledge holders have placed their range as bordered on the west by the Mackenzie mountains and on the east by the Canadian Shield. Boreal caribou have been observed as far north as Tuktoyaktuk and have also often been found south of Great Slave Lake, crossing into northern Alberta and British Columbia. Boreal caribou are found in their greatest numbers in the Dehcho and Tłı̨chǫ/North Slave regions. They have also been located in the South Slave region, and in the Sahtú Settlement Area (SSA) along the	**Distribution** Boreal caribou only occur in Canada. They occupy the boreal forests of seven provinces and two territories, extending from the northeast corner of Yukon east to Labrador and south to Lake Superior. In the NWT their range almost exclusively coincides with the Taiga Plains Ecoregion. Boreal caribou in NWT do not form cohesive herds but occur as a continuous distribution of individuals within their range, with possible barriers to movement in some places due to rivers or habitat discontinuity. Boreal caribou in the extreme northwestern portion of their range are shared with the Yukon; those in the southern NWT are shared with Alberta and

Mackenzie River. Boreal caribou have also been observed across the Inuvialuit Settlement Region (ISR)/Gwich'in Settlement Area (GSA), again often along the Mackenzie River. However, in these regions, populations are generally scattered and sparse and boreal caribou are said to be commonly mixed with barren-ground caribou. In these regions, knowledge holders have identified many traditional hunting grounds for the boreal caribou, while noting that they are a difficult and secretive animal to hunt and are primarily hunted in an opportunistic fashion.

Habitat

Boreal caribou require a diverse array of habitats that they will use over the course of a given year. Boreal caribou generally spend time in dense pine or spruce forests and areas of muskeg habitat. They are extremely difficult to spot in the brush and this is a likely reason for more frequent sightings in open areas. Boreal caribou use a variety of habitats and will move within their range to suit their requirements as the seasons change.

In the winter, boreal caribou are found in thicker pine and spruce forests where the snow is less deep and arboreal and terrestrial lichens are easier to access. In the spring, predator avoidance during the calving period heavily influences habitat choice. Boreal caribou separate and spread out along higher ridges, river edges, muskeg, islands, and meadows to calve. Boreal caribou also move to water or open breezy areas to avoid insects during the spring and summer. In the fall, they generally travel to higher ground,

British Columbia (BC). Although the current distribution of boreal caribou in the NWT is largely known, they are poorly surveyed in the northeastern portion of their NWT range. No subpopulations of boreal caribou have yet been defined in the NWT; however, radio-collared caribou data and genetic information suggest some potential lines for differentiation between subpopulations.

In the NWT, for boreal caribou, the extent of occurrence is 660,291 km^2, the area of occupancy is 433,993 km^2, and the index of area of occupancy (IAO) is 443,248 km^2. Because boreal caribou do not congregate and are distributed at low densities across a very large range, it is unlikely that a single threatening event would rapidly affect all individuals, and therefore, it is not possible to define locations for boreal caribou in the NWT.

Distribution Trends

There is no technical information on whether the currently defined boreal caribou range in the NWT differs from the historical distribution.

Habitat Requirements

Boreal caribou are closely linked to a variety of habitats within the boreal forest including bogs, fens, and lichen-bearing black and white spruce forests around peat lands. Open conifer lichen and open woodland needle-leaf forests are preferred during early winter to post-calving. During summer and fall open habitats such as tundra and recent burns may be selected for insect relief and foraging.

moving through a broad range of habitats during and after the rut.	Population growth rates are determined by adult female and calf survival and, as a result, habitat conditions that facilitate adult female and calf survival are critical for the long-term survival of boreal caribou. Seismic lines allow wolves to travel faster and increase their hunting efficiency in caribou habitat. Boreal caribou avoid seismic lines and other anthropogenic linear features, but their ability to do this decreases as the density of these features increase. In addition, the amount of functional habitat available to boreal caribou is inversely related to the density of linear features and amount of habitat disturbed by fire. Generally, as cumulative habitat disturbance increases, boreal caribou calf recruitment decreases. In the NWT, boreal caribou population growth rates were strongly correlated with the availability of large patches of undisturbed habitat (>500 km^2) where caribou could reduce their risk of predation. **Habitat Availability** Fires and human-caused disturbances (seismic lines, pipelines, roads, and logging) are the two most significant factors that have affected the availability of boreal caribou habitat in the NWT. Most current habitat disturbance in the NWT was caused by fire. There are broad differences in availability of habitat between the southern and northern portions of the NWT boreal caribou range. These differences could affect population growth rates at a local or regional level. Approximately 31% of the boreal caribou range in the NWT is currently affected by fires

	and human-caused disturbances, with a higher level of human-caused and total combined disturbance in the southern portion of the NWT. A predictive habitat map generated by a resource selection function suggests that selected habitat is available throughout the range including in the northeastern portion of the range in the NWT, where little is known about boreal caribou distribution. **Habitat Fragmentation** Currently, large patches of undisturbed habitat cover about 43% of the NWT range. The degree of habitat fragmentation in the NWT decreases from south to north; in the southern NWT, most of the undisturbed habitat is in small patches. **Habitat Trends** NWT boreal caribou habitat is experiencing warmer and more variable weather in all seasons, compared to in the past. Much of the NWT current range has an anthropogenic and fire disturbance footprint (i.e. approximately 31% or 35%, depending on the analysis), the majority of which is caused by fire. Additional human-caused disturbance will likely increase that footprint and thus increase the area of unsuitable habitat. Wildfires are also expected to increase as a result of climate change, but it is uncertain whether habitat recovery and regeneration rates will balance habitat changes due to wildfire. Comparable calculations of range disturbance in 2010 and 2015 suggests that the combined level of fire and human habitat

	disturbance on the NT1 boreal caribou range increased from 31% to 35% from 2010 to 2015. However, wildfires within the range of boreal caribou did decrease between 2014 and 2020.
Population	
Movements Boreal caribou are not generally known to migrate the long distances typical of barren-ground caribou, but they do make seasonal movements in response to changing habitat needs; these distances can vary from almost no distance up to 125 km. Some groups move in a linear small-scale migration; some groups move within a constrained area that contains a mixture of habitat types. Boreal caribou tend to be found in larger groups in the winter. Movement is most restricted in late winter. In the spring they generally move to suitable calving habitat. Boreal caribou move around less in the summer compared with the spring. They start to move greater distances in the late summer and fall. Human-made features such as highways and pipelines, as well as rivers and burned areas, can be barriers to movement in some cases. Boreal caribou do move between Alberta/British Columbia and the southern NWT. **Abundance** Boreal caribou sightings tend to be less common than other ungulate sightings and their overall abundance in the NWT is not well understood.	**Movements** Boreal caribou movement rates vary during the year and reflect changes in activity, with the greatest movement rates by adult female caribou just prior to calving. Most boreal caribou females are relatively sedentary and remain in the boreal forest throughout the year. The Mackenzie and Hay rivers may be barriers to dispersal. During the breeding season, movement by adult males is low with males concentrating in very small areas. **Abundance** The population estimate for boreal caribou in the NWT is 7,409 based on estimated boreal caribou densities within the range. In the NWT, approximately 82% of boreal caribou are adults, resulting in an estimate of about 6,091 adult (mature) individuals. A more reliable population estimate is needed. **Population Dynamics** Pregnancy rates for boreal caribou in the NWT are high, averaging about 91%. Calf recruitment based on the calf:100 cows ratio of all caribou counted during late winter surveys have ranged from 10-45 calves:100 cows across study areas. Annual adult female survival is variable but has been generally >80% in most years, and during the last three

Fluctuations and Trends

In some areas, boreal caribou group sizes are considered to be smaller in recent years. Changes in the abundance of boreal caribou are local and variable; limited new information was available to update population trends. In the Inuvialuit Settlement Region, information on boreal caribou abundance was inconclusive; in most areas, numbers are thought to be stable or increasing but there was limited information available. In the Gwich'in Settlement Area, boreal caribou were seen to be increasing in some areas and decreasing in others. In the Sahtú Settlement Area, the most recent information indicated that numbers are stable to increasing. In the Dehcho region, observations are mixed: numbers are increasing in some areas, stable in most areas, and slowly decreasing in others. In the Tłı̨chǫ and North Slave regions, trend data are mixed. Recent reports from Tłı̨chǫ harvesters suggest that boreal caribou are increasing in this region, but this observation may be explained by changes in caribou distribution in relation to wildfires. In the South Slave region there are mixed reports of population trends: some knowledge holders state that boreal caribou populations have increased over time, while other knowledge holders state that populations have declined. However, knowledge holders from the same study generally agree that it is more difficult to hunt boreal caribou now compared with hunting caribou in the past. This information should be interpreted with caution because many of the observations relate to specific, small geographic areas. Moreover, it is years, has been high ranging from 89% to 100%.

The majority of adult female mortalities are due to wolf predation. Most mortalities occur between March 15 and September 15, with the greatest peaks during pre-calving and mid-summer, and a lesser peak in the fall.

Fluctuations and Trends

In the national recovery strategy for boreal caribou, the NWT population is classified as 'likely self-sustaining'. This is based on a total range disturbance of 31%, which indicates that the probability of observing stable or positive population growth over a 20-year period is approximately 65%.

Population growth rates for the entire NWT population of boreal caribou are not known. Longer-term population trend data is only available for the Dehcho and Hay River Lowlands study areas, dating back to 2005/06 and 2003/04 respectively. Although neither of the datasets extends back three generations (27 years), data for both study areas suggest an overall decline since the early to mid 2000s. In all study areas with available data, population growth rates have generally been positive in the last 3-5 years. The most recent population growth estimate from the Gwich'in area in 2008/09 suggested an increasing population growth rate, but that estimate is now over 10 years old and does not necessarily represent the current situation.

Currently, there is no estimate of overall population change available for the whole boreal caribou population in the NWT.

difficult to discern whether some observations represent real declines in abundance or cyclic changes in habitat use.	Approximately half of the estimated number of NWT boreal caribou are found in areas where numbers have exhibited an overall long-term decline or population change is unknown (Dehcho and South Slave regions). The remaining boreal caribou are found in areas where the long-term trend is unknown (Gwich'in, Inuvialuit, Sahtu and North Slave areas). **Possibility of Rescue** It is unlikely that dispersal from boreal caribou in adjacent jurisdictions would augment or repopulate the NWT boreal caribou population should it decline or become extirpated. Because boreal caribou range condition in the NWT is more favourable for boreal caribou persistence than range conditions in BC and Alberta, it is more likely that the NWT boreal caribou population will act as a source population to rescue neighbouring populations, rather than BC and Alberta populations acting as sources for rescuing the NWT population.
Threats and Limiting Factors	
Habitat loss, fragmentation, and habitat disturbance, and the links between changes to habitat and predator populations, are the main threats to boreal caribou in the NWT. Areas burned by fire or disturbed by industry are not used by boreal caribou until the habitat recovers. Habitat recovery may take many decades and the return of boreal caribou would coincide with new growth sufficient enough for forage or cover from predators. People noted that fire have increased in severity and size over the last	The most important threat to the persistence of boreal caribou across their distribution in Canada is habitat alteration, especially from human activities, and the resulting effects on predator-prey relationships. The main threats to boreal caribou in the NWT are habitat alteration due to fire and human-caused disturbances, predation and climate change. Habitat alteration from fires <40 years old is distributed across the boreal caribou range in

several years and note that habitat will probably take longer to recover from the burns. Roads and seismic lines are also important threats because of their links to increased harvesting pressure and predation. Knowledge holders are concerned that more roads will increase increase the hunting pressure, exacerbating the declines that are observed in some areas. People expressed concerns about industrial development and impacts of noise and other sensory disturbance to caribou, although caribou may get used to some kinds of noise. In general, these types of disturbance are likely to increase in the future. Another important threat is climate change, with people noting that changes in ice, snow and permafrost are making it harder for caribou to move and changing their habitat. Parasites and disease are known to occur but were not generally a cause for concern, although there are some recent cases of disease reported by Tłı̨chǫ. Additional threats identified include invasive research methods, tourism, snowmobile and all-terrain vehicle use, negative interactions with other ungulates, pollution and contamination. The cumulative effects of all of these factors are an important concern to many communities in the NWT.	the NWT, but most of the area burned during the recent wide-scale fires in 2014 is in the southern portion of the range. Extensive petroleum exploration activities were conducted in the 1960s and 1970s, with additional activities in the late 1980s and early to mid 2010s across the range. Vegetation recovery on seismic lines is slow, with poor or no recovery in wet lowland areas. Forest harvesting has been conducted in the southeastern portion of the range and additional harvesting is planned. The proposed pipeline in the Mackenzie River Valley has been cancelled, but work on the highway has begun, and the right-of-way for the Tłı̨chǫ Highway in the eastern portion of the range has now been cleared. This road opened to the public in fall 2021. If fire disturbance increases as a result of climate change and regeneration of old burns does not balance habitat changes due to wildfire, then the total combined fire and human-caused disturbance could exceed the 35% disturbance level identified for critical habitat in the federal recovery strategy for boreal caribou and result in conditions where the population is no longer considered self-sustaining. Based on the most recent estimate of Indigenous and resident harvest of boreal caribou in the NWT, total harvest could be as low as ~85 (1.3% of the estimated population) and as high as ~210 (3.2% of the estimated population). More reliable harvest data and population estimates are required to determine sustainable harvest levels.

	Climate change may have significant future effects for boreal caribou habitat in the NWT. These could include loss of forest habitats due to permafrost thaws and increasing frequencies of fires; shorter and warmer winters with weather events that make travel, foraging, and predator avoidance more difficult; and longer, warmer summers resulting in longer periods of insect harassment. Although parasites and diseases have not yet been identified as significant current threats to boreal caribou in the NWT, exposure to the bacterium *Erysipelothrix rhusiopathiae* has been detected in boreal caribou in the southern NWT, and prevalence of wood ticks on boreal caribou in the southern NWT has increased since they were first detected in 2013. The meningeal worm and Chronic Wasting Disease are additional concerns if infected white-tailed deer from Alberta disperse into the NWT. Noise and light disturbance, accidental mortalities from collisions, and pollution are not considered as significant threats in the NWT at the present time.
Positive Influences	
Traditional stewardship practices that include rules and guidance for a respectful relationship with caribou in both harvest and research activities can also have a positive influence. Indigenous-led monitoring and research initiatives have also created networks of information sharing to better inform caribou	Since boreal caribou were formally listed as *Threatened* under the federal *Species at Risk Act* (SARA) in 2003, there has been an increase in conservation planning and research efforts that have provided information to better manage boreal caribou and their habitats in the NWT. Other territorial efforts include: an *Action Plan for Boreal caribou Conservation in the Northwest*

management and range planning. Range planning for boreal caribou is ongoing across all five regions in the NWT with a target for completion by 2023. The goal of these plans is to ensure a healthy and sustainable boreal caribou population across their NWT range that offers harvesting opportunities for present and future generations. Land use planning and habitat protection initiatives are underway where the protection of boreal caribou habitat is one of the primary goals. New protected areas in the NWT, such as the Edéhzhíe Protected Area and Ts'udé Niljné Tuyeta, support in protecting nationally significant boreal caribou habitat. Indigenous and community knowledge holders have also made many suggestions on specific practices for the protection of boreal caribou, areas to protect, research and monitoring.	*Territories* developed in 2010; *Recovery Strategy for the Boreal Caribou (Rangifer tarandus caribou) in the Northwest Territories* and a *Consensus Agreement Respecting the Implementation of the Recovery Strategy for Boreal Caribou in the Northwest Territories* completed in 2017; a Conservation Agreement for the conservation of boreal caribou signed between the Government of Canada and the GNWT under Section 11 of the federal *Species at Risk Act* in 2019; *A Framework for Boreal Caribou Range Planning* completed in 2019; and the *Wildlife Act* hunting regulations for boreal caribou amended in 2019. A national recovery strategy for boreal caribou was completed in 2012 with an update completed in 2020. The strategy identifies critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat; under the federal *Species at Risk Act* critical habitat is protected from destruction. The Government of Canada also tracks and reports on actions taken and measures put in place to protect identified critical habitat. There is some current and proposed habitat protection in place for boreal caribou in the NWT through existing and future protected areas, including Wood Buffalo National Park, Saoyú-ʔehdacho (~5,500 km^2), Edéhzhíe (~14,218 km^2), and Ts'udé Niljné Tuyeta (10,060 km^2). In addition, until land claim negotiations and land use planning are complete, and pursuant to relevant acts, an additional approximately 59,404 km^2 of land proposed for protection in the southern NWT is currently under a combination of surface

	and sub-surface land withdrawals. Depending on how much of these lands become protected and the types of protections that will apply, protected areas in the NWT have the potential to have a large positive influence. Regional land use plans and community conservation plans also contribute to the conservation of boreal caribou habitat. Currently, the density of moose and other ungulate species is low across much of the boreal caribou range in the NWT, which contributes to relatively low densities of wolves, and therefore range conditions that are more favourable for caribou persistence. A habitat offset plan was developed for the Tłı̨chǫ Highway, which proposes some offsets that will account for potential indirect disturbance effects within a 500-m zone of influence (ZOI) of the footprint.

Technical Summary – Indigenous and Community Knowledge Component

Question	Indigenous and Community Knowledge
About the Species	
For example: whether cultural relationships have been impacted by declines/changes in the species; whether the species is sensitive to natural/human-caused disturbances; the reproductive capacity of the species; the dispersal capacity of the species; whether the species has critical/important/sensitive habitat components.	Broadly, cultural relationships have been impacted by declines in caribou populations. Indigenous Elders are concerned about loss of intergenerational knowledge transfer associated with declining caribou habitat and populations. Boreal caribou are highly sensitive to human-caused disturbance, and move away from wildfires to find suitable habitat elsewhere. Indigenous knowledge points to the severe impacts on boreal caribou and caribou habitat resulting from the increasingly large and severe fires associated with climate change. Calf survival is a key limiting factor for boreal caribou populations. Caribou cows need enough food to successfully birth and raise calves, and disturbance from noise, smoke, dust and predators can have a negative effect on calf survival. Boreal caribou generally move less compared to barren-ground caribou movements, but may travel distances of up to 125 km during some seasons. Boreal caribou rely on a wide array of diverse habitats to support them throughout the year and across different seasons. Key habitats for boreal caribou are described in the *Biology and Behaviour* section of this report.
Place	
For example: amount and quality of habitat available to the species compared to the past; changes in range use by	Generally, boreal caribou populations in the NWT have not been as heavily impacted by habitat loss and disturbance compared to populations further south. Despite being relatively intact, industrial development and wildfires have

the species; whether knowledge holders feel there will be changes in habitat quantity/quality; whether the species has shifted its distribution/range, and if so, how.	resulted in habitat changes for boreal caribou habitat in the NWT, especially in the south. Substantial changes in muskeg habitat have also been observed in recent years and attributed to the melting of the permafrost. Concerns regarding current and future habitat trends include an increasing incidence of fires; increasing patterns of human disturbance; increased road access leading to increased predation/harvesting pressure; greater habitat fragmentation; and climate change impacts to boreal caribou habitat. Within the Dehcho, Sahtú and Tłı̨chǫ regions, knowledge holders have increasingly noted that environmental events such as large wildfires and unstable and warming temperatures (affecting permafrost, ice and snow conditions) have changed historical movement patterns of the caribou and impacted their ability to hunt them.
Population (e.g., local, regional)	
For example: how often the species is observed compared to the past (less, more, same) and, if possible, the degree of change in observed abundance; whether the species is now unavailable, or less available, in areas where it was historically abundant; whether these changes are seen as normal or not for the species; if knowledge holders are expressing concern about the species' future, whether they express these concerns in the short-, medium-, or long-term.	**Boreal Caribou Populations** Inuvialuit Settlement Region: Information on boreal caribou abundance is inconclusive; in most areas, numbers are thought to be stable or increasing, but little information is available. Gwich'in Settlement Area: Increasing in some areas and decreasing in others. Sahtú Settlement Area: Stationary to increasing. Dehcho Region: Increasing in some areas, stationary in most areas, and slowly decreasing in others. Tłı̨chǫ and North Slave Regions: Most observations indicate a general trend of decline for boreal caribou populations. Recent reports from Tłı̨chǫ harvesters indicate stable and possibly increasing numbers of boreal caribou in some areas, as they return to areas that have been burned. South Slave Region: Some knowledge holders report that boreal caribou populations are increasing, others report that

	populations are decreasing. Most knowledge holders report that it is more difficult to hunt boreal caribou today compared with previous hunting opportunities. Information on trends should be interpreted with caution because many of the observations relate to specific, small geographic areas, and it is difficult to discern whether there are real declines in abundance or cyclic changes in habitat use. **Concerns** Common concerns for boreal caribou include declining populations, increasingly degraded boreal caribou habitat due to wildfires, climate change, forest harvesting and industrial development, and increasing predator populations.
Threats and Limiting Factors	
For example: how knowledge holders characterize the degree of disturbance the species and/or its habitat are facing, through human-caused or natural sources.	Many knowledge holders expressed concerns about habitat disturbance, including loss of habitat, increases in sensory disturbance in habitat near industry, fragmentation by roads, and contamination of habitat as having major impacts to boreal caribou. Knowledge holders are concerned that disturbance will increase in the future. While fire is seen as a natural and restorative process, people are concerned about combined effects with other types of disturbance. In addition, climate change is increasing the size and severity of fires, which may result in a larger effect as habitat takes longer to recover. Increases in predator populations and changes in the distribution of other species are seen as important threats to boreal caribou, and are linked to habitat fragmentation and climate change. New roads, such as the Tłı̨chǫ Highway, may create increased harvesting pressure on boreal caribou. Other key concerns include changes in snow, ice and permafrost due to climate change. The cumulative effects of all of these factors are important: Elders fear that government will allow development and infrastructure that will compound the

	impacts of wildfires by fragmenting boreal caribou habitat, and emphasize to decision-makers that boreal caribou need the full extent of their current range.
Positive Influences	
For example: factors that are or are likely to have a positive influence on the status of the species in the NWT, including habitat protection, community conservation initiatives, etc.	Traditional stewardship practices that include rules and guidance for a respectful relationship with caribou in both harvest and research activities can also have a positive influence. Indigenous-led monitoring and research initiatives have also created networks of information sharing to better inform caribou management and range planning in the NWT and beyond. Land use planning and habitat protection initiatives are underway where the protection of boreal caribou habitat is one of the primary goals. New and future protected areas in the NWT, such as the Edéhzhíe Protected Area and Ts'udé Niljné Tuyeta, will protect nationally significant boreal caribou habitat. Range planning for boreal caribou is ongoing across all five regions in the NWT with a target for completion by 2023. Through these range planning efforts, 65% of habitat for boreal caribou would be retained in an undisturbed state over time. The goal of these plans is to ensure a healthy and sustainable boreal caribou population across their NWT range that offers harvesting opportunities for present and future generations.

Technical Summary – Scientific Knowledge Component

Question	Scientific Knowledge
Population Trends	
Generation time (average age of parents in the	Approximately 9 years.

population) (indicate years, months, days, etc.).	
Number of mature individuals in the NWT (or give a range of estimates).	Approximately 6,091 mature individuals (based on a total estimate of 7,409 for the NWT, and composition information from the Dehcho and North Slave study areas).
Percent change in total number of mature individuals over the **last** 10 years or 3 generations, whichever is longer.	Estimated growth rates for the entire NWT population of boreal caribou are not available. Population trend data are only available in some study areas, and only for up to 16 years ago, so may be insufficient to describe trend for the last 3 generations (27 years). For three study areas with >3 years of data (all in the southern NWT), available data since studies began suggest an overall decline. Population data in all study areas during the last 3-5 years suggest an overall increasing short-term trend. Based on available growth rate data for study areas with >3 years of data, approximately 53% of NWT boreal caribou are found in areas where caribou numbers have undergone long-term declines or where trend is unknown, and trend for approximately 47% of caribou is unknown.
Percent change in total number of mature individuals over the **next** 10 years or 3 generations, whichever is longer.	A population viability analysis has not been conducted for the NWT boreal caribou population. However, an analysis based on the level of total range disturbance (31%) suggests that the probability of observing stable or positive population growth over a 20-year period is approximately 65%.
Percent change in total number of mature individuals over any 10 year or 3 generation period that includes **both the past and the future**.	Unknown, but see above for information on changes in the recent past.
If there is a decline in the number of mature individuals, is the decline	Conservation management may be required to reverse the overall declines in some study areas that have occurred over the last 16 years in the southern NWT. Effective habitat

likely to continue if nothing is done?	management is also required to support self-sustaining population growth rates in the northern NWT.
If there is a decline, are the causes of the decline reversible?	Yes. Key factors to consider 1) patch size, distribution, and connectedness of undisturbed preferred boreal caribou habitats; 2) restoration of seismic lines to states that discourage predators from using them as travel corridors; and 3) protecting existing large areas of undisturbed habitat from additional human-caused habitat alterations.
If there is a decline, are the causes of decline clearly understood?	Declines are largely due to high mortalities and low recruitment rates. The likely ultimate cause of declines is increased predation facilitated by moderate to high densities of seismic lines.
If there is a decline, have the causes of the decline been removed?	No. In the southern NWT, post-fire regeneration of vegetation to preferred lichen-bearing open conifer stands may take up to 100 years. Some seismic lines were cut in the 1960s and 1970s, but limited information suggests that vegetation recovery is very slow, with no recovery observed on seismic lines in wet lowland areas. Although many protected areas have been proposed that could protect caribou habitat, few have been formally established.
If there are fluctuations or declines, are they within, or outside of, natural cycles?	Currently, there is no information suggesting that boreal caribou populations undergo natural cycles.
Are there 'extreme fluctuations' (>1 order of magnitude) in the number of mature individuals?	Unknown, but unlikely.
Distribution	
Estimated extent of occurrence in the NWT (in km^2).	Approximately 660,251 km^2.

Index of area of occupancy (IAO) in the NWT (in km^2; based on 2 x 2 grid).	Approximately 443,248 km^2.
Number of extant locations[1] in the NWT.	The most serious plausible threats to boreal caribou in the NWT are habitat alteration and climate change. However, because boreal caribou do not congregate and are distributed at low densities across a very large range, it is unlikely that a single threatening event would rapidly affect all individuals. Therefore, it is not possible to define locations for boreal caribou in the NWT.
Is there a **continuing decline** in area, extent, and/or quality of habitat?	Currently, the only information available on past habitat trend is from 2010 to 2020 based on range disturbance data compiled by Environment and Climate Change Canada, which indicates the combined level of fire and human habitat disturbance on the NT1 range increased from 31% to 35% from 2010 to 2015, primarily due to the large amount of area burned in 2014. However, between 2014 and 2020 the percent of boreal caribou range burned annually by fires decreased. Additional anthropogenic and fire disturbance will likely increase that footprint and thus increase the area of unsuitable habitat. Depending on the type of disturbance that occurs, functional habitat loss and risk to predation will also increase for boreal caribou. However, it is uncertain whether habitat recovery and regeneration rates will balance habitat changes due to wildfire. The additive effects of new impacts may negatively affect population growth rates in the southern NWT.
Is there a **continuing decline** in number of locations, number of populations,	Unknown

[1] Extant location - The term 'location' defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.

extent of occupancy, and/or IAO?	
Are there 'extreme fluctuations' (>1 order of magnitude) in number of locations, extent of occupancy, and/or IAO?	No
Is the total population 'severely fragmented' (most individuals found within small and isolated populations)?	No. There is a continuous distribution of individuals in the NWT.
Immigration from Populations Elsewhere	
Does the species exist elsewhere?	Yes
Status of the outside population(s)?	South of the NWT current range, all local populations in British Columbia and Alberta are not self-sustaining. Population growth rate for the northern Saskatchewan population suggests that the population is stable; however there does not appear to be any movement between boreal caribou in northern Sasktachewan and the NWT. Further east, most local populations in are self-sustaining, as likely as not self-sustaining, or of unknown status.
Is immigration known or possible?	Yes
Would immigrants be adapted to survive and reproduce in the NWT?	Yes
Is there enough good habitat for immigrants in the NWT?	Yes

Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	The NWT population of boreal caribou is likely self-sustaining. Boreal caribou populations south of the NWT in Alberta and British Columbia are not self-sustaining. Because boreal caribou range condition in the NWT is more favourable for boreal caribou persistence than range conditions in BC and Alberta, it is more likely that the NWT boreal caribou population will act as a source population for immigration to neighbouring populations, rather than BC and Alberta populations acting as sources of immigration for the NWT population.
Threats and Limiting Factors	
Briefly summarize negative influences and indicate the magnitude and imminence for each.	The main threats to boreal caribou in the NWT are habitat alteration due human-caused disturbances, habitat alteration due to natural disturbances (wildfire, permafrost changes), overharvesting, and climate change. Other threats of lower concern include predation and apparent competition with other ungulates, parasites and disease, along with other threats (noise and light disturbancehuman traffic and vehicle collisions, invasive reaserch techniquies and pollution/contamination).
Positive Influences	
Briefly summarize positive influences and indicate the magnitude and imminence for each.	Since 2002 there has been an increase in conservation planning and research efforts that have provided information to better manage boreal caribou and their habitats in the NWT. NWT plans and agreements include 1) An Action Plan for Boreal caribou Conservation in the Northwest Territories; 2) Recovery Strategy for the Boreal Caribou (*Rangifer tarandus caribou*) in the Northwest Territories (2017); 3) Consensus Agreement Respecting the Implementation of the Recovery Strategy for Boreal Caribou in the Northwest Territories (2017); 4) a Conservation Agreement for the conservation of boreal caribou was signed between the Government of Canada and the GNWT under Section 11 of the federal

	Species at Risk Act (2019); 5) A Framework for Boreal Caribou Range Planning (2019) as well as the Interim Wek'èezhìı Range Plan along with progress in the development of other regional range plans; 6) amendments to the *Wildlife Act* hunting regulations for boreal caribou (2019); and a Tłı̨chǫ Highway Habitat Offset Plan (2021). A national recovery strategy for boreal caribou was completed in 2012 and updated in 2020. The strategy identifies critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat; under the federal *Species at Risk Act* critical habitat is protected from destruction. The Government of Canada is also tracks and reports on actions taken and measures put in place to protect identified critical habitat. There is some current and proposed habitat protection in place for boreal caribou in the NWT through existing and future protected areas including Wood Buffalo National Park and Saoyú-. ʔehdacho, Edéhzhíe and Ts'udé Nilı̨né Tuyeta. Regional land use plans and community conservation plans also contribute to the conservation of boreal caribou habitat. Habitat protection has the potential to be an important positive influence on boreal caribou, depending on how much of the proposed lands become protected and the types of protections that will apply. Currently, the density of moose and other ungulate species is low across much of the boreal caribou range in the NWT, which contributes to relatively low densities of wolves, and therefore range conditions that are more favourable for caribou persistence.

Glossary

Term	Dialect	Translation	Source
Bedélé t'á núzhǫ	SD	We grew up with their blood	(Polfus *et al.* 2016)
Behé ts'enézhǫ	SD	We grew up with them	(Polfus *et al.* 2016)
Dazhadh tsoo	GG	Young bull	(Gwich'in Social & Cultural Institute *et al.* 2003)
Dazhoo tsoo	TG	Young bull	(Gwich'in Social & Cultural Institute *et al.* 2003)
Deshıwą́neǫ́ę́ tǫdzı	KG	Woodland caribou (boreal population)	(Sahtú Renewable Resources Board and SARC 2013)
Egii tsoo	TG	Caribou calf	(Gwich'in Social & Cultural Institute *et al.* 2009)
Ggoecha gots'anele	S	To hunt from downwind	(Polfus *et al.* 2016)
Goecha fehtə	S	To describe a situation in which a tǫdzı will loop back on his or her own trail so he/she can rest	(Polfus *et al.* 2016)
Gop'ı gotǫdzı	SD	Woodland caribou (boreal population)	(Sahtú Renewable Resources Board and SARC 2013)
Khada' aatsan	TG	Young cow	(Gwich'in Social & Cultural Institute *et al.* 2003)
Kw'ıjí	SD	Mosquito berry hill[2]	(Neyelle *et al.* 2016)
Mbedzih	DZ	Woodland caribou (both mountain and boreal)	(Acho Dene Koe First Nation 2018; Dehcho First Nations 2011)
Mbedzih cho	DZ	Larger boreal caribou bulls	(Dehcho First Nations 2011)
Medzih	DY	Boreal caribou	(Kátł'odeeche FN)

[2] This is an ecosystem classification that is fairly unique in the Sahtú Region. This habitat is important for caribou and is "characterized by well-drained, slightly higher terrain, covered in old growth black and white spruce forests."

Napaatukmiotat tuktut	I	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Napaaqturmiutat tuktut	SG	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Nodıı	TY	The place where boreal caribou belong	(Legat *et al.* 2018)
Tǫdzi	K, SD, S	Boreal caribou	(Polfus *et al.* 2016; Sahtú Renewable Resources Board *in* SARC 2012: 5; Bayha *in* SARC 2012: 5)
Tǫdzi	TY	Boreal caribou	(Wek'èezhìı Renewable Resources Board 2010; Chocolate 2011)
Tuktut	SG	Boreal caribou	(Community Corporations of Aklavik, Inuvik and Tuktoyaktuk 2006)
Tuttut	U	Boreal caribou	(Community Corporations of Aklavik, Inuvik and Tuktoyaktuk 2006)
Tuttuqpahugruit npaaqturmiutat	U	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Vadzaih	GG, TG	Caribou (all species)	(Benson 2011)
Vadzaih ch'iyaht'ok	TG	Cow with nursing calf	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih choo	GG, TG	Large bull	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih njòo'	TG	Cow with no calf	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih tr'ik	GG, TG	Caribou cow	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih tsal	TG	Caribou cow	(Gwich'in Social & Cultural Institute *et al.* 2003)

ɔedə	K	Caribou (related to the term for horn or antler)	(Polfus *et al.* 2016)
ɔekwę́	SD	Caribou (related to the term for flesh of meat)	(Polfus *et al.* 2016)
ɔepę́	S	Caribou (related to the term for flesh of meat)	(Polfus *et al.* 2016)

DY = Dene Yatié (South Slavey), DZ = Dene Zhatié (South Slavey), GG = Gwichya Gwich'in, I = Inuinnaqtun, K = K'áhsho, KG = K'ásho Got'ıę (Fort Good Hope and Colville Lake), S =Shúhta, SD = Sahtú/Délı̨nę, SG = Siglitun, TG = Teetł'it Gwich'in, TY = Tłı̨chǫ Yatıì, U = Uummarmiutun

Acronyms

Acronym	Term
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
EC	Environment Canada
ECCC	Environment and Climate Change Canada
ENR	Environment and Natural Resources
EOSD	Earth Observation for Sustainable Development of Forests
GNWT	Government of the Northwest Territories
GRRB	Gwich'in Renewable Resources Board
GSA	Gwich'in Settlement Area
IPCC	Intergovernmental Panel on Climate Change
ISR	Inuvialuit Settlement Region
IUCN	International Union for Conservation of Nature
NTS	National Topographic Series
SARC	Northwest Territories (NWT) Species at Risk Committee
SSA	Sahtú Settlement Area
WMIS	Wildlife Management Information System
WRRB	Wek'èezhìı Renewable Resources Board

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PLACE NAMES

The maps below (Figures 1 and 2) can be referred to for both the Indigenous and Community Knowledge and Scientific Knowledge components of this status report. Both maps provide context to readers who may be unfamiliar with the geographic features referred to in this report. Figure 1 shows the regions/settlement areas used to report out regionally on the status of boreal caribou across the NWT, and includes protected conservation areas. Figure 2 shows important mountains, rivers, lakes and place names referred to in this status report. Note that the regions and settlement areas are described further under *Place*.

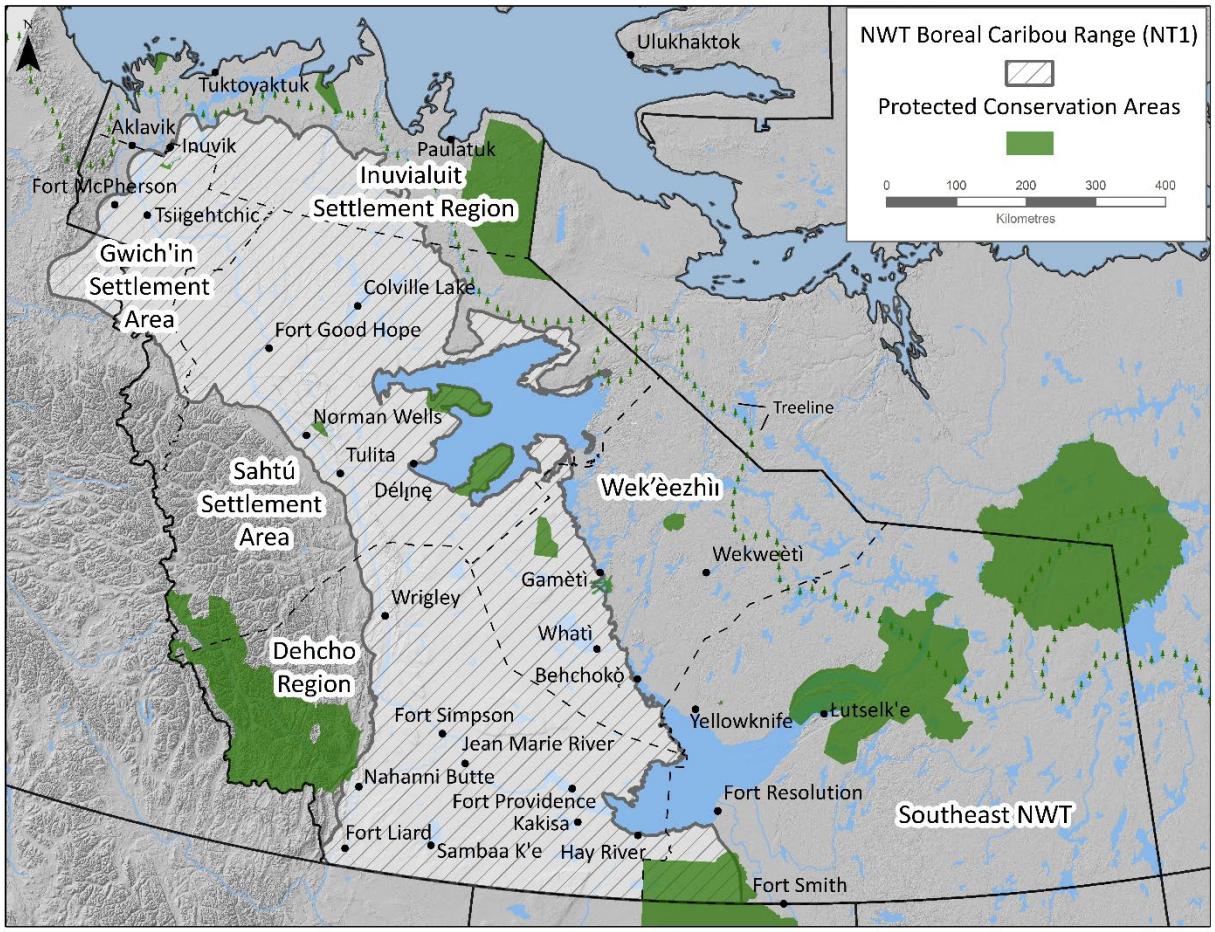

Figure 1. Map of Northwest Territories showing the different regions with settled land claim agreements (Wek'èezhìı, Sahtú, Gwich'in, and Inuvialuit) and regions without settled land claim agreements (Dehcho and Southeast NWT) mentioned in this report, as well as communities, protected areas (existing and proposed) and the range of boreal caribou (ENR unpubl. data 2021). Map courtesy of R. Abernethy, ENR.

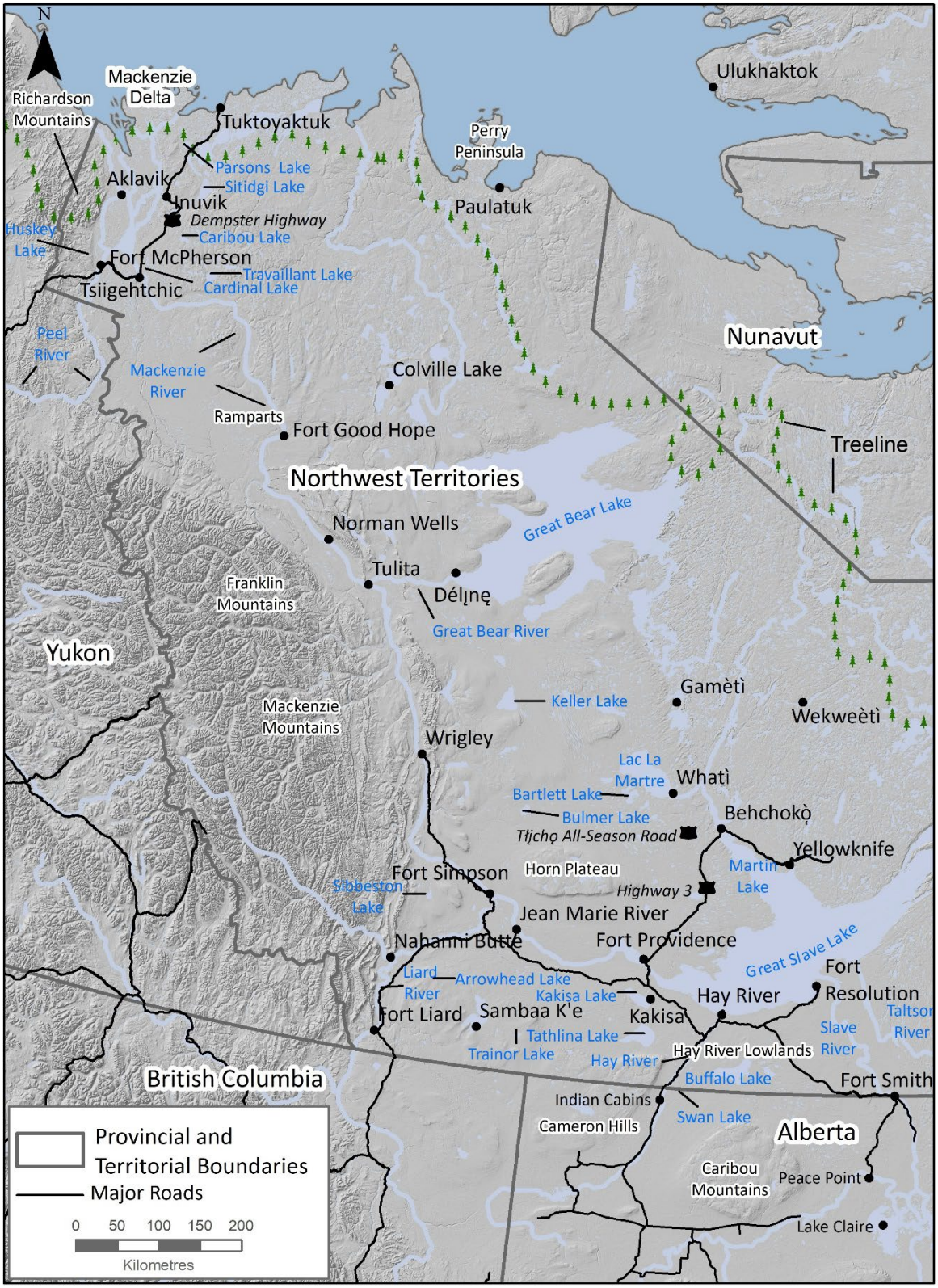

Figure 2. Map of Northwest Territories showing geographic features and place names mentioned in this report (ENR unpubl. data 2021). Map courtesy of R. Abernethy, ENR.

INDIGENOUS AND COMMUNITY KNOWLEDGE COMPONENT

Preface

"Our history is written on the land, in the placenames and stories, in the language. …And unless you speak the language, you will not fully understand the stories. I'm always searching for stories. That's where our knowledge comes from. That's how knowledge in my area is passed on." (Walter Bayha [Tulít'a] in Bayha 2012: 26)

The consideration of Indigenous peoples' cultural histories, identities, languages, social organizations, and interactions with their environment is of vital importance for the accurate assessment of species. While all reasonably available Indigenous and community knowledge was solicited for inclusion in this status report, limitations are acknowledged. First, in the completion of these reports, the Species at Risk Committee (SARC) is not able to conduct any primary research or information gathering activities (e.g., interviews). The transcription and verification of Indigenous and community knowledge is often complex and resource-intensive, not to mention sometimes controversial (Bayha 2012). It is often the case that only a small portion of the Indigenous and community knowledge that exists has actually been transcribed. This limits the completeness, and perhaps also accuracy, of a status report. Second, it is important to recognize that the Indigenous knowledge transcribed and available for inclusion in this status report, is, in many respects, removed from the cultural, spiritual, linguistic, and ecological context in which it was intended to be heard (Berkes *et al*. 2000; Thorpe 2004; SENES Consultants Ltd. 2010; Tłı̨chǫ Research and Training Institute [TRTI] 2016). Translation, in particular, can result in generalizations and the loss of sometimes subtle descriptions of inter- and intra-specific variation, interactions, and patterns (TRTI 2016; Polfus *et al.* 2017a). As noted by Polfus *et al*. (2017a: 17), "*words are used in context and convey different meaning depending on who is speaking, what dialect is being used, what questions are being addressed, where on the land the speaker is located, and the dialect or background of the audience*." Although Indigenous knowledge and its transmission is ultimately grounded in practice, language is integral to its interpretation (Bayha 2012; Polfus *et al.* 2016). Ultimately, understanding the environment (animals, plants, land, water, air, etc.); that is, practicing one's culture, is essential to understanding the stories and legends.

Preamble

The following section provides a summary of the data gaps in the Indigenous and community knowledge within this boreal caribou status report. However, these data gaps do not mean that the information does not exist within the memory, experience, and teachings of community members and knowledge holders in the NWT. For example, Wong and Kiistoff (2020) identified that the boreal caribou ecology and population information collection is often driven and limited by specific project scope in response to industry and development. Comprehensive Indigenous and community knowledge on boreal caribou would require more studies focusing on broader scale and topics (Wong and Kiistoff 2020).

Benson and Winbourne (2015) noted that the knowledge held by harvesters and families across the NWT is reliant on the continued ability to harvest and "be on the land". Changes to access and/or the availability of resources will in turn impact the knowledge available from Indigenous and community knowledge holders.

"If caribou numbers continue to decline, traditional knowledge surrounding caribou hunting techniques, techniques of processing the animal into tools, clothing, and food, together with the values and stories infused in the caribou harvest, risk being lost for future generations. Trails may cease to be used as routes to access caribou harvesting areas, and teaching and gathering sites may lose some of their traditional significance regarding caribou. The consequences of this situation is significant: as a result of declining caribou populations Acho Dene Koe First Nation members are not able to practice their traditional vocation of hunting caribou, which is contrary to their Treaty 11 right. The loss of Acho Dene Koe First Nation's hunting practice is leading to an increasing erosion of ADKFN's traditional way of life and transmission of cultural practices to current and future generations." (Acho Dene Koe First Nation 2018, p. 27)

Table B1 in *Appendix B* provides a summary of data gaps within this report by topic. Note that all data in this report are summarized by regions and settlement areas within the NWT: Dehcho Region, South Slave Region (SSR), North Slave Region (NSR), Tłı̨chǫ Region, Inuvialut Settlement Region (ISR), Gwich'in Settlement Area (GSA), and Sahtu Settlement Area (SSA) (see Figure 1).

This update to the *Species Status Report for Boreal Caribou (Rangifer tarandus caribou) in the Northwest Territories* (SARC 2012), Indigenous and community knowledge component, includes the following new resources (non-exhaustive list, refer to *Information Sources* for additional resources):

- Acho Dene Koe First Nation. 2018. Acho Dene Koe First Nation Boreal Caribou Traditional Knowledge and Cumulative Impacts Qualitative Assessment Non-Confidential Final Report. 42 pp.

- Benson, K. and J. Winbourne. 2015. Literature Review and Interviews: Indigenous Ways of Knowing Boreal Caribou Populations. ʔehdzo Got'ı̨nę Gots'ę́ Nákedı (Sahtú Renewable Resources Board) and the Department of Environment and Natural Resources, Government of the Northwest Territories. 62 pp.
- Chocolate, G., S. Van Der Wielen, and P. Jacobsen. 2015. K'àgòò tı̨lıı Deè Traditional Knowledge Study for the Proposed All-Season Road to Whatì. Tłıchǫ Government. Behchokǫ̀, NWT. 52 pp.
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ABOUT THE SPECIES

Names and Classification

There are two generally recognized populations of woodland caribou in the Northwest Territories (NWT): the boreal and northern mountain populations. Both are considered the same species (*Rangifer tarandus caribou*); however, these populations are known to be distinct based on where they live (either in the boreal forest or the Mackenzie Mountains). This status report will only focus on the boreal populations of woodland caribou in the NWT.

Table 1 provides a summary of the boreal caribou names from different Indigenous languages and dialects in the NWT. However, Indigenous naming conventions for caribou are complex (additional details are provided in points (1) to (6) in *Appendix A: Additional Information*). Refer to the *Glossary* for additional terms, translations, and references used in this report.

Table 1. Names for boreal caribou as represented within Dene Zhatié (South Slavey), Gwich'in, Inuvialuktun, Sahtúot'ı̨nę Yatı́ (North Slavey), and Tłı̨chǫ Yatìì languages.

Indigenous Language Terminology	English Translation	Source
Dene Zhatié (South Slavey)		
Mbedzih	Woodland caribou (both mountain and boreal)	(Acho Dene Koe First Nation 2018; Dehcho First Nations 2011)
Mbedzih cho	Larger boreal caribou bulls	(Dehcho First Nations 2011)
Medzih	Boreal caribou	KFN
Gwich'in		
Vadzaih (GG, TG [3])	Caribou (all species)	(Benson 2011)
Vadzaih tr'ik (GG, TG), *vadzaih tsal* (TG)	Caribou cow	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih njòo' (TG)	Cow with no calf	(Gwich'in Social & Cultural Institute *et al.* 2003)
Vadzaih ch'iyaht'ok (TG)	Cow with nursing calf	(Gwich'in Social & Cultural Institute *et al.* 2003)
Khada' aatsan (TG)	Young cow	(Gwich'in Social & Cultural Institute *et al.* 2003)

[3] Representing Gwich'in dialects of Teetł'it Gwich'in (TG) and Gwichya Gwich'in (GG).

Vadzaih chao (GG, TG)	Large bull	(Gwich'in Social & Cultural Institute *et al.* 2003)
Dazhoo tsoo (TG), *dazhadh tsoo* (GG)	Young bull	(Gwich'in Social & Cultural Institute *et al.* 2003)
Egii tsoo (TG)	Caribou calf	(Gwich'in Social & Cultural Institute *et al.* 2009
Inuvialuktun		
Napaatukmiotat tuktut (I)	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Napaaqturmiutat tuktut (SG[4])	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Tuktut (SG), *Tuttut* (U)	Caribou	(Community Corporations of Aklavik, Inuvik and Tuktoyaktuk 2006)
Tuttuqpahugruit npaaqturmiutat (U)	Woodland caribou (Caribou that stay in tree country)	(SARC 2011)
Sahtúot'ı̨nę Yatı́ (North Slavey)		
Gop'ı gotǫdzı (SD[5])	Woodland caribou (boreal population)	(Sahtú Renewable Resources Board and SARC 2013)
Deshıwʏ́aneʔę́ tǫdzı (KG)	Woodland caribou (boreal population)	(Sahtú Renewable Resources Board and SARC 2013)
Tǫdzı (K, SD, S)	Boreal caribou	(Polfus *et al.* 2016)
ɔekwę́ (SD), *ɔepę́* (S)	Caribou (related to the term for flesh of meat)	(Polfus *et al.* 2016)
ɔedə (K)	Caribou (related to the term for horn or antler)	(Polfus *et al.* 2016)
Tłı̨chǫ Yatıì		
Tǫdzı	Boreal caribou	(Wek'èezhìı Renewable Resources Board 2010; Chocolate 2011)

[4] Representing dialects spoken in the Inuvialuit Settlement Region of Inuinnaqtun(I), Siglitun (SG) and Uummarmiutun (U).

[5] Representing Sahtúot'ı̨nę Yatı́ dialects spoken in the Sahtú Settlement Area including K'áhsho Got'ı̨nę (KG), Sahtú/Délı̨nę (SD), and Shúhta (S).

Relationship with People

Boreal caribou are an important animal for First Nations and Métis communities in almost all regions of the NWT, with established cultural and economic importance (Acho Dene Koe First Nation 2018; Benson and Winbourne 2015; d'Entremont 2017; Polfus et al. 2016; Wong and Kiistoff 2020).

Harvesters and Elders have comprehensive traditional/Indigenous knowledge about past and current caribou populations, movements, health, habitat, and other topics, which is used to inform adaptive management and monitoring processes, and for determining state and trends for boreal caribou populations (Benson and Winbourne 2015).

Many Indigenous communities in NWT and Canada have a longstanding reliance on boreal caribou as a traditional food source in all regions where boreal caribou are found (Acho Dene Koe First Nation 2018; Benson and Winbourne 2015; d'Entremont 2017; Wong and Kiistoff 2020). Boreal caribou are critical to the economies, culture, and livelihoods of northern Indigenous communities (Polfus *et al.* 2016).

For example, for the Acho Dene Koe First Nation boreal caribou are integral to their subsistence values and cultural practices, including the transmission of teachings between generations related to hunting, preparation, and use of every part of the caribou (Acho Dene Koe First Nation 2018). In particular, boreal caribou are valued both for the meat and the material value of their hide. Cultural importance is also placed on communal sharing of harvested caribou, especially with community Elders (Acho Dene Koe First Nation 2018).

"Knowledge holders interviewed described traditional techniques of processing the animal into tools, clothing, drum skins, and dried meat, stressing the importance of using the entire animal—including intestines, hide, and bones—and minimizing waste." (KH02, KH04, January 2018 Interviews in Acho Dene Koe First Nation 2018)

Caribou has long been a focus of information sharing between communities and families, in which harvesters across the north would gather together annually or seasonally to discuss the harvest, health, and observations related to caribou with each other (Winbourne 2013; Bayha 2015 in Benson and Winbourne 2015).

Continued access to boreal caribou is vital for Indigenous communities to maintain cultural values and way of life for many generations to come (Acho Dene Koe First Nation 2018; Marcel 2012). In particular, personal and spiritual relationships of knowledge holders with caribou are recognized as the key to understanding caribou; these relationships are guided by Indigenous laws of reciprocity and mutual respect (Polfus *et al.* 2016).

"It's very important that we look after the animals, we have to have respect for them. There's a reason why they do what they do. They want to survive like we want to survive. It's the same thing. That's what my mom and dad always said: 'Animals are like human beings.' They do everything

for a reason, just like we do. Like we go to store, they get food for the whole winter. They raise their young ones and teach their young ones. We do the same thing." (Gordon Yakeleya, in Polfus et al 2016, p. 7)

"One example of this association was described by Alfred Taniton as bedélé t'á that translates to "we grew up with their blood"... Alfred Taniton said, "we were raised with the blood from the caribou. In the past, the people have always survived because of the blood of the animals. The intimate interaction between human and nonhuman animals highlights how many Indigenous people recognize the importance of their relationships with other beings on a daily basis. The concept behé ts'enézhǫ "we grew up with them," or as Walter Bayha translated, "we are people with them," further illustrates how Dene people relate to caribou as unique entities, capable of intelligence, identity, perception, self- awareness, rationality, and intentionality." (Polfus et al 2016, p. 6-7)

Threats to boreal caribou and declining populations threaten the intergenerational transmission of cultural practices, values, and knowledge surrounding caribou, which can in turn impact the ability to practice Treaty rights (Acho Dene Koe First Nation 2018).

Description

Boreal caribou are a medium-sized member of the deer family (Figure 3). Boreal caribou differ in body size from barren-ground and mountain woodland caribou; in particular boreal caribou tend to be larger than barren-ground caribou, but smaller than mountain woodland caribou (McDonald 2010; Wong and Kiistoff 2020). Boreal caribou size may also differ between regions – some areas are reported to have larger caribou than others (Benson 2011).

Boreal caribou are often described as being taller than their barren-ground counterparts, with longer legs. However, it was noted during a meeting with the NWT Métis Nation Board that boreal caribou around Hay River have shorter, more muscular legs than in other regions (Environment and Natural Resources (ENR) 2007k [NWT Métis Nation Board]).

Figure 3. Boreal caribou. Photo: John A. Nagy, GNWT.

Size is usually the first descriptor that people use to distinguish between the different types of caribou. Other key differences include colouring, antlers, hooves/tracks, location, behaviour, and taste of the meat, as described in further detail below.

Boreal caribou are usually darker in colour than barren-ground caribou with some white around the throat area, belly or underside (Johnson and Ruttan 1993; Zimmer *et al*. 2002; Benson 2011; Chocolate 2011; WRRB 2012; Chocolate *et al.* 2015). Females may be lighter in colour than males (Zimmer *et al.* 2002). In summer, male boreal caribou are brown, but in winter their coat turns to a greyish colour.

Both males and females grow antlers; those of the male are larger than those of the female (Chocolate 2011; WRRB 2012). In many areas, the antlers of boreal caribou are said to be larger, thicker and broader than those of barren-ground caribou, but there are also reports that the antlers may be smaller and have more branches (Olsen *et al.* 2001; Zimmer *et al.* 2002; Cluff *et al.* 2006; Benson 2011).

Boreal caribou have larger hooves than barren-ground caribou, with a pointed shape compared to the round shape of the barren-ground caribou; this adaptation helps them stay on top of soft surfaces like snow or muskeg (Cluff *et al.* 2006; Gunn 2009; Chocolate *et al.* 2015). As an example, the size and shape of the caribou tracks, as well as the location, habitat type, and group size, are used by knowledge holders in the Sahtú Settlement Area (SSA) for track identification (Polfus *et al.* 2017b).

Boreal caribou are generally found in small groups throughout their range, most often numbering from one to five individuals, although groups of up to ten or 11 can be seen together

(Olsen *et al.* 2001; Cluff *et al.* 2006; Benson 2011; Chocolate *et al.* 2015). The biggest groups of boreal caribou reported by participants in workshops and Indigenous and community knowledge studies were of 30-40 individuals, but those group sizes were apparently more common in the past (ENR 2007k [NWT Métis Nation Board]; Gunn 2009; Dehcho First Nations 2011).

Boreal caribou have distinctive behaviours and abilities when compared to barren-ground caribou. They are described as intelligent, secretive, and fast animals that are always on the move (Zimmer *et al.* 2002; Chocolate *et al.* 2015). They startle easily, are quick to run away and can jump large distances (Cluff *et al.* 2006). Elders and hunters in the SSA often refer to boreal caribou as the "secret" animals because of their elusive nature and behaviour (McDonald 2010). They can be harder to approach because they are wary and tend to be more afraid of hunters (Olsen *et al.* 2001; WRRB 2012; Chocolate *et al.* 2015). They are known for their ability to move quickly over rough or snowy ground (Benson 2011). Boreal caribou are known for being intelligent by their alert senses and the way they take care of their bodies, such as travelling carefully during the springtime when melting ice may cause tripping hazards (Chocolate *et al.* 2015). Boreal caribou would follow in the tracks made by Tłı̨chǫ hunters during times of deep snow to reduce exhaustion (Chocolate *et al.* 2015).

Boreal caribou has a distinct taste compared to barren-ground caribou (Polfus *et al.* 2016; Wong and Kiistoff 2020). North Slave Métis Alliance knowledge holders believe this difference is related to the varying diets between the species, in which boreal caribou have a broader diet resulting in "stronger, wilder" tasting meat (Wong and Kiistoff 2020).

Differentiation between boreal, mountain, and barren-ground caribou can be complicated at times by overlapping ranges and/or physical appearance. In the SSA, both the Bluenose-East and Bluenose-West herds of barren-ground caribou winter in the same area as the boreal caribou (Zimmer *et al.* 2002). In another example, participants at a meeting in Wrigley stated that it can be hard to tell the difference between boreal caribou females that are 'dry' (i.e., not pregnant but sexually mature) and males (ENR 2006c [Wrigley]).

Knowledgeable hunters and Elders are able to distinguish between caribou types in overlapping ranges based on their broad experience on the land and the teachings passed along between generations (Polfus *et al.* 2016).

Biology and Behaviour

Boreal caribou live within the boreal forest, moving around to find food and habitat favourable for calving and escaping predators and pests. They are known to be secretive and prefer to remain unnoticed, only coming into the open when they are safe from predators (Legat *et al.* 2018). Boreal caribou are known to mate and give birth about one month earlier than barren-ground caribou, and the big or dominant males collect small harems and remain with them

throughout the winter (G. Kochon, A. Lafferty and A. Chinna 1992 in Johnson and Ruttan 1993). In the Tłı̨chǫ region the breeding or rutting season is usually in late September or early October, and a single calf is usually born between May and the middle of June (Chocolate 2011; Legat *et al.* 2018). Inuvialuit participants said that females with young tend to live in the same areas when they get older, but males may disperse and move further away (ENR 2007e [Paulatuk]).

Indigenous and community knowledge about calving is not extensive and is not often documented in Indigenous knowledge sources—particularly with regard to woodland caribou populations (Benson and Winbourne 2015; Dehcho First Nations 2011). A number of factors may be at play to explain this gap: during the calving season, boreal caribou spread out over large areas and generally stay in areas that are difficult to access, like wetlands and burned areas (Dehcho First Nations 2011); calving occurs during spring melt, when it is difficult/dangerous to travel on the ice; it is important to avoid disturbing caribou during calving. As knowledge holders from the Dehcho First Nations have noted, calf survival is an important determinant in boreal caribou local populations and trends. Factors identified as affecting calf survival included disturbance to pregnant cows during the mid to late winter when energy conservation is important, and relocation is difficult due to snow conditions; disturbance to or in calving habitat during late April and through early June; and the presence of known predator populations such as wolves and bears (Dehcho First Nations 2011).

Islands on Lac La Martre and the North Arm of Great Slave Lake provide critical habitat when calves are young and during the summer months (Legat *et al.* 2018; see *Distribution*). The southern edge and area to the east of Edéhzhíe (Horn Plateau), as well as Too Choo (Celibeta) Lake, are known as calving areas (Acho Dene Koe First Nation 2018; see *NWT Distributions*). Acho Dene Koe First Nation hunters also pointed out that the importance of calving is acknowledged in their hunting rituals, with a knowledge holder explaining that female caribou are generally not targeted in the spring so as to give the young a greater chance of survival (Acho Dene Koe First Nation 2018).

Other communities have alternative practices. One Dene hunter noted:

"If [Dene] are going to hunt in the springtime they are going to be hunting cows. Sometimes they have a fetus or two – they would make a big deal if they ever harvested a cow with two fetuses and they talk about it as the health of the herd. If there are two fetuses, that means they are healthy to the Dene; that's very important to them." (Bayha 2015 in Benson and Winbourne 2015)

Diet and Feeding Behaviour

The availability of lichen is thought to be critical for suitable habitat for boreal caribou (Ruttan *in* SARC 2012: 17). In the Dehcho region, boreal caribou broadly rely on ground and hanging lichen as well as sedge and grasses for food (Dehcho First Nations 2011). Members of the K'átł'odeeche First Nation said that boreal caribou in the area of Wood Buffalo National Park

mostly eat lichen—known as 'caribou food', 'reindeer moss', 'reindeer lichen', 'white moss' (Andre and Fehr 2010)—and noted the white lichen that grows with moss and raspberries, as well as something that hangs from trees (likely arboreal lichen) as important food sources. It was reported that caribou also eat willows (Gunn 2009).

During the 2010 Gwich'in Indigenous and community knowledge study, hunters and Elders indicated that boreal caribou eat a variety of foods throughout the year. In summer they eat willows, willow leaves, sedges, and grass. Gwich'in Elders have seen signs of boreal caribou eating aquatic vegetation in spring. However, when hunted in winter they tend to have only lichen in their stomachs. They are known to have a special ability to find lichen in winter, perhaps by scent (Benson 2011). They will also eat tree buds in winter and are known to eat muskrat 'push-ups' (muskrat lodges which show through the frozen lakes). They may get certain nutrients from these lodges that are not otherwise available to the caribou (Benson 2011).

In the Tłı̨chǫ and North Slave regions boreal caribou prefer areas such as meadows that provide fresh plant growth, especially in summer months. They are also known to seek out mushrooms to eat (Chocolate 2011). Sambaa K'e (formerly Trout Lake) residents of the Dehcho region see many caribou in burnt areas in summer looking for fresh shrubs and morel mushrooms. Traditionally, people would light fires on ridges in the fall once there were dew drops on the trees (i.e., when the ground was no longer dry), to burn the vegetation down to the muskeg to encourage species like moose and caribou to come back (ENR 2006b [Trout Lake]). In contrast, two participants in the South Slave region said that boreal caribou sought out unburned areas when foraging (Gunn 2009), and one Indigenous and community knowledge holder from Fort Resolution indicated that boreal caribou do pass through burned areas but do not stay in them because there is no food for them to eat (Beck *in* SARC 2012: 18). It is possible that the type of controlled fire described by people in Sambaa K'e differs from a natural wildfire, after which the return of caribou may take decades. Meeting participants indicated that after a 1994 burn at Trainor Lake, caribou tracks were not seen in the area until the mid-2000s (ENR 2006b [Trout Lake]). Further comments from knowledge holders regarding boreal caribou preferences around food and fire can be found in the *Movement and Dispersal* and *Threats and Limiting Factors* sections.

Salt licks are actively sought by boreal caribou. Sahtú Elders say they see the caribou near rivers in spring when they seek out the salt licks (McDonald 2010). Inuvialuit Elders and harvesters documented mineral lick locations that might be used by boreal caribou (Nagy *et al.* 2002). Participants in boreal caribou consultation meetings in Paulatuk also said that there are natural salt licks in the ISR that might be used by caribou (ENR 2007e [Paulatuk]). In the Dehcho region, caribou are also known to use a large number of wallows [exposed soil used for accessing mineralized water] or licks (Dehcho First Nations 2011).

Knowledge holders from the Acho Dene Koe First Nation identified 13 sites with known or potential food sources for caribou in their region, including areas with mineral licks and muskegs surrounding lakes and rivers (Acho Dene Koe First Nation 2018). Too Choo (Celibeta) Lake was listed as an important source of the grass eaten by caribou, and the trail between this lake and Bovie Lake was reported as an important source of "old man's beard" lichen and spruce trees, which the caribou eat. Other vegetation noted as a food source for caribou included willow trees and *Xahdoú* grass (geese grass).

Knowledge holders from the Deninu Kue First Nation noted seasonal patterns in boreal caribou diet (d'Entremont 2017). Essential year-round foods for caribou include moss, lichen and willows, which are their primary diet during the wintertime months. In spring, caribou also feed on shrubs and new grasses; important supplements during summer months include shrubs and berries. In fall, caribou turn to berries, grasses, and tree bark as food sources.

Caribou also use trees as antler rubs, particularly jack pine, but also other tree species (Legat *et al.* 2018). It was noted that the caribou do not use jack pine for nourishment (Legat *et al.* 2018). Legat (*et al.* 2018) also identified other vegetation species important for the boreal caribou, listed in Table 2.

Table 2. Various vegetation identified by Legat (*et al.* 2018) as important for boreal caribou.

Lichens, Fungi and Moss	Shrubs	Trees
Lichen (various species) Black hairy tree lichen Rock tripe Moss (various species) Mushroom (various species)	Wild rose bush Raspberry bush Highbush cranberry Blueberry bush Gooseberry bush Cloudberry bush Kinnikinnik (Bearberry) Cranberry bush Saskatoon bush Labrador tea	Black spruce Birch Willow Tamarack Poplar Spruce Jack pine (not eaten) "Dry grey wood" Trees (various species)
Aquatics	**Grasses, Sedges and Rushes**	**Wildflowers**
Water weed (*Elodea*) Water lily Cattail, reeds Bulrush	Unidentified grass with purple flower Grasses and sedges	Fireweed (flower, primrose family)

Adaptations to Environment

A study of Gwich'in Indigenous and community knowledge by Benson (2011) was one of only a few studies in which questions about physiology and adaptability of boreal caribou were specifically asked. Gwich'in participants in the study stressed that these caribou are very sensitive to noise disturbances and will generally move away from an area if they are approached quickly by motorized vehicles. They most often react by moving into forested areas, where they may pause. If the disturbance continues to approach, they will then flee again. This behaviour may also allow slower members to remain with the group. One Inuvik hunter felt that the fleeing behaviour was a learned behaviour from experience being hunted rather than a genetic response and will therefore tend to be seen in areas where the animals are regularly hunted (Benson 2011). Conversely, K'átł'odeeche hunters find that once boreal caribou start running, they go for miles and miles before they slow down again, and that this is an intuitive response to being hunted (Gunn 2009).

Gwich'in participants felt that boreal caribou can adapt to motorized vehicles and other industrial disturbances over time, and in particular if the sound is constant and the vehicles are not giving chase or moving particularly fast. However, they felt that there is a level of disturbance which would drive the caribou away, to which the caribou could not adapt. Also, although boreal caribou may adapt to vehicles on the ground, flights—in particular low-flying or landing aircraft—are different and will continue to scare the boreal caribou and cause them to flee (Benson 2011).

Boreal caribou may learn which engine sounds are followed by gunshots and therefore discriminate between hunters and other human disturbances, which are less likely to impact them directly. Therefore, they may flee from snow machines more than from other types of motorized or industrial noises that do not have the same association with hunting (Benson 2011).

Tłı̨chǫ Elders report an increasing severity of wildfires and note that fires destroy boreal caribou habitat and forage such that boreal caribou must escape fires and burned regions to find other areas with suitable habitat (Legat *et al.* 2018). A discussion of the impacts of wildfires on boreal caribou is included in the section titled *Threats and Limiting Factors*.

Gwich'in hunters reported that boreal caribou can move quickly through difficult terrain, including soft snow, but they are not as adept at moving through deep snow with an ice crust such as in the spring or after a rare winter rain. This means they can be hunted more easily at that time (ENR 2007g [Inuvik]; Benson 2011). Boreal caribou are also known to be easier to hunt when they have not been hunted for years. Several Inuvik hunters indicated that on rare occasions boreal caribou will just stand still instead of fleeing – perhaps due to the novelty of the

people hunting them (ENR 2007g [Inuvik]). Boreal caribou can be affected by snow blindness in the spring, which makes them easy to hunt as they cannot run away (Gunn 2009).

In Gunn (2009), one participant reasoned that it is the shape of the boreal caribou hoof—acting like a snowshoe in soft terrain—that enables caribou to inhabit the muskeg more than other animals. Two participants noted that boreal caribou are good at walking on top of the snow.

Boreal caribou are known to be healthy animals, as they do not have to expend energy migrating like barren-ground caribou (Zimmer *et al.* 2002; Environment Canada 2010a [Aklavik]; Benson 2011). Females without calves are preferentially harvested as they are known to be particularly healthy (Benson 2011). Health is generally assessed by examining subcutaneous fat after harvest or by assessing body condition, in particular fat around the rump and on the ribs (Zimmer *et al.* 2002; Macdonald 2010; Benson 2011). Gwich'in hunters also examine organs and compare with what they know healthy organs to look and feel like. Whiter coloured fur can indicate a healthier animal compared to a darker one, which may have less fat. Caribou shedding their coats at the wrong time of year may be an indication of poor health (Benson 2011).

Relationship Within and Among Species

Information on boreal caribou interactions with their food species, such as lichen, can be found in *Biology and Behaviour* and *Diet and Feeding Behaviour*.

Predators

Predators can have a major impact on boreal caribou, especially wolves (Olsen *et al.* 2001). According to Gwich'in hunters, wolves and human hunters are the main predatory pressures on boreal caribou (Benson 2011). Wolves are also identified as important predators of boreal caribou in the Tłı̨chǫ and Dehcho regions (Chocolate 2011; Dehcho First Nations 2011; ENR 2006c [Wrigley]; Gunn 2009). Participants in an Inuvialuit Indigenous and community knowledge study reported they had seen wolves and other predators in areas where they see boreal caribou (Nagy *et al.* 2002). Participants in a Dehcho study reported wolf tracks in areas near the Cameron Hills where boreal caribou calve (Gunn 2009). West Point and K'átł'odeeche First Nations members report more wolves in boreal caribou habitat than barren-ground caribou habitat (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]). Increases in wolf populations were noted in many studies (Olsen *et al.* 2001; ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]; McDonald 2010; Benson 2011; Dehcho First Nations 2011; Legat *et al.* 2018). This trend is discussed further in the *Predation* section of *Threats and Limiting Factors*.

In addition to wolves, black bears and grizzly bears prey on boreal caribou. Although Indigenous and community knowledge reports do not generally specify whether grizzly or black bears are referred to, black bears specifically are recognized as important predators of boreal caribou at

least in the Dehcho and Tłı̨chǫ regions (Chocolate 2011; Dehcho First Nations 2011). Increases in unspecified bear populations have been noted in some regions (Nagy *et al.* 2002; Benson 2011; Dehcho First Nations 2011), and observations from the Tuĺıt'a and Norman Wells area indicate that grizzly bears follow seismic cutlines out of the mountains and now are seen on the Mackenzie River (Olsen *et al.* 2001).

Wolverine and lynx will hunt boreal caribou although likely have success mainly with calves; both will also scavenge (Benson 2011; Bayha *in* SARC 2012: 29). There are reports of cougars between Fort Resolution and Hay River and their specific relationship with boreal caribou was not recorded (ENR 2007b [Fort Resolution Métis Council]), although cougars are suspected of preying on boreal caribou in the South Slave and Dehcho regions (Dehcho First Nations 2011). More details are included in *Threats and Limiting Factors*.

Predation can increase under certain environmental conditions. For example, when snow is deep, boreal caribou will follow snow machine trails; wolves will also follow snow machine trails (ENR 2007j [Tsiigehtchic]). Ice crusts on snow make it easier for wolves to hunt caribou (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

Predation pressure is also influenced by the landscape, particularly linear disturbances. Participants at a meeting in Inuvik said that seismic cutlines make it easier for both people and wolves to hunt (ENR 2007g [Inuvik]). Dehcho harvesters know that seismic lines and other linear disturbances open up corridors for wolves, which can lead to increased predation of boreal caribou (Dehcho First Nations 2011). Sambaa K'e harvesters indicated that wolf populations are higher along linear disturbances such as seismic lines, resulting in lower caribou populations (Dehcho Land Use Planning Committee 2004 in AMEC Americas 2005). Increased highway access and oil and gas development in the SSA will likely increase predation (Wynes 2001 in Olsen *et al.* 2001).

Boreal caribou strategies to avoid predators are discussed in *Habitat Requirements*. Information on the impact and importance of predation as a threat to boreal caribou can be found in *Threats and Limiting Factors*. Predation pressure on boreal caribou can also be impacted by changes in the populations of other prey like moose, muskoxen, white-tailed deer, wood bison, and other types of caribou, as discussed below.

Other Types of Caribou

Indigenous and community knowledge sources indicate that boreal caribou and barren-ground caribou interact in many regions. This was documented in the ISR, the GSA, the SSA, and the North Slave, Tłı̨chǫ and Dehcho regions (Johnson and Ruttan 1993; Nagy *et al.* 2002; Gwich'in Social and Cultural Institute 2005; Cluff *et al.* 2006; Environment Canada 2010d [Gamètì]; Benson 2011; Dehcho First Nations 2011; Bayha *in* SARC 2012: 30; Legat *et al.* 2018). Most studies indicate that the two types of caribou share habitat primarily in winter months, when

both are mainly feeding on lichens. Participants in one Indigenous and community knowledge study noted that the two types of caribou have been seen walking and feeding together, in particular around Fish Lake (Dehcho First Nations 2011).

Tłı̨chǫ Elders report that boreal caribou share winter boreal forest habitat with barren-ground caribou that migrate to these areas (Legat *et al.* 2018). However, in the North Slave woodland caribou may prefer different vegetation and habitats compared to those selected by barren-ground caribou (Wong and Kiistoff 2020). Tłı̨chǫ Elders report that both types of caribou usually avoid each other (Legat *et al*. 2018). One Elder indicated that boreal caribou in the Tłı̨chǫ region are reported to 'dislike' the Bathurst (barren-ground) caribou, and that the two types do not generally travel together as boreal caribou are generally in forested areas and barren-ground herds stay on the tundra (Chocolate 2011).

However, there are rare occasions when the barren-ground caribou stay with the boreal caribou for a year and migrate back to the tundra the next spring (Legat *et al.* 2018). Boreal caribou infrequently follow barren-ground caribou north to the tundra in the spring and return in the fall (Legat *et al.* 2018). In particular, an Elder in Behchokǫ̀ stated that he has seen barren-ground caribou and boreal caribou in the same groups and specified that boreal caribou will travel with the barren-ground caribou while in the treeline but they do not move past the forest edge into the barrens. He described an event where he saw one boreal caribou follow a group of 30 barren-ground caribou (Environment Canada 2010c [Behchokǫ̀]).

In the Sahtú, it has been observed that when the barren-ground caribou migrate back to the tundra, the boreal caribou do not leave with them. No aggression or negative interactions were documented between the two types of caribou (Johnson and Ruttan 1993). Around Wood Buffalo National Park, barren-ground and boreal caribou used to mix, and the occasional barren-ground caribou would stay south with the boreal caribou. Of more concern to Elders was that some boreal caribou left the area and travelled north with the barren-ground caribou (Gunn 2009). One study participant described an event from around 1950 in which there used to be a lot of boreal caribou around the east side of Buffalo Lake, but after mixing with the barren-ground herd many left with them when they returned to the barren lands:

"What happened is that the barren land caribou came into where the woodland caribou [have] their young. And because of that, when the barren land caribou went back some of the woodland caribou also went with them, so there was a decline." (D. Sonfrere 2007 in Gunn 2009: 149)

Boreal caribou can also interact with northern mountain caribou that live in the Mackenzie Mountains. In the Dehcho region, there is evidence from Nahanni Butte and Wrigley that the two types interact, especially in the foothills and river valleys along the eastern edges of the mountain range (Dehcho First Nations 2011). Boreal caribou living west of the Liard River may interact with northern mountain caribou living in the Nahanni National Park Reserve (Dehcho First Nations 2011).

Other Ungulates

Many Indigenous and community knowledge sources indicated that boreal caribou interact with moose, muskoxen, wood bison, and white-tailed deer. Previous Indigenous knowledge reports for the North Slave region indicate that boreal woodland caribou co-occur with moose and bison (Wong and Kiistoff 2020). In some cases, these interactions are described as competitive (i.e., competing for resources). However, participants in a Dehcho Indigenous and community knowledge study indicated that moose and caribou generally do not share areas as they have different habitat requirements, and for predator avoidance (Dehcho First Nations 2011). In the SSA, moose and muskoxen frequently occur with boreal caribou; some relevant study results are included in Table 3 (Zimmer *et al.* 2002). Reports from the Tłı̨chǫ region suggest that boreal caribou and moose avoid bison due to the smell (Chocolate *et al.* 2015).

Table 3. Occurrence of other wildlife species with boreal caribou in the Sahtú Settlement Area as recorded from 40 interviews conducted in Fort Good Hope, Colville Lake, Norman Wells, and Tulít'a during Feb-Apr 2002 (from Zimmer *et al.* 2002).

Wildlife Species	Occur with Boreal Caribou?			
	Yes	No	Unknown	No Answer
Moose	17	6	0	17
Muskox	4	9	1	26
Grizzly Bear	3	2	0	35
Black Bear	4	0	0	36
Wolf	10	0	0	30
Wolverine	2	1	0	37
Lynx	3	0	0	37
Eagle	2	1	0	37

Some interactions are considered relatively recent phenomena. Members of K'átł'odeeche First Nation indicated that they have seen white-tailed deer in areas where they previously were not seen (ENR 2007a [K'átł'odeeche First Nation]). Members of the Fort Resolution Métis Council and NWT Métis Nation Board indicated that muskoxen are moving further south from Lutselk'e (ENR 2007b [Fort Resolution Métis Council]; ENR 2007k [NWT Métis Nation Board]). Muskoxen have been seen as far south as the Taltson Dam, approximately 80 km from Fort Smith (Kelly *in* SARC 2012: 31), as well as in Fort Chipewyan, Alberta in 2019 (CBC 2019).

Inuvialuit study participants observed that moose populations were increasing in areas where boreal caribou were decreasing. However, participants also reported that moose and boreal caribou were found in the same areas (Nagy *et al*. 2002). In the GSA, boreal caribou and moose can share habitat, based on tracks seen in the snow (Benson 2011).

Observations from the Tuĺit'a and Norman Wells area indicate that there are more moose in the Mackenzie valley than before (Olsen *et al.* 2001). Many wildfires in the 1990s reduced suitable boreal caribou habitat, and the burned areas have now been taken over by new and expanded moose populations (McDonald 2010). Zimmer *et al.* (2002) documented observations of interactions between boreal caribou and moose in the SSA, although the results were inconclusive. Some interviewees said that their food plants differ; some said they feed on the same species. It was frequently said that moose and boreal caribou are found in the same general locations, but at different times, or that they do not interact with each other (Zimmer *et al.* 2002).

Mixed views were also reported in the SSA for muskoxen. Some participants felt that muskoxen may cause boreal caribou to leave areas due to hair, noise or parasites. Others said that they have seen boreal caribou and muskoxen feeding on the same plants, in the same places, without evidence of competition or exclusion (Zimmer *et al.* 2002). In the GSA, muskoxen are identified as competing for food resources with caribou in general. In particular, this observation relates to how muskoxen will pull an entire plant, roots and all, from the ground when grazing, impacting the ability of caribou to feed in the area. It has also been observed that the urine of muskoxen will keep caribou away from an area (Benson 2011).

Negative interactions with wood bison are of concern to people in the North Slave, Tłı̨chǫ and Dehcho regions. In 2006, workshop participants in the community of Behchokǫ̀ expressed concern that encroaching wood bison may negatively impact boreal caribou, and that the increasing wood bison population was related to decreasing boreal caribou numbers (Cluff *et al.* 2006). In 2010, participants in a workshop in Behchokǫ̀ mentioned an increasing population of wood bison in the Mackenzie Bison Sanctuary—an area where boreal caribou were previously seen, but are no longer seen (Environment Canada 2010c [Behchokǫ̀]).[6] In a Tłı̨chǫ study, one Elder indicated that boreal caribou 'dislike' wood bison (Chocoloate 2011). Meeting participants from West Point First Nation and K'átł'odeeche First Nation also said that wood bison displace caribou when they increase in abundance (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

Indigenous and community knowledge sources also indicate that moose, muskox, wood bison, barren-ground caribou, and other prey species can impact the interactions between boreal

[6] Note that since the wood bison anthrax outbreak, which occurred in 2012 (after this workshop was held), this observation may no longer be relevant.

caribou and their predators. It has been noted that when the wood bison population increased in the Mackenzie Bison Sanctuary, predator populations also increased (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]). Large wolf packs seen in the Fort Providence area seem to be related to the increase in the wood bison population; it is not known to what extent these large packs have impacted boreal caribou (Dehcho First Nations 2011). Prior to 1983 wolf sightings near Déljne were relatively rare, but by the early 2010s, wolves were regularly sighted and there are wolf dens near the community. Participants in a Sahtú Indigenous and community knowledge study said they observed an increase in wolf populations in the early part of the 2000s, as well as increases in the abundance of prey species like moose, muskoxen and beavers. These participants indicated that increases in prey species like muskoxen and moose may result in fewer boreal caribou being taken by predators, and that this is having an effect on the boreal caribou populations. This report suggests that if there is a decrease in the number of other prey, then predators will hunt boreal caribou (McDonald 2010).

PLACE

Distribution

In the Northwest Territories (NWT), the boreal caribou population covers an extensive area of boreal forest, from as far north as Tuktoyaktuk to the southern reaches of the NWT, and across the border into northern British Columbia and northern Alberta. The western edge of its distribution roughly follows the foothills of the Mackenzie Mountains, and the eastern edge is defined by Great Bear Lake, Great Slave Lake and the Little Buffalo River along the edge of the Canadian Shield. The current known distribution of boreal caribou, based on a combination of local knowledge from community meetings and scientific knowledge, is shown in Figure 1, in relation to the cultural groups and communities discussed in this report.

There is one continuous population of boreal caribou in the NWT (Bayha *in* SARC 2012: 8), although several distinct 'populations' were noted in the Dehcho region (Dehcho First Nations 2011). Indigenous and/or community knowledge sources from other regions did not address population numbers. Accurately defining the range boundaries within and between the different groups of caribou is important in ensuring that evolutionary processes and population structures are well understood, and is a prerequisite for developing effective conservation plans and policies (Polfus N.D).

Inuvialuit Settlement Region (ISR)

Sources contacted for this report provided little new information on the current or past distribution of boreal caribou in the ISR, compounding a knowledge gap from the last report. Within the ISR, boreal caribou are reported to occur around Sitidgi, Parsons and Husky Lakes, Miner, Kugalik, and Makalik Rivers, the Parry Peninsula, and Tuktoyaktuk. They are occasionally

seen down as far as the coast and in the Mackenzie Delta (Community Corporations of Aklavik, Inuvik and Tukoyaktuk 2006; ENR 2007f [Tuktoyaktuk]). Some scattered boreal caribou are seen on the barrens every year, the majority are males, and they are sometimes mixed with barren-ground caribou (ENR 2007e [Paulatuk]). Some of these observations were recorded around fall and winter (ENR 2007f [Tuktoyaktuk]).

Some Inuvialuit hunting areas and historic and recent boreal caribou observations were documented for the ISR during an ENR study (Nagy *et al.* 2002). Participants' observations and harvest records in this area spanned the period from the 1920s to 2002. Previous observations or harvests were recorded in five geographic regions, but all were said to have few boreal caribou.

Gwich'in Settlement Area (GSA)

The Gwich'in Settlement Area (GSA) is an area of land covered by a Comprehensive Land Claim Agreement signed in 1992. The Agreement includes the communities of Aklavik, Fort McPherson, Inuvik and Tsiigehtchic.

There is well-documented Gwich'in knowledge on the distribution of boreal caribou in the GSA from 2011. Boreal caribou in the GSA are generally seen around the Peel River Preserve, between Fort McPherson and Tsiigehtchic, and north of the Mackenzie River. They are not seen in the mountains on the west side of the Peel River, where the Porcupine (barren-ground) caribou migrate, or in the Mackenzie Delta. North of the Mackenzie River, they are commonly seen around the decommissioned Canadian National Railway line, around Caribou and North Caribou lakes, and in the Travaillant Lake watershed to the Anderson River. They are also seen south of the Mackenzie River around Tree River (Benson 2011).

Figures B2, B3, B4, and B5 (in confidential *Appendix B*) show sightings and harvests of boreal caribou in the GSA, based on the observations of 20 Elders and hunters who participated in semi-structured interviews in 2010 for the federal Species at Risk recovery planning process, and 11 Elders and hunters interviewed by questionnaire in 2001. Gwich'in hunters did not report boreal caribou outside of the known population extent shown in Figure 2 (Benson 2011).

Most Gwich'in hunters feel that boreal caribou do not have known herds or named groups in the GSA, but that they are dispersed across the landscape in what are likely family groups. The groups may intermingle, in particular during the rut when males may travel great distances by themselves. One hunter thought that geographically distinct groups existed, although they are not known as such or named. In the GSA, larger groups might occur more often up the Arctic Red River south of the community of Tsiigehtchic (Benson 2011).

Sahtú Settlement Area (SSA)

In the SSA, boreal caribou range throughout the Mackenzie River valley that bridges the three Sahtú districts, between the foothills of the Mackenzie Mountains and the edge of the treeline to the east of Great Bear Lake (Sahtú Renewable Resources Board 2020). Some knowledge holders have defined the SSA as the northern limit of the range of the boreal caribou (Polfus N.D). The eastern boundary of the boreal caribou range map (Figure 1) currently follows the boundary of the Taiga Plains Ecoregion (Ecosystem Classification Group 2007). In general, more information is needed to verify the distribution of boreal caribou in this area (Bayha *in* SARC 2012: 10).

Boreal caribou are found in two general areas on either side of the Mackenzie River (McDonald 2010). Hunters from Tuĺıt'a and Norman Wells say that many people harvest boreal caribou in the SSA (Olsen *et al.* 2001). Boreal caribou in the K'asho Got'ine District occur mostly in small groups and occupy the area along the Mackenzie River on the west side from the Ramparts, south of Fort Good Hope, down river to McBride Lake, and then east towards Muskeg Lake past Colville Lake. This area appears to be the prime habitat for boreal caribou in the SSA and an area where the majority of the boreal caribou kills occur (McDonald 2010). Indigenous and community knowledge sources also harvest boreal caribou in this area based on tracking knowledge and reported sightings (Polfus *et al.* 2016).

People from Fort Good Hope report boreal caribou along the Mackenzie River (Olsen *et al.* 2001). Johnson and Ruttan's (1993) Indigenous and community knowledge study conducted in Fort Good Hope and Colville Lake showed that boreal caribou occur in small numbers in the forested habitat on both sides of Dehcho [Big River/Mackenzie River]. Figure 4 below provides a map illustrating woodland caribou tracking and density of craters during the winter months in the Central Mackenzie Valley of the SSA (Tigner 2019). Whether craters were associated with boreal caribou or northern mountain caribou is unknown.

Small groups of boreal caribou have been observed around the community of Déljne on occasion, and several groups have also been seen along the North Shore of Great Bear Lake (McDonald 2010). Since 1983 the Dene of Déljne have been hunting a group of boreal caribou 10-15 km southwest of the community from late October to late winter (Bayha *in* SARC 2012: 11). However, people in Déljne tend to hunt barren-ground caribou more than boreal caribou (McDonald 2010).

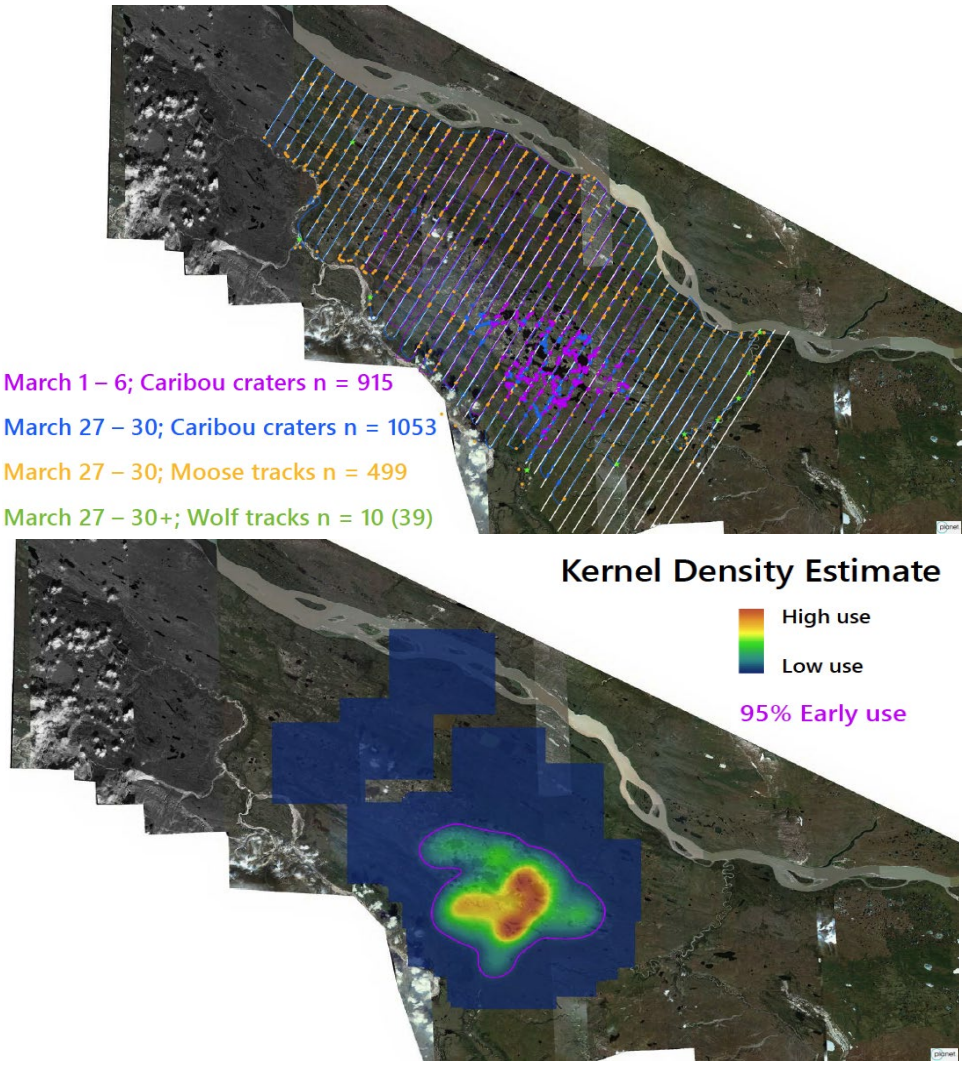

Figure 4. Tracking and density of craters for woodland caribou over winter in the Central Mackenzie Valley, NWT. Whether boreal or northern mountain caribou craters is unknown (Tigner 2019).

Figure B6 (in *Appendix B)* is a confidential map of some boreal caribou habitat observations and harvesting areas for the SSA. Information on boreal caribou conservation and management in the SSA has been summarized and is presented by sub-region or district in Olsen *et al.* 2001. There are also further distribution details resulting from a Sahtú Indigenous and community knowledge study in this area in McDonald 2010.

Dehcho and South Slave Regions

Boreal caribou are common throughout the Dehcho region, with some areas tending to have higher concentrations of individuals (Dehcho First Nations 2011). The whole Dehcho region is considered to be boreal caribou range, and the whole area is populated by boreal caribou to some degree (Dehcho First Nations 2011). More specifically, workshop participants indicated that there are populations along the Liard River valley and immediately west of the valley; east

of the Liard River, between Trout Lake and the Liard River, and south of, and within the Arrowhead Lakes area. Additionally, boreal caribou are seen throughout the entire Sambaa K'e (formerly Trout Lake) area, and the Wrigley area. They are seen to the east of the Franklin Mountains. Outside of their region, Dehcho Knowledge holders have shared that they have also seen boreal caribou throughout the Fort Simpson area, including Edéhzhíe, and the foothills and lowlands around Sibbeston Lake and the Jean Marie River area.

Although the Mackenzie Mountains are generally identified as northern mountain caribou range, there is evidence of interaction between northern mountain and boreal caribou along the eastern edge of the Mackenzie Mountains (Dehcho First Nations 2011). This is discussed in *Interactions*.

Participants in an Indigenous and community knowledge study from the K'átł'odeeche First Nation, Little Red River Cree Nation and Mikisew Cree First Nation documented sightings and occurrences of boreal caribou in an area of approximately 45,000 km² in southern NWT and northern Alberta, encompassing Wood Buffalo National Park and including the area north of Buffalo Lake to Great Slave Lake and the area west of Buffalo Lake to the Cameron Hills (see Figures B7 and B8 in *Appendix B*). Because study participants reported a lot of boreal caribou movement between northern Alberta and the NWT, some information documented for Alberta is considered relevant and included here (Gunn 2009). Most sightings of boreal caribou and their tracks occurred in winter and were clustered along openings such as snowmobile trails, near lakes, open prairie or muskeg, highways, trails and seismic cutlines (Gunn 2009).

It was noted during the Joint Review Panel hearings for the Mackenzie Gas Project at Sambaa K'e (Trout Lake) that the density of boreal caribou increases as the proposed pipeline corridor gets closer to K'e'otsee (Trainor Lake). This area was identified as very good boreal caribou habitat (Gau 2006 [Trout Lake]). The Cameron Hills is an area where boreal caribou are consistently seen (Gau 2006 [Kakisa]).

In addition to the information provided by K'átł'odeeche Elders and hunters (Gunn 2009), knowledge of boreal caribou in the Dehcho region has been documented through various community meetings and consultation sessions and compiled by the Dehcho First Nations for Environment Canada (Dehcho First Nations 2011).

Consultations held with Acho Dene Koe First Nations knowledge holders in 2018 documented 27 sites representing caribou sightings and areas of caribou habitat in the Dehcho region (Acho Dene Koe First Nation 2018). Site identification was based on evidence including observed tracks, known locations of important vegetation, and oral reports from Acho Dene Koe First Nation members. These locations included the area east of Hook Lake and surrounding the Arrowhead River. These Acho Dene Koe First Nation knowledge holders also identified a possible calving area near Too Choo (Celibeta) Lake, with prolific numbers of young observed.

Edéhzhíe (Horn Plateau) is known to have one or more boreal caribou populations. The southeast portion of Edéhzhíe is known to be used by boreal caribou in winter, and in late winter, caribou can be found at the south-western edge of the plateau. Summer distribution includes the centre of the plateau. The southern edge of Edéhzhíe, and the area to the east, are known as calving areas, possibly separate populations (Deh Cho First Nations 2001). "It was the opinion of the Liidlii Kue First Nation harvesters and Elders that the woodland (boreal) caribou found [on the Horn Plateau] might be a separate population (i.e. genetically different) from other woodland caribou, which would account for the difference in their flavour and look," (Deh Cho First Nations 2001:7).

Boreal caribou are found in the general area north of the Sambaa K'e winter road. From the winter road south to Trainor Lake there are high concentrations of boreal caribou. They generally move into the corridor between the winter road and possibly Trout Lake during winter (Gau 2006 [Fort Simpson]). A Fort Providence resident indicated that boreal caribou are seen around Big Point (Berger 1976). Elders in Buffalo Lake also indicated that boreal caribou are found in the Snake River area, west of Wood Buffalo National Park, and an area south of Buffalo Lake (Gunn 2009).

Acho Dene Koe First Nation knowledge holders identified ten muskeg areas used by boreal caribou within Acho Dene Koe First Nation's traditional territory in the Northwest Territories (Acho Dene Koe First Nation 2018). These muskeg locations were scattered throughout Acho Dene Koe First Nation territory in the NWT, but were especially frequent in the southern and eastern portions of this area (Acho Dene Koe First Nation 2018). Furthermore, a large area was identified surrounding the numerous lakes in the south-east portion of Acho Dene Koe First Nation territory in the NWT, including TooChoo (Celibeta) Lake, and was described as significant caribou habitat containing favourable vegetation, where mature and young caribou have historically been sighted by the community (Acho Dene Koe First Nation 2018).

There is very little information on the current or past distribution of boreal caribou for the South Slave region available in the published Indigenous or community knowledge sources reviewed for this report. During a meeting with the Fort Resolution Métis Council, it was noted that very few boreal caribou are seen between Fort Resolution and Fort Smith. It was also noted that the boreal caribou range includes the area south of Great Slave Lake to the Little Buffalo River (ENR 2007b [Fort Resolution Métis Council]; Gau *in* SARC 2012: 14). Interviews with local knowledge holders have also placed boreal caribou in the South Slave region near the northern border of Alberta (Wong and Kiistoff 2020). Other sources have found significant numbers of boreal caribou documented in areas such as Fish Lake, Pine Point, and Hay River (ENR 2006c [Wrigley]; ENR 2007b [Fort Resolution Métis Council]; ENR 2007k [NWT Métis Nation Board]). In Deninu Kue First Nation (DKFN) territory south of the Great Slave Lake, caribou are often observed along the highway between Pine Point and the Buffalo River (d'Entremont 2017).

Dehcho Knowledge holders have shared that they have also seen boreal caribou in the Fort Providence area, north of the Mackenzie River, and in the Mackenzie Wood Bison Sanctuary (Dehcho First Nations 2011). They were also noted to be distributed in the Kakisa area throughout the Tathlina and Kakisa lakes areas, on the Cameron Hills, throughout the Hay River area including the area around the Hay River Dene Reserve and surrounding the north and west sides of Buffalo Lake.

Tłı̨chǫ and North Slave Regions

Boreal caribou are found throughout the western part of the Tłı̨chǫ region, although in low numbers (Cluff *et al.* 2006). They live in forested habitat between the Mackenzie Mountains and the Canadian Shield (Chocolate 2011). They have been found to occupy several plateaus in the region, including ʔedèezhìì, Shìigǫǫ̀la, Gotłı̨shìh, Kwechoozhìì, and Gowhashìh plateau (Legat *et al.* 2018). Bartlett and Weyburn Lakes have been noted as very important areas for boreal caribou; people from Whatì say they see boreal caribou there frequently (Environment Canada 2010b [Whatì]). The Edéhzhíe (Horn Plateau) area was especially important boreal caribou habitat (Environment Canada 2010c [Behchokǫ̀]; Dehcho First Nations 2011; WRRB 2012). Boreal caribou habitat was also identified along the Nǫdìi Plateau on the west side of Whatì (Chocolate 2011; WRRB 2012). Tłı̨chǫ Elders highlight specific islands on Lac La Martre and the North Arm of Great Slave Lake that provide critical habitat when boreal caribou calves are young and during the summer months (Legat *et al*. 2018). Islands that provide boreal caribou habitat include *Tadłaadìı* on the lake known as Whatì (Lac La Martre) and Dinàgà in the North Arm of Great Slave Lake (Legat 2013). According to the Elders, *tǫdzı* prefer the plateaus during the fall rutting season (late September or early October) and during spring calving (May) (Legat 2013). Other more recent consultations with Elders have confirmed the presence of boreal caribou southwest of Whatì (Chocolate *et al.* 2015, *Appendix B* - 1), and in the regions of Lac La Martre and the north arm of the Great Slave Lake (GNWT 2012, *Appendix B* - 2; Wong and Kiistoff 2020, *Appendix B* - 3). Figure 5 presents more recent data on boreal caribou presence in near Lac La Martre in the Tłı̨chǫ region.

Boreal caribou are seen west of Gamètì towards the Keller Lake area, and from Edéhzhíe area extending north. Participants in a 2010 meeting in Gamètì to discuss boreal caribou recovery planning agreed with a range boundary that showed the edge of the boreal caribou range at Gamètì; no one at the meeting reported seeing boreal caribou east of Gamètì (Environment Canada 2010d [Gamètì]). One Elder said that boreal caribou are spread out in low numbers, so it is hard to know the actual boundaries of their range (Environment Canada 2010c [Behchokǫ̀]). According to workshop participants in areas around N'Dilo and Dettah, boreal caribou are found in low numbers throughout the region (Cluff *et al*. 2006). Other consultations with Elders in the region revealed that their knowledge of the eastern edge of the range of the boreal caribou differed from the range mapped by biologists (Legat *et al*. 2018). Elders noted that boreal

caribou may sometimes travel within the Canadian Shield portion of the range mapped by biologists, but that the primary range of the boreal caribou is located to the west and south of Lac La Martre (Figure 6). Tłı̨chǫ Elders in Behchokǫ̀ and Whatì reported similar known ranges (Wek'èezhìı Renewable Resources Board 2017, *Appendix B* - 4).

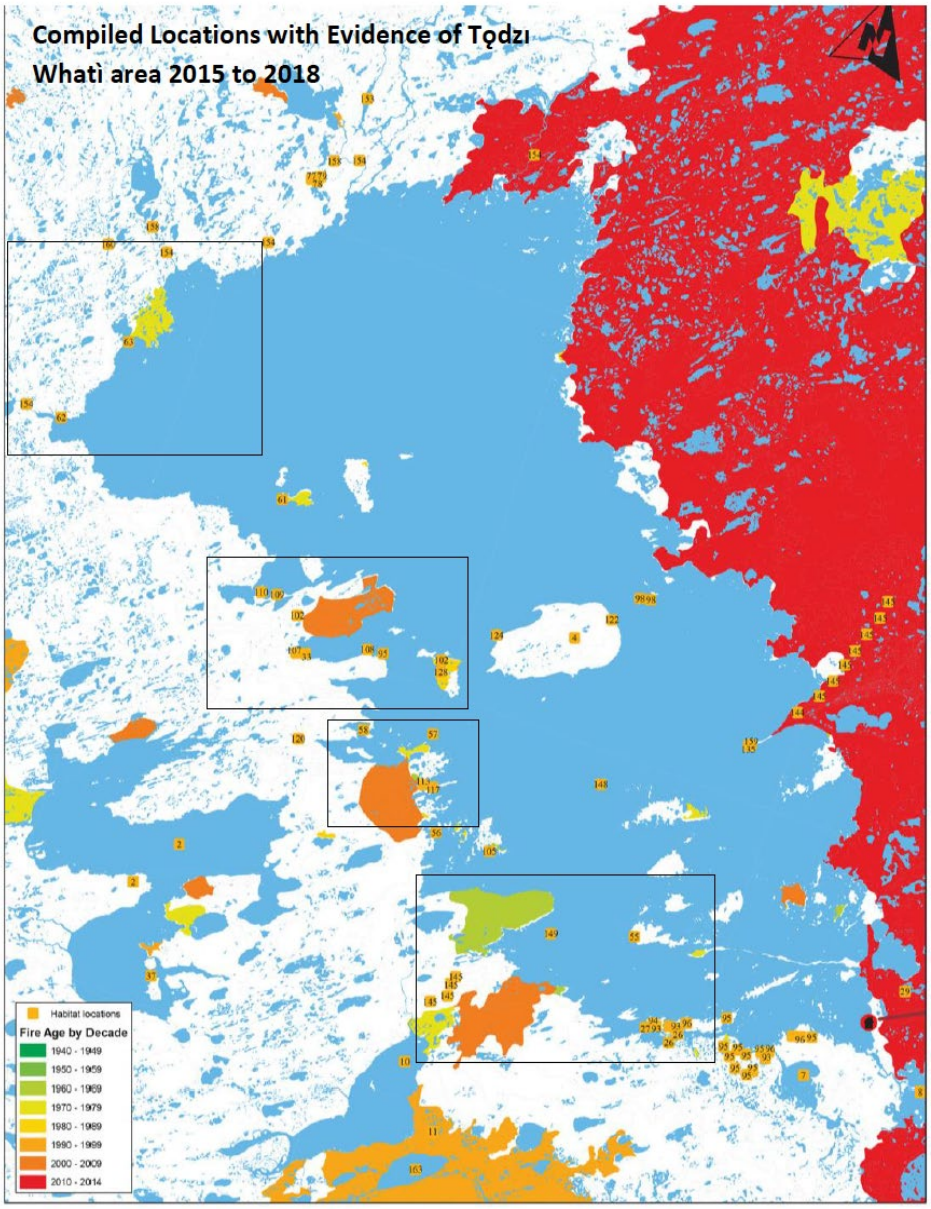

Figure 5. Locations bearing evidence of Tǫdzi (Boreal Caribou) presence on Lac La Martre in the Whati area of Tłı̨chǫ from 2015-2018 (Legat *et al.* 2018).

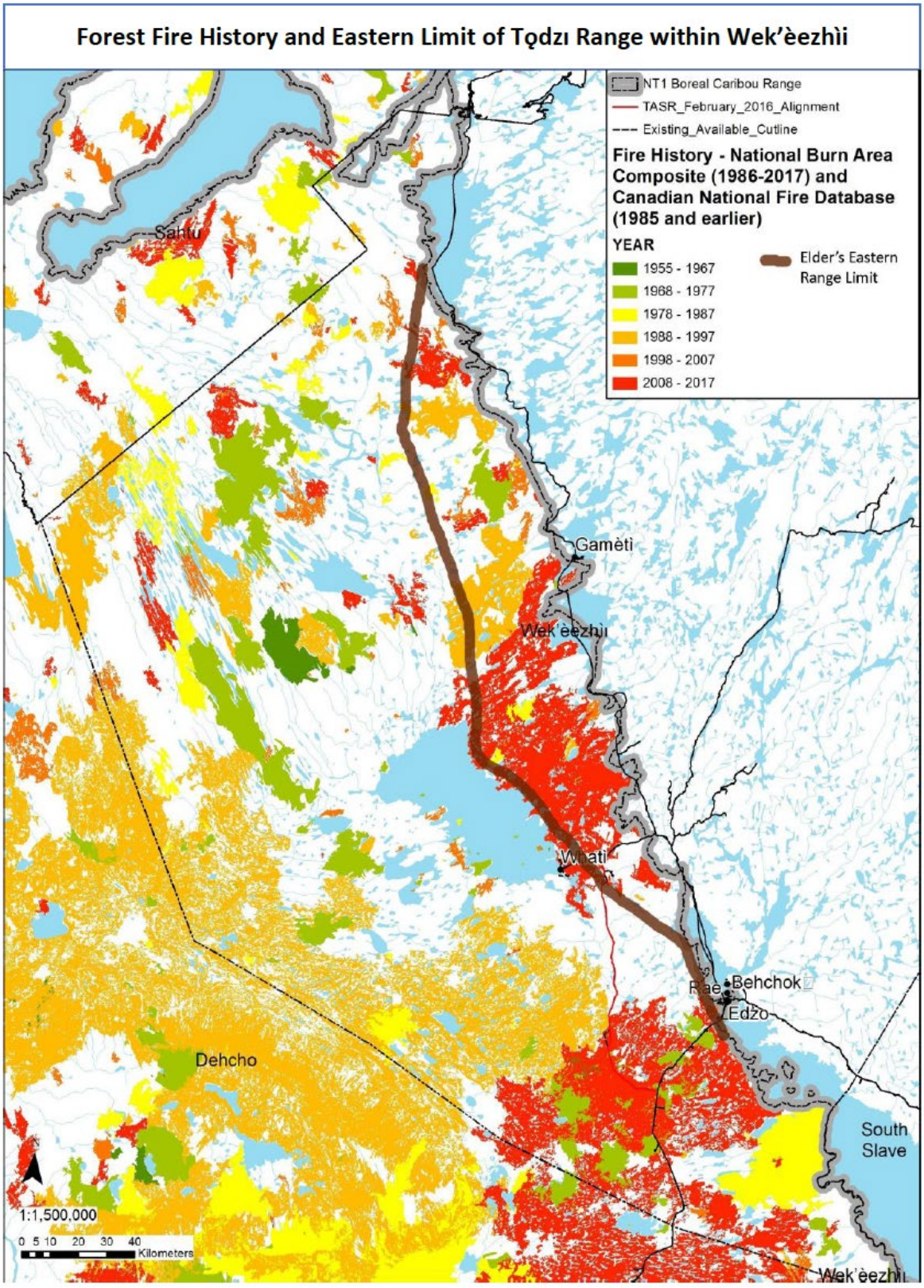

Figure 6. Eastern limit of woodland caribou range and history of fire in the Tłı̨chǫ and North Slave regions (Legat *et al*. 2018).

Search Effort

"Search effort" refers to how well hunters know where the boreal caribou are, based on their knowledge of boreal caribou behaviour. With regard to Indigenous and community knowledge, search effort can often be reflected by hunting patterns. However, this concept of search effort is not as easily applicable or relevant for boreal caribou as for some other more regularly harvested species because boreal caribou harvesting is primarily opportunistic and at a relatively low rate.

Boreal caribou were said to be hunted opportunistically by the Gwich'in, the K'átł'odeeche First Nation, and by harvesters attending Environment Canada meetings in Gamètì and Whatì (Gunn 2009; Environment Canada 2010b [Whatì], 2010d [Gamètì]; Benson 2011). For the most part, boreal caribou are harvested if seen while travelling along trails, roads, and by boat along the shoreline, or taken while hunting or trapping other species. Similar hunting patterns (opportunistic harvests and relatively low harvest rates) were documented for Behchokǫ̀, as well as for communities in the SSA and ISR (Olsen *et al.* 2001; Nagy *et al.* 2002; Zimmer *et al.* 2002; ENR 2007e [Paulatuk]; Environment Canada 2010c [Behchokǫ̀]).

There is some evidence that boreal caribou used to be hunted more actively in the past, and even snared at times (Nagy *et al.* 2002; Gunn 2009). For example, before contact there were people in the Sahtú region called Bedzikatįnœ that harvested boreal caribou and lived in strategic locations to hunt them. Hunters would kill up to 30 animals and then move the whole camp. Oral history documents the distribution and numbers of boreal caribou around Great Bear Lake (Bayha *in* SARC 2012: 15).

There are few records documenting how much time or area was 'searched' for boreal caribou in the past. A more appropriate method of assessing search effort is to directly ask experienced hunters and Elders whether it is harder or easier to find boreal caribou today, and whether there are more or fewer hunting opportunities now than in the past. This type of information was not successfully collected or targeted in most of the studies reviewed for this report. If collected, this type of information would indicate whether caribou are easier or harder to hunt than in the past but would not reveal much about why they are easier or harder to hunt, which may be confounded by population changes and methods used for hunting (see below).

Boreal caribou are generally only hunted in the winter when access to their habitat is possible using snow machines. However, they flee from motorized vehicles and are difficult to hunt. They are easier to hunt when travelling on foot or with a dog team (Gunn 2009; Benson 2011). In the Dehcho region, the change from the relatively quiet transportation of dog teams to snow machines is partly responsible for a reduction in boreal caribou sightings (and an observed decline in boreal caribou harvesting) (Dehcho First Nations 2011). Tłı̨chǫ Elders have noted that boreal caribou are difficult to hunt due to their intelligence and acute senses, and have identified

areas hunters frequent for the hunting of woodland caribou (Chocolate *et al.* 2015, *Appendix B* – 5).

In the GSA, boreal caribou are not specifically sought when hunting as they do not migrate in large groups and are dispersed at low densities through their range (Benson 2011). Members of the K'átł'odeeche First Nation reported similar themes when interviewed about boreal caribou: the animals are uncommon in their region and loosely dispersed; participants seldom see boreal caribou and therefore rarely harvest them (Gunn 2009). Most sightings occurred when people were travelling by snow machine and in winter – generally between December and March; travel through muskeg was too difficult at other times (Gunn 2009). Gunn (2009) suggests that frequency of encounters may reflect human use of the landscape rather than boreal caribou abundance, and that a comprehensive documentation of the type and frequency of peoples' use of any area would be required to interpret the frequency of encounters. Some Elders of the K'átł'odeeche First Nation indicated that in the past, people encountered and hunted boreal caribou more regularly (Gunn 2009).

Meeting participants in Fort Resolution said they do not generally hunt boreal caribou (ENR 2007b [Fort Resolution Métis Council]). During an Environment Canada meeting in Whatì, people said that they do not harvest as many boreal caribou as they used to, because there are fewer than there used to be (Environment Canada 2010b [Whatì]). This was confirmed in 2017 when Deninu Kue First Nation hunters related that most members do not specifically hunt for boreal caribou, but that they will harvest them opportunistically if seen while out hunting and trapping for other animals (d'Entremont 2017). Furthermore, they indicated that residents of Fort Resolution have no specific areas where they hunt caribou, but instead have more generalized hunting areas where they hunt and trap a variety of wildlife species. North Slave Métis Alliance community members in the region stated that they generally prefer hunting barren-ground caribou instead of woodland caribou and that the two subspecies are generally hunted using different methods (Wong and Kiistoff 2020, *Appendix B*-6).

Dene hunters highlight the importance of understanding the difference between caribou subspecies and their unique behaviour as fundamental to a successful hunt (Polfus *et al.* 2016). They note boreal caribou are extremely sensitive to the presence of humans, and that during a hunt it is essential to anticipate their actions. In particular, they use the Dene phrase *goecha fehtə* to describe how boreal caribou, if followed, will loop back upon their own trail to lie in wait downwind in a sheltered area in order to determine if they are being followed by a predator. For a hunter to be successful, the Dene describe the *goecha gots'anele* approach "to hunt from downwind", having the hunter loop around behind the caribou to secure their position further downwind, so as to remain undetected as they move in. Dene hunters noted that moose also exhibit this looping behaviour, but *ɔekwę́* (Bluenose east barren-ground caribou) and *shúhta goɔepę́* (mountain caribou) do not.

In a series of interviews in 2018, Acho Dene Koe First Nation identified 33 caribou hunting sites, although some sites were noted as associated with the northern mountain populations of woodland caribou rather than the boreal caribou (Acho Dene Koe First Nation 2018). The Acho Dene Koe First Nation reports that despite the historical and cultural significance of the boreal caribou to their peoples, the Nation's members have considerably changed their hunting practices in recent years in response to increasing levels of concern about the wellbeing of the species. They now target other large ungulate species, that are increasingly encountered more frequently. However, members of the Nation have still continued to harvest boreal caribou, and when this occurs a priority is placed on sharing within the community and the usage of each part of every animal.

One emerging barrier affecting searching and tracking efforts in locating boreal caribou is a rapidly changing climate (Parlee and Maloney 2017). Information collected during *Sahtú hé Dəocha hé Dene Naó werá Chets'elə* (Great Bear Lake and Mackenzie River Dene Knowledge) Research Camps in 2016 indicated that it was commonly noted that ice in the Mackenzie River Basin did not freeze as thickly as in past, as well as melting earlier and faster with freeze-up and break-up times becoming irregular. These recent changes have resulted in a reduced ability to travel on the land and in the region during the winter. One knowledge holder noted, "You have to really watch where you're going. You have to check the ice before you cross the lake. But it's not as thick as before so you really need to watch." (Parlee and Maloney 2017). Participants from the DehCho K'ehodi Youth Trip (Fort Simpson to Willow Lake River) all commonly described how changes in ice and snow had dramatically impacted travel, making it more difficult and more dangerous. They strongly agreed that the ice in their regions had become dramatically thinner, and the consistency had changed to become more slushy. They also noted that changes in permafrost thaws, including thawing frost heaves and increased craters and lumps across the land, had impacted the ability to travel and limited accessibility to certain important places for harvesting (Parlee and Maloney 2017).

These observations are directly relevant to the forthcoming discussion of *Distribution Trends*, located under *Key Habitats.*

Changes in Distribution

As noted above, boreal caribou are elusive and seen irregularly, and many interviewees and workshop participants did not feel comfortable discussing distribution or other trends for this reason. When trends were noted, it appears that changes in distribution are variable and local, and probably relate to numerous factors. Trends in distribution and local trends in population are also difficult to separate as hunters will report on observations and sightings. For example, if boreal caribou are not observed in an area where they were in the past, it may relate to population declines or movement to other areas (population trends or distribution trends).

People in Fort McPherson said they see patterns in boreal caribou distribution over time—the caribou may leave an area for some time (decades) and then may return (ENR 2007h [Fort McPherson]). Indications of increasing or decreasing local populations may be hard to discern as hunting pressure will cause boreal caribou to move out of an area, giving the appearance of a decrease in population (Benson 2011).

Gunn *et al.* (2004) used a database from the Dehcho First Nations with 1,070 boreal caribou harvest kill sites from the previous 60 years, and sightings from a 2002 aerial survey to compare current and past boreal caribou occurrence and occupation in the Dehcho region. The study revealed that boreal caribou occupation had not changed at the regional level (Gunn *et al.* 2004).

In 2002, John Nagy interviewed a small number of people in the ISR and recorded boreal caribou sightings and harvest information for 26 Inuvialuit hunting areas spanning approximately 80 years (Nagy *et al.* 2002). Overall, the results were inconclusive in regards to distribution trends.

Various observations have been made about areas where boreal caribou used to be seen but are no longer seen. During meetings held in communities in the GSA, the ISR and the SSA from 1996 to 2000, participants indicated that they had not seen boreal caribou within portions of their range for about a decade (Nagy *et al.* 2002). During a boreal caribou consultation meeting held in Inuvik, participants said that in the 1970s and 1980s there used to be more boreal caribou towards Aklavik and Tsiigehtchic, but people hardly see them in these areas anymore (ENR 2007g [Inuvik]). A later study on boreal caribou confirmed that they do not occur in the Mackenzie Delta at all, so perhaps the observations in the 1970s and 1980s were of Porcupine caribou near Aklavik (Benson 2011).

Colville Lake residents in the SSA indicated that they had not seen boreal caribou near their community since the 1960s (Zimmer *et al.* 2002).

During Environment Canada meetings in Whatì in 2010, one Elder stated that they used to see boreal caribou around Marten Lake, but now they do not see many anymore (Environment Canada 2010b [Whatì]). Workshop participants in Behchokǫ̀ indicated that they used to see boreal caribou in the Mackenzie Bison Sanctuary but had not seen them there in more recent times; the wood bison population had increased in this area at the time of these observations (Environment Canada 2010c [Behchokǫ̀]). In the Tłı̨chǫ region, it was reported that fires since the mid-1990s had caused boreal caribou to move north and west closer to the Mackenzie River (WRRB 2012). Caribou harvesters from Tłı̨chǫ and surrounding regions further expanded on this past phenomenon through noting changes in caribou distribution in their area: harvesters noted that caribou had moved further west and northwest from their region (Legat *et al.* 2018). Tłı̨chǫ Elders in Behchokǫ̀ and Whatì also reported changes in occupancy and distribution of woodland caribou in their region, noting that such changes may be related to patterns of wildfire, with

caribou first being affected by fires in their region prior to 2014, and fires in the SSA following that period (Wek'èezhìı Renewable Resources Board 2017, *Appendix B* - 4).

Acho Dene Koe First Nation knowledge holders identified former habitat sites in the Dehcho region where caribou are no longer seen (Acho Dene Koe First Nation 2018). One Acho Dene Koe knowledge holder noted that Bovie Lake no longer shows signs of caribou habitation, despite once indicating evidence of caribou habitation (as discussed in *Habitat Trends and Fragmentation*; Acho Dene Koe First Nation 2018). They also noted areas where observations were increasing likely due to reduced seismic activity in recent years (Acho Dene Koe First Nation 2018)

There were no specific observations recorded of areas where boreal caribou now live, that they did not in the past. However, in the Sahtú where the boreal caribou typically ranges throughout the Mackenzie River valley between the foothills of the Mackenzie Mountains and the edge of the treeline to the east of Great Bear Lake, it has been reported that caribou may be moving northward to become more available in Dehlá Got'ıne territory (Sahtú Renewable Resources Board 2020).

Movement and Dispersal

Movement Patterns and Scale

Boreal caribou are not generally known to migrate the long distances typical of barren-ground caribou herds, but they do make seasonal movements in response to changing habitat needs throughout the year (as discussed in detail in *Seasonal Habitat Requirements*). For example, Inuvialuit hunters described boreal caribou moving within their area to the best available habitat, to find certain features in the habitat, and in response to extreme weather events (ENR 2007e [Paulatuk] and 2007f [Tuktoyaktuk]). Tłı̨chǫ Elders' oral narratives describe how boreal caribou camouflage themselves within thick bush, cover themselves with mud for protection from insects, travel in circles to avoid predators, run quickly if the terrain is hard and use both high plateaus (uplands) and islands, depending on the season (Legat 2013).

Boreal caribou movements tend to be most restricted in later winter months when they concentrate in larger groups in patches of suitable habitat (Dehcho First Nations 2011). These reduced movements are likely related to snow conditions, thermal requirements, and shifts in habitat preference; predation and noise disturbance are thought to be contributing factors (Sambaa K'e Dene Band 2009; Allaire *et al.* 2010; Joint Review Panel 2010; Dehcho First Nations 2011). In the GSA, boreal caribou group together in winter for protection from predators before separating to calve (Benson 2011). In spring, there is generally a movement to suitable calving habitat. It is possible that females that will be calving have different movement patterns from barren females (Ruttan *in* SARC 2012: 34). Boreal caribou move around less in the summer but start to move more in the late summer and early fall. They move around during the fall rut and

post-rutting time to use various habitats. People often see boreal caribou in the fall as they cross or move along water bodies (Dehcho First Nations 2011).

In the SSA it has been reported that boreal caribou do not migrate very far during any time of the year, although in Tuĺıt'a and Norman Wells some boreal caribou leave with the barren-ground herd when they move back north (Olsen *et al.* 2001). However, it has also been reported that boreal caribou migrate seasonally and move hundreds of kilometres within areas as large as 1000 km^2; the group of boreal caribou hunted by Délı̨ne Dene are an example of this (Bayha *in* SARC 2012: 35). Legat (2013) concluded that the boreal caribou in the Sahtú region have similar movement patterns to the boreal caribou movement patterns in the Tłı̨chǫ region based on McDonald's (2010) work.

In the Dehcho region, the types of habitats that are available strongly influence the movements of boreal caribou, so much so that different groups of caribou in different areas will have differing movement patterns (Gunn 2009; Dehcho First Nations 2011). Some boreal caribou make significant, linear seasonal movements to different habitat areas. Others remain for the most part in large multi-habitat areas and simply shift their pattern of use of those areas based on seasonal habitat preferences (Dehcho First Nations 2011). Specifically, the Edéhzhíe, Cameron Hills and Nahanni Butte areas have the mixed habitat required for the caribou to refrain from the seasonal linear movements documented elsewhere; in these areas, caribou move or 'rotate' between rolling forested hills and open muskeg / mixed forests (Dehcho First Nations 2011). Boreal caribou used to move seasonally between Beaver Lake and the base of Edéhzhíe in late summer and early fall, returning in early spring. However, study participants noted that this pattern has diminished, possibly due to expansion of wood bison in the area (Dehcho First Nations 2011).

In the area of Wood Buffalo National Park, a range of movement behaviour was reported in the 1930s (Soper 1942 in Gunn 2009) and confirmed in Gunn's 2009 study. Movements of boreal caribou in the eastern part of the park were described as erratic from year to year, while in other areas, regular seasonal movement patterns were identified, and yet other groups were described as sedentary or non-migratory. K'átł'odeeche participants indicated that boreal caribou can be variable in their movement behaviour and that they are particularly elusive when they have calves (Gunn 2009). The study documented numerous movement patterns (see Figures B7, B8, and B10 in *Appendix B*). Participants described seasonal boreal caribou movements that entailed significant elevation changes, possibly ranging from 380m to 600m, depending on where they descended from the Caribou Plateau in Alberta (Gunn 2009).

In the area of Wood Buffalo National Park, some boreal caribou groups were reported to have seasonal migrations of between 50 and 125 km in each direction, while others were described as sedentary (Gunn 2009). Movement distances were not generally recorded in other available Indigenous and community knowledge sources.

In addition to seasonal movements, daily movement patterns have also been recorded in some areas. Gwich'in hunters noted that boreal caribou will feed in open areas during the day and move to the protection of wooded areas at night (Benson 2011). Similarly, a K'átł'odeeche First Nation study participant reported that boreal caribou will lay down for the night along a line of spruce trees (Gunn 2009).

Elders from the Tłı̨chǫ region shared that when the resources upon which caribou depend are depleted due to habitat loss, degradation and fragmentation, they will move to more favourable locations within their range (Legat *et al.* 2018). The Elders further noted that boreal caribou are sensitive to noise and smells and if they smell predators or hear loud motors, they will move to thick bush to hide (Legat *et al.* 2018).

Travel Routes and Preferences

In winter, boreal caribou travel wherever there is hard ground and adequate cover provided by forest growth (McDonald 2010). Participants in a meeting in Sambaa K'e (formerly Trout Lake) said boreal caribou tend to stay on high ridges, not moving very much, when there is soft snow (ENR 2006b [Trout Lake]). In Fort Good Hope, participants said that in winter, boreal caribou come out of the mountains along main river drainages (Olsen *et al*. 2001).

Boreal caribou are known to move along the Mackenzie River corridor west of Déljne (Great Bear Lake Working Group 2005) and are known to live throughout the Mackenzie River valley in the Sahtú region, which also includes travel corridors for Bluenose west and east barren-ground caribou (Sahtú Renewable Resources Board 2020).

It has been noted that on Edéhzhíe, boreal caribou trails are embedded in the moss due to ongoing use (Dehcho First Nations 2011). There are movement corridors on Edéhzhíe between winter areas, summer areas, and calving areas (Deh Cho First Nations 2001). Boreal caribou have been observed to follow seismic lines and linear disturbances if they are heading in the appropriate direction; this movement was noted in particular in the summer (Gunn 2009; Benson 2011).

In the Dehcho region, knowledge holders reported several migration routes frequented by the boreal caribou, including one route between Bovie Lake and the Arrowhead River connecting the NWT to northern British Columbia, and another route from TooChoo (Celibeta) Lake north toward Arrowhead River that provides important food for caribou during their journey (Acho Dene Koe First Nation 2018). These routes were based on the provision of important food resources for the caribou; knowledge holders noted that if food resources are diminished it may alter migration routes. These knowledge holders also identified that the numbers and movements of predator populations such as wolves also impact migration routes. In general, each herd has a certain habitat range and boreal caribou do not migrate vast distances, but rather follow familiar migration routes within their ranges. Acho Dene Koe First Nation

knowledge holders also noted the use of human transportation routes by various forms of wildlife, observing that caribou had been seen walking along pipelines and wolves had been observed to follow snowmobile trails to access hunting areas (Acho Dene Koe First Nation 2018).

Barriers to Movement

There is some indication that human-made features can present a barrier to boreal caribou movement in some cases. In Wrigley, boreal caribou used to come to the highway in spring, but after the pipeline came through, they changed their movement patterns. The caribou stayed on the east side of the mountains for 4-5 years and did not come down to the highway (ENR 2006c [Wrigley]). Boreal caribou are known to cross the highway between Enterprise and Kakisa (ENR 2007a [K'átł'odeeche First Nation]).

Rivers may also present a barrier to movement in some cases; however, there are differing perspectives on this. In the southern portion of the Hay River area, boreal caribou do not cross over the Hay River and Mackenzie Highway and do not mix with the caribou on the other side (Dehcho First Nations 2011). In Gunn's (2009) study, some participants reported discrete groups of boreal caribou on either side of the Hay River that stay separate and do not cross the river. Other participants agreed that based on the many boreal caribou tracks seen in that area, they did not think that caribou would swim across the Hay River. There was no explanation as to why the boreal caribou would not cross the river in winter when frozen (Gunn 2009). However, another study participant described two boreal caribou movement routes that both entailed crossing the Hay River (Gunn 2009). In other parts of the Dehcho region, caribou populations are noted to mix (Dehcho First Nations 2011), implying that rivers are not always a barrier to movement. Dehcho harvesters and Elders indicated the likelihood of an east-west migration of boreal caribou across the Mackenzie River (Larter and Allaire 2006a).

Wildfires in the 1990s and 2000s were said to drive boreal caribou from the Tłı̨chǫ and North Slave regions into the SSA (Cluff *et al.* 2006). In the Dehcho region, boreal caribou tend to avoid burned areas when feeding, but there is some evidence that they may use the burned areas as travel corridors and that some foraging on fresh growth does occur (Dehcho First Nations 2011). However, they do not frequent burned areas in the mid to late winter, even for travel purposes (Dehcho First Nations 2011). Because boreal caribou are thought to avoid areas that have burned (see *Wildfires*), wildfires could potentially create 'barriers' that change boreal caribou movement patterns. Other knowledge holders from the North Slave region substantiated this, remarking that boreal caribou move in response to fires and that while migrating to preferred habitat, they will travel through burned areas if grasses and bushes have recovered to a satisfactory level, noting that grass is their preferred food (Legat *et al.* 2018). Further comments from knowledge holders regarding boreal caribou preferences around food and fire can be found in the *About the Species* section of the report under the *Diet and Feeding Behaviour*.

In the Sahtú region, Whitefish Lake, which is located at the headwaters of the Anderson River and is home territory of the *T'ashrn Got'rne*, has been identified as an important caribou hunting area (Parlee 2016). Although the subspecies of caribou hunted was not specifically identified by the knowledge holder, it was noted that the lake is located on a caribou migration route with ancient caribou fences in the area.

Key Habitats

Habitat Requirements

In most of their range within the NWT, boreal caribou tend to spend time in habitat characterized by dense spruce or pine forests and/or areas of muskeg, in habitat that differs from that chosen by moose, white-tailed deer or wood bison. While they are also observed along shorelines, river edges and open tundra, it is thought that they may be more frequently sighted in open areas because they are easy to see in this type of habitat; these observations do not necessarily indicate a preference for open areas. The animals are extremely difficult to spot in the brush, whether from the ground or by air (Zimmer *et al.* 2002; Gunn 2009; Benson 2011; Chocolate 2011; Dehcho First Nations 2011).

As in most areas, preferred boreal caribou habitat in the SSA was described as mainly spruce forest with ground lichens (Johnson and Ruttan 1993). Research based on the Dehcho database of lifetime kills determined that boreal caribou were strongly associated with black spruce and lichen on both uplands and lowlands (Gunn *et al.* 2004). Study participants in both the GSA and SSA indicated that ridges or hilly areas are important terrain for boreal caribou (Zimmer *et al.* 2002; Benson 2011), and one Gwich'in hunter felt that higher areas and hillocks were more important to boreal caribou than wooded areas. The hunter said that the spruce-covered hillocks between Fort McPherson and Tsiigehtchic in the GSA were good examples of boreal caribou habitat (Benson 2011). In the Sahtú, the majority of people interviewed said that boreal caribou have a preference for alpine areas and uplands, with muskeg and dense vegetation also being important (*Zimmer et al.* 2002). Interview responses from the SSA regarding habitat are summarized in Table 4.

The Délı̨nę Got'ı̨nę Plan of Action emphasizes the importance of *kw'ıjí* for caribou—the literal translation of which is "mosquito berry hill" (Neyelle *et al.* 2016). This habitat type is fairly unique in the Sahtú Region, and is similar to an ecosystem classification or biogeoclimatic zone (Neyelle *et al.* 2016). *Kw'ıjí* is "characterized by well-drained, slightly higher terrain, covered in old growth black and white spruce forests", and the Délı̨nę Got'ı̨nę Plan highlights the need to protect *kw'ıjí* for caribou (Neyelle *et al.* 2016; see the section *Positive Influences*).

Table 4. Habitat types used by boreal caribou in the Sahtú Settlement Area as recorded during 40 community interviews, Feb-Apr 2002 (from Zimmer *et al.* 2002).

Vegetation Type	Number of Observations
Mountains/ high hills	50
Muskeg	20
Dense vegetation	20
River shore/ beach	16
Old growth forest	12
Edge of a burn	10
Lichen	4
Ice in the summer	4
Open areas	3
Non-burnt areas	3
Burnt areas	1
Drier areas	1
All types of vegetation	1
Total	**145**

South from K'átł'odeeche and around the west end of Buffalo Lake, the landscape resembles prairie with few small trees creating habitat described like "little islands". Travellers through this area reported that they often saw boreal caribou and/or their sign in this open country. They reported that the caribou like to go where the habitat is open like this and noted that caribou are seen using prairie-like habitat west of Buffalo Lake. This is an area where some K'átł'odeeche First Nation members hunt boreal caribou (Gunn 2009).

K'átł'odeeche First Nation members also pointed out the importance of water bodies to boreal caribou (in Gunn 2009). Rivers, creeks and lakes were mentioned in sightings during seasons other than winter, and participants said that boreal caribou like to live near little lakes. This is consistent with findings from Legat *et al.* (2018), for the North Slave region, which reported that caribou prefer to occupy areas around lakes or protected streams in the summer. Caribou sightings reported by K'átł'odeeche First Nation members showed concentrations of caribou

around Swan Lake, and north and west of Buffalo Lake (see Figures B7 and B8 in *Appendix B).* People said that the selection of wet areas was for predator avoidance during calving (more on this topic is included below and in *Threats and Limiting Factors*). It was suggested at a public meeting that boreal caribou will also seek out the water to avoid insects (ENR 2007k [NWT Métis Nation Board]). As of 2019, K'átł'odeeche First Nation developed a Dene Yati vegetation classification system, which has enhanced landscape classification accuracy in relation to preferred boreal caribou habitat. The system highlights the importance of using Indigenous knowledge as the basis for research and then adapting contemporary satellite and GIS technology to analyze and depict that knowledge in map format (K'átł'odeeche First Nation 2019).

Prominent hunting areas used by Acho Dene Koe First Nation include areas near water sources, such as the Petitot River. Acho Dene Koe First Nation community members engaged in land use planning activities emphasized the importance of clean water sources for maintaining healthy boreal caribou populations (Acho Dene Koe First Nation 2018).

Tłı̨chǫ Elders describe a diverse variety of landforms that provide habitat for boreal caribou (Legat *et al.* 2018). Caribou forage for all vegetation except juniper and bushes with thorns when on dry land. Tłı̨chǫ Elders state that boreal caribou favour regions underlain by a mixture of black and sandy soil covered by sparse vegetation throughout the year to find forage vegetation as well as to be able to run to areas of thicker bush. Boreal caribou habitat features in the Tłı̨chǫ region may provide multiple life requisites, including predator and insect avoidance, food and temperature regulation. In particular, Tłı̨chǫ Elders note the importance of rivers for boreal caribou: boreal caribou gather at the oxbow morphology of rivers to forage on preferred vegetation and spend time in the water, and are known to forage for the rich vegetation associated with highly sinuous streams that flow into lakes. These sinuous stream habitats also provide thick willow patches (often located at stream bends), which allow caribou to hide from predators. Boreal caribou use areas where rivers widen to cool off and forage for grasses and willows. They also frequent banks with short, steep shorelines (1 - 15 feet) topped with grasses and bushes to browse on vegetation, escape from insects in the water and find shade under the larger trees at the top of the bank (Legat *et al.* 2018).

Tłı̨chǫ Elders also highlight the role of other types of water in sustaining boreal caribou (Legat *et al.* 2018). Boreal caribou use narrow lakes and small ponds that they can swim across to find forage vegetation. Tłı̨chǫ Elders know that boreal caribou use 'water-soaked land' and water holes to sink into the water to escape from insects as well as to browse on surrounding grasses and other vegetation. Boreal caribou also use sandy beaches to graze for grasses and cool off in the water while avoiding insects. Upon sensing nearby predators, boreal caribou will escape from the beaches to the adjacent thick bush (Legat *et al*. 2018).

Tłı̨chǫ Elders describe the importance of other terrestrial habitats for providing boreal caribou habitat, including meadow habitats which provide boreal caribou with grasses, sedges, berry bush leaves, berries and mosses to eat (Legat *et al.* 2018). Tłı̨chǫ Elders say that boreal caribou forage for vegetation and avoid predators in the thick trees and bushes associated with wide valleys, water bodies and watercourses between two large hills or mountains. Tłı̨chǫ community members may observe boreal caribou tracks in these valley habitats, but Tłı̨chǫ Elders state that boreal caribou themselves are never seen in these valleys (Legat *et al.* 2018). Boreal caribou use these habitats between hills and mountains to avoid detection by predators by standing still for a long time. If there is no wind, boreal caribou will rest in dry valleys that predators do not pass through (Legat *et al.* 2018).

Boreal caribou are known to generally avoid industrial development, linear features, and areas recently burnt by wildfire (see d'Entremont 2017 and Legat *et al.* 2018; as discussed in *Threats and Limiting Factors*). While caribou tracks have been documented on highways, seismic cutlines, trapping trails and next to an airstrip during Gunn's study (2009), these human-made features may be at least a partial barrier to caribou movement (discussed in *Barriers to Movement*).

Seasonal Habitat Requirements

While boreal caribou do not migrate the long distances typical of barren-ground caribou, there is evidence that they move within their range to suit their requirements as the seasons change (e.g. Bayha *in* SARC 2012: 20). Because seasonal requirements appear to be a driving force in habitat selection, other specific habitat requirements are outlined here by season. The scale and pattern of these movements can vary and are discussed below in *Movements*.

In general, boreal caribou spread out across wetlands in the spring for calving, remain in wetland areas in the summer, and move through a range of habitat in the fall and early winter (Dehcho First Nations 2011; Legat *et al.* 2018). Tłı̨chǫ Elders' stories convey that the Tłı̨chǫ have always observed and harvested boreal caribou throughout *nǫdıı* (the place where boreal caribou belong), but that boreal caribou have preferred areas (Legat 2013). Boreal caribou in the Tłı̨chǫ region graze on various types of lichen in late fall and winter, and forage for various plants such as sedges, grasses, leaves, and berries in spring, summer and early fall (Legat 2013). When considering boreal caribou habitat requirements within a region, Tłı̨chǫ Elders emphasized the importance of understanding their character as it relates to boreal caribou movements and terrain use (Legat 2013). Together these factors protect both adults and calves from predators such as humans, wolves, lynx and bears (Legat 2013). For example, boreal caribou prefer thick bush habitat year-round, but particularly in winter when it is more difficult for caribou to remain camouflaged from potential predators such as humans, lynx, wolves and bears. Tłı̨chǫ Elders explain that boreal caribou prefer to be around water in the summer to benefit from a greater

abundance of food, to avoid bugs while cooling off, and to avoid wolves. Boreal caribou will move to islands in spring and summer with their calves (Legat 2013).

Boreal caribou habitat modeling based on Indigenous and community knowledge interviews with Deninu Kue First Nation community members indicates that suitable calving habitat tends to include wetland herb and shrub communities, while suitable winter habitat is generally made up of treed wetlands and open coniferous forest (d'Entremont 2017). Boreal caribou tend to remain close to areas where there are ground and arboreal lichens and sedges and grasses, such as white muskeg areas (Dehcho First Nations 2011). During winter, boreal caribou seek out thicker black spruce and pine forests close to muskeg and 'willow prairie' areas that have ground lichens, sedge and grasses (Dehcho First Nations 2011). Boreal caribou need access to all seasonal habitat types within their range to maintain a healthy population (Legat *et al.* 2018).

Winter Habitat

In winter, boreal caribou prefer thick bush (WRRB 2012). As snow depth increases, caribou move into denser canopy-covered habitats to better avoid predators (Legat *et al.* 2018). They concentrate in areas where the spruce or pine forests are thicker, arboreal lichens are available, and snow and lichen conditions are more favourable for feeding and mobility. During winter, caribou eat a variety of different lichen species (Legat *et al.* 2018). They spend less time in open and muskeg areas and they concentrate in larger groups. This over-wintering habitat is considered critical (Sambaa K'e Dene Band 2009; Allaire *et al.* 2010; Joint Review Panel 2010; Dehcho First Nations 2011).

Sambaa K'e Dene Band members noted that boreal caribou choose the thicker spruce during late winter months because the snow is softer and arboreal lichens are generally present, but that they also require access to open areas to forage for sedges and grasses during winter months (Sambaa K'e Dene Band 2009; Allaire *et al.* 2010). Based on two seasons of field surveys, and taking into account Indigenous and community knowledge information provided by Elders and harvesters, it was concluded that boreal caribou choose overwintering habitat based on a combination of specific vegetation characteristics, but generally choose habitat that provides dense cover, softer snow conditions, and ready access to a variety of winter forage. They also tend to move within a larger and more varied habitat range during early winter (October through December) than late winter (January through March). This movement appears to decrease and become more concentrated throughout winter, even within preferred habitat areas (Sambaa K'e Dene Band 2009). Elders and hunters in Sambaa K'e identified some important overwintering areas for boreal caribou, where boreal caribou move into concentrated numbers by late December and remain until March (Allaire *et al.* 2010).

As in other regions, suitable boreal caribou winter habitat in the Tłı̨chǫ and North Slave regions is characterized by both ground and tree lichens, and in winter the boreal caribou are said to

favour uplands and slopes where they can kick the snow away to feed (Chocolate 2011). Tłı̨chǫ Elders say that boreal caribou use thick stands of tall white spruce growing on a mixture of sandy and black soil covered with sparse vegetation in winter (Legat *et al.* 2018). Boreal caribou usually spend a lot of time in these white spruce areas after December, which is when deep snow has typically accumulated in the more open areas. This white spruce habitat allows boreal caribou to hide from predators and forage for lichen. At times the snow may be too deep for boreal caribou to access the ground lichens, so the caribou will switch to foraging for tree lichen. Tłı̨chǫ Elders say that boreal caribou use the tops of eskers in both summer and winter to find black rock tripe and lichen as well as to avoid predators. Winds keep these esker habitats relatively free of snow in winter, so boreal caribou may easily dig for food in these habitats. As observed for the Dehcho region, caribou habitat use in the North Slave region also shifts throughout the winter. Boreal caribou tend to use low and clear areas in early winter, where they can quickly escape from predators, but prefer areas of thick bush as snow depth increases (Legat *et al*. 2018).

Boreal caribou winter habitat selection patterns in the GSA generally align with those for the Tłı̨chǫ and North Slave regions. A Gwich'in hunter observed that the lesser amount of snow on hillocks in the winter makes it easier for the boreal caribou to dig food out (Benson 2011). Additionally, boreal caribou within the GSA generally tend to move to forested areas in winter, especially when it is foggy (Benson 2011). In the Sahtú region, the forest also provides shelter from winter winds and snowstorms (Johnson and Ruttan 1993).

Boreal caribou habitat requirements can be driven by extreme seasonal events such as 'icing' – when the weather warms enough to rain and then the rain freezes to ice. Meeting participants in Paulatuk said that icing can kill boreal caribou, as they can't get to their food (ENR 2007e [Paulatuk]). When there is icing, caribou will move somewhere else (ENR 2007f [Tuktoyaktuk]). Snow condition was also mentioned as a likely factor influencing where boreal caribou range. Tuktoyaktuk participants indicated that deep snow is difficult for caribou (ENR 2007f [Tuktoyaktuk]). In the winter, boreal caribou will follow snowmobile trails if the snow is deep (ENR 2007j [Tsiigehtchic]). One study in the SSA found that boreal caribou have a tendency to stay in one area in the winter months and move around more once the snow melts (Zimmer *et al.* 2002).

Spring Habitat

Predator avoidance during the calving period is a major factor influencing boreal caribou habitat choice in the spring. Calving habitat characteristics are described here; further information on predation avoidance during calving is included in sections on *Interactions* and *Threats and Limiting Factors*.

In most areas, boreal caribou are thought to seek out high ridges or very wet habitat in the spring (Johnson and Ruttan 1993; Gunn 2009; Environment Canada 2010b [Whatì]; Benson 2011;

Chocolate 2011; Dehcho First Nations 2011; WRRB 2012). Wetlands, for example, were documented as landscape features of high importance to boreal caribou during the calving period (d'Entremont 2017). Deninue Kue First Nation members reported that wet meadows (also referred to by the participants as "prairies") are important areas for boreal caribou during this time, as they provide both water and forage, while also offering good predator visibility and escape terrain. Wet sites also help boreal caribou and their calves to avoid being detected by predators (d'Entremont 2017). Boreal caribou are highly secretive when calving and tend to stay near these wet meadows and muskeg areas during this period (d'Entremont 2017; Gunn 2009).

Large lakes with islands have also been reported as important calving areas (Environment Canada 2010b [Whatì]; Legat *et al.* 2018). In the Tłı̨chǫ and North Slave regions boreal caribou reportedly travel to islands in the spring and summer to protect their calves from predation (Legat *et al.* 2018; WRRB 2012). Tłı̨chǫ Elders also say that boreal caribou use small, clear areas surrounded by grasses and trees, which allow the caribou to hide in the bush with their calves and forage for grasses and lichen (Legat *et al.* 2018). Some females migrate to islands in Great Slave Lake while there is still lake ice in the spring. Female boreal caribou also migrate toward Edéhzhíe to higher mountain areas to calve (Chocolate 2011).

Gwich'in harvesters felt it is likely that boreal caribou calve throughout their range in the GSA, but noted that caribou do seem to seek out high elevation areas or locations near the water where they can escape flies and mosquitoes by staying in the wind (Benson 2011). It should be noted that numerous Elders and hunters were asked about calving locations in the GSA, and generally the answer was that Gwich'in do not travel through potential calving areas during calving time, and were not comfortable saying with any certainty where boreal caribou calve (Benson 2011). In the SSA, Dene are taught to stay away from potential calving areas during calving time (Bayha *in* SARC 2012: 22).

Calving areas in the Dehcho region are also generally located in wetlands and marshes, but Indigenous and community knowledge indicates that burned areas that are difficult for predators to access are also used (Dehcho First Nations 2011). Calving areas documented in proximity to Wood Buffalo National Park were very large, suggesting that boreal caribou disperse to calve (i.e. study participants didn't document specific sites, but general calving habitat) (see Figure B7, B8, and B9 in *Appendix B*; Gunn 2009). Gunn indicated that several participants may have been inferring boreal caribou calving areas from their knowledge of moose; overall, people said that boreal caribou choose the same kinds of places to calve as moose (Gunn 2009). Some of the areas identified as calving habitat during Gunn's study were also noted as important breeding and calving habitat for boreal caribou and many other species by participants in a Joint Review Panel meeting at Hay River in 2006 (Gau 2006 [Hay River]).

There were very few observations of boreal caribou calves mentioned in the available sources, however participants in a Sahtú study reported sightings of lone cow-calf pairs along the

Mackenzie River (Zimmer *et al.* 2002). No participants in Gunn's research reported seeing young calves; only one participant reported seeing older calves able to keep up with their mothers along the shores of Buffalo and Great Slave lakes (Gunn 2009).

Summer Habitat

In both spring and summer boreal caribou are often found in association with water (WRRB 2012). There were some observations that in both spring and summer months, boreal caribou generally move to meadows on high ground to feed, but will also move to rivers and lakes to avoid insects (Johnson and Ruttan 1993). In the Dehcho region, summer habitat for boreal caribou was described as muskeg or muskeg-accessible, including heavy moss over permafrost where the caribou will lie to remain cool (Dehcho First Nations 2011).

Tłı̨chǫ Elders note that boreal caribou use points of land covered with sparse vegetation to hide in the summer because people and wolves do not expect to find the caribou in these areas (Legat *et al*. 2018). Caribou use these sparsely vegetated habitats to find lichen, shade and water to cool off and avoid insects. These sparsely vegetated habitats also allow boreal caribou to observe and escape from approaching predators. Boreal caribou will similarly use open, flat areas on islands in the Tłı̨chǫ region to observe predators and escape into the surrounding bush. Boreal caribou also use ponds or small lakes in the Tłı̨chǫ region during the summer (especially in July) to avoid insects. Tłı̨chǫ Elders said that boreal caribou use the tops of eskers to find black rock tripe and lichen in the summer well as to avoid insects and predators. The ground surface associated with these esker habitats is hard and smooth, allowing caribou to run without hurting their legs (Legat *et al.* 2018).

Fall Habitat

Boreal caribou may travel to high ground during the fall (Johnson and Ruttan 1993). In the SSA, fog and ice fog are very common in early winter before freeze-up of the main rivers and lakes. Boreal caribou tend to stay away from these foggy conditions. Generally, boreal caribou (and moose) will move up into higher elevations, partly to get away from the fog and poor visibility, and partly because temperatures are generally warmer at higher elevations in the fall (Bayha *in* SARC 2012: 24).

Boreal caribou use various habitats as they move around during the fall rut and post-rutting time. Tłı̨chǫ Elders state that boreal caribou use small, clear areas surrounded by grasses and trees for rutting, and these habitats are often located on islands. (Legat *et al.* 2018). Boreal caribou will seek out trees to rub the velvet off their antlers, and may continue to seek breezy areas – even the Dempster Highway – to get away from insects (ENR 2007j [Tsiigehtchic]; Benson 2011). People often see boreal caribou in fall as they cross or move along water bodies. Open grassy areas are also used, but boreal caribou will still spend considerable time in muskeg areas (Dehcho First Nations 2011).

Habitat Trends

More research is needed to identify quantifiable trends in the amount of suitable boreal caribou habitat in the NWT based on Indigenous and community knowledge. A conclusive assessment of habitat trends for the NWT as a whole was not available, but a clear theme emerged from review of available Indigenous knowledge highlighting the alteration of boreal caribou habitat by wildfires. Specific concerns regarding current and future habitat trends include an increasing incidence and severity of fires; increasing patterns of human disturbance on the landscape; and climate change impacts to boreal caribou habitat (especially in conjunction with changing fire regimes). Details on these trends are included in *Threats and Limiting Factors*.

Community-based knowledge shared in traditional and Indigenous knowledge studies and boreal caribou meetings generally indicated that boreal caribou habitat in the NWT has not been as heavily impacted as caribou habitat in more developed areas to the south (see for example Environment Canada 2010a-d; Benson 2011; Dehcho First Nations 2011). In the Dehcho region, for example, boreal caribou habitat was considered to be relatively intact. With the exception of the Cameron Hills and Mackenzie Bison Sanctuary, there has been minimal change to boreal caribou habitat since the halt of oil and gas activities in the 1970s and many seismic lines have started to revegetate. While participants noted that revegetated seismic lines may not necessarily produce boreal caribou habitat, they reported that these recovering linear features do not seem to be a deterrent to use and that boreal caribou seem to have adapted to the landscape (Dehcho First Nations 2011). Acho Dene Koe First Nation knowledge holders stated that a substantial portion of boreal caribou habitat range in Acho Dene Koe First Nation territory in the Dehcho region of the NWT is undisturbed (Acho Dene Koe First Nation 2018). However, there are areas of disturbance with high-density linear features. In some areas reduced activity recently has allowed boreal caribou to return. But in the Bovie Lake area, these disturbances have made the habitat no longer hospitable for caribou due to a high-density of linear features surrounding the lake. This information aligns with the development footprint of Bovie Lake, which shows it is a highly disturbed area (Acho Dene Koe First Nation 2018).

Wildfires appear to be the primary cause of habitat loss in the NWT; for example, d'Entremont (2017) states that "[f]orest fires and anthropogenic disturbances (e.g., seismic lines, roads, transmission lines) are the two most significant factors that have affected the availability of boreal caribou habitat in the NWT." Similarly, several meeting participants stressed that wildfires are the main cause of caribou habitat loss in the Tłı̨chǫ region (Environment Canada 2010b [Whatì]). Tłı̨chǫ Elders highlight the emergence of "massive and intense fires that have come with climate change" and raise the issue that the behaviour and impacts of these new kinds of fires are not sufficiently understood (Legat *et al.* 2018). Comments from Gwich'in hunters indicate that wildfires in the GSA have been allowed to burn in recent decades, resulting in losses to boreal caribou habitat (Benson 2011). Specific areas impacted by wildfires in the

Dehcho region include south of Bulmer Lake, between Mills Lake and the base of Edéhzhíe, and immediately southeast of Beaver Lake (Dehcho First Nations 2011). Acho Dene Koe First Nation knowledge holders also noted that recent wildfires reported southwest of TooChoo (Celibeta) Lake destroyed local vegetation on which caribou depend (Acho Dene Koe First Nation 2018). Wildfires also resulted in a drastic loss of caribou habitat within the SSA in the mid-1990s, but the availability of boreal caribou habitat has remained fairly stable since, due to the low incidence of wildfires in recent years (McDonald 2010). More information on the impacts of wildfires on boreal caribou habitat is included in the section on *Threats and Limiting Factors.*

Climate change was also noted as a factor influencing trends in boreal caribou habitat quality and availability in the NWT. Participants in the Dehcho K'ehodi Youth Trip, for example, report that the landscape is changing as the permafrost thaws (Parlee and Maloney 2017). One participant observed that trees in muskeg habitats are uprooting and falling over, covering the muskeg like toothpicks, and that large craters in the ground are now found where big frost heaves used to be. Another participant echoed these sentiments, noting that the trees generally seem less healthy, and that it's becoming more difficult to travel in muskeg areas. Across the Mackenzie River Basin, there are widespread reports of decreased water levels and water flows, including dried up creeks. Warming winter temperatures have also led to earlier break-up and later freeze-up in many areas (Parlee and Maloney 2017). More information on climate change impacts to boreal caribou is included in the section on *Threats and Limiting Factors.*

Habitat Fragmentation

Habitat fragmentation (the breaking up of habitat into isolated sections) can be caused by a variety of natural and human influences, with implications for boreal caribou habitat quantity and quality. While little information is available from an Indigenous and community knowledge-based perspective on the total extent of caribou habitat fragmentation in the NWT, community knowledge sources did identify habitat fragmentation as a concern (e.g., Benson 2011) and reported on potential impacts to boreal caribou movement and habitat use.

Habitat fragmentation as a result of human-made features, such as roads and pipelines, may be at least a partial barrier to boreal caribou movement in some cases (discussed in *Barriers to Movement*). Both the direct impacts (i.e., the physical area disturbed by the activity), as well as the indirect effects of increased noise and activity, may contribute to habitat fragmentation. Many studies and study participants suggested that roads, seismic cutlines, and human activities that disturb habitat – such as seismic work or logging – can negatively impact boreal caribou. It was reported that boreal caribou tend to avoid linear features on the landscape, which can affect movement patterns and habitat use (discussed further in *Threats and Limiting Factors*).

Habitat fragmentation can also be caused by natural factors. Certain rivers, for example, can act as barriers to boreal caribou movement. Boreal caribou are also known to avoid areas recently

burnt by wildfires (d'Entremont 2017). These natural 'barriers' affecting boreal caribou movement patterns are discussed more extensively *in Barriers to Movement*.

The degree of boreal caribou habitat fragmentation in the NWT was not examined in the Indigenous and community knowledge sources reviewed for this report. The extent of habitat fragmentation and magnitude of impact to boreal caribou populations from an Indigenous and community knowledge-based perspective remains a key information gap.

POPULATION

Abundance

Boreal caribou sightings tend to be less common than sightings of other ungulates in all regions of the NWT. The available Indigenous and community knowledge sources did not include estimates of total abundance. Benson and Winbourne (2015) note that harvesters may quantify certain wildlife species and keep a mental record of these numbers for many years, but often the question is focused on "is there enough" rather than "how many are there."

Knowledge holders have reported qualitative estimates of population levels in the Dehcho and SSA. Despite a higher level of disturbance in their territory compared to the rest of the NWT, Acho Dene Koe First Nation knowledge holders indicate that healthy caribou populations consisting of healthy individuals still exist within their traditional territory [SW of the Dehcho region] (Acho Dene Koe First Nation 2018). This Acho Dene Koe First Nation knowledge suggests that caribou have managed to make effective use of the region for habitat (Acho Dene Koe First Nation 2018). However, it should be noted that due to the caribou's patterns of behaviour, it may appear that some boreal caribou groups are healthy while the species itself is at risk (Acho Dene Koe First Nation 2018). Boreal caribou remain relatively stationary in their habitat, living in small sub-groups (Acho Dene Koe First Nation 2018). A healthy herd may be subject to relatively little predation and disturbance, while a nearby herd may suffer from significant development pressures (Acho Dene Koe First Nation 2018).

The Sahtú Renewable Resources Board concluded there was sufficient conservation concern to trigger a hearing based on concerns about boreal as well as barren-ground and mountain caribou in the NWT (Sahtú Renewable Resources Board 2020). A community member from Norman Wells stressed the concern for boreal caribou given current abundance estimates:

"The boreal caribou are scarce and far and few between. There's not … lots of them. The point about them being sensitive and volatile is that they're small, little herds, anywhere from two, three to twenty, right? And they can get wiped out pretty quick." (Roger Odgaard [Normal Wells] in Sahtú Renewable Resources Board 2020)

Population abundance is an information gap; however, more information is available on observed population trends and fluctuations.

Population Dynamics

Indigenous and community knowledge on population structure and rates, such as age of parents and life span, does exist (Bayha *in* SARC 2012: 34), but minimal information on this topic was available in the sources reviewed for this report. Future Indigenous and community knowledge studies could be targeted to address this gap in the documented literature.

Benson (2011) noted that caribou cows may not breed and calve if their body condition does not support it (see the section *Threats and Limiting Factors*). Dispersal and immigration of boreal caribou were not specifically addressed in the available Indigenous and community knowledge sources. However, a great deal of boreal caribou movement between southern NWT and northern Alberta and British Columbia has been documented or observed (Larter and Allaire 2006b; Gunn 2009; Dehcho First Nations 2011; Larter *in* SARC 2012: 37; see confidential Figures B7, B8, and B10 in *Appendix B*). Caribou Mountain just south of the NWT/Alberta border was described as a reservoir of animals for surrounding areas, and therefore important to boreal caribou populations both in the NWT and Alberta (Gunn 2009). Discussion of caribou movement in response to fire noted by Tłı̨chǫ harvesters is discussed in the section *Changes in Population Size* (Legat *et al.* 2018). The *Threats and Limiting Factors* section notes that wildfires can also cause burns to caribou calves (Legat *et al.* 2018).

Changes in Population Size

This section discusses Indigenous and community knowledge on trends and fluctuations in boreal caribou abundance for each region of the NWT. Except for one new study for the South Slave region, little new information was available for population trends across the regions of the NWT since the last review of literature conducted in 2012. Information on boreal caribou abundance for the ISR remains generally inconclusive. Boreal caribou numbers were thought to be stationary or increasing in the majority of areas but there was little information available as of 2012. Similarly, the most recent information as of 2012 in the GSA region suggests that boreal caribou were seen to be increasing in some areas and decreasing in others. In the SSA, the most recent information indicated that numbers were stable to increasing as of 2012. In the Dehcho region observations were mixed as of 2012: numbers were increasing in some areas, unchanging in most areas, and slowly decreasing in others. As of 2012, in the Tłı̨chǫ and North Slave regions most observations indicated a general declining trend for boreal caribou populations, although there were signs of increasing populations in some areas (Legat et al. 2018). Indigenous knowledge holders in the South Slave region provided mixed reports of trends in caribou population numbers (d'Entremont 2017).

This information should be interpreted with caution because many of the observations relate to specific, small geographic areas. Also it is difficult to discern whether some observations represent real declines in abundance or fluctuations in habitat use. For example, Gwich'in

participants noted that boreal caribou will eat all the available lichen in an area and move away from it. The caribou will then avoid the area for a decade or more. It might take four years for boreal caribou to fully graze an area before they move away. This may make their population seem cyclic to people who are using any one area, according to Gwich'in Elders, but relates to their movement through their habitat rather than to population changes (Benson 2011). In turn, Tłı̨chǫ harvesters noted an increase in boreal caribou as of 2018, but this phenomenon was attributed to changes in caribou distribution in relation to wildfires (Legat *et al.* 2018).

Inuvialuit Settlement Region (ISR)

As of 2012, boreal caribou population trends in the majority of areas of the ISR appeared to be stable to increasing, but with few boreal caribou overall. Details provided by Inuvialuit interviewees for specific geographic regions are summarized in Nagy *et al*. (2002). In five out of eight regions, participants reported that boreal caribou numbers were stationary or increasing as of 2002. In one region, there was an observation that boreal caribou were decreasing due to moose. Four factors need to be considered when reviewing the information from this study: interviewees seldom see boreal caribou; some of the observations are only from a single participant; many of the observations are not current (pre-1990); and trend information (as presented) is inconclusive (Nagy *et al.* 2002).

Gwich'in Settlement Area (GSA)

As of 2012, boreal caribou populations in the GSA were increasing in some areas and decreasing in others. Population levels had increased around Fort McPherson (ENR 2007h [Fort McPherson]; Benson 2011). Although boreal caribou have always been present on the Peel River Preserve, in earlier reports they were noted to have increased in abundance during the last two decades, most noticeably near Fort McPherson. This may relate to factors such as a change in plant growth patterns, a decrease in hunting pressure, movement due to wildfires or adaptation to human activity. The increase in sightings might also be partly attributable to people spending more time in the area immediately around town. Hunters have also noticed an increase in boreal caribou around the Dempster Highway between Fort McPherson, Tsiigehtchic and Inuvik. Boreal caribou are reportedly decreasing around Cardinal Lakes and east and north of Tsiigehtchic more broadly (Benson 2011).

The population of boreal caribou around Inuvik may be increasing compared to other surrounding areas. However, populations east and southeast of Inuvik were thought to be decreasing, in part due to hunting pressure from increased access due to the decommissioned Canadian National Railway line. As of the early part of the 2010s, there were also fewer boreal caribou around North Caribou Lake than there were in the past (Benson 2011).

Sahtú Settlement Area (SSA)

In the SSA, a 2010 study reported that boreal caribou populations were stable to increasing in some areas:

"The general consensus of the people interviewed is that there are more caribou within the region now. All interviewees reported seeing more signs of groups of caribou. This is attributed to a decrease in industrial activities throughout their habitat in recent years; as caribou tend to avoid developed areas including roads and seismic lines. Lots of tracks are evident throughout the year and caribou are only hunted when opportunistically encountered by hunters." (McDonald 2010: 5)

It was noted that primary habitat for boreal caribou has remained fairly stable as of 2010 when this study was conducted due to the low incidence of disturbance by fire (McDonald 2010). Aside from a report from a knowledge holder at a Sahtú Renewable Resources Board hearing, minimal new information was available to confirm the continuance of this trend to present.

These findings differ somewhat from the conclusions of two studies conducted in the early 2000s, almost ten years earlier (Olsen *et al.* 2001; Zimmer *et al.* 2002). Both of these studies reported mixed trends in abundance. At that time, Sahtú participants were seeing fewer boreal caribou in the Mackenzie River valley compared to the past, and they also said they were seeing fewer tracks (Olsen *et al.* 2001). In contrast, residents in Tuĺıt'a and Norman Wells said that they thought the numbers of boreal caribou were increasing in their area, as they were not harvesting as many anymore (Olsen *et al.* 2001).

In Zimmer *et al. (*2002), participants noted that in general boreal caribou populations in the area were either stable or perhaps decreasing in both numbers and range. However, there were mixed impressions of trends in abundance, perhaps because boreal caribou have never been very plentiful in the area and sightings can be quite rare. Over 40% of those asked did not feel comfortable answering questions about trends; 10% felt that boreal caribou populations were gradually increasing; 25% said they were stable; and 23% felt they had seen a decline. When asked how many boreal caribou currently occur in the SSA, 70% of the study participants said 'few.' The six people that answered 'none' were from Colville Lake, where boreal caribou have not been seen for many years. When information for trends in specific locations was analyzed, it was found that boreal caribou were thought to be increasing in nine locations, stable in 24 and decreasing in 37 (Zimmer *et al.* 2002). In contrast, one knowledge holder from the Colville Lake community stated the following at the recent (2020) Sahtú Renewable Resources Board hearing on caribou:

"There's more woodland caribou [tǫdzı]. We had woodland caribou up on the hill all summer long." (David Codzi [Colville Panel] in Sahtú Renewable Resources Board 2020)

Dehcho and South Slave Regions

Observations of boreal caribou population trends in the Dehcho Region were mixed as of 2012. The population was noted as being stable in most areas and in a slow decline in areas where wildfires, introduced wood bison and other threats were present. Other factors implicated in declines in some areas include increased access by snowmobiles, hunting pressure, and oil and gas development (Dehcho First Nations 2011). Observations on population levels, trends and group size in different parts of the Dehcho and South Slave regions, as presented in a 2011 Indigenous and community knowledge report, are summarized in Table 5 (Dehcho First Nations 2011). Group sightings in fall and winter generally included a mix of adult and younger animals, with adults being the majority of the group. In some areas, group sizes were considered to be smaller in recent years (Dehcho First Nations 2011).

Table 5. Observations of boreal caribou population level, trend and group size in different parts of the Dehcho and South Slave regions (Dehcho First Nations 2011). Fort Providence, Cameron Hills and Kakisa areas are in the South Slave.

Area	Population Level	Population Trend	Group Size
Nahanni Butte: along Liard River valley and to the west between the river and mountains	Low	Stable	Between 1 and 3 animals, but in late winter a group as large as 20 was seen
Nahanni Butte: east of Liard River, between Liard River and Trout Lake, particularly in and south of Arrowhead Lake area	High	Stable	Not available
Sambaa K'e (Trout Lake) area	Moderate to high throughout entire area	Stable	Common group sizes range from 2-3 to 7-8 animals; up to 40 animals in late March
Wrigley area	Moderate to high throughout most of the area; strongest population is to the east of the Franklin mountains	Stable in most areas, except in the corridor between the Mackenzie River and Franklin Mountains where there was some decline	Group sizes of 6-7 animals were common in fall and early winter; up to 30-40 animals not uncommon in late winter, especially east

			of the Franklin Mountains
Fort Simpson area	Moderate; certain areas (Edéhzhíe; lowlands and foothills around Sibbeston Lake) had relatively strong populations	Stable	Group sizes of 5-7 animals were not uncommon; groups of up to 17-19 observed in mid to late winter
Fort Providence area	Edéhzhíe population remained the strongest in the area	Generally and slowly declining, likely due to wildfires, expansion of wood bison and increased sensory disturbance; decline was most noticeable south and southeast of Edéhzhíe, north of Mackenzie River, and in and around the Mackenzie Wood Bison Sanctuary	Groups of 2-3 animals were common at the time of the study; larger groups were more common in the past but less common today.
Cameron Hills plateau		Declined due to development pressures	Not available
Jean Marie River area	Common but not abundant	Appeared to be in slow decline	Groups of 2-3 animals were most common at the time of the study; 5-7 not uncommon; up to 15 seen in late winter. Group sizes used to be larger.
Kakisa area: Tathlina Lake and Kakisa Lake areas	Relatively high, particularly in the area between and to the west of these lakes		Group sizes of 10-15 animals during mid-winter were not uncommon northwest of Tathlina Lake; groups of 5-7 occasionally

			sighted inland from the south shore of Beaver Lake
Hay River area	Generally stable	Some declines were reported at the time of this study southwest of Buffalo Lake and west of the community of Hay River; a decline in the area west of Hay River previously noted by West Point First Nation	Group sizes of 2-3 animals, and up to 5-8, were most common at the time of this study; groups as large as 40 observed in the past southwest of Buffalo Lake in late winter.

There is some evidence that boreal caribou were once an important game resource for the K'átł'odeeche First Nation and that populations have declined over the decades (Gunn 2009). One K'átł'odeeche First Nation participant said that despite reporting an increase in wolf numbers around the Cameron Hills since the 1990s, he felt that boreal caribou were increasing in abundance on both sides of the Hay River (Gunn 2009). However, at a meeting in 2007, participants from both the K'átł'odeeche and West Point First Nations said that from the late 1970s to around 2007 boreal caribou populations had decreased significantly (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

Members of the K'átł'odeeche First Nation reported that there were more boreal caribou near Cameron Hills and Buffalo Lake in 2012 than there used to be. However, there was also an observation that there used to be lots of boreal caribou tracks towards Buffalo Lake, and in 2012 there were not as many (ENR 2007a [K'átł'odeeche First Nation]). One K'átł'odeeche participant noted that boreal caribou tracks can be deceptive in that they wander around in an area, giving the impression that there are more animals than there actually are (Gunn 2009).

One Acho Dene Koe First Nation knowledge holder was optimistic about caribou population numbers in their region, noting that the more recent reduction of seismic activity had allowed the return of boreal caribou in their area (Acho Dene Koe First Nation 2018). In contrast, another Acho Dene Koe First Nation knowledge holder cautioned that the additional linear disturbances caused by roads, pipelines and seismic lines will increase predation by wolves and further threaten caribou populations (Acho Dene Koe First Nation 2018).

In 2007, representatives of the NWT Métis Nation reported that boreal caribou appeared to be stable in some areas, but were decreasing in others (ENR 2007k [NWT Métis Nation Board]).

Almost half of Deninu Kue First Nation (DKFN) respondents in a study in the South Slave region reported that there are more caribou in 2017 compared to when they were younger or when their parents/grandparents were younger, while the other half reported that there were fewer in 2017 compared to the past (d'Entremont 2017).The majority of respondents from the DKFN study reported that it was harder to hunt boreal caribou in 2017 compared to the past; however, most residents do not actively hunt boreal caribou (d'Entremont 2017).

Tłı̨chǫ and North Slave Regions

In general, reports from 2011 and earlier in this region suggest a declining boreal caribou population, while the recent report from 2018 (Legat *et al.* 2018) provides evidence for an increasing number of boreal caribou in the Tłı̨chǫ region. A study published in 2011 from the Tłı̨chǫ and North Slave regions indicated a general trend of decline for boreal caribou populations, with some observations suggesting that boreal caribou seemed to be disappearing, possibly due to unhealthy habitat (Chocolate 2011). One Elder from Behchokǫ̀ said that he has never seen the boreal caribou population increase in his lifetime, and that there used to be a lot more boreal caribou in the area before the highway was paved (Environment Canada 2010c [Behchokǫ̀]). In Whatì, meeting participants stated that they do not see as many boreal caribou in the region compared to the past and that the population is not as healthy as it once was (Environment Canada 2010b [Whatì]). Some participants at meetings in Gamètì echoed these sentiments. One member stated that he believes the boreal caribou numbers may be declining in the region overall. However, another Elder stated that he was concerned with how accurate survey counts were for boreal caribou. He agreed that populations were declining in the south but did not think that the boreal caribou population is declining in the NWT (Environment Canada 2010d [Gamètì]).

The recent (2018) study conducted by Legat *et al.* provides evidence for an increasing number of boreal caribou in the Tłı̨chǫ region. Tłı̨chǫ harvesters stated that there currently appears to be an increase in boreal caribou in their region (Legat *et al.* 2018). It is unclear whether these observations represent a population increase or a shift in habitat use as boreal caribou are returning due to the presence of fires elsewhere (Legat *et al.* 2018).

Health

Valuable information related to boreal caribou health in the Tłı̨chǫ region was available from Legat *et al.* (2018). Although it is difficult to evaluate specific trends from the Tłı̨chǫ information, Tłı̨chǫ harvesters provide illuminating reports of caribou health and changes to health. Some Tłı̨chǫ harvesters report that the caribou they have seen most recently appear to be relatively healthy (Legat *et al.* 2018). However, Tłı̨chǫ harvesters have observed some boreal caribou they have hunted previously to be sickly and in poor health (Legat *et al.* 2018).

One Tłı̨chǫ harvester described travelling to the *Takadaà* area for trapping where he found a lot of *tǫdzi* (boreal caribou) tracks in the area, and discussed a potential cause of infections for boreal caribou:

"When we shot toḍzı [boreal caribou] we check between the joints of the arm/legs and if we see some kind of infection. But if we cut it up, we can smell it and it's strong and we know toḍzı is sick. At another time too when I shot toḍzı the smell was so strong; it was not healthy. But this year I haven't seen any toḍzı that are unhealthy. But sometimes when toḍzı have some kind of infection on its arms it's because toḍzı travel in deep snow." (John Beaverho, January 2018 in Legat et al. 2018)

Tłı̨chǫ women clean the boreal caribou meat once it is harvested; as one Tłı̨chǫ harvester says: "We monitor everything around us, as women" (Irene Zoe in Legat *et al.* 2018). Tłı̨chǫ women harvesters report observations of encountering new phenomena in terms of sickly, odorous and infected boreal caribou meat, with some meat containing white spots and worms:

"My husband is always hunting for toḍzı [boreal caribou]. The meat is healthy but last year when he shot a toḍzı, just as I was cutting in between the joints there were a lot of white spots. It looked like worms, too. There were 'ever lots'. I've never seen toḍzı like this before. … I clean and cut up toḍzı meat, and it [always] looks healthy. … That was the first time we saw a sick toḍzı. Just once in a while we see spots. [I can usually cut them out]. But not like this.

I check toḍzı heart and liver, and there was pus on it here and there. So, I took and cut out a small piece, put it on paper towel, slice it, and watery stuff come out of it. Maybe it's sores. I don't know what it was so we pack everything in a box and Bobby threw all the meat away far from the community. I didn't eat any meat from it. Even fish (trout) we see white spots on it and we cut it out." (Albina Nitsiza, February 2018 in Legat et al. 2018)

Another Tłı̨chǫ harvester also encountered an unhealthy boreal caribou:

"Her [brother], Freddy asked me to clean/cut up the meat. The meat was so smelly and he gave me a piece. I boiled it and we couldn't eat it and I threw it away. It was so smelly even my hands were smelly." (Cathy Simpson, February 2018 in Legat et al. 2018)

In the above instances both Tłı̨chǫ harvesters report having to discard the poor-quality meat (Legat *et al.* 2018). One Tłı̨chǫ harvester is worried because her family depends on food from the land to survive (Legat *et al.* 2018). Further work is needed to address the underlying causes of the poor health observed in the Tłı̨chǫ region to ensure that Tłı̨chǫ harvesters have access to sufficient food sources.

Benson and Winbourne (2015) discuss the issue that body condition assessments are non-random sampling and may not show the full picture of boreal caribou health. Referencing past work by Lyver (2005), Benson and Winbourne (2015) note that harvesters are skilled at identifying caribou body condition disparities even when far away from the animal. In turn, harvesters select the caribou to harvest that often have the best relative body condition (Benson

and Winbourne 2015). Additional research may be required to develop systematic approaches to Indigenous and community knowledge monitoring of caribou health.

Rescue Effects

Habitat connectivity is an important consideration for ensuring that animals can move around the landscape, allowing animals from elsewhere to "rescue" populations where declines have been observed. There is no information available to suggest that populations of boreal caribou have previously disappeared from areas of the NWT and at this time, the population in the GNWT is generally considered to be contiguous and connected to populations elsewhere. However, it is important to note the phenomenon described in section "Changes in Population Size": boreal caribou may use a given area for several years until it is fully browsed, and then move to other areas of their range. According to Gwich'in Elders, this movement phenomenon might make the population appear cyclic to people who are using any one area despite the fact that these changes are due to movement through habitat rather than changes in population numbers (Benson 2011).

Evidence of barriers to boreal caribou movement within the NWT is presented in *Barriers to Movement*. However, little information was available to provide context for the presence of any barriers inhibiting movement to and from other populations of boreal caribou outside of the NWT. As described in *Population and Movement*, boreal caribou typically exhibit lower movement rates compared with barren ground caribou. However, boreal caribou are known to move around a lot and in particular move seasonally in response to changing habitat needs: this seasonal movement can vary from almost no distance up to 125 km.

In terms of available Indigenous knowledge to suggest that populations have been isolated in the past, it was noted during a meeting with the NWT Métis Nation Board that boreal caribou around Hay River have shorter, more muscular legs than in other regions (Environment and Natural Resources (ENR) 2007k [NWT Métis Nation Board]). This observation suggests that there may have been some genetic isolation between the populations in the Hay River and other areas of the NWT.

Abundant evidence suggests boreal caribou population declines are linked with deteriorating habitat condition throughout Canada. In general, boreal caribou habitat in the NWT is considered to be in better condition than adjacent habitat to the south; however, habitat is more disturbed in the southern part of the NWT range than in the north (e.g., see the discussion in section 6.5.1 of MVRB 2018a). As discussed in *Changes in Population Size*, Tłı̨chǫ harvesters noted that shifts in the number of caribou in a specific region were related to habitat degradation due to wildfire (Legat *et al.* 2018). Based on the available evidence, declines in boreal caribou populations in some regions of the GNWT are likely linked to habitat degradation, among other factors.

THREATS AND LIMITING FACTORS

Factors that can negatively influence the survival or reproduction of boreal caribou include direct mortality, stress or poor health, and habitat change. The causes of these impacts are viewed as 'threats' particularly when they exceed what is natural for the boreal caribou.

Indigenous and community knowledge sources indicate that boreal caribou are very sensitive to most types of human disturbance and habitat change. In particular, industrial development and wildfires can result in changes to the landscape that can make boreal caribou not use an area for many decades. Managing habitat disturbance is one of the keys to sustaining boreal caribou populations (Environment Canada 2010b [Whatì]). Other factors that can have major negative impacts on boreal caribou populations are predation (particularly at low population levels) and climate change. Concerns about climate change impacts to boreal caribou appear to have increased since the last review was conducted in 2012. Overharvesting is an increasing concern among knowledge holders (Chocolate *et al.* 2015; Legat *et al.* 2018; Acho Dene Koe First Nation 2018). Parasites and disease are known to occur but were not generally a cause for concern in the previous review, and concerns remain low currently (though there are some recent cases of disease reported by Tłı̨chǫ; see *Health*). Additional threats identified include invasive research methods, tourism, snowmobile and all-terrain vehicle use, negative interactions with other ungulates, pollution and contamination.

All stressors can have impacts on boreal caribou health. Cows may not breed and calve if their body condition does not support it (Benson 2011). Threats to boreal caribou in turn threaten the intergenerational transmission of cultural practices and values surrounding caribou, which can impact Treaty rights (Acho Dene Koe First Nation 2018).

Regional Assessment of Threats

Although threats to boreal caribou are often identified and described in Indigenous and community knowledge sources, there is generally little information on the relative importance or impacts of the identified threats. The available information indicates that threats and their relative importance differ in the various regions of the NWT. A general pattern is that boreal caribou in the southern parts of the NWT are more susceptible to threats than caribou in the northern parts of the NWT.

This review found no new information on threats to boreal caribou in the ISR or the GSA. In the previous review, threats to boreal caribou habitat in the ISR included oil and gas exploration and development, road and hydro development, increased tourism and other non-consumptive human activity, wildfire, and climate change (Nagy *et al.* 2002). In the GSA, hunters felt that wolf predation and over-harvesting were the main threats, although they did not observe decreasing boreal caribou populations in the GSA (see *Changes in Population Size*) (Benson 2011).

A 2020 report from the Sahtú Renewable Resources Board notes that although *tǫdzı* are federally and territorially listed as Threatened, this listing is primarily due to threats further south in the NWT and Canada, and *todzi* populations are considered stable or increasing in the Sahtú region based on Indigenous and community knowledge (Sahtú Renewable Resources Board 2020). Potential disturbances in the future could include petroleum development, construction of an all-weather road, or fire. People interviewed for earlier studies indicated that boreal caribou populations were healthy at that time, but cautioned that climate change, industrial activities and predation may negatively impact them in the future (McDonald 2010). At a 2001 workshop in the SSA, participants indicated that predators and seismic exploration have a major impact on boreal caribou, while pollution, contaminants and climate change have a minor impact, and hunting and tourism have no impact. Results for pipelines, forestry and logging, and highway construction were inconclusive (Wynes 2001 in Olsen *et al.* 2001; see also Table B2 in *Appendix A*). At the time, participants noted that the biggest impact to boreal caribou in the Sahtú Settlement Area may be from habitat change, and stressed that habitat changes need to be addressed first. Both hunting and predation tend to increase as habitats become fragmented and access increases. People also felt that there are bigger impacts from a resulting pipeline corridor through hunting pressures and increased predation than from the construction phase (Wynes 2001 *in* Olsen *et al.* 2001).

In the Dehcho region, the Acho Dene Koe First Nation identified that a range of disturbance threats are causing declines to boreal caribou, including human development, contamination from industrial sites, continued impacts from wildfires, vegetation clearing and linear features (Acho Dene Koe First Nation 2018). Knowledge holders from Acho Dene Koe First Nation noted that populations of moose, deer, wolves and bears have increased in that region in recent times and relate the growth in wolf and bear numbers to boreal caribou declines, saying that increased predation is having a negative impact on boreal caribou. This knowledge contrasts with earlier reports from the Dehcho region (pre-2012), which indicated that boreal caribou numbers were considered stable at that time, except where wildfires, introduced wood bison populations, industrial development, or other threats were causing a slow decline, particularly in the Fort Providence area (attributed to bison, wolf predation and wildfire) and on the Cameron Hills plateau (attributed to oil and gas activity). A decline observed in the early 2010s southwest of Buffalo Lake may relate to increased skidoo access and hunting pressure. Participants in a 2011 Dehcho Indigenous and community knowledge study indicated that there was minimal resource development activity occurring at that time in the Dehcho, with the exception of the Cameron Hills. However, a few major projects were pending (Dehcho First Nations 2011). No update is currently available on more recent impacts to this area. In 2009, K'átł'odeeche participants said that warm weather, overhunting, human activities and fire are all possible stressors for boreal caribou in their region (Gunn 2009).

Although boreal caribou populations appear to be increasing based on recent harvester observations in the Tłı̨chǫ region, Tłı̨chǫ Elders expressed concern about boreal caribou populations due to habitat change from industrial development and more frequent, widespread, and intense fires (Legat *et al*. 2018). This report and earlier reports from the same study (e.g., Legat 2013) echo concerns expressed by Tłı̨chǫ knowledge holders in 2010 and 2011 that increased frequency of wildfires, an increasing wolf population, climate change, tourism, as well as increases in levels of noise and light disturbance are all important threats to boreal caribou in that region (Environment Canada 2010b [Whatì]; Chocolate 2011).

No recent updates on threats within the North Slave region or South Slave region were available for this report, and it remains an important knowledge gap. Earlier sources from the South Slave region noted that muskoxen were moving further south from around Lutselke'e, moose and white-tailed deer were increasing in the Fort Resolution area, and cougars were reported between Fort Resolution and Hay River. Potential impacts of these factors on boreal caribou were not discussed in these reports (ENR 2007b [Fort Resolution Métis Council]).

The sections that follow summarize further information on threats to boreal caribou by cause. While these are not ordered in terms of importance, they are organized loosely based on the availability of Indigenous and community knowledge and the authors' interpretation of the level of urgency/concern from knowledge holders.

Wildfires

It is recognized that fires are natural occurrences and can have a rejuvenating effect on the land (Benson 2011). However, the Indigenous and community knowledge reports and information reviewed here indicate that wildfires negatively impact boreal caribou. The impacts of wildfires on boreal caribou habitat and populations have been well documented in a myriad of Indigenous and community knowledge reports: knowledge holders report that fires destroy habitat, and the effects can last for many years, if not decades. Wildfires can impact the ability of caribou to acquire food and can force boreal caribou to relocate to more desirable locations (McDonald 2010). Cree trappers who hunt boreal caribou around James Bay have noted that boreal caribou are moving south into areas of thicker bush, avoiding disruptions from logging and wildfires (Herman *et al.* 2012 in Legat 2013). Fires are seen as a threat to boreal caribou populations (Zimmer *et al*. 2002; ENR 2007b [Fort Resolution Métis Council]; ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]; Benson 2011; Legat 2013; Legat *et al*. 2018; Acho Dene Koe First Nation 2018). A map of the fire history for the NWT is shown in Figure 7, to illustrate the extent of boreal caribou range that has been burned over the last 40 years.

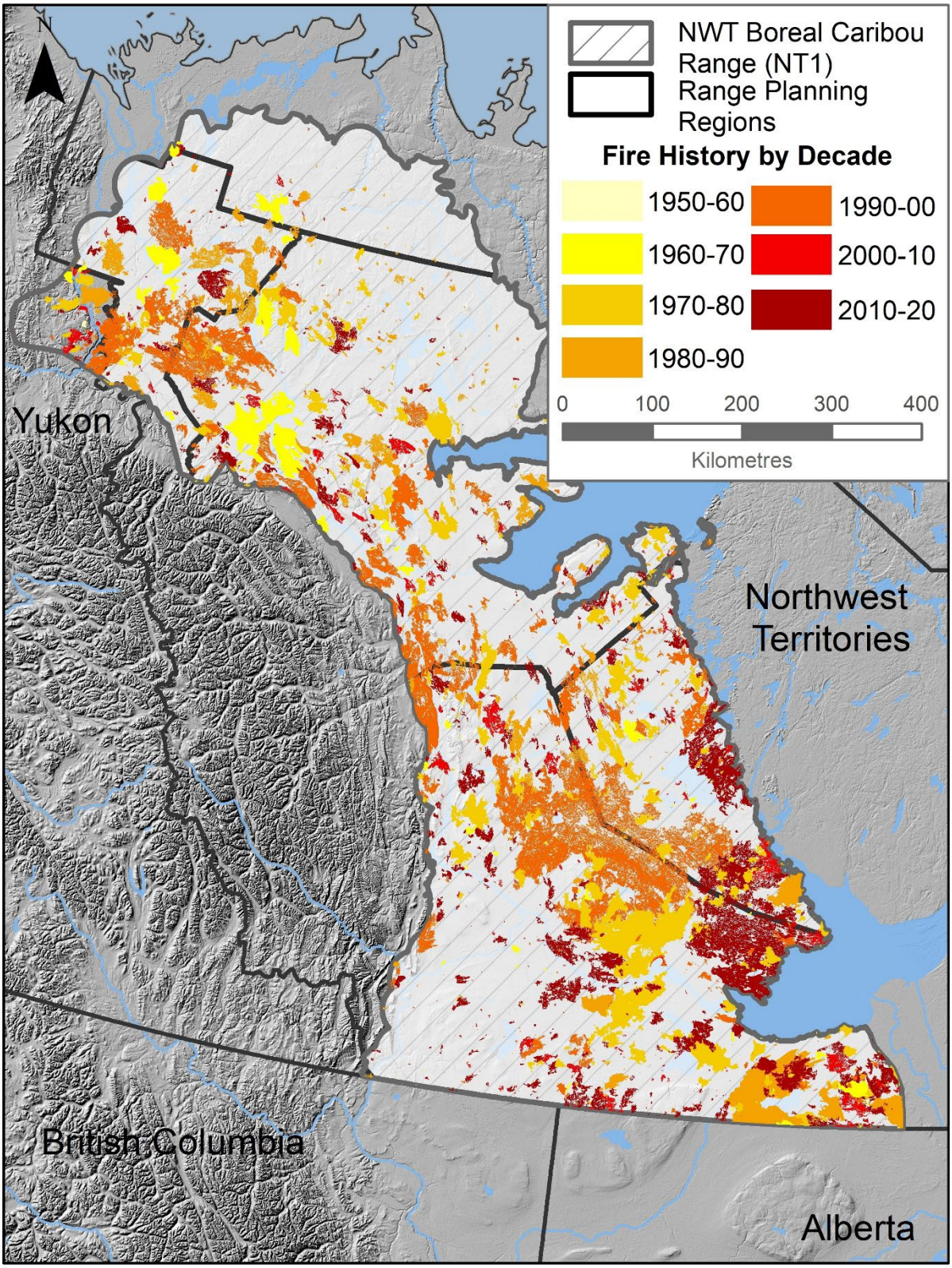

Figure 7. Location of fires that burned over the last 70 years (1950 – 2020) within boreal caribou range in the NWT. Map courtesy of R. Abernethy, ENR.

Wildfires are believed to be the main cause of habitat loss and boreal caribou population declines in the Tłı̨chǫ region (Environment Canada 2010b [Whatì], 2010c [Behchokǫ̀], 2010d [Gamètì] (see Figure 6 in this report to the extent of wildfires in the Tłı̨chǫ region). Fire in the thick bush of the taiga plain, or nǫʔıı, has led to fewer boreal caribou in that ecozone (Legat 2013). A five-year study on boreal caribou habitat in the Tłı̨chǫ region conducted from 2011-2016 looked at impacts of fire on the state of *tǫdzı* habitat on Edéhzhíe (Horn Plateau; Legat *et al.* 2018). Elders who participated in this study reported that fires destroy caribou habitat—both lichen, which is needed for winter forage, and cover habitat, which caribou need to hide from predators. One Tłı̨chǫ knowledge holder identified that "forest fires are our main concern because most often these fires burn all of the animals' food on the land" (Jimmy Rabesca, Feb. 13 2012; cited *in* Legat 2013). In the Dehcho region, knowledge holders from Acho Dene Koe First Nation observed continued impacts from recent wildfires in the southeastern portion of the region, discussing the negative impacts of fire on vegetation important to local caribou herds and the subsequent impacts on food availability (Acho Dene Koe First Nation 2018). Knowledge holders from Deninu Kue First Nation observe that boreal caribou will avoid recently burned areas (d'Entremont 2017).

Elders and knowledge holders express differing views on how long it takes habitat to recover after it burns. For example, Gwich'in hunters in the GSA noted two different timelines for boreal caribou re-entry into burned areas. The first timeline is short—just a few years; the second timeline was more often noted, and was a long-term timeline of between two to four (or more) decades. The different timelines may relate to re-growth of the various types of boreal caribou foods; deciduous foods such as grass and browse become available quickly, whereas lichen may take decades to return (Benson 2011). This study also suggests that boreal caribou in the GSA will avoid burned-out areas longer than other large species such as moose (Benson 2011).

The timeline for return by boreal caribou also relates to the intensity of the burn. A slow, hot burn will remove all the lichen, but a fast-moving fire may leave some food behind (Benson 2011). In the Tłı̨chǫ and North Slave regions, caribou are said to not return to a burned-out area for at least 30 years, and fires have also been seen to cause large-scale population movements (Cluff *et al.* 2006; Environment Canada 2010c [Behchokǫ̀]). Elders from the 2011-2016 Tłı̨chǫ study of *tǫdzı* habitat stated that it takes 20 to 30 years or longer for lichen to recover after a fire, depending on the severity of the fire that has occurred and the landscape and habitat that have been burned (Legat *et al.* 2018). Elder Benny Jeremek'a explained:

"When the plants come back it depends on the forest fire. [It depends on] how deep it is, whether the land is soft and it burns deep [then the plants take longer], or if the land is hard and it burns across the top. … When the land is burned, maybe toǫ̨dzı never returns to that area. Toǫ̨dzı probably travels to where they find healthy ʔadzıı, leaves, grass."

In the same study, female Elders with detailed knowledge of plants and soil reported that plants start to grow back into burned areas within five years, and grasses and small trees will recover enough to draw animals in the summer after 8-10 years. However, it takes longer for boreal caribou to come back as the tall trees have not yet returned. Male Elders reported that it takes 15-25 years for caribou to return to an area in the winter, because it takes this long for regeneration to provide shelter and protection from predators. Some participants from the Tłı̨chǫ region said boreal caribou will not return to burned areas, will not move to places with smoke, and will avoid vegetation that is burned or covered in ash. Elder Jimmy B. Rabesca explained it this way:

"Toı̨dzı eats grass that grows along the shore. Toı̨dzı also eat dahghoı̨oı̨ [especially in the winter]. It grows on trees but once there's a fire, and toı̨dzı food is all burn—even the grass that grows in small ponds is burnt. When the land burns the smell of smoke is so strong, the animals leave. … Animals go to places where their food is healthy. This is how animals live. Even me or other people would not go to places that are burnt. What are we going to harvest? All animals' food is gone." (September 2017) (Legat et al. 2018, p. 48)

Elder Pierre Beaverho clarified by adding:

"Even the roots deep in the ground burn. It takes time for trees to grow. Then afterwards will grow fast, that's how it is after the fire. So it takes ten to fifteen years for plants; trees to start growing." (September 2017) (Legat et al. 2018, p. 49)

In the SSA, interviewees expressed different opinions on how long burns may affect boreal caribou. Some interviewees stated that boreal caribou return to burned areas once there is new growth, while others stated that caribou will never return to these sites again (McDonald 2010). Members of the West Point and K'átł'odeeche First Nations said that it takes at least ten years before a boreal caribou will use a burn (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

It is recognized that fires are natural occurrences and can have a rejuvenating effect on the land (Benson 2011). Wildfires are thought to be increasing, both in frequency and in severity, impacting boreal caribou habitat as a result. Increases in fires may be related to climate change, with more lightning and drier summers being reported (ENR 2007j [Tsiigehtchic]). Elders interviewed in the Tłı̨chǫ region expect that wildfire impacts on habitat and distribution will be greater in the future due to climate change, and while they understand the behaviour of small fires, larger, more intense fires that have emerged due to climate change are not understood. Elders noted that large fires move quickly and kill many young animals. According to Tłı̨chǫ Elders, new fires are very different than past fires (Legat *et al*. 2018).

In addition to impacts through habitat change, wildfires can also impact boreal caribou directly by burning the animals or through smoke inhalation (Benson 2011; Legat *et al*. 2018). Boreal caribou will stay in burning areas to protect their young instead of trying to escape a fire

(Environment Canada 2010b [Whatì]). Elders from the Tłı̨chǫ region have observed that boreal caribou calves can be burned from wildfires, and note the importance of islands as refugia: "When there's a wildfire, and *tǫdzı* food is burning, they will swim across to an island, [or] … go to a different area where the land is not burnt." (Sophie Williah, September 2017). Smoke from fires impacts the ability of animals to run; caribou do not have time to escape with their young, especially if they are on islands (Legat *et al.* 2018).

Industrial Activities

Industrial activities and development are considered major factors causing some of the largest impacts on boreal caribou across many regions in the NWT. Some of the ways that industrial activities can negatively affect boreal caribou include sensory disturbance and habitat change (including habitat loss, fragmentation, increased access for predators, and contaminants).

Noise, light, and other disturbances come from drilling, seismic cutline activities, slashing, and machinery. Indigenous and community knowledge studies indicate that boreal caribou do not tolerate noise or human disturbance well, and that minimizing noise and light disturbance is important for boreal caribou (Environment Canada 2010b [Whatì]). Although some habituation to consistent noise was noted in the GSA, noise was cited as a major factor impacting boreal caribou in many studies (Sambaa K'e Dene Band 2004 in AMEC Americas 2005; McDonald 2010; Benson 2011; Dehcho First Nations 2011, Legat 2013; Acho Dene Koe First Nation 2018). In the SSA, participants specified that development should not occur during the calving season or near boreal caribou habitat because of disturbance from noise and camp lighting (McDonald 2010). One Elder in Whatì reported seeing an overall change in boreal caribou behaviour as a result of increased disturbance and noise. He said that the animals did not seem rested, and that they were always moving (Environment Canada 2010b [Whatì]). People have said that boreal caribou that are highly stressed from sensory or other disturbances taste different (Dehcho First Nations 2011).

In the Dehcho Region in southwestern NWT, people from Acho Dene Koe First Nation expressed concerns about the impacts of industrial activity on caribou health through water contamination (Acho Dene Koe First Nation 2018). Their study identified 87 hectares of disturbed land in the study area attributed to disturbance from oil and gas well sites. Well site contamination may extend beyond these areas into nearby water bodies and groundwater, affecting downstream vegetation and the wildlife that feed on it. Interviews conducted for this study identified one specific contaminated area near Fisherman Lake, further illustrating Acho Dene Koe First Nation members' concerns over contaminated water (Acho Dene Koe First Nation 2018).

Impacts from development are not limited to the time of disturbance. It can take many years for boreal caribou to return to an area that was disturbed in the past. While there is some evidence that boreal caribou eventually adapted to landscapes impacted by the oil and gas industry 40 to

60 years ago, some Elders have also commented that since these extensive disturbances, boreal caribou have become more wary and do not linger as long in open areas as before (Dehcho First Nations 2011). Besides the primary disturbance sites, boreal caribou also avoid associated developments, such as winter field camps and access roads (Zimmer *et al.* 2002). In addition, secondary impacts such as hunting and predation, which tend to increase as habitats become fragmented and access increases, may ultimately be more impactful that those resulting from the initial construction or development work (Olsen *et al.* 2001). In contrast, knowledge holders from the Deninu Kue First Nation in the South Slave region reported that, although boreal caribou will avoid areas disturbed by industrial development, they still move through the Pine Point area despite the level of disturbed land in that area (d'Entremont 2017).

Despite these conflicting observations, it remains consistent that current and new developments as well as the cumulative impacts of development are of concern to many of the participants in the studies reviewed. Concerns related to specific types of development are outlined below for oil and gas exploration and development, mining, linear disturbances, and other industrial activities.

Oil and Gas Exploration and Development

In the Dehcho region, seismic lines, sensory disturbance from oil and gas exploration, oil and contaminant spills, and use of seismic wire all resulted in immediate impacts to boreal caribou during major oil and gas exploration activities that took place from the late 1950s to the early 1970s (Dehcho First Nations 2011). Animals were said to be driven away from development activities and did not return to the affected areas for many years (Dehcho First Nations 2011). Elders in Wrigley said that boreal caribou left the area during the construction of the Norman Wells pipeline, and when they returned years later, those harvested near the corridor had a taste associated with stress (Dehcho First Nations 2011).

Oil and gas exploration and development has increased in recent years and some communities have concerns that these activities disturb boreal caribou feeding areas. Tłı̨chǫ people who harvest boreal caribou find that there is serious potential for industrial development and associated infrastructure to increase impacts on boreal caribou and their habitat in the NWT (Legat 2013). Impacts from oil and gas exploration are thought to be worse in winter and can result in a loss of habitat, increased predation and added hunting pressure (Olsen *et al*. 2001). The Sambaa K'e Dene Band identified sensory disturbance from the proposed Mackenzie Gas Project (MGP) during the overwintering period as potentially having short- and long-term impacts on populations (2009). In addition, some people have noted that noise seems to travel greater distances in the cold weather (Gau 2006 [Fort Simpson]).

Linear Disturbances

Linear habitat features like roads, pipelines and seismic lines can impact boreal caribou in a variety of ways, including destroying habitat, creating barriers to movement, and increasing predation and noise, among other effects (Dehcho Land Use Planning Committee 2004 in AMEC Americas 2005; ENR 2007g [Inuvik]; ENR 2007i [Aklavik]; Joint Review Panel 2010; McDonald 2010; Chocolate *et al.* 2015). Presence of roads, road construction, traffic, and pipeline rights-of-way are other examples of linear habitat disturbances that may be impacting boreal caribou in the NWT (Zimmer *et al.* 2002; ENR 2007j [Tsiigehtchic]).

Many of these types of developments are increasing or are proposed for regions of the NWT. Figure 8 shows a map of linear features (seismic lines, pipelines, hydrolines, and roads) buffered by 500 m within the NWT, with focused insets on the Sahtu and Dehcho regions as the two areas with the highest densities of linear features. People from Acho Dene Koe First Nation expressed that linear disturbance in the region from access roads will further increase wolf predation and put pressure on the boreal caribou population (Acho Dene Koe First Nation 2018). Throughout the course of the recent environmental assessment for the Tłı̨chǫ All-Season Road (TASR) to Whatì, many concerns were expressed about the effect that this road would have on boreal caribou, including concerns about increased noise and dust pollution, increased hunting pressure, and the potential for new species to be introduced. These concerns were expressed as early as 2010 in meetings held in Whatì (Environment Canada 2010b [Whatì]). The Traditional Knowledge Study for the Tłı̨chǫ All-Season Road (TASR) discusses many concerns about impacts of roads on boreal caribou based on observations from other roads (Chocolate *et al.* 2015). As a result of the information shared through the traditional knowledge study and other sources, the Mackenzie Valley Review Board found that building the TASR will likely cause significant adverse impacts on boreal caribou because of lost habitat, sensory disturbance and impacts to caribou behaviour, barriers to movement, habitat fragmentation and increased hunting pressure. The MVRB agreed that the TASR will likely lead to increased boreal caribou mortality through non-Indigenous hunting and Indigenous harvest pressures in the area, a concern that was expressed by the Tłı̨chǫ, Yellowknives Dene First Nation, and North Slave Métis Alliance (MVRB 2018a).

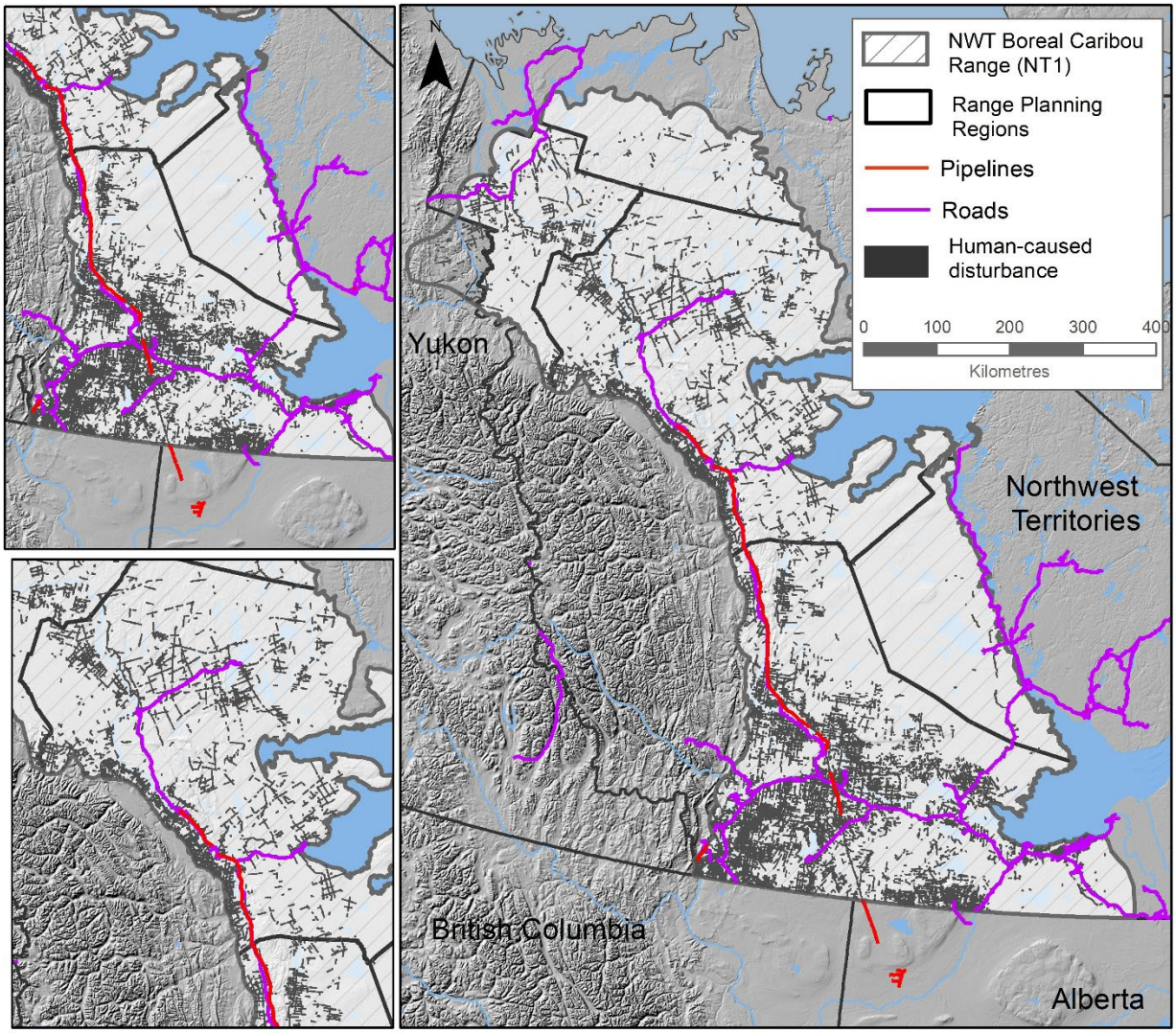

Figure 8. Linear features (seismic lines, pipelines, hydrolines, and roads) buffered by 500 m within the NWT, with focused insets on the Dehcho (upper-left) and Sahtú (lower-left) regions. Map courtesy of R. Abernethy, ENR.

While Elders and active hunters in the Tuĺıt'a area have observed boreal caribou crossing linear features, they are said to generally avoid them and/or only stay on them for very short distances (McDonald 2010). Predators and hunters use linear features such as seismic cutlines to travel and hunt, which can increase their efficiency at targeting boreal caribou (Olsen *et al.* 2001; Zimmer *et al.* 2002; Gau 2006 [Trout Lake]). Linear disturbances can open corridors for wolves and other predators, leading to increases in boreal caribou predation (Olsen *et al*. 2001; Dehcho First Nations 2011).

Direct negative impacts of roads include contamination, dust, garbage, calcium use, or toxic fumes or chemicals (ENR 2007a [K'átł'odeeche First Nation]; ENR 2007b [Fort Resolution Métis Council]; ENR 2007j [Tsiigehtchic]; Benson 2011). Roads can act as barriers to boreal caribou,

and it is thought that road noise and other impacts (e.g., dust, vibration) create a zone of influence around roads that affect caribou use of areas near roads. Seismic cutlines or linear disturbance can also affect the way highway noise travels, meaning that noise from roads might affect boreal caribou even further from the road than previously thought (ENR 2007d [Fort Providence Resource Management Board]).

Because boreal caribou generally avoid roads, motor vehicle collisions were not considered a threat to populations in most parts of the NWT (ENR 2007a [K'átł'odeeche First Nation]; Environment Canada 2010c [Behchokǫ̀]; Environment Canada 2010d [Gamètì]; McDonald 2010). In the Fort Providence area, vehicle collisions with boreal caribou were reported to occur mainly between Enterprise and the Kakisa turn-off (ENR 2007d [Fort Providence Resource Management Board]). Participants at workshops in Behchokǫ̀ and Gamètì stated that since the highway (Highway 3) was paved they have seen fewer boreal caribou in the region, however they still did not think collisions were an issue. Instead, they felt it was the noise disturbance from the highway that had pushed boreal caribou out of the area (Environment Canada 2010c [Behchokǫ̀]; Environment Canada 2010d [Gamètì]).

Further concerns about specific linear disturbances and developments are included in *Appendix A*, points (6) and (7).

Other Industrial Activities

Mining can also affect boreal caribou habitat and habitat use (ENR 2007a [K'átł'odeeche First Nation]). People have witnessed barren-ground caribou avoiding industrial activity close to diamond mines and suggested that similar activities could affect boreal caribou (Environment Canada 2010d [Gamètì]). Participants at a meeting in Behchokǫ̀ also raised concerns about pollution and contamination from mining. Tailing ponds and hazardous waste (arsenic) have not been adequately managed in the past, so there is concern about future mining activities. The Fortune Minerals NICO mine located 80 km north of Behchokǫ̀ and within boreal caribou range was raised as a specific concern (Environment Canada 2010c [Behchokǫ̀]). Indigenous and community knowledge and use study conducted with Tłı̨chǫ people in 2012 in regard to this proposed mine noted concerns with respect to contamination on vegetation as well as noise:

"… if the chemicals go to the contaminated area, if the chemical's contaminating stuff and it goes out into the environment, the caribou rely on lichen. So, in the summer, the caribou will eat lichen, and some of those shrubs … the caribou will get ill, it will be unhealthy -- it won't be healthy, and so if the mining goes ahead, the caribou are sensitive to noise, then the caribou will avoid those areas." (Rose Romie, cited on p. 43 of Olson et al. 2012)

The Mackenzie Valley Review Board's Report of Environmental Assessment and Reasons for Decision for the NICO mine (MVRB 2013) show that while the mine itself is not directly in boreal caribou range, the road leading to the mine is (see Map from MVRB 2013, p. 92). Suggestion #6

from the 2013 Report of Environmental Assessment suggests that additional input from Tłı̨chǫ Elders and knowledge holders may be available relative to the mine and impacts to boreal caribou; however, this information is not publicly available and has not been included in this report.

With regard to known boreal caribou movement patterns in the South Slave region, one meeting participant said "most crossings are where Tamerlane [Ventures – new Pine Point mine owner/developer] is going to put their hole in the ground," (ENR 2007k [NWT Métis Nation Board]). Other concerns raised with respect to the Pine Point mine include noise, light and dust pollution (ENR 2007b [Fort Resolution Métis Council]). Additional details are found in points (7) and (8) in *Appendix A*.

It has been noted that logging or cutting trees can have a negative impact on boreal caribou because of their dependence on densely forested habitat (ENR 2007e [Paulatuk]).

Predation

In addition to the increased predation that can result from linear disturbances (discussed above and in *Relationship Within and Among Species - Predators*), increased predator abundance is also seen as a threat to boreal caribou. Wolf populations are said to be increasing in the GSA, the SSA and the Dehcho region (McDonald 2010; Benson 2011; Dehcho First Nations 2011, Acho Dene Koe First Nation 2018), and wolf predation was identified one of the main threats to boreal caribou in the Tłı̨chǫ region (Environment Canada 2010c [Behchokǫ̀]; Environment Canada 2010d [Gamètì]). Some communities think the increase in number of wolves may be due to decreases in hunting and trapping activities (McDonald 2010; Dehcho First Nations 2011). An earlier report from the Dehcho First Nation noted that increased predation of boreal caribou by wolves, bears and cougars may be offset by the fact that other prey species such as moose, wood bison and white-tailed deer are available—and in some cases increasing in numbers (Dehcho First Nations 2011). This observation was also recorded in the Sahtú, where communities report not just an increase in wolves, but a general increase in the abundance of moose, muskoxen and beavers. Some knowledge holders thought that these increases may have an indirect effect on the boreal caribou populations—namely, if there is a decrease in the number of other prey then predators will hunt more boreal caribou (McDonald 2010). More recent work with the Acho Dene Koe First Nation points to increases in other prey species such as moose and deer, and increases in bear and wolf populations, which have correlated with a marked decline in the boreal caribou population (Acho Dene Koe First Nation 2018).

In 2011, harvesters reported that wolf numbers were especially high in southern areas of the NWT (Dehcho First Nations 2011). In 2009, ongoing increases in wolves were reported in the Wood Buffalo National Park area since the 1990s (Gunn 2009). Wolf predation was cited as one reason for the perceived decline in boreal caribou numbers west of Buffalo Lake (Gunn 2009),

yet it was noted that boreal caribou were increasing in abundance on both sides of the Hay River despite the increase in wolves (Gunn 2009). With the exception of the Fort Providence area, there was no evidence of increased killing of boreal caribou by wolves (Dehcho First Nations 2011). At that time, knowledge holders reported that the Fort Providence area appeared to have large wolf packs due to the increased wood bison population, and had also seen the biggest decline in boreal caribou wolf predation may be one of the factors involved in this decline (Dehcho First Nations 2011). The pattern of increased wolf and bear numbers in the Dehcho region appears to be getting more pronounced, based on reports from Acho Dene Koe First Nation knowledge holders (Acho Dene Koe First Nation 2018).

In the GSA, reporting in 2011 suggested that wolf populations may be negatively affecting prey populations in most areas where boreal caribou were harvested, although boreal caribou numbers and presence around Tsiigehtchic were not thought to be impacted by a large pack immediately around the town (Benson 2011). Gwich'in hunters felt that controlling wolf populations was key to managing any decline in boreal caribou (Benson 2011). Participants at a meeting in Wrigley pointed out that wolves have a purpose; they kill the sick boreal caribou (and moose) and help keep the animals healthy. However, they also felt there was a need to control predators (ENR 2006c [Wrigley]).

In the South Slave Region, the Deninu Kue First Nation reported that populations of predators, primarily wolves, have likely remained stable over the years. However, approximately half of the respondents reported that there were more wolves now than in the past (d'Entremont 2017).

Grizzly bears and black bears also prey on boreal caribou. Bear populations were reportedly increasing as a result of less hunting pressure in the earlier part of the 2000s (ENR 2007k [NWT Métis Nation Board]; Benson 2011; Dehcho First Nations 2011). Too many grizzly bears are thought to be affecting caribou, as they feed on young caribou (ENR 2007e [Paulatuk]). Grizzly bears will hunt boreal caribou calves or scavenge from carcasses (ENR 2007e [Paulatuk]; Benson 2011). Grizzly bears can learn to follow the sound of gunshots to a caribou carcass to feed. Bears are known to follow pregnant females when their waters breaks, and take the calves; they may also take the female at these times (ENR 2007k [NWT Métis Nation Board]). Tłı̨chǫ harvesters also talk of bears hunting caribou, saying that bears kill *tǫdzı* from behind, whereas wolves hunt *tǫdzı* in packs (Legat 2013). Gwich'in hunters say bear behaviour is changing—they are becoming less timid of human activity (Benson 2011).

While wolverine and lynx may also hunt and/or scavenge boreal caribou (especially preying on calves) they were not mentioned as a particular threat. Nonetheless, it was noted in 2011 that wolverine populations may be increasing in the GSA (Benson 2011). Golden and bald eagles have also been known to take boreal caribou calves (Gau *in* SARC 2012: 52).

There are additional concerns about possible impacts of new predators that are expanding their range northward (Benson 2011). A possible increase in cougar numbers in the Tłı̨chǫ region was stated as a concern for boreal caribou (Environment Canada 2010c [Behchokǫ̀]). Cougars, or their tracks, were increasingly seen throughout the Dehcho region in the early 2000s, and they are suspected of preying on boreal caribou—although there is as yet no direct evidence of this occurring. Their increase may be associated with the concurrent increase in white-tailed deer in this area, as well as extensive oil and gas exploration in northern Alberta and British Columbia, which is thought to push cougars northward (Dehcho First Nations 2011). As evidence of possibly increasing northern range, a 2011 report noted a cougar observed around Fort McPherson (Benson 2011). The extent of cougar movement northward is an important knowledge gap.

Coyotes may also be moving northward, and some people feel they may present a threat to boreal caribou: several participants at a 2010 workshop in Behchokǫ̀ noted that coyote populations and distribution were expanding in their area at that time (Environment Canada 2010c [Behchokǫ̀]), and one Gwich'in hunter may have seen coyote tracks in the Mackenzie Delta (Benson 2011). As with cougar, the extent of coyote movement northward is an important knowledge gap.

Further details on predation as a threat and associated implications for boreal caribou habitat management are included in points (10) to (12) in *Appendix A*. While increases in predator populations are a common theme in Indigenous and community knowledge reports reviewed for this update, there is a lack of consistent reporting on whether these observed increases have become more pronounced in the nine years since the last update in 2012. Given the relationship between habitat change, predator population changes, and caribou declines, the lack of consistent reporting on predator populations in the regions of the NWT is an important knowledge gap.

Climate Change

Climate change is another factor impacting boreal caribou. Many Indigenous and community knowledge reports suggest a myriad of effects from climate change, including changing snow conditions (Nagy *et al.* 2002; Zimmer *et al.* 2002; ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]; ENR 2007e [Paulatuk]; Dehcho First Nations 2011; Parlee and Maloney 2017); warmer summers and winters (Nagy *et al.* 2002; Zimmer *et al.* 2002; ENR 2007b [Fort Resolution Métis Council]; ENR 2007g [Inuvik]; Environment Canada 2010b [Whatì]; McDonald 2010; Benson 2011; Dehcho First Nations 2011; Legat 2013; Parlee and Maloney 2017; Legat *et al.* 2018); changes in the distribution and abundance of predators (ENR 2007a [K'átł'odeeche First Nation]; Acho Dene Koe First Nation 2018); and changes in habitat due to melting permafrost (Benson 2011; Dehcho First Nations 2011; Parlee and Maloney 2017).

Changing habitat and weather conditions are impacting the ability of boreal caribou to feed in numerous ways (Benson 2011; Dehcho First Nations 2011). One example cited is the occurrence of rain in the winter and/or fall: once very rare but now increasingly seen, it covers vegetation with ice and can produce a crust on the snow which impedes caribou movements and causes injury to their legs (Benson 2011; Dehcho First Nations 2011).

In a 2017 report from the Mackenzie River Basin, people talked about decreased water levels and water flows, including dried up creeks. The report speculates that these widespread observations may be the result of warming weather and lower levels of precipitation. Warming winter temperatures have led to earlier break-up and later freeze-up in many areas, and there are observations of extreme weather events, such as unseasonably warm winter days (Parlee and Maloney 2017).

The Dehcho K'ehodi Youth Trip from Fort Simpson to Willow Lake River reported the following observations:

"The landscapes where [the harvesters] used to go trapping are somewhat flooded or somewhat uprooted because the permafrost is thawing and all of a sudden you're having trees laying all over, like somebody dumped toothpicks. So, all of the trees are just uprooting. They're just all falling down. Like when you come to the muskeg area, they used to have these big frost heaves, when you're travelling. But all of a sudden, these frost heaves are here no more. And all of a sudden there's big craters in the ground." (Parlee and Maloney 2017, p. 35)

Another participant echoed these sentiments, noting that trees are falling much more than before and generally seemed less healthy: "drying up for some reason". He also described the changes in terrain to the muskeg explaining that when he used to duck hunt in June, he would wear rubbers and moccasins. As he walked through the muskeg, he would sink down only as far as his ankle making this footwear adequate. "You could walk anywhere on the muskeg then" These days, however, he explains, the permafrost thaw makes travel more difficult as he now will sink up to just below his knee (Parlee and Maloney 2017).

In a 2018 research bulletin by the NWT Cumulative Impact Monitoring Program (NWT CIMP), changes in caribou habitat in Jean Marie River First Nation traditional territory were documented using traditional knowledge and scientific knowledge. Results showed that boreal caribou habitat conditions are being affected by forest fires and permafrost thaw, with the latter having a particularly high impact (NERB 2018).

As noted above in the section on wildfires, Tłı̨chǫ Elders and knowledge holders report that fire behaviour is changing with climate change, with larger, more intense fires becoming more common. Based on the knowledge they shared in reports by Allice Legat and colleagues, it will likely take longer for boreal caribou to return to the areas affected by these larger, more intense fires (Legat 2013, Legat *et al.* 2018).

Additional details on climate change are found in points (13) through (21) in *Appendix B.*

Overharvesting and Non-Traditional Harvest Practices

There are increasing concerns about hunting pressure as a threat to some boreal caribou populations in the NWT, particularly in association with new roads that are proposed or being constructed in some areas (e.g., the Tłı̨chǫ All-Season Road between Whatì and Behchokǫ̀; Chocolate *et al.* 2015; Wong and Kiistoff 2020). Knowledge holders are concerned that more roads will increase the influx of people from outside of regions and/or the NWT, and will lead to increased hunting of boreal caribou, exacerbating the declines that are observed in some areas. People talk about roads as places that animals avoid, possibly because of increased hunting pressure (Chocolate *et al.* 2015).

Based on the review conducted in 2012, the available evidence at that time suggested that harvest of boreal caribou is relatively low. Indigenous people tend to only harvest this type of caribou opportunistically; most communities rely more on barren-ground caribou or moose for sustenance (Gunn 2009; Environment Canada 2010d [Gamètì]; McDonald 2010; Benson 2011; Chocolate 2011). In most areas of the NWT, there is limited sport hunting or harvest by resident hunters. Based on information from the NWT Resident Hunter Survey (2001-2018), resident hunters took an estimated 49 woodland caribou per year, including boreal woodland and mountain caribou. On average about 40% of these reported kills were likely boreal caribou based on location of hunt. This estimate is based on the assumption that boreal and mountain woodland caribou kills are equally likely to be reported (ENR unpublished data 2018).

The connection between other threats and harvesting pressure has been raised in earlier reports: people note that when boreal caribou population numbers are lower than any natural cycle would bring, any threats are exacerbated, and recovery is slower (ENR 2007j [Tsiigehtchic]). Because boreal caribou groups are typically small and fragmented, people fear that any increase in harvesting could have a negative impact (Olsen *et al*. 2001). Several concerns have been raised in regard to potential future impacts of hunting on the boreal caribou population.

In the Tłı̨chǫ region, people expressed concerns that the TASR will increase hunting pressure along this area of boreal caribou habitat from Behchokǫ̀ to Whatì, echoing concerns that were raised during the assessment process for a new road associated with the NICO mine in the NICO REA (MVRB 2013). The MVRB agreed with this concern in their 2018 Report on the Environmental Assessment (REA), finding that there is a significant risk of increased hunting pressure along the TASR (MVRB 2018a, b). As a result of this finding, the GNWT, in collaboration with Indigenous groups, is required to determine sustainable harvest levels for boreal caribou (todzi) and to work with the Tlicho Government to implement measures to ensure harvest is sustainable if harvest levels are observed to reach unsustainable levels. (MVRB 2018b). This

program started in 2021 and should provide valuable information on the impacts of this road on hunting pressure in the Tłı̨chǫ region.

Gwich'in hunters fear that as barren-ground caribou populations decline in other areas, and new rules about hunting are introduced to deal with these population declines, more people may harvest boreal caribou (Benson 2011). Already, reduced numbers of barren-ground caribou in the ISR have caused more people to travel from the Inuvialuit coastal communities to the boreal caribou areas to hunt (ENR 2007j [Tsiigehtchic]).

Overharvesting of boreal caribou in the Dehcho region was not an issue involving Dehcho harvesters because traditional harvesting has declined. However, there has been a slow increase in non-Dehcho and non-Dene hunters in several areas, resulting in 'moderate concern' about overharvesting from study participants (Dehcho First Nations 2011). Restrictions on barren-ground caribou harvesting north of Yellowknife, increased access to river systems using jet boats, and more public knowledge of key habitat for boreal caribou has added to concerns about overharvesting (Dehcho First Nations 2011). In Jean Marie River, harvesters are concerned about the targeting of *mbedzih cho* – the larger boreal caribou bulls – as these are thought to be the best breeders (Dehcho First Nations 2011). The need for better harvest data in the Dehcho has been emphasized. There is some suggestion that current harvest information may be underestimating the actual harvest (Dehcho First Nations 2011).

As mentioned in *Linear Disturbances*, hunting pressure can increase when there is increased access through seismic lines, road construction and other industrial development. There is a concern that resident populations of boreal caribou near Sahtú communities are disappearing because of ease of year-round access (Zimmer *et al*. 2002). A possible local decrease in boreal caribou numbers in the areas east and southeast of Inuvik was attributed in part to increased hunting pressure due to access created by the now decommissioned Canadian National Railway line (Benson 2011). Increased hunting pressure at Cardinal Lakes in the GSA may be due to an ice road into the area and may account for the population decrease there (Benson 2011). A road to North Caribou Lake also caused hunting to increase in that area (ENR 2007j [Tsiigehtchic]). Further increases in access are anticipated with new developments such as the proposed Mackenzie Gas Pipeline and Mackenzie Highway (Benson 2011).

Non-traditional or unlawful harvest practices are considered a threat to boreal caribou. These include reckless shooting; over-use of motorized vehicles; wasting meat and leaving carcasses on the ground; not sharing meat; and not using the entire carcass. Caribou may move out of an area if traditional and respectful hunting practices are not followed (Benson 2011). In the case of the Pine Point mine, excessive harvesting of boreal caribou by mine workers depleted populations in that area. Participants at a meeting said that many caribou were killed by the mine workers: "West of Hay River, we still have woodland caribou, but to the east of here, there aren't as many because of Pine Point (the air traffic, cutlines, and hunting by mine staff), there

are still some around Big Buffalo," (ENR 2007k [NWT Métis Nation Board]). Elders have stressed that traditional hunting practices need to be used when hunting boreal caribou (Zimmer *et al.* 2002; Environment Canada 2010c [Behchokǫ̀]).

For more details on overharvesting and non-traditional harvest practices that have potential implications for the management of boreal caribou, see points (23) to (26) in *Appendix A*.

Parasites and Disease

Overall, boreal caribou are generally considered healthy, with a healthy fat content. Parasites and disease were generally not indicated to be major threats in the available sources. Boreal caribou are reported to have fewer diseases than moose (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]). Only nine instances of sick or dead boreal caribou were documented in an Indigenous and community knowledge study in the SSA. Generally, the animals were reported to be healthy and the majority of carcasses found were from wolf predation (Zimmer *et al.* 2002). In an Indigenous and community knowledge study of boreal caribou in the Dehcho region, harvesters expressed concern about the handling and collaring of boreal caribou for research purposes and the appearance of two apparently stressed and unusually thin animals (Dehcho First Nations 2011). However, participants in a Gwich'in study said there is an increasing trend towards unhealthy caribou in the GSA. Unhealthy animals can be identified by having spots on organs, poor body condition, lack of fat, lumps and pus, or other evidence of disease (Benson 2011). Similarly, in recent years, Tłı̨chǫ harvesters have observed some harvested boreal caribou to have similar signs of poor health (Legat *et al.* 2018). See *Health* for these observations. Further work is needed to explore the underlying causes of the poor health observed in the Tłı̨chǫ region.

Boreal caribou in the GSA occasionally have brucellosis or pus in their joints. They have nose bots in spring, which are expelled through sneezing. They have warble flies in spring as well. Nose bots and warble flies are considered normal in boreal caribou (Benson 2011). Hunters in the GSA, SSA and ISR provided the following information about caribou parasites, which likely applies mainly to barren-ground and Porcupine caribou but may also be relevant for boreal caribou (Kutz 2007):

- Warbles are seen in most caribou but are not a problem for them. Their prevalence has not changed over time.
- Nose bots are seen in some to most caribou but are not a problem for them. Their prevalence might be changing over time but most hunters do not think so.
- Brucella is rarely seen. It hasn't changed over time, but a few hunters felt that it may be a problem for people or caribou. Most did not feel it was a problem.

- Besnoitia is rarely to sometimes seen. Most hunters felt it wasn't a problem for caribou or people. It has not been changing over time.
- Muscle cysts are seen in some caribou. Interestingly, only people from Inuvik and Tsiigehtchic in the Gwich'in area indicated that they never see muscle cysts. They may be changing over time and are considered a problem for caribou and people in the SSA.
- Liver cysts are never or rarely seen and are not considered a problem (except in Aklavik, which would likely be hunting Porcupine caribou).
- Lung cysts are seen never, rarely, or sometimes. They are not considered to be a problem and their prevalence is not changing.
- Warts are very rarely seen and are not considered a problem.
- Yellow-green fluid (fluid under the skin) is seen sometimes, in the Gwich'in and Sahtú areas. It is considered a problem for caribou and people, and is changing over time.

Other Causes of Negative Impacts

Elders and harvesters from across the NWT have noted that some research methods may affect boreal caribou negatively. Multiple Indigenous groups are concerned with impacts of radio collars—collars wear away fur, and facilitate infection; collars are seen as disrespectful. Collaring remains controversial in many communities; while Elders express concern, many agree that baseline data gathered using these methods is necessary (Dehcho First Nations 2011). Now that baseline data have been collected, the general consensus is that collaring should not continue (Dehcho First Nations 2011). In the Dehcho region, the two main concerns are that the netting, handling and collaring causes physical injury and weakening of the animals, and that these practices are culturally inappropriate and disrespectful (Dehcho First Nations 2011). In many areas, collars are seen to affect boreal caribou and cause them to change their behaviour, or even cause disease (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]; ENR 2007h [Fort McPherson]; Environment Canada 2010c [Behchokǫ̀]; Dehcho First Nations 2011). In addition to the behavioural changes, the area around the neck where the collar sits are at times worn raw and may become infected (McDonald 2010). Dehcho Elders fear that collaring will impact a caribou's relationship with other caribou and otherwise impact the integrity of the caribou (Dehcho First Nations 2011).

Communities also have concerns with the use of drugs for the chemical restraint of captured animals, particularly related to the safe consumption of meat from previously captured animals being harvested and possible implications for caribou health and welfare. In the NWT, Wildlife Care Committee-approved operating procedures for the capture, handling, and release of caribou seek to minimize trauma, stress, and long-term health impacts on the animal and populations (GNWT 2018). Caribou handling activities for research and monitoring use physical restraint methods. The use of chemical restraint during caribou captures is very rare and has not

been used in the NWT in the last fifteen years (Jutha 2022). Chemical restraint is an option of limited use in caribou across Canada and would only be used in specific, rare circumstances that would be in the best interest of caribou health, welfare, and human safety (GNWT 2018). Tourism is also cause for some concern with respect to boreal caribou. Increased tourism has attracted an influx of people into the Tłı̨chǫ region. There are concerns that tourists do not respect the land, and their visits result in more airplanes, more use of all-terrain vehicles (ATVs), and overall increases in noise and light disturbance for boreal caribou (Environment Canada 2010b [Whatì]; Chocolate 2011).

All-terrain vehicle and snowmobile use can drive boreal caribou away and the effects are exacerbated by the ease at which snowmobiles travel down seismic cutlines. The decrease in boreal caribou seen between Hay River and Point de Roche is thought to be due to increased human activity in the area (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]). One harvester in Behchokǫ̀ reported that there has been increased ATV use in the Tłı̨chǫ region over the past few years, and that sometimes he sees as many as ten quads traveling together in a group, right through boreal caribou habitat. He said this activity pushes the caribou away and that off-road vehicle use is a main threat to the boreal caribou in this area (Environment Canada 2010c [Behchokǫ̀]).

Negative interactions between boreal caribou and other ungulates, particularly wood bison, are also cause for concern. In 2006, workshop participants in the community of Behchokǫ̀ expressed concern that encroaching wood bison may negatively impact boreal caribou, and that the increasing wood bison population is related to decreasing boreal caribou numbers (Cluff *et al.* 2006). In 2010, participants in a workshop in Behchokǫ̀ mentioned an increasing population of wood bison in the Mackenzie Bison Sanctuary—an area where boreal caribou were previously seen, but are no longer seen. They stated that the increasing wood bison population has led to more wolves in the region (Environment Canada 2010c [Behchokǫ̀]).[7]

Participants at a meeting in Behchokǫ̀ were very concerned about pollution and contamination. It was suggested that pollution and acid rain may be affecting the boreal caribou range and therefore the caribou. There were also concerns about contaminated historic mining sites posing a threat to boreal caribou in this region (Environment Canada 2010c [Behchokǫ̀]).

Beyond looking at threats individually, it is also important to consider the combined impact of multiple threats (cumulative effects). Tłı̨chǫ Elders expressed a desire for scientists to 'leave the caribou alone' and protect habitat; they have expressed concerns about the cumulative effects of development, infrastructure and fires on boreal caribou (Legat *et al.* 2018). In the SSA, it has been noted that if highway access and oil and gas development proceeds without adequate

[7] Note that since the anthrax outbreak, which occurred in 2012 and impacted the wood bison population in the Mackenzie Bison sanctuary, this concern may no longer be relevant.

cumulative effects assessment, mitigation or monitoring, the impacts on boreal caribou will likely be significant, based on experiences in Alberta. For example, these development activities will likely lead to an increase in predation (Wynes 2001 in Olsen *et al.* 2001). Based on their collective experience of the major oil and gas exploration activities that took place in the Dehcho during the late 1950s through to the early 1970s, Dehcho harvesters are concerned about the cumulative impacts of development, as well as the immediate impacts (Dehcho First Nations 2011).

Cumulative effects are also an important concern identified by Acho Dene Koe First Nation knowledge holders, particularly the relationship between disturbance, roads, predator populations, harvesting pressure, and fires (Acho Dene Koe First Nation 2018). Many knowledge holders identified ways in which caribou harvesting, preparation, and other related cultural activities have already been impacted by declining populations. Once an extremely prevalent cultural activity among Acho Dene Koe First Nation members, hunting caribou is less common than it was in the past because of declining populations, and because of Acho Dene Koe First Nation members' intentional avoidance of the animal due to its vulnerability. Some traditional sites identified by Acho Dene Koe First Nation members have changed from present use to past use within the span of the knowledge holders' lifetime, as a result of declines in caribou availability. If caribou numbers continue to decline, Indigenous knowledge surrounding caribou hunting techniques, techniques of processing the animal into tools, clothing, and food, together with the values and stories infused in the caribou harvest, risk being lost for future generations. Trails may cease to be used as routes to access caribou harvesting areas, and teaching and gathering sites may lose some of their traditional significance regarding caribou. The consequences of this situation are significant: as a result of declining caribou populations Acho Dene Koe First Nation members are not able to practice their traditional vocation of hunting caribou, which is contrary to their Treaty 11 right. The loss of Acho Dene Koe First Nation's hunting practice is leading to an increasing erosion of Acho Dene Koe First Nation's traditional way of life and transmission of cultural practices to current and future generations.

POSITIVE INFLUENCES

The main avenues of positive influence on boreal caribou in the NWT include traditional stewardship practices, Indigenous monitoring and research initiatives, community conservation actions, land use planning for habitat protection, and ongoing boreal caribou range planning. These areas of positive influence are explored in further detail below.

Suggestions from Indigenous and community knowledge sources on specific practices for protection of boreal caribou, habitat areas to protect, as well as suggestions for research and monitoring, are included in points (27) through (48) of *Appendix A*.

Traditional Stewardship Practices

"...In our hearts we know that we're not wrong because we spend a lot of time on the land. Right to this day, a lot of us, we spend time on the land with the caribou. If the caribou was in trouble, somehow they'll communicate with us. So that's why we hang on to our way of life, our traditional way of doing things. Very important." Joseph Kochon (Sahtú Renewable Resources Board 2020)

Indigenous and community knowledge study participants often talked about the ways in which boreal caribou should be paid respect and how to respectfully steward and harvest the species. When followed, these traditional practices can be a positive influence on boreal caribou populations (Benson 2011).

The Dɬǫ̨nę Got'ǫ̨nę Plan of Action[8] outlines steps to ensure caribou populations for current and future generations and ensure respectful and sustainable harvest (Neyelle *et al.* 2016). The Dɬǫ̨nę Got'ǫ̨nę Plan emphasizes the importance of maintaining beneficial relationships with caribou. Key components of human and caribou health include maintaining balance, relationships and sharing practices, living with caribou, governance and harvesting different foods for survival. The plan further notes the importance of considering that human knowledge is never completely omniscient.

The Dɬǫ̨nę Got'ǫ̨nę Plan states that conditions on the landscape are changing, and there is a need to implement community-based self-regulation of caribou harvest to support healthy caribou populations. This practice aligns with traditional practices of concentrating harvest efforts on other food sources or regions when one food source declines or disappears: this Dene practice is translated as the phrase "it's gone down so we're going to let it rest". The Dɬǫ̨nę Got'ǫ̨nę Plan asserts that mentorship is necessary to ensuring that this self-regulation system works in practice, as youth need to become knowledgeable about hunting in order to learn respectful practices including killing animals humanely. Education is an important priority to support sustainable relationships between humans and caribou. The Dɬǫ̨nę Got'ǫ̨nę Plan notes that animals may not return if humans waste meat that humans have killed, and it is important to dispose of bones respectfully in the bush. Furthermore, Traditional Dene protocols mandate that humans must never hit caribou with a stick, and, that humans must thank ancestors and animals for successful hunting. Restriction- or penalty-based harvest management systems imposed by governing bodies outside of Dene communities will not be successful in the Dene area; instead, the Dɬǫ̨nę Got'ǫ̨nę Plan focuses on supporting people as stewards of caribou and not relying on wildlife officers enforcing harvest regulations and criminalizing hunters.

According to the Plan, a cultural shift is necessary to respond to changes in caribou populations and preserve beneficial relationships. Studying caribou according to Indigenous ways of knowing is an essential step to foster caribou recovery. There is a need for people to unify to

[8] Guidance was provided by Walter Bayha (pers comm. 2020; 2021) to interpret the themes and recommendations of this plan for boreal woodland caribou. The preparers thank Walter and *ʔehts'e* (Grandfather Bayha) for their knowledge and support in preparing this report.

make decisions to solve the problems at hand and work together. In turn, it is crucial that government supports the Délı̨nę Got'ı̨nę Plan of Action and listens to knowledge and management decisions from Indigenous knowledge holders. The Délı̨nę Got'ı̨nę Plan recommends habitat protection measures including conserving *kw'ıjí* habitat for caribou. *Kw'ıjí* is "characterized by well-drained, slightly higher terrain, covered in old growth black and white spruce forests". The Plan thus provides a clear path forward to protect caribou that is grounded in Indigenous knowledge, education and fostering respectful relationships with caribou.

K'átł'odeeche participants stressed that respect for animals, land and water; protection of animals and specific areas; and local control of resources was necessary to manage a species like boreal caribou (Gunn 2009). They said there are numerous practices and rituals that are a critical part of life on the land, such as following seasonal rhythms, leaving offerings, and prayer. Similarly, Dene in the Dehcho region describe a spiritual relationship with *mbedzih*, which carries with it, obligations not to unduly harm or disrespect the animals; there are important offerings and rules about the use of the meat and hide to maintain respect (Dehcho First Nations 2011).

Harvesting and sharing practices is another way of respecting the land and the animals. In the SSA, when groups of boreal caribou are encountered, only a few caribou from each group are harvested and more bulls are harvested than cows and calves (McDonald 2010). Gwich'in hunters felt that instilling the Gwich'in values of respectful harvest were key to any future management of boreal caribou (Benson 2011). Resource distribution and management was traditionally conducted through well-defined rules and practices (Gunn 2009).

Traditional stewardship practices are grounded through Indigenous laws and guiding principles. For example, in the Sahtú region, Dene and Métis representatives from local ʔehdzo Got'ı̨nę (Renewable Resources Councils; RRCs) passed a resolution in September 2012 calling for a renewed commitment to adopt Indigenous and community knowledge and the laws of the Dene people as the guiding principles for all caribou research and management (Polfus 2015; Polfus *et al.* 2016).

Additional details on traditional stewardship practices are found in points (25) and (26) of *Appendix A*.

Indigenous Monitoring and Research Initiatives

Indigenous and community-based monitoring and research initiatives in the NWT provide an avenue for continual learning and information sharing regarding the status of boreal caribou populations. Examples of programs include the Sahtú Dene Council's *Nę K'ádı́ Ke* (Keepers of the Land) monitoring program, Tłı̨chǫ Government boreal caribou monitoring activities and mapping workshops, and ongoing work by K'átł'odeeche First Nation to describe boreal caribou habitat use based on Dene vegetation classification, among others (Sahtú Renewable Resources Board 2020; Legat *et al.* 2018; Behrens pers. comm. 2020; K'átł'odeeche First Nation 2020).

Monitoring and research initiatives often include information sharing across caribou-reliant communities to support decision-making around sustainable use (Benson and Winbourne 2015). Traditionally, families and communities would share information through annual or seasonal gatherings when people would gather together to discuss the harvest, health, and other observations related to the caribou populations. Family leaders would use this information to determine where and what to harvest (Winbourne 2013; Bayha 2015; Benson and Winbourne 2015). Observation networks and collaborative research approaches are also being used across the NWT to support the sharing of boreal caribou information to better inform management decisions (Benson and Winbourne 2015).

Community Conservation Actions

Although a mandatory restriction of Indigenous harvest is not currently contemplated in the NWT, some community members in the NWT have voluntarily limited their harvest of boreal caribou. People in Whatì have reduced their harvest of boreal caribou because the boreal caribou population is not as healthy as it once was (Environment Canada 2010b [Whatì]). Some Dehcho hunters, aware of declining populations in southern Canada, have changed their hunting habits to hunt fewer boreal caribou in response (Dehcho First Nations 2011). Within the SSA, the Sahtú Renewable Resources Board has decided that harvest regulation for all caribou populations must be subject to community conservation planning measures (Sahtú Renewable Resources Board 2020).

K'átł'odeeche Elders indicated that they know how to balance use of boreal caribou with conservation, and would rotate the areas they hunted every year or so to not deplete one place (ENR 2007a [K'átł'odeeche First Nation]). Gwich'in hunters have changed the way they hunt boreal caribou in response to new information they receive about population decreases (Benson 2011). Gwich'in hunters do this on a planning level – for example, they will not hunt in an area known to have declining populations. They also do it 'on the fly' while hunting. For example, if a larger group of boreal caribou is seen, some individuals will be harvested from this group rather than taking a solitary animal (Benson 2011).

A Gwich'in Indigenous and community knowledge study from 2011 indicated that hunting regulations in the GSA (which included bans on hunting boreal caribou for resident hunters in certain zones) produced noticeable increases of boreal caribou numbers in some areas. According to Gwich'in Indigenous and community knowledge, prior to the hunting regulations, boreal caribou numbers in regulated areas were seen to be declining or lower although the mechanisms were not understood. Gwich'in Indigenous and community knowledge suggested that the result of hunting regulation on boreal caribou were being seen in areas where they had not been for some time (Benson 2011).

Land Use Planning for Habitat Protection

Indigenous land use planning emphasizes the importance of cumulative effects on existing caribou habitat, including the relationship of NWT boreal caribou to declining populations of boreal caribou in other regions in Canada (Acho Dene Koe First Nation 2018). The development of land use and community conservation plans in the NWT provides a structure for monitoring, reporting and evaluation related to boreal caribou conservation efforts (Dehcho First Nations 2011; Sahtú Renewable Resources Board 2020).

Legislated federal and territorial recovery plans have also been completed for boreal caribou and provide an opportunity for Indigenous communities to participate in range planning efforts (Sahtú Renewable Resources Board 2020).

Through the NWT Protected Areas Strategy a number of sites have been proposed by communities for legislated protection where the protection of boreal caribou habitat is one of the primary goals (Redvers *in* SARC 2012: 58; Bayha *in* SARC 2012: 58).

The establishment of National Wildlife Areas and protected areas within NWT is also indicated as a positive influence for boreal caribou populations. For example, the Edéhzhíe Protected Area was established in 2018 through an agreement between the Dehcho First Nations and the Government of Canada, protecting nationally significant habitat for boreal caribou (ECCC 2020). There is also a proposal to make Edéhzhíe a National Wildlife Area under the *Canada Wildlife Act*. In addition, Dınàgà Wek'èhodì, in the northern portion of the north arm of Great Slave Lake is a Candidate Area under the NWT Protected Areas Act. This 790 km² area, proposed for protection by the Tłı̨chǫ Government, includes important habitat for boreal caribou. An establishment agreement was signed in 2019 for Ts'udé Nilı̨né Tuyeta – a future territorial protected area that lies west of the Mackenzie River and the community of Fort Good Hope and is 10,060 km² in size (ENR 2022). Established under the *Protected Areas Act*, Ts'udé Nilı̨né Tuyeta will strive to protect the biodiversity of the Taiga Plains and Taiga Cordillera (ENR 2022).

Boreal Caribou Range Planning

Regional boreal caribou range planning in the NWT, which began in 2019 and is due to be completed by March 2023 (GNWT Newsletter August 2020), will have a positive influence on habitat for boreal caribou over the coming years. Ranging planning provides a proactive approach to ensuring that development is maintained below established thresholds for boreal caribou throughout the NWT. To recognize the different regional pressures across the NWT, range plans are being developed across five regions: southern NWT (Dehcho and South Slave regions), Wek'èezhìı, Sahtú, Inuvialuit and Gwich'in. Each regional plan is being developed by a regional working group, composed of Indigenous governments and organizations, renewable resources boards, environmental organizations, land and water boards, and federal and territorial governments. Indigenous and community knowledge was used to identify critical boreal caribou habitat within the Wek'èezhìı region. About 15% of the Wek'èezhìı region is

currently under the intensive management class, which prohibits human disturbance indirectly protecting boreal caribou habitat (GNWT 2021). Input from traditional knowledge holders across the NWT boreal caribou range is being incorporated into the development of range plans; advice from local industry and land use planners will be considered as range plans are finalized. The goal of these plans is to ensure a healthy and sustainable boreal caribou population across their NWT range that offers harvesting opportunities for present and future generations. When combined, the regional plans will collectively meet the federal requirement for boreal caribou range in the NWT to contain at least 65% undisturbed habitat.

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- Gordon, A.B.
- Edwards, G.
- Carmichael, H.
- Carmichael, J.
- Ross, R.
- McPherson, W.
- Alexie, W.
- 38 community members (*unnamed*)

Behchokǫ̀:

- Mackenzie, R.
- Williah, F.
- Rabesca, H.
- Apple, C.
- Football, J.
- Drybones, N.
- 35 community members (*unnamed*)

Colville Lake:

- Kochon, W.
- Kochon, R.
- Rabisca, F.
- Blancho, A.
- Kochon, S.
- 9 community members (*unnamed*)

Déljne:

- Kenny, A.
- Baton, D.
- Taniton, R.
- Bayha, W. and *ʔehts'e* (Grandfather Bayha)

Fort Good Hope:

- Kochon, G.
- Pierrot, F.
- Kakfwi, E.
- Caesar, K.
- Lafferty, M.
- 10 community members (*unnamed*)

Fort Liard:

- 9 Acho Dene Koe First Nation knowledge holders (*unnamed*)

Fort McPherson:

- Peterson, A.
- Kay, E.
- Teya, M.
- Pascal Sr, M.
- Alexie Sr, R.
- Landry, T.
- 29 community members (*unnamed*)

Fort Providence:

- Lacorne, J.

Fort Resolution:

- Collins, F.
- Beaulieu, R.
- Sanderson, A.
- King, P.
- Beaulieu, L.
- Beaulieu, W.
- McKay, L.
- MaKay, H.
- Sinclair, L.
- McKay, D.
- Pierrot, L.
- McKay, M.
- Smith, P.
- Mandeville, R.
- Boucher, M.
- Boucher, C.
- Mandeville, P.
- O'Reilly, S.
- Unka, T.
- Giroux, G.
- Giroux, R.
- Mandeville, P.
- McKay, D.
- McKay, E.
- Beaulieu, J.
- Norn, L.
- King, B.
- Beck, A.
- King, K.
- McKay, R.
- Cardinal, L.
- Hunter, T.
- Fabien, F.
- 5 Deninu Kue First Nation knowledge holders (*unnamed*)

Fort Simpson:

- Norwegian, H.
- Tsetso, R.

Fort Smith:

- Villebrun, B.
- Fraser, L.
- Villebrun, L.
- Hudson, K.
- Johns, M.

Gamètì:

- 30 community members (*unnamed*)

Hay River:

- Bloomstrand, G.
- Belanger, C.
- Johns, F.
- Lafferty, A.
- Jones, V.
- Michel, N.
- Michel, W.
- Thomas, K.

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- Baetz. C.
- Vittrekwa, E.
- Firth, J.B.
- Wright, T.
- Simon, W.
- Elias, L.
- Arey, D.
- Dick, E.
- 50 community members (*unnamed*)

Kikisa:

- Simba, D.

Nahanni Butte:

- Betsaka, E.

Norman Wells:

- Oudzi, E.
- 10 community members (*unnamed*)

Paulatuk:

- 10 community members (*unnamed*)

Ross River:

- Dick, D.
- Charlie, T.

Sachs Harbour:

- Amos, B.

Sambaa K'e (formerly Trout Lake):

- Punch, J.
- Jumbo, E.
- Kotchea, T.
- Deneron, D.
- Jumbo, V.

Tsiigehtchic:

- Ross, A.
- Kendo, D.
- Norbert, J.
- Cardinal, L.
- Ross, P.
- 17 community members (*unnamed*)

Tuktoyaktuk:

- Wolki, F.
- 50 community members (*unnamed*)

Tulít'a:

- MacCauley, C.
- Lennie, J.
- Etchinelle, D.
- 11 community members (*unnamed*)

Ulukhaktok:

- Klingenberg, E.
- Kuptana, R.

Whatì:

- Simpson, F.
- Beaverho, P.
- Jeremick'ca, B.
- Champlain, J.
- Nitsiza, J.
- Nitsiza, J.
- Romie, M.
- Romie, R.
- Rabesca, J.B.
- Beaverho, A
- 43 community members (*unnamed*)

Wrigley:

- Hardisty, G.
- Moses, A.
- Lennie, T.
- Neyelle, M.
- Moses, G.

Community Unspecified:

- Yakeleya, G.
- Taniton, A.
- Bayha, W.
- Andrew, F.
- Kochon, J. (SSA)
- Bayha, W. (SSA)
- Łidlini, T. (SSA)
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- Odgaard, R. (SSA)
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- Sabourin, P.
- Cardinal, A.

- Norn, L.
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- Buggins, P.
- Lafferty, C.
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- Smallgeese, S.
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BIOGRAPHY OF PREPARER

This report was prepared by Firelight Research Inc., with Susan Leech (MSc, RPBio) as the lead author, supported by Kalene Gould (BSc) and Sashka Warner (BSc). Firelight is an Indigenous owned company that only works for Indigenous and local communities, or on projects where communities support our participation, with a focus on supporting Indigenous rights and interests. Our goal is to provide high-quality research, analysis, and capacity building services to create solutions for a shared future. Firelight's ecology team is comprised of highly skilled research professionals with strong social science and ecological skills. We specialize in working with communities to bring Indigenous knowledge, practices and laws into natural resource management planning and decision-making, with a specific focus on protecting and restoring Indigenous values. Firelight's ecology team has supported numerous Indigenous and science-based knowledge studies related to large mammals and particularly caribou. The lead author, Susan Leech, is a registered professional biologist with over 25 years of experience in natural resource management and conservation, and is currently co-lead of Firelight's ecology team. Susan has a Bachelor of Science from Queen's University (1994) and a master's in science from Dalhousie University (1996). Sashka Warner is a researcher and data analyst, and Kalene Gould has been involved in monitoring work for Tłı̨chǫ Government. Additional writing support was provided by Jessica Holden (MSc, RPBio) and Claudia Ho-Lem (MSc).

SCIENTIFIC KNOWLEDGE COMPONENT

ABOUT THE SPECIES

Names and Classification

Scientific Name:	*Rangifer tarandus* (Lin.), subspecies *caribou* (Gmelin 1788; Banfield 1961, 1974), boreal ecotype
Common Name (English):	Boreal caribou
Common Name (French):	Caribou des bois
Populations/subpopulations:	Northwest Territories
Synonyms:	Caribou, woodland caribou (boreal population)
Class:	Mammalia
Order:	Artiodactyla
Family:	Cervidae (deer)
Life Form:	Animal, vertebrate, mammal, deer, caribou

Systematic/Taxonomic Clarifications

All caribou and reindeer in the world belong to one species, *Rangifer tarandus*. In Canada, Banfield (1961) classified caribou into four extant subspecies, including the "woodland caribou" (*R.t. caribou*) based on skull measurements, pelage, hoof shape and antler shape. COSEWIC (2011) concluded that Banfield's subspecies classification was out-of-date with respect to current science and defined 12 Designatable Units (DUs) in Canada. DUs are "discrete and evolutionarily significant units of a taxonomic species" (COSEWIC 2013), and for caribou are based on information on phylogenetics (evolutionary lineage), genetic diversity and structure, morphology, movements, behaviour and life history strategies, and distribution (COSEWIC 2011). Caribou in this report are synonymous with "Boreal caribou (DU6)" under the DU framework for caribou in Canada adopted by COSEWIC in November 2011 (COSEWIC 2011).

Range Planning Regions and Study Areas

The National Recovery Strategy for Woodland Caribou, Boreal Population (ECCC 2012) identified three transboundary ranges including the Northwest Territories range (NT1; see Figure 11). The NWT Recovery Strategy called for the development of regional range plans focused on managing human disturbance (CMA 2017). The NWT Range Planning Framework

divided the NWT portion of the NT1 range into five range planning regions (Inuvialuit, Gwich'in, Sahtú, Wek'èezhìı, and the Southern NWT portions of the range; see Figure 14; GNWT 2019b). For the purposes of population monitoring programs using radio-collared caribou, 11 study areas have been identified (see Figure 13; ENR unpubl. data, 2020e).

Description

Boreal caribou are medium-sized members of the deer family (Cervidae) measuring 1.0-1.2 m at the shoulder and weighing 110-210 kg (Thomas and Gray 2002; EC 2008; COSEWIC 2011). They are dark to tawny brown with white manes and sides, with a white area on the rump below the tail (Figure 9). Females will often flag their tails like white-tailed deer when alarmed. Males and females have flattened, complex, dense antlers when compared with barren-ground caribou (Thomas and Gray 2002), although the proportion of females with one or two antlers may vary among localities and time of the year. Boreal caribou have large, rounded hooves that allow them to move on deep snow or in wetlands without sinking and to dig for forage under snow (Thomas and Gray 2002).

Figure 9. Two adult female boreal caribou (*Rangifer tarandus*) walking on a lake in late winter (17 April 2006) in the Gwich'in Settlement Area, Northwest Territories, Canada. Photograph courtesy of John A. Nagy.

Life Cycle and Reproduction

The mating system of boreal caribou is polygynous, with dominant bulls breeding with a number of cows (BC Ministry of Environment 2010). Breeding occurs from about mid September to late

October, with the peak of the breeding season in the southern NWT (20 September – 4 October in the Cameron Hills, South Slave, and Dehcho study areas) occurring approximately 6 days earlier than in the north (26 September – 10 October in the Sahtu and Gwich'in study areas; Nagy 2011).

Female caribou first breed at age two (Bergerud 1974), producing their first calves at age three, and typically give birth to only one calf. In the Dehcho study area, there is one documented case of radio-collared female producing a calf when she was two years old (Larter and Allaire 2013), but it is not known how frequently this occurs. Female boreal caribou are solitary during pre-calving and calving, and are widely dispersed with an average of 25 km between individual calving locations (Table 6). This space-away strategy is used to reduce predation risk (James 1999; Dzus 2001; Schaefer *et al*. 2001; Bergerud *et al*. 2008; Larter *et al*. 2019), unlike the congregation on distinct calving grounds strategy used by barren-ground caribou. Therefore, large areas of secure calving habitat are required to reduce predation risk and facilitate survival of boreal caribou calves and females.

Table 6. Distance from a radio-collared adult female caribou calving site to the nearest adjacent calving site of an adult radio-collared female (from SARC 2012).

Study Area	Nearest Calving Site (km to the nearest site used by another radio-collared female)			
	N	**Average[1]**	**Minimum**	**Maximum**
Cameron Hills	36	14.3	0.2	77.9
Dehcho/South Slave	66	25.8	0	184.8
Gwich'in Settlement Area	25	23.7	1.2	96.6
Sahtú Settlement Area	27	36.7	3.7	191.4
Total	**154**	**24.7**	**0**	**191.4**

[1] Because a small percent of the females in an area are collared, the actual distances between adjacent females during a calving period may be much smaller (Nagy 2011). However, these distance measures indicate that a wide range of dispersed calving sites are used.

Fidelity to calving sites is highly variable with some adult female caribou exhibiting strong fidelity to calving sites (e.g. calving sites during successive years for six females were <300 m apart), while others do not return to the same area each year (e.g. for six females the average distance between four calving sites was >30 km; Larter *et al*. 2019).

Most calves are born from late April to early June. In the Dehcho from 2004-2018, 372 calves were born from 7-31 May. An average of 57% were born by 15 May (Larter pers. comm. 2021).

Calf survival during the first six weeks of life is low, often 50% or less (Bergerud 1974). Calves remain with the maternal females until the next pre-calving dispersal period. Calf survival is discussed further in *Population dynamics*.

In the NWT, adult female boreal caribou can be long-lived. In the Dehcho region, of 31 caribou whose ages were determined at time of death, one lived until she was 22 years old, one lived until she was 17 years old and 15 others were 11-15 years old (Larter *et al*.2019). The 22-year old caribou had calves when she was 20 and 21, and six of seven caribou >12 years old had at least one calf during their final years (Larter and Allaire 2016a).

The generation time (average age of parents of newborn individuals in the population) is estimated at approximately 9 years using a formula ([1/adult mortality rate] + age at first reproduction) from the IUCN guidelines (IUCN Standards and Petitions Subcommittee 2019) and the mean survival/mortality rate of radio-collared caribou from all study areas and all years combined (see Table 17). Because females likely produce young up to maximum age, generations overlap.

The only reliable information available on bulls:100 cows from population surveys is from the North Slave population survey in March 2020. Results indicate 51 bulls:100 cows in the total survey area (N=577 caribou counted) and 48 bulls:100 cows in the Tłı̨chǫ All-Season Road (TASR) portion of the survey area (N=445 caribou counted; Nietfeld and Hodson, in prep.; ENR unpublished data 2021a). Although bulls are classified during late winter calf recruitment surveys, the bulls:100 cows ratio may not represent the conditions for the whole population because the surveys focus on radio-collared adult female caribou and incidental sightings and do not attempt to sample a broader spectrum of groups across the whole population (Hodson pers. comm. 2021a; Kelly pers. comm. 2021).

Physiology and Adaptability

Caribou are highly adapted to their environment and cold winter conditions. Their large shovel-like hooves and furred muzzle are adaptations to travelling on and foraging in snow. Thick coats of semi-hollow hair allow caribou to withstand very cold winter temperatures and wind chills (Soppela *et al*. 1986; Thomas and Gray 2002) and provide buoyancy while swimming across rivers and lakes. The moult after calving transforms these caribou into dark sleek animals and as a result shade, cool forests, or open areas exposed to the wind may be important for thermal regulation and insect relief during summer (Thomas and Gray 2002; Nagy *et al*. 2005).

During winter, lichens are an important part of the boreal caribou diet (Schaefer and Pruitt 1991; see *Interactions*). Boreal caribou may eat terrestrial and arboreal lichens and vary foraging behaviour and associated habitat use in response to snow conditions (Stardom 1975; Darby and Pruitt 1984; Schaefer and Pruitt 1991). Although lichens are low in protein content (Scotter 1965; Rowe 1984; Nieminen and Hiskari 1989), they are highly digestible (Person *et al*. 1980, Thomas

et al. 1984), which allows caribou to maximize extraction of nutrients from lichens and exploit a niche that other ungulates are less able to exploit. Caribou have also adapted to the low protein content of lichens by conserving nitrogen through recycling urea (Parker *et al*. 2005).

Unlike other members of the deer family, female caribou grow antlers. Presence of antlers on females likely evolved in response to competition for access to feeding craters during winter. In group situations, a caribou can be displaced from a feeding crater that it dug, by another caribou. At winter feeding sites in Quebec, female caribou with antlers were successful in almost all their interactions at feeding craters with males that had shed their antlers, even though the males were larger in body size (Barrette and Vandal 1986).

Interactions

Boreal Caribou

Little information is available on the diet of boreal caribou specifically in the Northwest Territories. In the Gwich'in study area, Nagy *et al*. (2003) found caribou cratering for terrestrial lichens in open forests, and possibly for cured stalks of horsetail (*Equisetum* spp.) along shorelines of lakes. In other boreal caribou ranges in Canada, caribou forage primarily on lichens during winter, but may eat a wider variety of plants during the snow-free period (DeMars and Boutin 2014; Thompson *et al*. 2015; Denryter *et al*. 2017). In northeastern BC, terrestrial lichens were the dominant forage in faecal samples collected during both winter (7 samples) and calving (7 samples), with moss, sedges/rushes and horsetails the next most prevalent forages (DeMars and Boutin 2014). In Ontario, based on observations from video camera collars, terrestrial lichens are the most prevalent forage throughout the year, with graminoids increasing in importance during spring, and forbs increasing in importance in late spring and summer (Thompson *et al*. 2015). Based on observations of tame caribou[9] foraging in boreal caribou habitat in northeastern BC, during summer and early fall caribou selected deciduous shrubs in more productive habitats (boreal treed rich fens, boreal white spruce forests) and terrestrial lichens in less productive habitats (boreal black spruce bogs and fens, boreal black spruce uplands) but also consumed forbs, grasses/sedges, mushrooms and arboreal lichens (Denryter *et al*. 2017). Lactating adults, which had higher nutritional requirements, spent more time foraging and had a higher daily intake of forage than non-lactating adults or subadults (Denryter *et al*. 2020).

Lichens, the primary winter food source of caribou, are poor competitors against vascular plants and mosses, and are most abundant on sites where growing conditions for other plants and mosses is poor (Johnson 1978). Lichens are also slow growing (Scotter 1963) and *Cladina* sp., the preferred caribou terrestrial forage lichen, often does not become abundant following fire

[9] Tame caribou used in foraging observations were captured in Alaska.

disturbance until 30-80 post-disturbance (Ahti 1977). In the Taiga Plains in the NWT, terrestrial lichen recovery for caribou forage is predicted to take 50-100 years following fire and depends on stand type (Greuel *et al*. 2021).

In the NWT, boreal caribou group size varies throughout the year. Group size is smallest during calving, when adult female caribou are generally found with a calf, alone, or in groups with one or two other caribou (Nagy *et al*. 2005; Larter and Allaire 2005, 2006a, 2006b; Davison and Branigan 2007). Mixed sex groups begin to form in late summer (August) in preparation for the rut, with typical group size of nine caribou in the Gwich'in study areas in the fall (September-November); however, mixed sex groups of up to 25-30 have been observed during the rut/post rut period (Nagy *et al*. 2005; Davison and Branigan 2007). Incidental sightings made during telemetry surveys conducted during May-August and September-April in the Gwich'in study areas indicate that male boreal caribou were widely distributed in the area (Nagy *et al*. 2005). During recruitment surveys in late winter, group size is generally less than 15 caribou (Nagy *et al*. 2005; Davison and Branigan 2007; Kelly and Cox 2013; Williams 2017; Hodson and Patenaude 2018; Hodson 2019; Nietfeld and Hodson, in prep.), although groups of up to 24 caribou (mostly mixed-sex groups) have been observed (Jung *et al*. 2019). During late winter, mean and typical group size of boreal caribou in the Dehcho area were about 6 and 8 caribou respectively, and were larger during years with deeper snow, potentially to reduce energy expenditure, increase efficiency in accessing forage, and/or reduce predation risk (Jung *et al*. 2019).

Predator-prey Interactions

In the NWT, boreal caribou are one component of a predator-prey system that is made up of a variety of species combinations depending on the area within the boreal caribou range (GNWT 2020a; Table 7). Wolves (*Canis lupus*), wolverine (*Gulo gulo*) and lynx (*Lynx canadensis*) are common throughout boreal caribou range in the NWT (Table 7). Black bears (*Ursus americanus*) are abundant or common in most of the boreal caribou range in the NWT, with the exception of the northern portion of the range in the Gwich'in and Inuvialuit regions where they are less abundant, and where grizzly bears (*Ursus arctos*) are present (Table 7). Coyotes (*Canis latrans*) and cougars (*Puma concolor*) are present primarily in the southern portion of the boreal caribou range in the NWT, but are less abundant than other predators (Table 7).

Moose (*Alces americanus*) and beavers (*Castor canadensis*) are present across the entire boreal caribou range, while other prey species are more localized in distribution. The density of moose in areas within boreal caribou range in the NWT is relatively low with densities generally less than 7 moose/100 km^2 (Table 8), which is comparable to moose densities in boreal caribou habitat in northern Saskatchewan (Neufeld *et al*. 2021) and in the northernmost portions of boreal caribou ranges in BC adjacent to the NWT border (Thiessen 2010), and lower than moose densities in the remaining portions of boreal caribou range in BC (7.4-24.6 moose/100 km^2; Thiessen 2010; McNay *et al*. 2013; Webster and Lavallee 2016) and in Alberta (0.1-31.0

moose/100 km²; see Jensen *et al.* 2018). The higher density of moose in the Mackenzie River moose survey area in the NWT (Table 8) may reflect a concentration of moose along the Mackenzie River.

Table 7. Relative abundance of other prey and predators within boreal caribou range in the Northwest Territories.

		Other Prey[1,2]								Predators[1,2]						
Range Planning Region	Study Area	Caribou – Barren-ground	Caribou – Northern Mountain	Beaver	Deer – White-tailed	Elk	Moose	Muskox	Wood Bison	Black bear	Cougar	Coyote	Grizzly bear	Lynx	Wolf	Wolverine
Inuvialuit	None	3		3			3	3		2			4	4	4	4
Gwich'in	Gwich'in North	3		3	1		3			2		1	3	4	4	4
	Gwich'in South	3		5	1		4			2		1	3	4	4	4
Sahtú	Sahtú	3	2	5	1		3	3		4			3	4	4	4
	None	3		3			3			4			3	4	4	4
Wek'èezhìı	North Slave	1			1		3		4	5	1	2		4	4	4
	None	3		3			3			4				4	4	4
Southern NWT	Dehcho North	2		5			3		1	4				4	4	4
	Dehcho South			5	2	1	4		3	5	1	2	2	4	4	4
	Mackenzie	1		4	2		4		4	5	1	2		4	4	4
	Hay River Lowlands			5	2		4		1	5	1	2		4	4	4
	Pine Point/Buffalo Lake			5	2		4		1	5	1	2		4	4	4
	Cameron Hills			4	0		3		1	5	1	0		4	4	4

[1] Relative abundance interpreted from the Biodiversity Species Distribution layer on the NWT Species and Habitat Viewer at https://www.maps.geomatics.gov.nt.ca/Html5Viewer/index.html?viewer=NWT_SHV (accessed December 2020). Where more than one relative abundance category occurred within a study area, the most widespread category in the study area was used.

[2] 5 Abundant 4 Common 3 Localized 2 Occasional 1 Sparse 0 Expected

Table 8. Moose densities from the most recent moose surveys conducted in boreal caribou range in the Northwest Territories.

Region	Moose Survey Area	Survey Year	Moose Density (#moose/100 km²)	Source
Gwich'in	Delta	2017	5.6	Davison and Callaghan (2019)
	Fort McPherson	2017	3.5	Davison and Callaghan (2019)
	Tsiigehtchic[1]	2017	3.2	Davison and Callaghan (2019)
	Mackenzie River	2017	14.0	Davison and Callaghan (2019)
	Mackenzie Gas Pipeline Route	2017	0.9	Davison and Callaghan (2019)
Sahtú	Southern Sahtú	2020	1.4	Chan (2020)
Dehcho	Mackenzie Valley	2017/18	4.5	Larter (2018)
	Liard Valley	2017/18	7.2	Larter (2018)
North Slave	Taiga Plains	2012	2.9	Cluff (2018)
South Slave	Buffalo Lake	2019	1.8	Kelly (2020a)
	Fort Providence	2019	6.3	Kelly (2019)

[1] Referred to as Arctic Red River in Davison and Callaghan (2019)

White-tailed deer (*Odocoileus virginianus*) are found occasionally in the southernmost portion of the NWT, but are also sparsely distributed along the Mackenzie River valley as far north as the Fort McPherson area (GNWT 2020a). Three populations of wood bison (*Bison bison athabascae*) overlap boreal caribou range including the Nahanni population, which overlaps the southwestern corner of the range, the Mackenzie population, which overlaps portions of the Mackenzie and North Slave study areas, and the Greater Wood Buffalo Ecosystem population which overlaps a small portion of the southeastern portion of the range in Wood Buffalo National Park (SARC 2016). Elk (*Cervus elaphus*) are sparsely distributed in the southwestern corner of the range, while muskox (*Ovibos moschatus*) are locally abundant in the Sahtú area north and east of the Great Bear and Mackenzie rivers. Muskox are also increasing in abundance in the Gwich'in and Inuvialuit areas (Davison, pers. comm. 2020).

In addition to other prey species, the boreal caribou range in the NWT overlaps with barren-ground caribou range, and to a lesser extent northern mountain caribou range; however, the role that the two other ecotypes of caribou play as possible competitors with boreal caribou is unknown. Barren-ground caribou winter ranges (Nagy 2011) overlap approximately 41% of the current boreal caribou range, although the distribution of boreal caribou in the zone of overlap requires verification (see *Search Effort*). It is possible that the two types of caribou may compete for space and resources with boreal caribou in the zones of overlap. Nagy *et al*. (2003) found at least one barren-ground cow in a group with boreal caribou bulls, suggesting that boreal and barren-ground caribou could occur in mixed groups in areas of overlap during winter. Recent declines in barren-ground caribou numbers and contraction of ranges to the northeast (CMA 2020), suggests that current overlap between boreal caribou and barren-ground caribou may be low.

Although boreal caribou forage primarily on lichens during winter and do not compete directly with other prey species for food resources, 'apparent competition' between caribou and other prey species could potentially occur indirectly through sharing a common predator (Holt 1977). Increases in other prey can lead to increases in predator numbers and subsequently to increased predation on caribou and potentially to population declines (see *Threats – Predation*).

Wolves are the primary natural predators of adult female boreal caribou throughout most of Canada (Stuart-Smith *et al*. 1997; Rettie and Messier 1998; Schaefer *et al*. 1999; McLoughlin *et al*. 2003; Culling and Culling 2016). In the southern NWT, 93 of 135 (69%) known causes of mortality of adult female radio-collared caribou from 2003 to 2018 were due to wolf predation and 6 (4%) were due to black bear predation (Kelly 2020b). Although only three mortalities were observed among radio-collared females in the Gwich'in study areas during 2002-2004, one of those mortalities was caused by wolf predation (Nagy *et al*. 2005). Recent wolf density estimates in boreal caribou range in the NWT range from 0.5 to 5.3 wolves/1000 km^2 (Table 9) and are lower than wolf density estimates in boreal caribou ranges surveyed in BC and Alberta (range 7.0-15.6 wolves/1000 km^2; Serrouya *et al*. 2016). The highest wolf density in boreal caribou range in the NWT is in the Dehcho South-Fort Liard wolf survey area (5.3 wolves/1000 km^2). Wolf density in the Slave River area, just east of boreal caribou range, is also higher at 8.3 wolves/1000 km^2 (GNWT 2020b). Factors contributing to higher wolf densities in those areas may be presence of wood bison as another prey species in both survey areas, and a high density of linear features in the Dehcho South-Fort Liard survey area (GNWT 2020b).

Wolves in boreal caribou range in the NWT forage on a wide variety of prey species (Larter 2016; O'Donovan *et al*. 2018). In the Mackenzie study area, wood bison dominated the winter diet of wolves with very minor contributions from caribou, moose, beaver, snowshoe hare and fish (O'Donovan *et al*. 2018). In the Pine Point/Buffalo Lake study area, wood bison was the most significant prey species, however, caribou, moose, beaver, snowshoe hare and fish made up a

larger component of the wolf diet than in the Mackenzie study area (O'Donovan *et al.* 2018). Boreal caribou and moose were the most frequently detected prey species in wolf scats collected in the Dehcho area although another 16 prey items were also detected (Larter 2016).

Table 9. Wolf densities from recent wolf surveys conducted in boreal caribou range in the Northwest Territories.

Boreal Caribou Range Planning Region	Boreal Caribou Study Area - Wolf Survey Area	Survey Year	Wolf Density (#wolves/1000 km²)	Source
Inuvialuit	N/A	N/A	N/A	N/A
Gwich'in	N/A	N/A	N/A	N/A
Sahtú	N/A	N/A	N/A	N/A
Wek'èezhìı	North Slave – Tłı̨chǫ All-Season Road (TASR)	2020	2.2	Serrouya et al. 2021
Southern NWT	Dehcho North – Wrigley	2020	4.8	ENR unpubl. data 2021b
	Dehcho South – Fort Liard	2016	5.3	Serrouya et al. 2016
	Dehcho South – Jean Marie River	2020	1.8	Serrouya et al. 2021
	Hay River Lowlands	2016	1.6	Serrouya et al. 2016
		2017[1]	0.4	GNWT 2020b
		2017[1]	0.5	GNWT 2020b
	Mackenzie	2020	1.8	ENR unpubl. data 2021b
	Pine Point/Buffalo Lake – West	2018	1.4	GNWT 2020b
	Pine Point/Buffalo Lake – East	2018	0.6	GNWT 2020b

[1] Two surveys were conducted in 2017 in two slightly different survey areas, which were both different from the 2016 survey area

Although no population estimates are available for black bears in the NWT, they are considered common or abundant throughout most of the boreal caribou range in the NWT except for in the northernmost section (see Table 7). Average grizzly bear density along the Inuvik to Tuktoyaktuk Highway was estimated at 9.7 bears/1000 km² in 2013 and 2014, prior to construction of the highway (Boulanger and Branigan, in prep.). In north-central British Columbia, northern

mountain caribou made up 2-7% of grizzly bear diet from spring to fall (Milakovic and Parker 2013). Wolverine predation has been documented on adult female radio-collared boreal caribou in northeastern BC (Culling and Culling 2016). There is no information on wolverine abundance below the treeline in the NWT and wolverine predation on boreal caribou in the NWT has not yet been recorded. Lynx are known to attack caribou in Alaska and the Yukon (Stephenson *et al.* 1991; Mowat and Slough 1998). Lynx are cyclic with densities reaching 30 per 100 km^2 when populations peak in some areas of the NWT (Poole 1994). Cougars occur in the southern NWT and are a possible predator of boreal caribou. Although cougar numbers may be increasing in the southern NWT they likely only occur at low densities (Gau *et al*. 2001). Cougar predation is a significant source of mortality for southern mountain caribou (DU9) in southeastern BC (Kinley and Apps 2001; Wittmer *et al*. 2005), and has recently been documented as a source of mortality on northern mountain caribou (DU7) in west-central BC (White *et al*. 2020).

Although most radio-collared adult female boreal caribou mortalities were caused by wolf predation in the NWT, the causes of calf mortalities are largely unknown. Wolf predation is likely a cause of calf mortality since mortality factors affecting adults, also likely affect calves. Lynx may be significant predators of calves particularly during the years following snowshoe hare declines. Black bears are potentially a significant predator of boreal caribou calves (Rettie and Messier 1998; Zager and Beecham 2006; Latham *et al*. 2011a). DeMars and Boutin (2014) found that boreal caribou neonate calf survival in northeastern BC was best explained by predation risk from black bears, based on resource selection function (RSF) models, although actual causes of calf mortality were not assessed. One study in Quebec found that 57% of newborn boreal caribou calf mortality was caused by black bear predation (Pinard *et al*. 2012). Golden eagles (*Aquila chrysaetos*) may potentially prey on boreal caribou calves. Golden eagles are known predators of barren-ground caribou calves (Whitten *et al*. 1992) and northern mountain caribou calves (Gustine *et al*. 2006), and a golden eagle was observed circling a neonate boreal caribou calf in northeastern BC (Culling *et al*. 2006).

Low densities of other prey species (moose and deer) and wolves in caribou habitat result in low rates of wolf-caused caribou mortalities; high densities of other prey species and wolves result in high rates of wolf-caused caribou mortalities (Latham *et al*. 2011b). Early seral vegetation provides habitat for primary prey species such as moose, white-tailed deer, bison, and elk (Latham *et al*. 2011c) and for omnivores such as black bears. Anthropogenic linear features such as seismic lines are used as travel corridors by predators and may increase their hunting efficiency (Thurber *et al*. 1994; James 1999). As a result, predator-prey dynamics may favour wolves for extended time periods within portions of boreal caribou range that are disturbed by fire and/or anthropogenic features (seismic lines, roads, cut blocks). In areas where large numbers of wolves are supported by large numbers of prey species other than caribou and where wolves do not actively select for caribou, there is an increased probability that more caribou will

be killed because more wolves are searching for prey. These are referred to as "incidental" kills. Higher incidental predation on caribou may be sufficient to cause caribou declines (Latham *et al*. 2011c).

Beavers, another alternate prey species for predators in boreal caribou ranges, play an important role in the summer diet of wolves in boreal caribou habitat in BC and Alberta (Culling *et al*. 2006; Latham *et al*. 2013). Also, during winter, wolverines actively excavate beaver lodges and predate on beavers (Thiessen 2010; Culling and Cichowski 2017; Scrafford and Boyce 2018).

Humans

In the NWT, boreal caribou are harvested for subsistence use by Indigenous people and resident hunters (Olsen *et al*. 2001; McDonald 2010; Benson 2011). Prior to the 2019/20 hunting season, resident and non-resident hunters could harvest one boreal or northern mountain caribou (either sex), from July 15 to January 31 for residents, and from July 25 to October 31 for non-residents (GNWT 2018). In 2019/20, hunting regulations were separated for boreal and northern mountain caribou for resident hunters, and non-resident hunting was retained only for northern mountain caribou (GNWT 2019a). As part of the change, the hunting season for residents was shortened to July 15 to December 15 and the bag limit was changed to one male only boreal caribou. Also prior to 2019/20, there were no restrictions on boreal caribou harvest for general hunting licence (GHL) holders or Aboriginal harvesters. In 2019/20, for GHL holders, the same hunting season as resident hunters (July 15 – December 15) was adopted and now GHL holders can only harvest male boreal caribou (now requiring a tag), but there continues to be an unlimited bag limit. There are no bag limits or season limits for boreal caribou for Indigenous harvesters.

Boreal caribou are not a primary targeted species for hunters in most of the NWT and are harvested opportunistically (McDonald 2010; Benson 2011; Larter pers. comm. *in* SARC 2012). However, some harvesters do actively harvest boreal caribou in the South Slave Region (Kelly pers. comm. 2021). Some boreal caribou may be harvested unintentionally on winter ranges where they occur with migratory barren-ground caribou.

Accurate harvest information is lacking in some areas, and in some areas, people do not differentiate between different caribou ecotypes when they report their harvest (Veitch pers. comm. *in* SARC 2012). Based on information from the NWT Resident Hunter Survey (2001–2019), resident hunters took an estimated 48 woodland caribou per year, and on average about 40% of their reported kills were likely boreal caribou based on location of hunt (Figure 10; ENR unpubl. data 2020a). This estimate is based on the assumption that boreal and mountain woodland caribou kills are equally likely to be reported (ENR unpublished data 2020a). The average estimated annual harvest by NWT resident hunters from 2001 to 2019 was 19 (range 6-

44) and was less than 30 per year except in 2010, when harvest was estimated at 44 (ENR unpublished data 2020a).

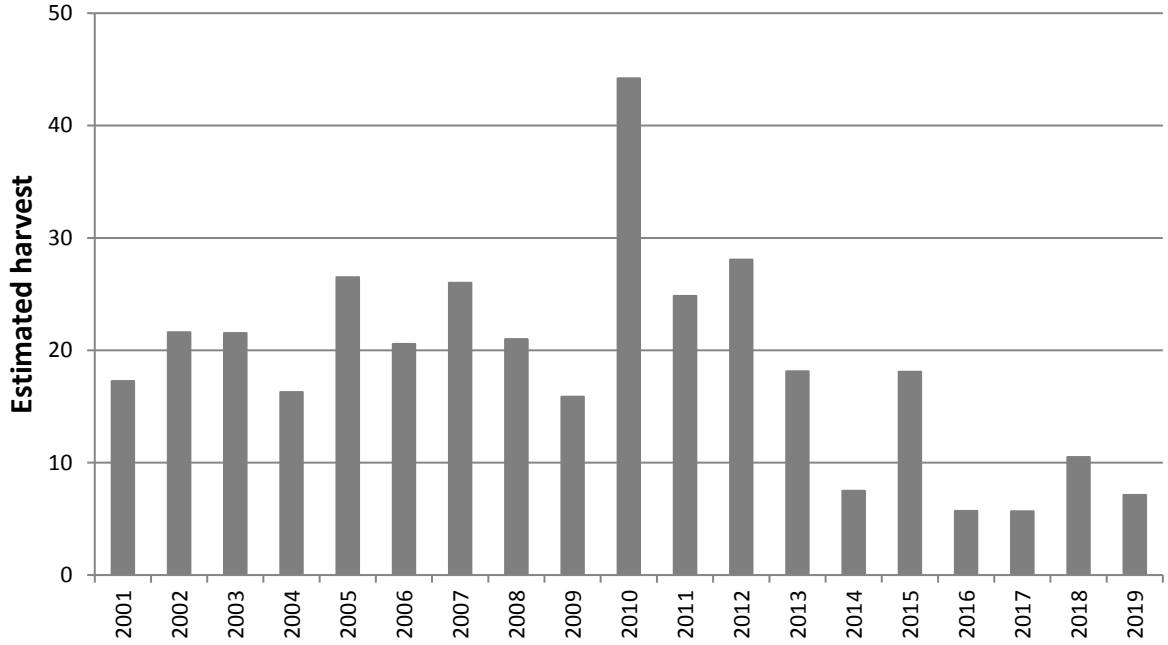

Figure 10. Estimated number of boreal caribou harvested by resident hunters in the NWT from 2001 to 2019 (ENR unpubl. data 2020a).

Based on the Gwich'in harvest study, only 11 woodland caribou were taken in the Gwich'in Settlement Area from 1995 to 2001 (2 per year; Gwich'in Renewable Resource Board 2009). However, some Gwich'in believe that boreal caribou numbers have declined and some attribute local declines to overhunting (Benson 2011). Many hunters harvest woodland caribou in the Sahtú Settlement Area with annual harvests varying among communities (Olsen *et al*. 2001). Based on the Sahtú Renewable Resources Board Harvest Study an average of 72 woodland caribou were harvested annually in 1998-2005, of which approximately 36 per year were likely boreal caribou and the rest were northern mountain caribou, using percentages estimated by A. Veitch (Veitch *in* SARC 2012: 102). Estimates by ENR staff in the Dehcho Region suggest that people in Sambaa K'e harvest an average of 15 boreal caribou per year. Based upon 10 years of data from April 2005 to April 2018, people from other Dehcho communities (Wrigley, Jean Marie River, Fort Simpson, Fort Liard and Nahanni Butte reported a harvest of 115 caribou or an average of 12 per year (Larter pers. comm. 2021). However, it has been suggested that much harvest is unreported and the actual number harvested in the Dehcho region alone could be 100-150 (Dehcho First Nations 2011).

In 2019 the estimate of Indigenous annual harvest of boreal caribou in the NWT suggests that it could be as low as 65 (1% of the estimated population) and as high as 190 (2.9% of the estimated population; Canada and the Government of the Northwest Territories 2019).

Parasites and Diseases

Johnson *et al*. (2010) analyzed blood and fecal samples from boreal caribou captured in the southern NWT and found a number of parasites and diseases. However, many of those were previously reported in boreal caribou, barren-ground caribou, or reindeer and did not appear to significantly affect their health. The presence of some previously unreported parasites (*Toxoplasma gondii*, *Eimeria*, *Giardia*, *Ostertagia gruehneri*, *Teledorsagia boreoarcticus*) and evidence of exposure to an unknown herpesvirus and to *Toxoplasma gondii*, indicated that further health and disease monitoring in boreal caribou should be conducted (Johnson *et al*. 2010). Based on samples collected during boreal caribou captured in the Dehcho area from 2012 to 2019, the prevalence of common diseases and parasites remained low (Larter and Allaire 2012, 2013, 2014, 2015, 2016b, 2017, 2018; Larter *et al*. 2019).

In the Dehcho area, exposure to the bacterium *Erysipelothrix rhusiopathiae* was found in 18 of 115 samples (15.7%) collected during the study (Larter *et al*. 2019). *E. rhusiopathiae* has been associated with moose and boreal caribou mortalities in BC (Forde *et al*. 2016; Bondo *et al*. 2019), and high numbers of mortalities of muskoxen on Canadian Arctic Islands that coincided with population declines (Kutz *et al*. 2015; Mavrot *et al*. 2020). Exposure to *E. rhusiopathiae* has also been found in northern mountain caribou in the NWT (Carlsson *et al*. 2015).

Winter tick (*Dermacentor albipictus*) prevalence has increased on boreal caribou in the NWT. Winter ticks were first detected on boreal caribou in the NWT on two caribou captured in the Hay River Lowlands study area in February 2013 (Kelly and Cox 2013). In the Dehcho area, from 2004 to 2015, no ticks were detected on 136 caribou handled (Larter and Allaire 2016b). Since then, tick prevalence was 11% (1/9) in 2016, 31% (4/13) in 2017, 50% (10/20) in 2018, and 0% (0/18) in 2019 (Larter *et al*. 2019). Larter *et al*. (2019) reported a noticeable absence of hair loss due to ticks both on captured animals and during the late winter survey in 2019, and commented that 2018/19 was the first winter in a number of years with an extended period of temperatures below -40C. In the North Slave study area, tick-related hair loss was detected on captured caribou: 57% (12/21) in 2017 (Williams 2017), 20% (1/5) in March 2018 (Hodson and Patenaude 2018), and 43% (3/7) in March 2019 (Hodson 2019).

If white-tailed deer expand their range in the NWT, it could lead to increased risk of the introduction of the meningeal worm (*Parelaphostrongylus tenuis*) and Chronic Wasting Disease (CWD). CWD is a progressive and fatal disease of the nervous system and it is known to naturally infect white-tailed deer, mule deer, moose, red deer, elk, and reindeer (ENR 2019a). CWD is transmitted and spread through both direct (animal-to-animal) and indirect environmental (animal-to-premises-to-animal) transmission (ENR 2019a). In Canada, the Canadian Wildlife Health Cooperative (CWHC) surveillance program diagnosed CWD in cervids within Alberta and Saskatchewan (CWHC 2022). CWD has not been recorded in the NWT, however it is a concern and ENR is working with hunters and neighbouring jurisdictions to prevent the spread of CWD

into the NWT (ENR 2019a). These parasites and diseases occur in white-tailed deer in Alberta and have caused ungulate population declines in other areas (Bergerud and Mercer 1989; Happ *et al*. 2007).

PLACE

Distribution

Canadian Distribution

Boreal caribou are found only in Canada (Figure 11). Their current distribution includes Labrador, Quebec (QC), Ontario (ON), Manitoba (MB), Saskatchewan (SK), Alberta (AB), British Columbia (BC), Northwest Territories (NWT), and Yukon Territory (YT) (EC 2011; COSEWIC 2011; ECCC 2020a). Although the biological distribution of boreal caribou extends across political borders, boreal caribou in AB, BC and SK are identified as separate local populations while those in YT are considered part of the NWT local population (ECCC 2020a).

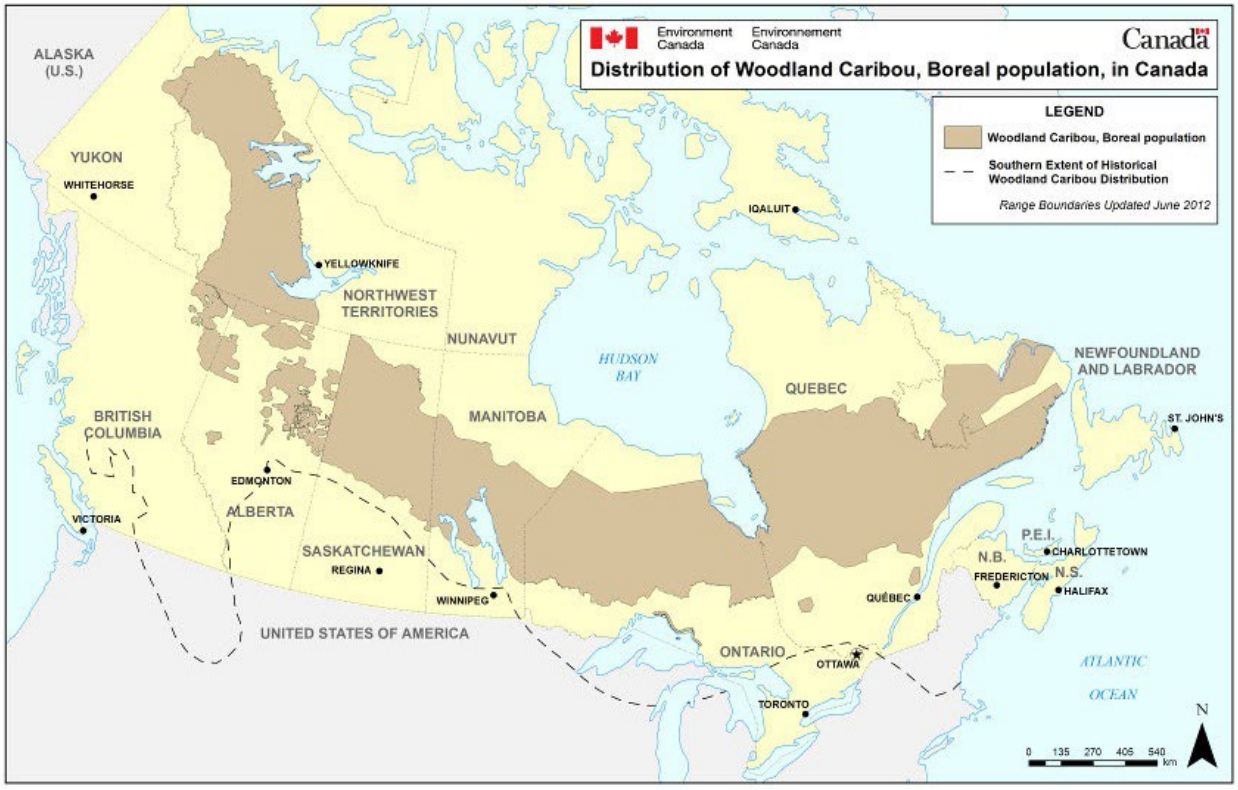

Figure 11. Distribution of boreal caribou in Canada. The current distribution of boreal caribou is shown in brown. Reproduced with permission from ECCC (2020a).

NWT Distribution

In the NWT, boreal caribou are found south of the treeline with their distribution almost exclusively coinciding with the Taiga Plains Ecoregion (Figure 12; Ecosystem Classification Group 2009). The NWT includes almost all of the NT1 boreal caribou range (defined by Environment Canada [2012]), except for a small area in the northwestern portion of the range that lies within Yukon.

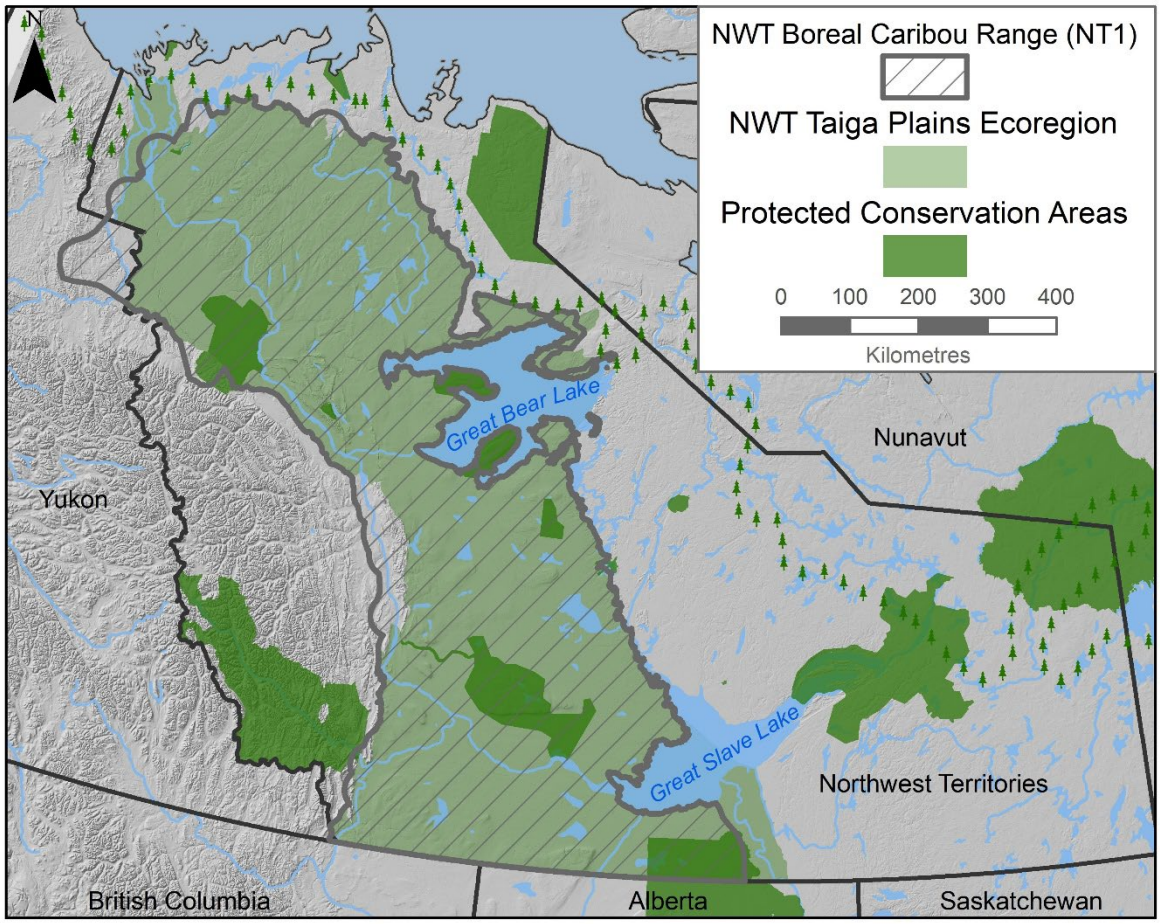

Figure 12. Current range of boreal caribou in the Northwest Territories based on the NT1 range defined by Environment Canada (2012) and updated by GNWT ENR (2016). Map courtesy of R. Abernethy, ENR.

Boreal caribou in the northwestern portion of the NWT range are contiguous with those in the Peel River watershed in Yukon, and those in the southern portion of the NWT range are contiguous with boreal caribou in the Maxhamish and Calendar ranges in northeastern BC and the Bistcho and Yates ranges in northern Alberta (EC 2012). Mountainous areas to the west of the Taiga Plains Ecoregion are occupied by northern mountain caribou, and areas to the north and east are occupied by migratory barren-ground caribou.

Although no subpopulations have yet been identified in the NT1 range, radio-collared caribou studies (11 study areas; Figure 13) and range planning (five range planning regions; Figure 14;

GNWT 2019b) are conducted at a regional level. The distribution of boreal caribou in the NWT is contiguous as demonstrated by overlapping radio-collared caribou locations from different study areas. Less information is available about the distribution of boreal caribou in the northeastern portion of their range outside of the 11 existing study areas (see *Search Effort*) and additional information is needed to verify distribution in that part of the range. Within the Mackenzie study area, radio-collaring (Figure 13) and recruitment surveys (ENR 2021a) indicate that Boreal caribou are present in the Mackenzie Bison Sanctuary.

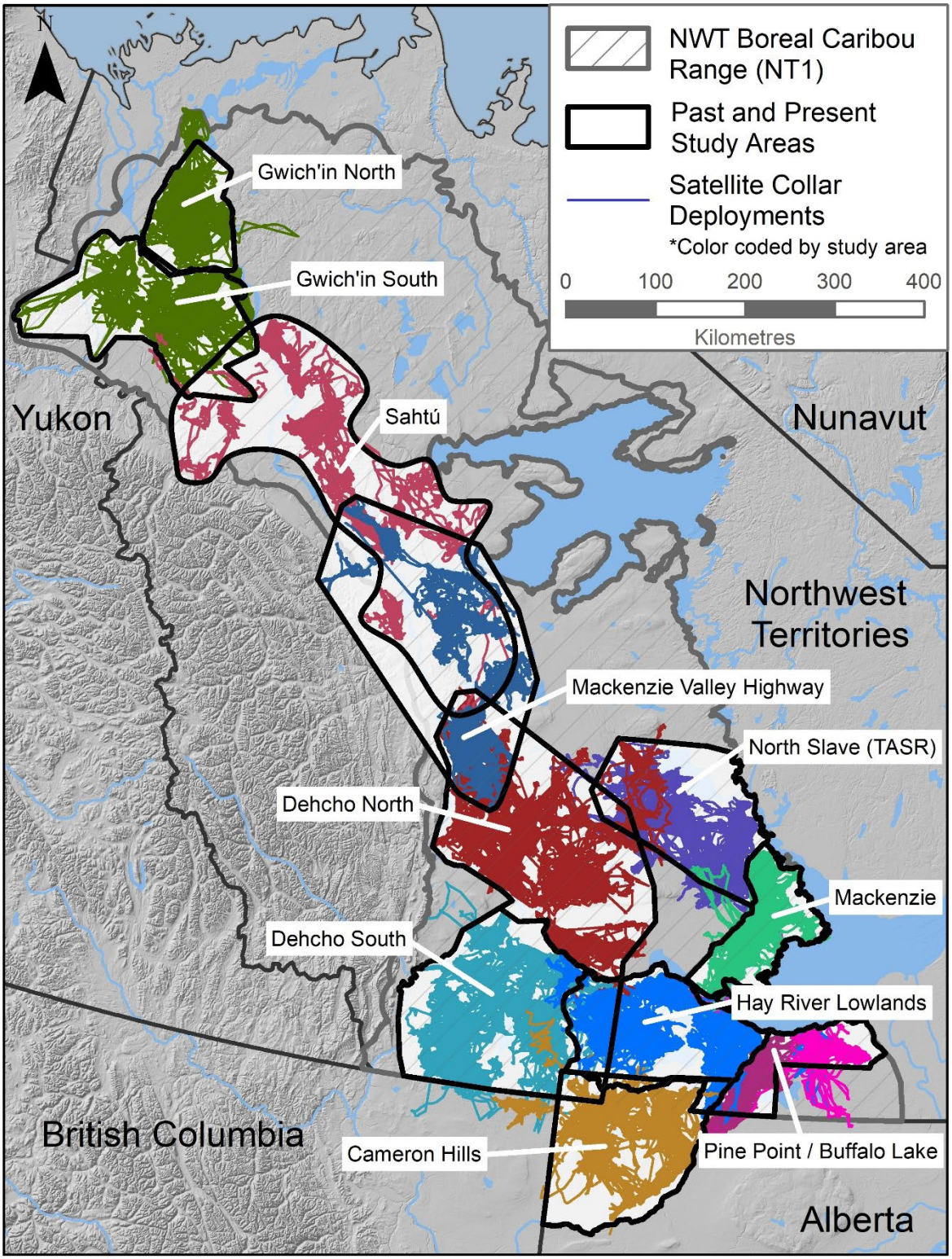

Figure 13. Boreal caribou study areas in the Northwest Territories. Coloured lines represent movement paths from individuals that were collared within the study area (ENR unpubl. data, 2020e). Map courtesy of R. Abernethy, ENR.

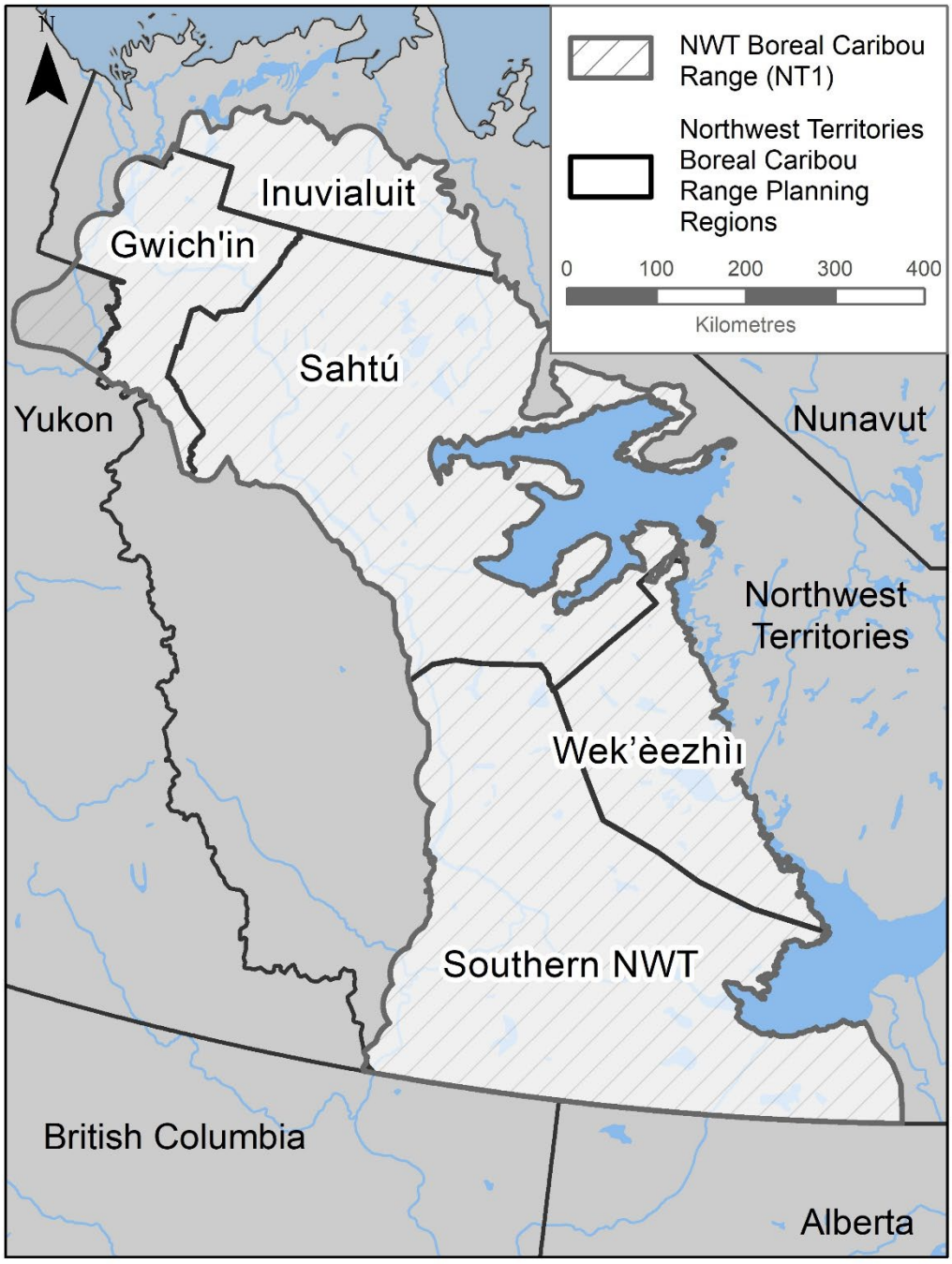

Figure 14. Range planning regions for boreal caribou in the Northwest Territories (from GNWT 2019b). Map courtesy of R. Abernethy, ENR.

Based on cluster analyses of location data from 140 boreal caribou tracked with satellite collars for more than one year from 2002-2009, Nagy *et al.* (2011) identified two distributions suggesting two boreal caribou subpopulations in the NWT that are separated by about a 50 km gap centered on the Bear River drainage between Great Bear Lake and the Mackenzie River. However, the apparent gap in distribution may have been an artifact of a temporary fire

disturbance and/or a lack of collared caribou in that area (Nagy *et al*. 2011). A Bayesian cluster analysis of locations collected from 1982 to 2016 from 1226 radio-collared boreal caribou in northeastern BC, northern Alberta and the southern NWT suggested four distinct boreal caribou groups entirely within the southern NWT and roughly equivalent to 1) Pine Point/Buffalo Lake study area, 2) Mackenzie/North Slave study areas (including the Mackenzie Bison Sanctuary), 3) the northern 75% of the Dehcho North study area, and 4) the portion of the South Dehcho study area northwest of the Liard River (Wilson *et al*. 2020). The remaining portion of the southern NWT (southern 25% of Dehcho North, Dehcho South south of the Liard River, Hay River Lowlands, Cameron Hills) was part of one large boreal caribou group that also included the Maxhamish, Calendar and Snake-Sahtaneh ranges in BC, and the Bistcho, Yates and Caribou Mountains ranges in Alberta. Wilson *et al*. (2020) cautioned that some of the identified groups could have been the result of limited sampling and that further work was required to incorporate other sources of information. Also, Wilson *et al*. (2020) did not include caribou location data north of the Dehcho North study area and therefore, did not address the potential gap in distribution described in Nagy *et al*. (2011), nor population structure of boreal caribou in the Sahtú, Gwich'in and Inuvialuit regions.

Recent genetic studies provide some information that could contribute to defining distribution of subpopulation units of boreal caribou in the NWT. The evolutionary history of boreal caribou in Canada east of Alberta suggests that boreal caribou originated from the North American Lineage (NAL), which came from refugia south of the area covered by ice during the last ice age, while barren ground and northern mountain caribou originated from the Beringian-Eurasian Lineage (BEL), which came from refugia north of the ice sheet (Dueck 1998; Cronin *et al*. 2003; Zittlau 2004; Polfus *et al*. 2016; Taylor *et al*. 2020). However, in the NWT, most boreal caribou originate from the BEL lineage, although the prevalence of boreal caribou of NAL origin increases towards the southern portion of the range (Polfus *et al*. 2016; Manseau *et al*. 2017; Taylor *et al*. 2020). Caribou originating from both BEL and NAL are also found in boreal caribou ranges in Alberta (McDevitt *et al*. 2009; Weckworth *et al*. 2012) and indicate post-glacial mixing of the two lineages in those areas (McDevitt *et al*. 2009). Manseau *et al*. (2017) detected three broad genetic clusters in the NWT: 1) Sahtú/Dehcho North/Mackenzie; 2) Dehcho South/Hay River Lowlands/Cameron Hills; and, 3) Pine Point/Buffalo Lake/Wood Buffalo National Park, with a higher proportion of NAL in the south, suggesting that boreal caribou in the northern portion of the NWT distribution may have a different evolutionary origin than those from the south. Manseau *et al*. (2017) also found that roads strongly influenced fine-scale genetic differentiation and recommended updating analyses with additional caribou collared since 2016.

Although further analyses are required, both the cluster analysis (Wilson *et al*. 2020) and the genetic structure analysis (Manseau *et al*. 2017) suggest at least two potential lines for differentiation between subpopulations: the Hay River, which separates the Pine Point/Buffalo

Lake study area and Wood Buffalo National Park from other caribou in the southern NWT, and approximately the Mackenzie River, which separates the Dehcho North (or the northern 75% of Dehcho North) from other caribou in the southern NWT (Dehcho South, Hay River Lowlands, Cameron Hills/Bistcho, Yates).

The NWT Species at Risk Committee defines the 'extent of occurrence' as "the area included in a polygon with concave angles that encompasses the geographic distribution of all known populations of a species" (SARC 2020). The extent of occurrence for boreal caribou in the NWT is 660,291 km^2, and was calculated based on a minimum convex polygon drawn around the NWT boreal caribou range.

'Area of occupancy' is defined as 'the area within 'extent of occurrence' that is occupied by a species, excluding cases of vagrancy' (SARC 2020). The area of occupancy for boreal caribou in the NWT is 433,993 km^2, and was calculated as the area of the NWT boreal caribou range. 'The index of area of occupancy (IAO) is a measure that aims to provide an estimate of area of occupancy that is not dependent on scale. The IAO is measured as the surface area of 2 km x 2 km grid cells that intersect the actual area occupied by the wildlife species (i.e. the biological area of occupancy)' (SARC 2020). The IAO for boreal caribou in NWT is 443,248 km^2.

Locations

The Species at Risk Committee defines 'location' as 'a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations. Where a species is affected by more than one threatening event, location should be defined by considering the most serious plausible threat.' (SARC 2020). The most serious plausible threats to boreal caribou in the NWT are habitat alteration and climate change (see *Threats and Limiting Factors*). However, because boreal caribou do not congregate and are distributed at low densities across a very large range, it is unlikely that a single threatening event would rapidly affect all individuals. Therefore, it is not possible to define locations for boreal caribou in the NWT.

Search Effort

The distribution of boreal caribou in the NWT was based on the best available information provided by the Government of the Northwest Territories, including telemetry data (2,316 VHF locations and 261,884 satellite locations from 2002 to 2011), incidental observations (1924 observations from 1978 to 2011), and biophysical characteristics (EC 2011; ECCC 2020a). In addition, Parks Canada provided a map of boreal caribou observations within Wood Buffalo National Park (Parks Canada unpubl. data 2011). From 2012 to 2017, an additional approximately 400,000 telemetry locations were collected (DeMars *et al*. 2020), but did not result in any significant changes to the distribution.

The distribution of boreal caribou in the NWT is largely known, although boreal caribou are poorly surveyed in the northeastern portion of their NWT range, in the eastern part of the Sahtú Settlement Area. Incidental observations and collared caribou locations described above do not include any records of boreal caribou from the area around Colville Lake, north of Great Bear Lake. However, harvest distribution data obtained from hunters in Colville Lake and observations by people in Fort Good Hope and Colville Lake and by R. Popko (Olsen *et al*. 2001; Popko *in* SARC 2012: 76) suggest that boreal caribou likely do occur in this area. The distribution of boreal caribou in the northeastern portion of the NWT current range requires verification to determine whether the reported sightings and harvests are of vagrants or whether they are indicative of a continuous distribution in the Sahtú. If the former is the case, then the extent of the NWT current boreal caribou range may have been overestimated.

Distribution Trends

There is no technical information on whether the currently defined boreal caribou range in the NWT differs from the historical distribution. Information on distribution of boreal caribou in the NWT based on radio-collared caribou locations has only been available since 2002, and therefore only provides a very recent representation of the NWT boreal caribou range. Additional radio-collared caribou locations obtained since the previous status report (SARC 2012) have contributed to some refinement of the boreal caribou range boundary in the NWT. However, the refinement is in response to new information becoming available rather than to an actual change in distribution.

Tigner (2020), while conducting aerial surveys of caribou winter use in the Sahtú region, described observing almost all evidence of caribou winter range use in an area outside of the mapped boreal caribou range. However, the area was also near the northern mountain caribou range, and because most of the evidence observed consisted of feeding craters, it is possible that the craters may be been from northern mountain caribou, rather than boreal caribou. Due to the lack of definitive evidence that the area was used by boreal caribou and not by northern mountain caribou, this area was not included in the current boreal caribou range.

Movements

Although boreal caribou do not migrate between discrete winter and summer ranges like barren-ground caribou, individual caribou do undergo movements within their annual home ranges. Movement rates vary during the year and are largely synchronized among females in the southern and northern study areas (Figure 15; Nagy 2011; DeMars *et al*. 2020). For adult female boreal caribou, movement rates are greatest prior to calving, drop during calving then increase progressively from post-calving until the late fall before gradually decreasing from early winter until late winter (Figure 15). Movement rates are at their lowest during late winter and during the first few days around calving. Pre-calving movement rates peak earlier in the

southern portion of the NWT boreal caribou range than the northern portion, while fall movement rates peak at about the same time (Figure 15).

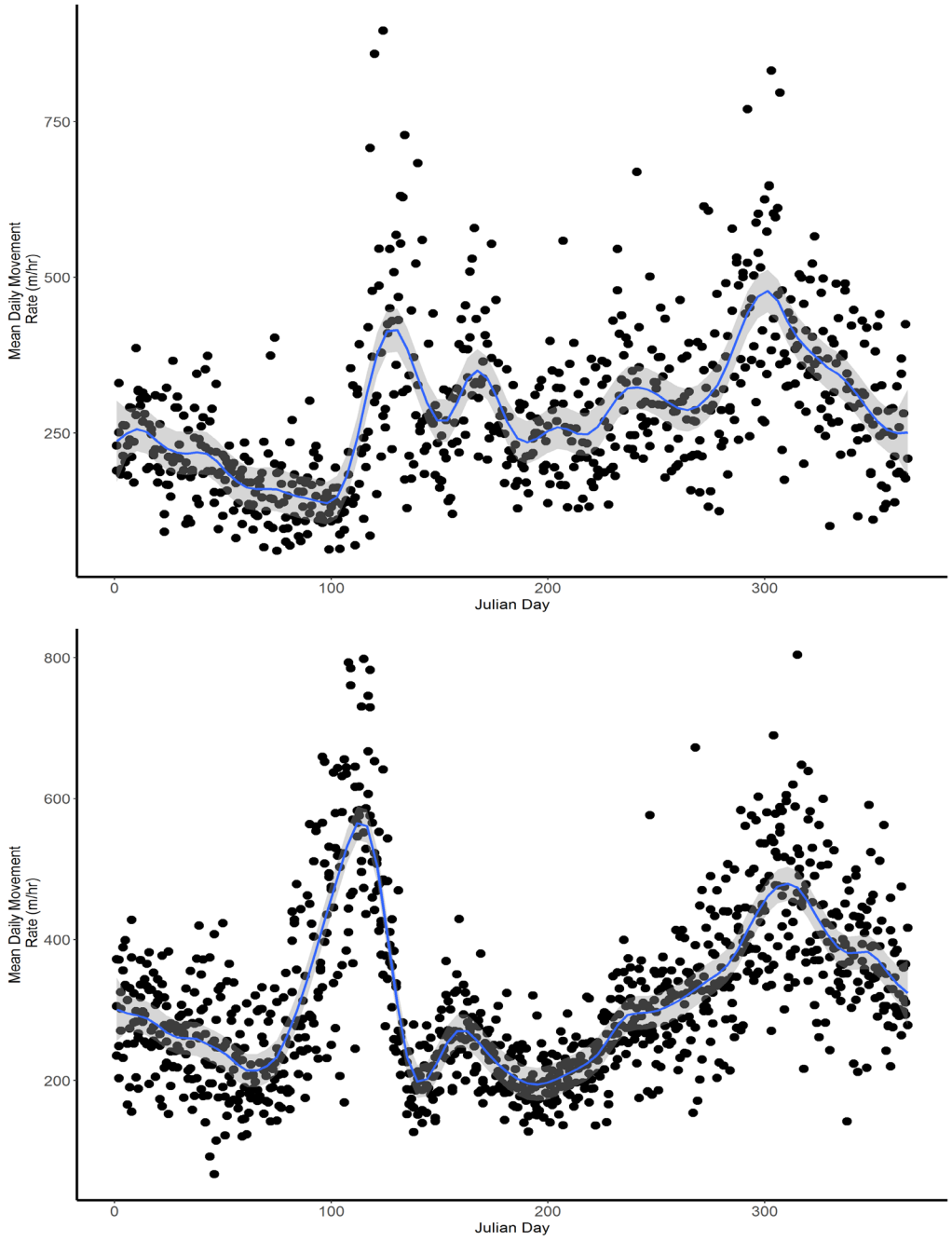

Figure 15. Seasonal movement patterns of boreal caribou in the northern (top) and southern (bottom) portions of their range in the Northwest Territories (from DeMars *et al*. 2020). Grey shading is the 95% confidence interval around the blue trendline. Julian Day represents the continuous count of days since January 1st of a given year (i.e., 100 = April 10th, 200 = July 19th, and 300 = October 27th).

In the Gwich'in study area, movement rates were lower during early morning than during the day and evening in March and April, and higher during early morning than during the day and

evening from June to August, suggesting that boreal caribou were more active during early morning in the summer and more active during the day in the winter (Nagy *et al*. 2005). Also, snow conditions affected boreal caribou movements in the Gwich'in study area, where unusually high snowfall between mid-March and early April 2004 made it difficult for boreal caribou to travel (Nagy *et al*. 2005). By mid-April, a 2.5 cm thick ice layer below the surface of the snow in non-forested areas was strong enough for caribou to travel on top in most areas, but caribou broke through in some areas (Nagy *et al*. 2005).

Because boreal caribou range in the NWT is contiguous, and is contiguous with boreal caribou range in BC and Alberta, boreal caribou move among study areas in the NWT, and among the three jurisdictions (see Figure 13; also, see home range and movements maps in Kelly and Cox 2011; Alberta Government 2017; Larter and Allaire 2018; Larter *et al*. 2019). One female caribou was radio-collared in the Cameron Hills/Bistcho study area in March 2005, then moved to the Trainor Lake area in Dehcho South where she was re-collared in February 2007 and remained in that area until she returned to the Bistcho Lake area in January 2010 (Larter and Allaire 2010). Most boreal caribou females are relatively sedentary and remain in the boreal forest throughout the year. However, one adult female in the Gwich'in-south study area migrated annually into the Richardson Mountains in the Yukon during early June and returned to the boreal forests in the NWT by early-mid July during the three years it was tracked with a satellite collar (Nagy *et al*. 2005). The movements described here suggest that boreal caribou are capable of dispersing long distances.

During the breeding season, movement rates of adult males is very low with males concentrating in very small areas, suggesting that breeding males potentially stay in small areas waiting for females to come to them for breeding (Larter *et al*. 2019).

The fidelity of individual boreal caribou in the NWT to seasonal-use areas within their annual ranges is variable. Fidelity to calving sites is highly variable with some adult female caribou exhibiting strong fidelity to calving sites (e.g. calving sites during successive years for six females were <300 m apart), while others do not return to the same area each year (e.g. for six females the average distance between four calving sites was >30 km; Larter *et al*. 2019). Telemetry locations for one adult male during two consecutive breeding seasons suggests strong fidelity for that male to the breeding site and to use of a small range (Larter *et al*. 2019).

Potential barriers to dispersal of female boreal caribou appear to be the Mackenzie and Hay rivers (see *Habitat Fragmentation*). However, some movement across the Mackenzie River has been documented between Dehcho North and Dehcho South caribou (Larter *et al*. 2019). Because limited information is available on the movements of male boreal caribou, it is unknown if those two rivers act as barriers to dispersal for male boreal caribou. Highway 3, a highway that connects Fort Providence, Behchokǫ̀ and Yellowknife, may also potentially influence boreal

caribou movements, as evidenced by only infrequent crossings of the highway by radio-collared caribou (Hodson 2019).

Habitat Requirements

Boreal caribou range in the NWT is located almost exclusively in the Taiga Plains Ecoregion (see Figure 12), which consists primarily of low-lying terrain with a few significant hill systems (Ecosystem Classification Group 2009). Peatlands cover almost half of the landscape while waterbodies make up another 18% (Ecosystem Classification Group 2009). Forest cover ranges from moderately-closed canopied stands of white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) with jack pine (*Pinus banksiana*) on drier sites in the south, to very open, stunted forests of black spruce (*Picea mariana*) and white spruce in the north, where aspen is rare and jack pine is absent. Permafrost varies from discontinuous in the south to widespread and continuous in the north (Ecosystem Classification Group 2009). Climate ranges from warm, moist summers and very cold and snowy winters in the south, to very short, cool summers and very cold winters in the north (Ecosystem Classification Group 2009).

Boreal caribou in the NWT primarily use unburned habitats (>60 yrs since last known wildfire) consisting mostly of sparse and open conifer stands, treed wetlands and shrub wetlands throughout the year (ENR Dehcho Region 2010; DeMars *et al*. 2020). In the Dehcho area, boreal caribou prefer to use unburned open conifer stands that are 100 years or older (ENR Dehcho Region 2010). In the Gwich'in area, caribou selected open conifer lichen and riparian cover types throughout the year, but also used tussock tundra, low shrub, and open mixed needle-leaf land cover types (Nagy *et al*. 2006). Use of burned areas varies seasonally, but also may depend on the extent of fire within a range; however, these inferences are to be interpreted with caution as fire history data in the NWT only goes as far back as in the mid-1950s. In general, boreal caribou in the NWT select recent burns during the snow-free season, but avoid them during the winter (Nagy *et al*. 2005, 2006; DeMars *et al*. 2020). Age of burn appears to influence use, with boreal caribou selecting younger burns (<10 years old) and older burns (31-40, and 40-60 years old) and avoiding middle-aged burns (11-30 years old; Nagy *et al*. 2006; DeMars *et al*. 2020). During snow-free months, boreal caribou may select recent burns and other open habitats to access high quality forage sources (herbaceous vegetation and shrubs), to avoid predators and insects, or to rut (Nagy *et al.* 2005). Boreal caribou may use older burns for foraging on lichens if lichens have re-established and become sufficiently abundant. In the Mackenzie study area, burn severity influenced use of recent burns. In all seasons, boreal caribou that used recently-burned habitat (≤ 3 years old) were found most often in low-intensity burned areas, except in summer, when use of higher intensity burned areas increased (Gurarie *et al*., in prep.).

In the NWT, boreal caribou generally avoid human-caused habitat alteration. Nagy (2011) found that boreal caribou avoided areas ≤400 m from seismic lines in the NWT. In the Sahtú and

Gwich'in study areas, boreal caribou were more likely to occupy home ranges in areas without roads, with a low to intermediate density of seismic lines (<0.8 km/km^2), and that had not burned in the previous 40 years (Stantec 2020). Within their home ranges, boreal caribou were less likely to use areas close to (< about 3 km) or distant from (> about 6 km) seismic lines, especially during calving and summer (Stantec 2020). Across all seasons, boreal caribou in the NWT used areas farther away from major roads, especially during calving and summer, and farther away from other human-caused habitat alterations such as cutblocks, mines, reservoirs, built-up areas, well sites, agriculture, and oil and gas facilities, especially during calving and late fall/early winter (DeMars *et al*. 2020). However, during calving, boreal caribou were found closer to settlements than expected, which may have reflected logistical challenges of collaring caribou in areas distant to settlements (DeMars *et al*. 2020). Boreal caribou generally avoided areas with high densities of linear features, except in mid to late winter (DeMars *et al*. 2020).

Boreal caribou population growth rates are primarily determined by adult female and calf survival (Hatter and Bergerud 1991). Therefore, habitat conditions that facilitate adult female and calf survival are critical for the long-term survival of boreal caribou. Seismic lines fragment habitat and reduce the effectiveness of boreal caribou strategies of spacing away from each other and other ungulates and from seismic lines to reduce predation risk during the snow-free period (Stuart-Smith *et al*. 1997).

Boreal caribou in the NWT require range conditions that are sufficient for supporting a self-sustaining population. The level of habitat alteration within a range influences population stability with negative relationships found between: population change (lambda) and industrial (+ 250 m buffer) and fire disturbance (Sorenson *et a*l. 2008); population change (lambda) and linear feature density plus the amount of area <30 years old disturbed by fire and forest harvesting (Boutin and Arienti 2008); and calf recruitment and level of industrial habitat alteration (+ 500 m buffer; EC 2008, 2011). The spatial configuration of habitat at the range level, i.e. the size, shape, and distribution of patches of preferred habitats, is important (O'Brien *et al*. 2006); Nagy (2011) suggests that the amount and configuration of undisturbed areas is more important than level of habitat alteration. Nagy (2011) found that boreal caribou population growth rates in the NWT were highly correlated with the availability and use of patches of secure habitat (unburned areas >400 m from disturbance) that were >500 km^2, in that boreal caribou that had access to large areas or "patches" of secure unburned habitat (>500 km^2) during the seismic line avoidance period had higher population growth rates than those that did not. Therefore, boreal caribou require large patches (>500 km^2) of undisturbed boreal forest to effectively employ their anti-predator strategies to reduce predation risk (Nagy 2011).

Environment and Climate Change Canada (EC 2008, 2011) determined that there is a ≥60% probability that a boreal caribou population is self-sustaining when human-caused habitat alteration (+ 500m buffer) and fires ≤40 years combined do not exceed 35% of the range. As a

result, Environment and Climate Change Canada (EC 2012; ECCC 2020a) identified critical habitat as "the area within the boundary of each boreal caribou range that provides an overall ecological condition that will allow for an ongoing recruitment and retirement cycle of habitat, which maintains a perpetual state of a minimum of 65% of the area as undisturbed habitat; and biophysical attributes required by boreal caribou to carry out life processes." Table 10 summarizes biophysical attributes for boreal caribou habitat in the Taiga Plains. More recently, Johnson *et al*. (2020) found that fire played much less of a role than human-caused habitat alteration in boreal caribou calf recruitment and adult female survival. Although they re-affirmed that 65% undisturbed range was still a reasonable proxy for achieving self-sustaining populations in ranges dominated by human-caused habitat alterations, they suggested that some boreal caribou ranges where fire is the dominant disturbance may be less vulnerable, such as SK1 in Saskatchewan, where habitat alteration was almost exclusively due to fire. Here the population was self-sustaining with only 40% undisturbed habitat (Johnson *et al*. 2020). However, they recommended 65% undisturbed habitat as a minimum for all other ranges, including the NT1 range (Johnson *et al*. 2020).

Table 10. Biophysical attributes for boreal caribou critical habitat in the Taiga Plain Ecoregion (from ECCC 2020a).

Type of Habitat	Description
Broad scale	Mature forests (jack pine, spruce, and tamarack) of 100 years or older, and open coniferous habitat. Large areas of spruce peat land and muskeg with preference for bogs over fens and upland and lowland black spruce forests with abundant lichens, and sedge and moss availability. Flatter areas with smaller trees and willows, hills and higher ground.
Calving	Open coniferous forests, tussock tundra, low shrub, riparian, recent burned areas, south and west aspects and hills and higher locations. Muskegs, marshes, staying close to water sources. Caribou observed on small islands of mature black spruce or mixed forests within peat lands, in old burns at the edge of wetlands, in alder thickets with abundant standing water and on lake shores.
Post-calving	Muskegs or areas with access to muskegs, open meadows on higher ground, close to water (lakes and rivers) and mixed bush areas. Open coniferous forests with abundant lichens, low shrub, riparian, tussock tundra, sparsely vegetative habitat, recent burns and west aspects. Old burns and neighbouring remnant unburned forests selected in late spring and early summer.

Rutting	Open coniferous and mixed wood forests, low shrub, riparian, tussock tundra, recent burns and west aspect. Still use muskegs that harbour ground lichen and sedges, mixed bush areas, areas of higher ground. Regenerating burns and sparsely vegetated habitat.
Winter	Open coniferous forests (black spruce and pine) that provide adequate cover with abundant lichens, riparian areas. Caribou observed in muskeg areas in early winter. Spruce-lichen forests, fire regenerated, sparsely vegetated habitat, herbaceous and tall shrub habitat and sphagnum moss with scattered spruce. As snow depth increases, they remain more often in areas of dense pine or thickly wooded black spruce, with hanging lichen and remains access to open, mixed vegetation for ground forage.
Travel	Females show high fidelity to calving sites among years (i.e. within 14.5 km). Many caribou shift the pattern of use based on seasonal preferences, in large multi-habitat areas. Rates of movement increase during the rut and are greatest in winter.

Habitat Availability

For boreal caribou in the NWT, habitat availability can be evaluated based on: 1) the level of disturbance on the landscape as identified for critical habitat (ECCC 2020a); 2) size and configuration of undisturbed "secure" habitat (Nagy 2011); and, 3) predictive habitat selection maps from Resource Selection Function (RSF) modeling (DeMars *et al*. 2020).

Currently, the level of undisturbed habitat for NT1 (71%) exceeds the minimum threshold (≥65%) for critical habitat for boreal caribou as defined in the national boreal caribou recovery strategy (Table 11; ECCC 2020a; ENR 2022a). Fire accounts for almost 75% of habitat disturbance in the NT1 range, and for almost 100% of habitat disturbance in the Wek'èezhìı Region (Table 11). The highest current levels of human habitat alteration and combined habitat alteration is in the Southern NWT Region, where only 58% of the area is undisturbed, and where the majority of NWT's boreal caribou live (ENR 2022a).

Nagy (2011) defined 'risk habitat' as areas ≤400 m from linear features (seismic lines, pipelines, and roads), and 'secure unburned habitat' as unburned habitats >400 m from linear features. Using spatial layers for: fire (1965-2010) obtained from the NWT WMIS and Government of Alberta; seismic line data obtained from the Canadian National Energy Board, the National Topographic Series (NTS) map database, the Dehcho Land Use Planning Board, and the Government of Alberta; and road and pipeline obtained from the NTS map database, approximately 62% of boreal caribou range in the NWT (excluding water) was secure unburned

habitat. Overall, the northern part of the NT1 range in the NWT provides more unburned secure habitat (69%) than the southern part (56%; SARC 2012). Calculations of secure unburned habitat have not been updated with new disturbances on the landscape since 2010.

Table 11. Habitat disturbance in boreal caribou range in the Northwest Territories. Fire disturbance includes wildfires from 1977-2020 (from ENR 2022a).

Range Planning Region	Size (km²)	% Undisturbed	% Disturbed[1]		
			Fire (<40 years)	Human[2] (+500 m buffer)	Combined
Southern NWT	162,418	58.0	28.3	16.1	42.0
Wek'èezhìı	49,505	67.6	32.0	0.8	32.4
Sahtú	149,015	79.8	14.8	6.9	20.2
Gwich'in	38,662	71.1	23.6	6.9	28.9
Inuvialuit	34,393	97.4	1.3	1.3	2.6
Yukon	8,928	77.2	19.6	4.5	22.8
Total NT1[3] (includes Yukon)	**442,920**	**71.0**	**21.5**	**9.1**	**29.0**

[1] Human disturbance is based on 2015 disturbance data published by Environment and Climate Change Canada. Wildfire disturbance is based on a combination of the National Burn Area Composite (1986-2020) and the Canadian National Fire Database (1977-1985). The National Burn Area Composite excludes unburned areas and water features within burn perimeters, and therefore the estimates of area burned by the National Burn Area Composite are generally lower than the estimates by the Canadian National Fire Database (Hall *et al*. 2020).

[2] Human disturbance is defined as disturbances visible on 1:50,000 scale Landsat satellite imagery and includes a 500 m buffer around disturbances (EC 2011).

[3] The NT1 subpopulation as defined by Environment and Climate Change Canada (EC 2011), includes all boreal caribou in the NWT and Yukon.

Although boreal caribou in the NWT are currently considered a single population unit (2020a), calculations of both total habitat alteration, and unburned secure habitat indicate greater levels of disturbance in the southern portion of the NWT range than in the northern portion. The difference could affect boreal caribou population growth rates at a local or regional level.

Figure 16 shows areas predicted to be selected by caribou throughout the year at the second order of selection, which represents how caribou select areas within the population's range (DeMars *et al*. 2020). Colours represent a continuum of relative habitat suitability with darker blue areas (Bins 7-10) selected by caribou, while Bins 6 and lower are used in proportion to their availability or less than expected (DeMars *et al*. 2020). The predictive map indicates that selected habitats are available throughout the NT1 range and suggests that potentially suitable habitat is available in the areas outside of the radio-collared caribou study areas, where technical information on presence of boreal caribou is currently lacking (Figure 16).

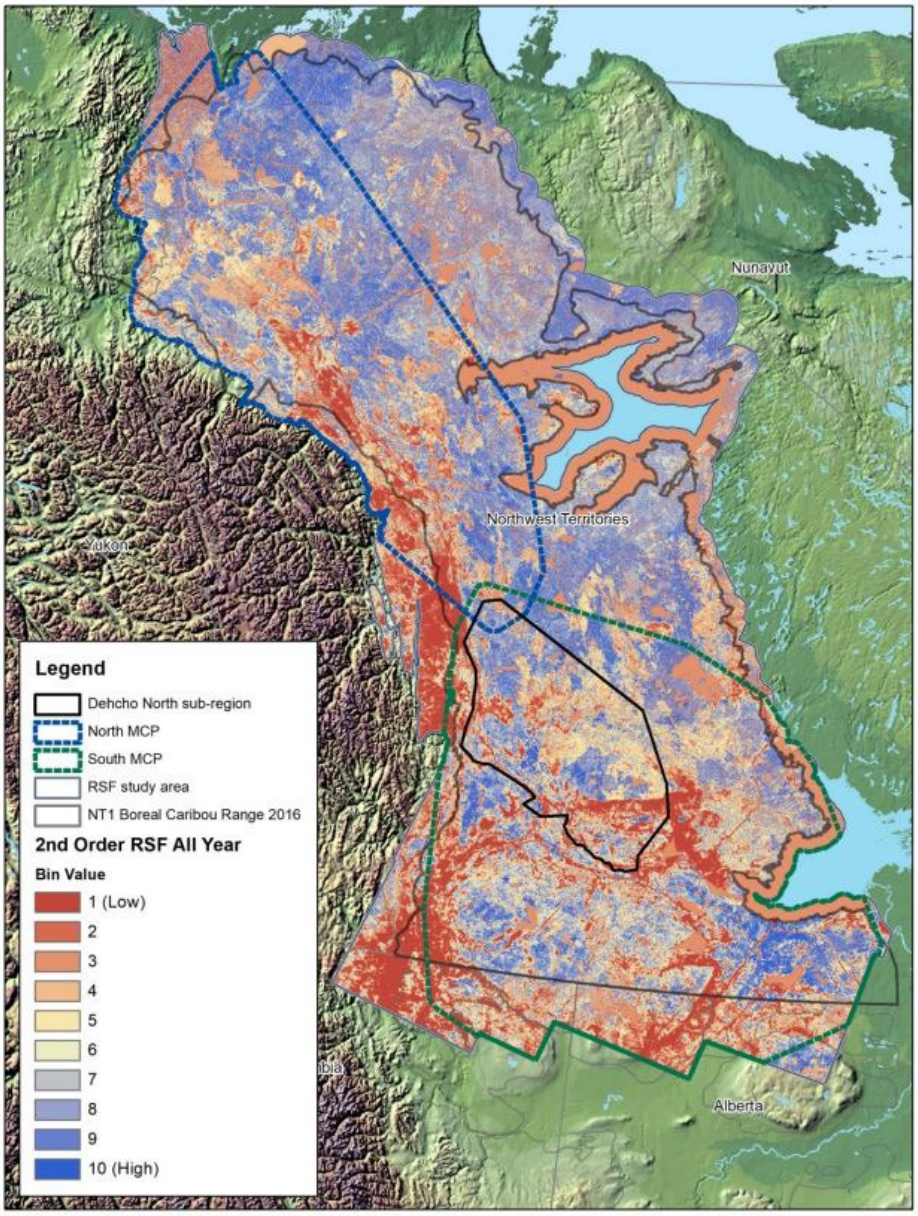

Figure 16. Predictive map of habitat selection from the 2nd-order All Year RSF model (from DeMars *et al*. 2020). Dark red represents the least selected habitat and dark blue represents the most highly selected habitat[10]. Habitat condition is based on fire data up to and including 2017, and human-caused disturbance as measured in 2015 (DeMars *et al*. 2020). The study area includes a 15 km buffer along the shorelines of Great Bear and Great Slave lakes to capture islands used by caribou (DeMars *et al*. 2020). Predicted habitat selection is based on radio-collar data collected in the North Minimum Convex Polygon (MCP) and South MCP and therefore predictions for areas outside of the two polygons have been extrapolated beyond the extent of collar data (see DeMars *et al*. [2020] for additional discussion).

[10] Bins were specified using an "equal area" approach where the RSF predictions from the random points (n=40,000) sampled within the North and South MCPs were assigned to one of 10 bins with each bin having an equal number of points (DeMars *et al*. 2020).

Habitat Trends

Fires and habitat alteration caused by human activities (seismic lines, pipelines, roads, and logging) are the two most significant factors that have affected the availability of boreal caribou habitat in the NWT (Figure 17). In the last 40 years, most of the area burned in boreal caribou range in the NWT was due to fires that occurred in only six years: 1980, 1981, 1993, 1994, 1995, and 2014 (Figure 18). Most seismic lines in the northern part of the range were cut in the 1960s and 1970s and to a lesser extent in the mid to late 1980s (Nagy *et al.* 2006), but the state of recovery to preferred boreal caribou habitat on these lines is largely unknown.

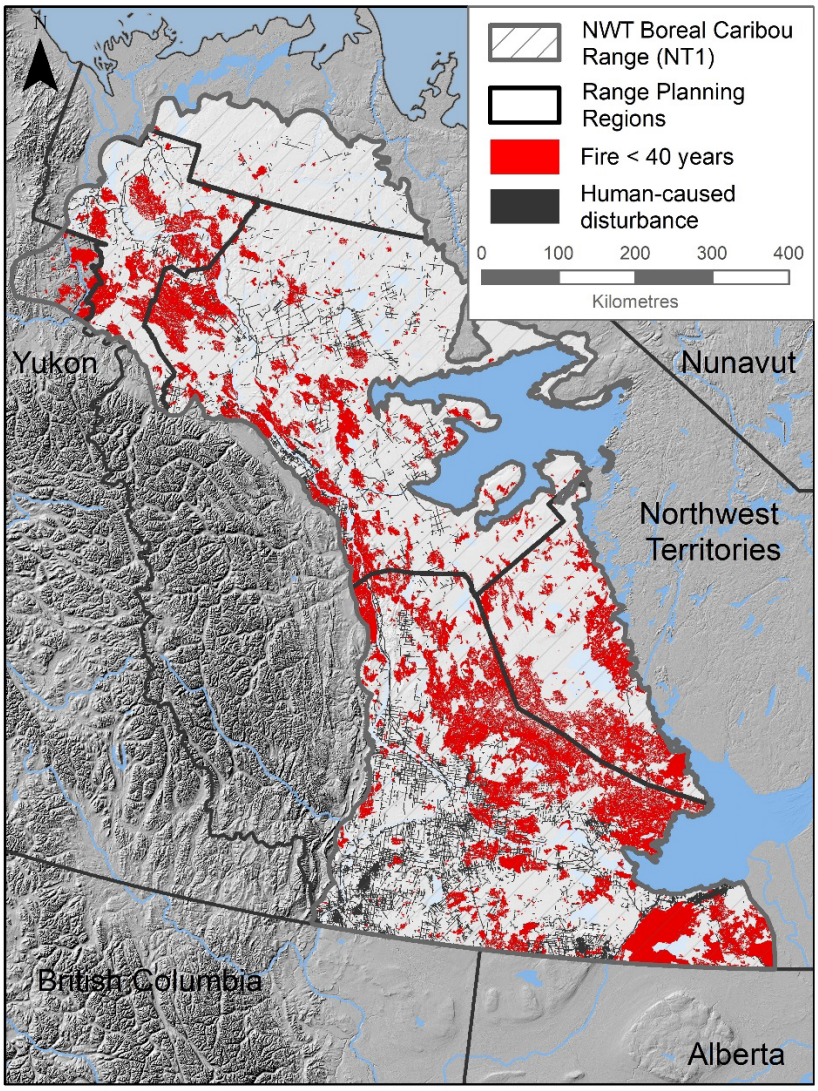

Figure 17. Distribution of wildfires <40 years (red) and habitat alteration due to human activities (black) within boreal caribou range in the Northwest Territories. Human disturbance is based on the 2015 disturbance data published by Environment and Climate Change Canada. Wildfire disturbance is based on a combination of the National Burn Area Composite Data (1986-2020) and the Canadian National Fire Database (1977-1985). Map courtesy of R. Abernethy, ENR.

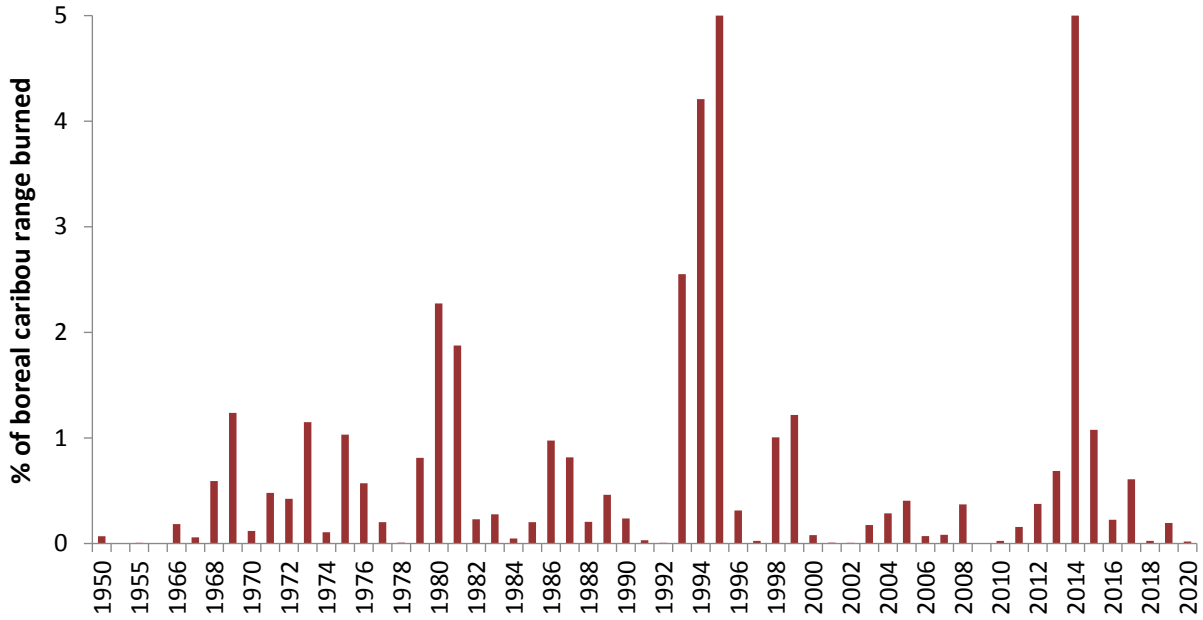

Figure 18. Percent of the boreal caribou range in the Northwest Territories burned by fires annually from 1950 to 2020 (ENR unpubl. data 2021c).

Currently, the only information available on past habitat trend is from 2010 to 2020 (Table 12). Based on range disturbance data compiled by Environment and Climate Change Canada, the combined level of fire and human habitat disturbance on the NT1 range increased from 31% to 35% from 2010 to 2015, primarily due to the large amount of area burned in 2014 (Table 12; Figure 18; ECCC 2017). However, between 2014 and 2020 the percent of boreal caribou range burned by fires decreased (Figure 18). ENR (2022a) updated the area burned estimate up to 2020 using the National Burn Area Composite (NBAC) for 1986 to 2020, and the Canadian National Fire Database (CNFD) for 1977 to 1985. Because the NBAC excludes burned areas and water features within burn perimeters, estimates of area burned are generally lower than estimates by the CNFD (Hall *et al*. 2020). Although the NBAC provides a better representation of area burned, the 2020 habitat disturbance estimate is not directly comparable to the 2010 and 2015 estimates due to the difference in the data used for fire disturbance. The increase in human-caused disturbance includes some of the oil and gas exploration activity that was conducted in the Sahtú region from 2011-2014 (Hodson, pers. comm. 2020).

Table 12. Habitat disturbance within the NT1 caribou range in 2010, 2015, 2017 and 2020.

Year	% Disturbed[1]			Years Covered		Source
	Fire (<40 years)	Human (+500 m buffer)	Combined	Human Disturbance	Fire[2,3]	
2010	24	8	31	2009+2010	1971-2010 (CNFD)	EC (2011) ECCC (2017)
2015	28	9	35	2015	1976-2015 (CNFD)	ECCC (2017)
2017	24	9	31	2015	1977-1985 (CNFD) 1986-2017 (NBAC)	GNWT (2019b)
2020	22	9	29	2015	1977-1985 (CNFD) 1986-2020 (NBAC)	ENR (2022a)

[1] Human disturbance is based on 2015 disturbance data published by Environment and Climate Change Canada. Human disturbance was defined as disturbances visible on 1:50,000 scale Landsat satellite imagery (EC 2011). Wildfire disturbance is based on a combination of the National Burn Area Composite (1986-2020) and the Canadian National Fire Database (1977-1985). The National Burn Area Composite excludes unburned areas and water features within burn perimeters, and therefore the estimates of area burned by the National Burn Area Composite are generally lower than the estimates by the Canadian National Fire Database (Hall *et al*. 2020).

[2] EC (2011) and ECCC (2017) included fire data for the last 40 years but did not explicitly state which years were covered.

[3] CNFD=Canadian National Fire Database; NBAC=National Burn Area Composite. The NBAC excludes unburned areas and water features within burn perimeters, and therefore the estimates of area burned by the NBAC are generally lower than estimates by the CNFD (Hall *et al*. 2020).

In the future, disturbance due to fire, forest insects, and permafrost melting is expected to increase as a result of climate change (Price *et al*. 2013; see *Threats – Climate change*). Two all-season highway construction projects include the Mackenzie Valley Highway from Wrigley to Norman Wells in the Dehcho and Sahtú study areas, and the Tłı̨chǫ Highway connecting the community of Whatì with the Yellowknife Highway in the North Slave study area. The right-of-way for the 97 km Tłı̨chǫ Highway has been cleared and the road opened to the public on November 30, 2021. The Mackenzie Valley Pipeline was approved in 2011, but the project was cancelled by the proponents in 2017 due to the low price of natural gas. Two Forest Management Agreements were signed in 2015, which included portions of the Pine Point/Buffalo Lake, Hay River Lowlands, and Mackenzie study areas. Forest harvesting in the two Forest Management Areas could have localized impacts, and a landscape disturbance model predicted that the forest harvesting in the current Forest Management Areas would

increase the level of disturbed range in the southern half of boreal caribou range in the NWT by about 2% over the next 100 years (Blyth *et al*. 2016). In the model, the amount of undisturbed range was expected to increase, based on habitat recovery 40 years following fire used in EC (2011) calculations; however, slow recovery and growth rates of trees and regeneration delays of up to 50 years in the NWT, suggest that using 40 years to indicate habitat recovery may be optimistic (Blyth *et al*. 2016). Wildfires are expected to increase as a result of climate change, but it is uncertain whether habitat recovery and regeneration rates will balance habitat changes due to wildfire.

Habitat Fragmentation

Habitat fragmentation in the NWT is caused by fires (natural disturbance) and development activities (seismic lines, pipelines, and roads). Currently, the majority of habitat disturbance in the NWT boreal caribou range is natural (Tables 11 and 12), with human-caused disturbances playing a greater role in southern NWT than in the north. As of 2010, secure unburned habitat patches >500 km^2 covered approximately 188,000 km^2 (43%) of the NWT current range (J. Nagy, unpubl. data). The degree of habitat fragmentation, based on variation in patch sizes of secure unburned habitats decreased from south to north (Table 13, Figure 19; Nagy 2011). In parts of the Cameron Hills/Bistcho Lake, South Slave, and Dehcho-south study areas only 0-15% of the secure unburned habitat was in patches >500 km^2, with 56% of the secure unburned habitat in the Cameron Hills/Bistcho Lake study area in patches ≤10 km^2 (Table 13). Secure unburned habitats in the Dehcho-north and Gwich'in-south study areas were moderately fragmented, with 46-54% occurring in patches >500 km^2 and 8-10% in patches ≤10 km^2. The Gwich'in-north study area was least fragmented with 88% of the secure unburned habitat in patches >500 km^2. Population growth rates in these study areas were strongly correlated with the availability of large patches of secure unburned habitat (>500 km^2; Nagy 2011).

Areas disturbed by fire or anthropogenic linear features are permeable barriers to the movement of boreal caribou. Caribou may not select areas that are disturbed by fire because they may lack areas of favourable habitat (Nagy *et al*. 2006). Caribou cross seismic lines during all times of the year but they are less likely to cross them during periods when cows are most vulnerable to predators (Nagy 2011). The Mackenzie and Hay rivers may be significant barriers to caribou movement in the NWT; very few satellite-collared cows tracked in the NWT from 2002 to 2019 crossed the Mackenzie or Hay rivers (Larter *et al*. 2019).

Table 13. Percent of boreal caribou study areas by unburned secure habitat patch size (km²) (Nagy 2011).

Study Areas	Percent of Area by Secure Unburned Habitat Patch Size (km²)[1]												
	≤0.25	>0.25-≤0.5	>0.5-≤1	>1-≤2.5	>2.5-≤5	>5-≤10	>10-≤25	>25-≤100	>100-≤500	>500-≤1000	>1000-≤2000	>2000-≤3000	>3000
Cameron Hills/ Bistcho Lake	3.4	3.9	6.4	12.3	14.4	15.2	14.7	19.8	9.9	0	0	0	0
South Slave[2]	0.1	0.2	0.7	1.8	2.6	4.2	9.8	20.2	45.2	14.6	0.6	0	0
Dehcho-south	0.3	0.4	1.3	4.6	7.6	13.9	20.4	24.8	12.9	0	13.8	0	0
Dehcho-north	0.2	0.1	0.4	1.3	2.7	5.1	10.5	19.3	14.4	7.7	9.6	1	27.7
Gwich'in-south	0.1	0.3	0.4	0.9	1.8	4.2	9	14.1	15.7	0	12.6	9.8	31.1
Gwich'in-north	0	0	0	0.2	0.1	0.4	1	2.9	7.7	5	0.1	0	82.6

[1] Fire data are from the Government of the Northwest Territories and Government of Alberta. Seismic line data are from the Canadian National Energy Board, National Topographic Series (NTS) map database, Dehcho Land Use Planning Board, and Government of Alberta. Road and pipeline data were obtained from the NTS map database.

[2] Note that the distribution data from the Dehcho Land Use Planning Board does not include the South Slave portion of the range does not fully capture all of the disturbance around the Pine Point Mine area nor does it capture public highways to Fort Resolution and Fort Smith.

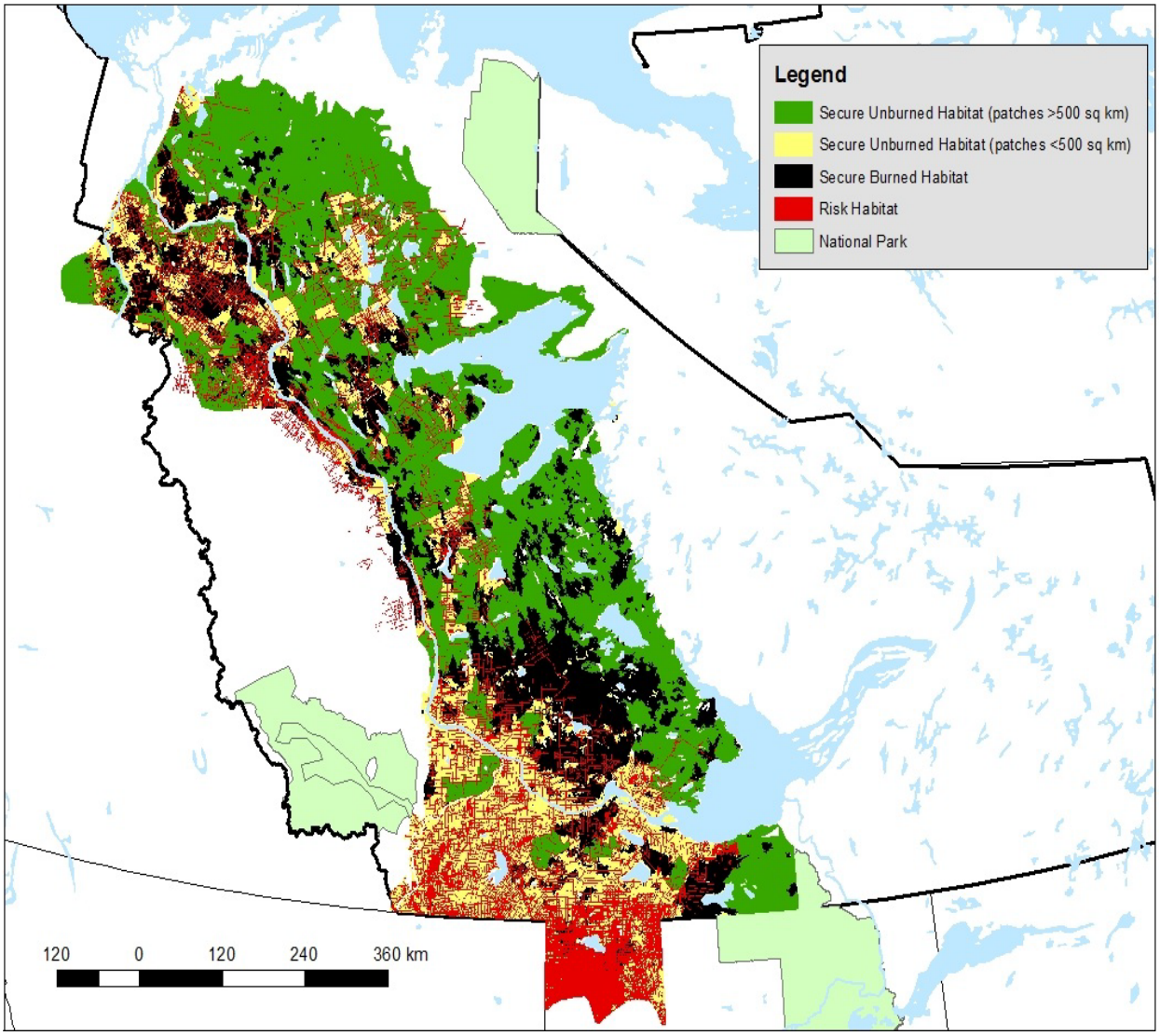

Figure 19. Distribution of secure unburned habitat, secure burned habitat, and risk habitat in the NWT current boreal caribou range and northern Alberta, Canada as of 2010. Habitat classes include: i) secure unburned habitats (areas >400 m from seismic lines, pipelines, and roads that were not disturbed by wildfires during 1965-2010); patches >500 km^2 in green and patches <500 km^2 in yellow; ii) secure burned habitats (areas >400 m from seismic lines, pipelines, and roads that were disturbed by wildfires during 1965-2010) in black; and iii) risk habitats (areas ≤400m from seismic lines, pipelines, and roads) in red; (Nagy 2011). Fire data were obtained from the NWT WMIS and Government of Alberta. Seismic line data were obtained from the Canadian National Energy Board, National Topographic Series (NTS) map database, Dehcho Land Use Planning Board, and Government of Alberta. Road and pipeline data were obtained from the NTS map database. Note that the distribution data from the Dehcho Land Use Planning Board does not include the South Slave portion of the range does not fully capture all of the disturbance around the Pine Point Mine area nor does it capture public highways to Fort Resolution and Fort Smith.

POPULATION

Abundance

Boreal caribou are notoriously difficult to census because they live at very low densities and are distributed across very large ranges. The size of the boreal caribou population in the NWT was estimated by GNWT biologists in 2011 as part of the scientific review conducted by Environment and Climate Change Canada (EC 2011). Local and scientific knowledge were used to estimate boreal caribou densities ranging from one to three caribou/100 km^2. The density estimates were applied to seven areas within boreal caribou range in the NWT, resulting in a population estimate of approximately 6,500 caribou (Figure 20; EC 2011; SARC 2012).

The estimated size of the boreal caribou population in the NWT has not been updated since 2011. Preliminary results from a population survey conducted in the North Slave region in February and March 2020 suggest that the density in the North Slave region is higher than what was used in the 2011 estimate (Nietfeld and Hodson in prep.). Nietfeld and Hodson (in prep.) recorded a minimum density of 2.74 caribou/100 km^2 in the North Slave region, indicating there are approximately 1,290 boreal caribou residing in this region. The revised population estimate in the North Slave region results in a population estimate of 7,409 boreal caribou in the NWT.

Based on late winter composition surveys in the Dehcho (2006-2019; Larter *et al*. 2019) and North Slave (2018-2020; Hodson and Patenaude 2018; Hodson 2019; Nietfeld and Hodson in prep.) study areas, about 82% of caribou counted are adults. Using this percent composition, in 2012 SARC reported an estimate of approximately 5,300 adult (mature) boreal caribou and in 2022 the estimate is approximately 6,091 adult (mature) boreal caribou in the NWT. However, an updated and more reliable estimate of the number of boreal caribou in the NWT is needed.

Based on an estimate of approximately 33,000 – 34,000 boreal caribou in Canada (EC 2011; COSEWIC 2014), the estimated boreal caribou population in the NWT represents approximately 22% of the boreal caribou in Canada.

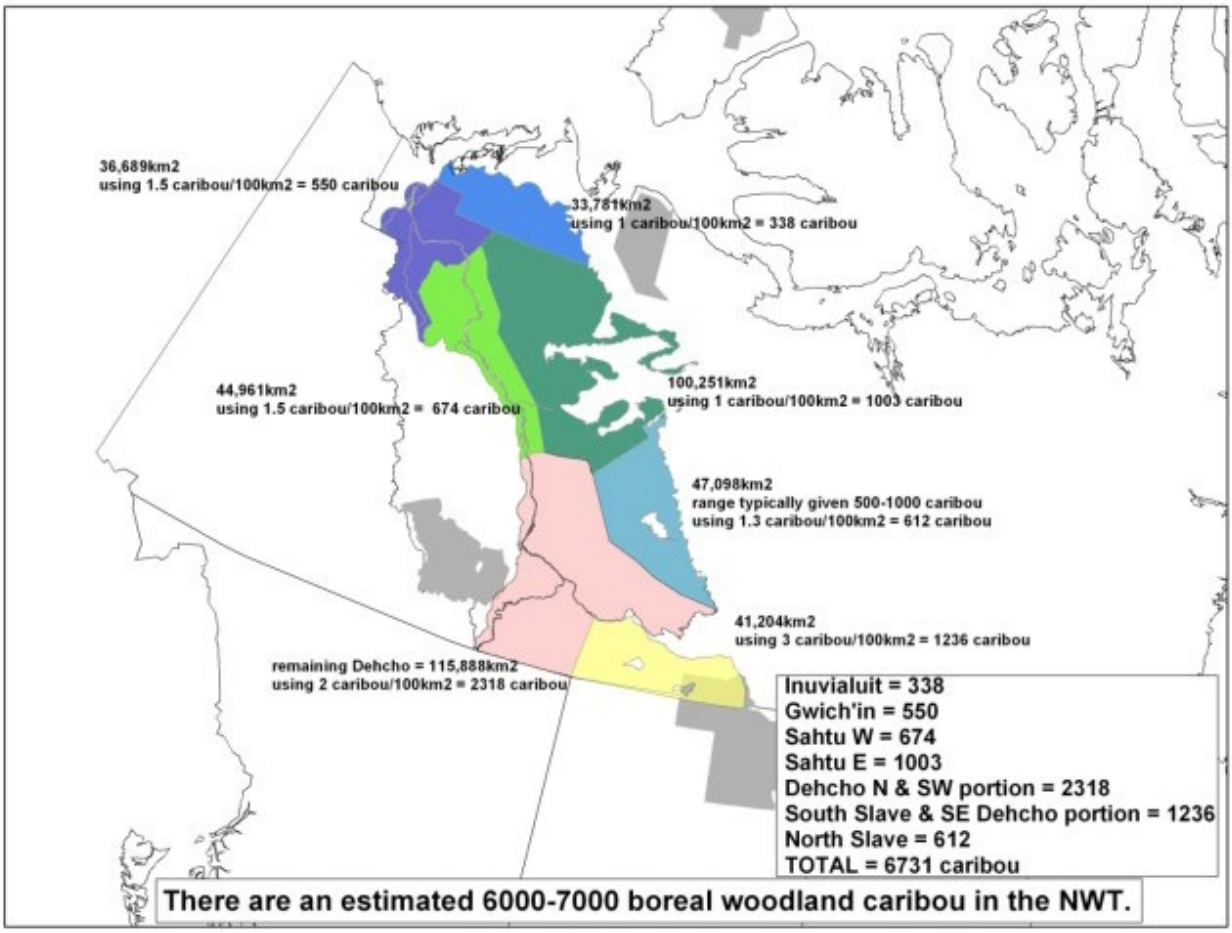

Figure 20. Estimated density and abundance of boreal caribou in different parts of the NWT current range. Note that population estimates have not been updated since 2011; however preliminary results from a population survey in the North Slave region in February and March 2020 suggest a minimum density of 2.74 caribou/100 km^2 in the North Slave region or approximately 1,290 individual boreal caribou (Nietfeld and Hodson in prep.). The revised population estimate in the North Slave region results in a population estimate of 7,409 boreal caribou in the NWT. Map reproduced from ENR (2012) *in* SARC 2012.

Population Dynamics

The demographic indicators from NWT boreal caribou monitoring programs described in the following section are based on annually updated data sets maintained by GNWT-ENR (ENR unpubl. data 2021a). In some cases, the numbers presented in the Tables and Figures below differ from those published in previous ENR regional progress reports due to refinements in the approach to calculating annual adult female survival rates, calf recruitment rates, and population growth rates derived from those two parameters which resulted in retroactive changes to results reported in previous years. For example, some collared caribou were reassigned to a different study area from where the collar was initially deployed based on where they spent the majority of their time while collared. Calf-recruitment rates were retroactively recalculated for the Dehcho region based on all groups censused rather than basing them only

on groups containing collared caribou, to be consistent with the approach used in other regions. The fates of some collared caribou that were unknown at the time of an annual progress report were later determined, which resulted in changes to survival estimates.

Pregnancy Rates

Pregnancy rates for boreal caribou are generally high (Stuart-Smith *et al*. 1997; Rettie and Messier 1998; McLoughlin *et al*. 2003). Pregnancy rate is calculated based on the level of progesterone in blood samples taken from adult female caribou captured and radio-collared in late winter. In addition to pregnancy rates, calving events can be predicted based on a reduction in movement rate of satellite or GPS-collared caribou during the calving period (Nagy 2011). In the NWT, 92% of adult female caribou captured during late winter were pregnant (Table 14), and 90% of adult female radio-collared caribou were predicted to have produced a calf during the calving period (Table 15).

Table 14. Pregnancy rates of adult female boreal caribou in the Northwest Territories based on serum progesterone levels of caribou captured in late winter.

Study Area	Years	% Pregnancy	Source
Gwich'in	2005	100 (14/14)	Nagy (2011)
North Slave (TASR)	2017	89 (17/19)	Williams (2017)
	2018	100 (5/5)	Hodson (2019)
	2019	100 (6/6)	Hodson (2019)
Dehcho	2004-2019	92 (164/179)	Larter et al. (2019)
Cameron Hills	2005-2007	86 (71/83)	Kelly and Cox (2009b)
Hay River Lowlands	2003-2007	91 (125/137)	Kelly and Cox (2009a)
	2013-2020	90 (77/86)	Kelly and Cox (2013) ENR (unpubl. data 2022b)
Pine Point/ Buffalo Lake	2015-2020	100 (48/48)	ENR (unpubl. data 2022b)
Mackenzie	2015-2020	94 (50/53)	ENR (unpubl. data 2022b)
Total		**92 (577/630)**	

Table 15. Predicted calving rates of radio-collared adult female boreal caribou in the Northwest Territories based on reduced movement rates during calving.

Study Area	Years	% Parturition	Source
Gwich'in	2002-2007	89 (55/62)	Nagy (2011)
Sahtú	2003-2008	71 (46/65)	Nagy (2011)
Dehcho	2004-2018	94 (378/404)	Larter et al. (2019)
Hay River Lowlands	2008-2009	95 (21/22)	Kelly and Cox (2011)
Cameron Hills	2008-2009	89 (41/46)	Kelly and Cox (2011)
Total		**90 (541/599)**	

Calf Recruitment

In the NWT, calf recruitment was estimated based on all caribou counted during late winter surveys for most surveys conducted (Table 16). In the 2000s, recruitment was generally higher in the Gwich'in, Dehcho and North Slave study areas than in the Hay River Lowlands and Cameron Hills (Table 16). Bergerud and Elliot (1998) suggested that late winter calf recruitment >24 calves/100 cows is required for a stable population trend. Calf recruitment was less than 24 calves/100 cows in the Hay River Lowlands from 2003/04 to 2008/09 and in the Cameron Hills from 2005/06 to 2010/11 (Table 16). Since 2010/11, calf recruitment has equalled or exceeded 24 calves/100 cows in all study areas with current monitoring programs with the exception of 2013/14 in the Hay River Lowlands. In addition, calf recruitment averaged 21 calves/100 cows (range: 11 - 33 calves/100 cows) from 2006/07 to 2019/20 in Bistcho/Cameron Hills and 22 calves/100 cows (range: 12 - 32 calves/100 cows) from 2007/08 to 2019/20 in the Yates range (Alberta Environment and Parks, unpubl. data 2020).

Weather events may have played a factor in lower calf recruitment in 2012/13 and 2013/14 in the Dehcho study area (Larter and Allaire 2013, 2014). In 2012, the Dehcho area experienced a heavy wet snowfall May 16-18; of the 17 radio-collared cows that had calves prior to May 16, 8 (47%) survived to March while none of the five calves born from May 17 to 24 survived to March, two of which died a few days after birth (Larter and Allaire 2013). Higher snowfall in winter 2012/13 may have also contributed to poor calf survival that year. In 2013/14, abnormal warming events combined with freezing rain on snow may have also potentially affected calf survival that year (Larter and Allaire 2014). Conversely, calf recruitment was higher during milder winters in

2014/15 and 2015/16 (Larter and Allaire 2015, 2016b). Larter *et al*. (2017) found no relationship between snow depth and calf recruitment during the same winter or during the following winter, but suggested that other snow characteristics, such as density and resistance also need to be considered.

Overall, calf recruitment has been higher during the 2010s than in the 2000s; however, the most recent estimates of calf recruitment (2019/20) in both Dehcho and North Slave were lower than calf recruitment in previous years (Table 16; Larter and Allaire 2017, 2018; Larter *et al*. 2019; ENR, unpubl. data 2020b,c).

Table 16. Calf recruitment (calves/100 cows; expressed as %) for all caribou counted during late winter calf recruitment surveys for boreal caribou in the Northwest Territories.

Year	Gwich'in[1]		Dehcho[3]		North Slave (TASR)[4]		Mackenzie[5]		Hay River Lowlands[5,6]		Pine Point/ Buffalo Lake[5]		Cameron Hills[5,7]	
	%	(N[2])	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
2001/02	31	(69)												
2002/03	36	(135)												
2003/04	33	(9[8])							18	(221)				
2004/05									22	(353)				
2005/06			27	(170)					18	(310)			13	(262)
2006/07	26	(66[9])	22	(216)					16	(213)			16	(301)
2007/08			23	(241)					22	(261)			21	(292)
2008/09	49[9]	(82[9])	31	(291)					19	(240)			13	(148)
2009/10			35	(235)					50	(177)			10	(108)
2010/11			43	(161)					25	(130)			17	(72)
2011/12			38	(197)										
2012/13			28	(282)					27	(167)				
2013/14			27	(196)					21	(126)				
2014/15			45	(303)			43	(80)	38	(268)	33	(31)		

2015/16			31	(213)			40	(90)	41	(185)	28	(69)		
2016/17			40	(337)			41	(99)	31	(240)	36	(218)		
2017/18			33	(318)	33	(155)	34	(108)	36	(203)	27	(219)		
2018/19			40	(331)	37	(189)	54	(115)	41	(215)	24	(148)		
2019/20			27	(351)	26	(445)	56	(179)	44	(164)	29	(133)		

[1] Sources: 2001/02 & 2002/03 (Nagy *et al*. 2003); 2003/04 (Nagy *et al*. 2005); 2006/07 (Davison and Branigan 2007); 2008/09 (Davison and Milakovic 2009). In addition, Environment and Climate Change Canada (EC 2011) reported average recruitment rates of 45 calves/100 cows in Gwich'in North from 2004/05 to 2005/06, and 29 calves/100 cows in Gwich'in South from 2003/04 to 2005/06.
[2] (N) = total number of caribou counted during the survey
[3] Sources: 2005/06 to 2019/20 (ENR unpubl. data 2020b)
[4] TASR = Tłı̨chǫ All-Season Road. Source: ENR (unpubl. data 2020c)
[5] Source: ENR (unpubl. data 2021a)
[6] Source: ENR (unpubl. data 2021a)
[7] Source: ENR (unpubl. data 2021a)
[8] N = number of radio-collared caribou (Nagy et al. 2005)
[9] Based on data from ENR (unpubl. data 2020d)

Adult Female Survival

Adult female survival rate was variable but >80% in most years in the Dehcho, North Slave and Hay River Lowlands study areas (Table 17). In the Dehcho study area, adult female survival rate was <70% in 2005/06, 2006/07 and 2013/14 and in the Hay River Lowlands in 2013/14. Snow depth was above average in both the Dehcho and Hay River Lowlands study areas in 2012/13 (Larter and Allaire 2013; Kelly and Cox 2013). Some potential effects of the deep snow year in 2012/13 on adult female survival may not have been realized until the following year (2013/14). In northeastern BC, which experienced similar deep snow conditions in late winter 2012/13, several adult female boreal caribou mortalities were attributed to poor body condition between December 2012 into the summer of 2013 (Culling and Culling 2014). In the Dehcho study area, adult female caribou survival was higher during the year of the big snow in 2012/13 (88%) than the following year (68%; Table 17). In the Hay River Lowlands, adult female survival was also low in 2013/14 (65%; Table 17). Adult female survival was also relatively low in both Dehcho and Hay River Lowlands in 2015/16.

Adult female survival rate in the Hay River Lowlands was relatively stable between 2004/05 and 2009/10, ranging from 83% to 94% (ENR unpubl. data 2021a). In the Cameron Hills study area, adult female survival rate was <80% in three of five years (Table 17). In addition, adult female survival rate averaged 86% (range: 66%-99%) from 2006/07 to 2019/20 in Bistcho/Cameron Hills and 89% (range: 72%- 97%) from 2007/08 to 2019/20 in the Yates range (Alberta Environment and Parks, unpubl. data 2020).

Adult female survival rates during the last three years (2017/18 to 2019/20) have been high and generally >90% in all study areas (Table 17).

The majority of adult boreal caribou mortalities in the NWT have occurred between March 15 and September 15, with the greatest peaks during pre-calving and mid-summer, and a lesser peak in late fall (Kelly 2020b). The majority of known causes of mortality were due to wolf predation, although some predation mortalities were attributed to bears (Kelly 2020b). Non-predation mortalities, most likely due to starvation, occurred primarily during post-calving in early July, corresponding to when caribou fat reserves were low (Kelly 2020b).

Immigration and emigration are difficult to address for boreal caribou in the NWT because they occur as a continuous distribution of individuals on a landscape with habitat discontinuity and possible barriers to movement (Nagy 2011). There is insufficient information to measure immigration and emigration rates. However, it is unlikely that the NWT boreal caribou population depends on immigration for survival since adjacent populations in BC and Alberta are considered "Not self-sustaining" (ECCC 2020a), and therefore unlikely to provide reliable sources of immigrants into the NWT.

Table 17. Percent of adult female radio-collared caribou that survived from April 1 to March 30 in the Northwest Territories from 2003/04 to 2019/20.

Year	Gwich'in[1]		Dehcho[3]		North Slave (TASR)[4]		Mackenzie[5]		Hay River Lowlands[5,6]		Pine Point/ Buffalo Lake[5]		Cameron Hills[5,6]	
	%	(N[2])	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)	%	(N)
2003/04	89	(9)							76	(17)				
2004/05	86	(23)							90	(31)				
2005/06	97	(34)	65	(20)					90	(30)			90	(32)
2006/07	86	(25)	69	(26)					83	(28)			76	(43)
2007/08	91	(16)	88	(33)					87	(32)			91	(40)
2008/09	95	(21)	83	(29)					94	(37)			79	(33)
2009/10	86	(15)	72	(25)					93	(30)			71	(26)
2010/11			83	(30)					85	(14)				
2011/12			80	(20)										

2012/13			88	(26)										
2013/14			68	(28)					65	(29)				
2014/15			97	(30)					86	(29)				
2015/16			74	(35)			100	(8)	78	(33)				
2016/17			74	(31)			91	(11)	87	(32)	96	(11)		
2017/18			93	(27)	95	(19)	87	(28)	90	(31)	96	(27)		
2018/19			94	(33)	100	(22)	93	(29)	88	(35)	93	(30)		
2019/20			92	(37)	97	(29)	97	(31)	100	(33)	90	(36)		

[1] Sources: 2003/04 from Nagy *et al.* (2005); 2004/05 to 2009/10 calculated from ENR (unpubl. data 2020d)
[2] N = number of radio-collared adult female caribou
[3] Source: ENR (unpubl. data 2020b)
[4] Source: ENR (unpubl. data 2020c)
[5] Source: ENR (unpubl. data 2021a)
[6] Source: ENR (unpubl. data 2021a)

Trends and Fluctuations

In the national recovery strategy for boreal caribou (EC 2012; ECCC 2020a), the NWT population of boreal caribou was assessed as 'likely self-sustaining'. This is based on a risk assessment that uses population size and the relationship between total range disturbance and the probability of observing stable or positive population growth over a 20-year period. Range disturbance was measured as the percent of the range disturbed by fires within the last 40 years, plus anthropogenic disturbances buffered by 500 m (EC 2011). For the NWT boreal caribou population, with total range disturbance estimated at 29% by ENR (2022a) or 35% by ECCC (2017), the probability of observing stable or positive population growth over a 20-year period is approximately 65% (EC 2012).

Estimated population growth rates for the entire NWT population of boreal caribou are not available. Estimates of annual growth rates have been derived for boreal caribou during varying periods between 2003/04 and 2019/20 in the Cameron Hills, Pine Point/Buffalo Lake, Hay River Lowlands, Mackenzie, Dehcho, North Slave (TASR), and Gwich'in study areas, and are based on annual survival rates of radio-collared adult females and recruitment rate of calves (Hatter and Bergerud 1991; see *Population dynamics* Tables 10 and 11). This method is only reliable if adequate numbers of adult females are collared and their status and reproductive performance are accurately tracked. Small sample sizes lead to large confidence intervals around estimates and uncertainty. In addition to estimating population growth rate each year, population trend over time can be assessed relative to population size at the beginning of the study (estimated

realized population change) by applying the growth rate in the first year of the study to a hypothetical initial population (e.g. 100) to estimate the population at the end of that year. In each successive year, the estimated population growth rate is applied to the population estimate at the end of the previous year. Although this does not provide actual estimates of population size, it tracks whether the population increases or decreases over time and the relative size of the changes.

Estimated population growth rates suggest that boreal caribou in the southern portion of the range (Dehcho, Hay River Lowlands, Cameron Hills) decreased during most years in the mid to late-2000s (Figure 21a). The most consistent decline was in the Cameron Hills study area, where the population had decreased to an estimated 50% of the initial population size from 2005/06 to 2009/10 (Figure 21a; Kelly and Cox 2011). In the Hay River Lowlands, the population remained relatively stable or slightly decreased until 2009/10, then decreased again from 2012/13 to 2013/14 and remained stable until 2017/18 when it started to increase (Figure 21a; Kelly and Cox 2011). By 2009/10 the Hay River Lowlands population was estimated at about 90% of the initial population size, however, the confidence interval around this estimate overlapped with the initial population size, suggesting that the population could have been stable (ENR unpubl. data 2021a). The confidence interval around the Cameron Hills estimate in 2009/10 did not overlap the initial population size (Kelly and Cox 2011).

In the Dehcho study area, estimated population growth rates suggested that the population was decreasing in nine of 15 years, and increasing in six of 15 years, resulting in an overall decrease to about 40% of the initial population size by 2019/20 (Figure 21a; ENR unpubl. data 2020b). However, it is important to note that the sample size of collared individuals in the first two years of the study (2006-2007) was small, leading to wide confidence intervals. There would be 66% of the initial population left by 2019/2020 if these two years of data were excluded (Hodson pers. comm. 2022b). The population decreases in 2013/14 in both the Dehcho and Hay River Lowlands study areas corresponded to the year following the 2012/13 deep snow winter (see Adult female survival) and demonstrate how much effect these unpredictable events can have on population growth.

Monitoring programs more recently initiated in the Mackenzie, North Slave (TASR) and Pine Point-Buffalo Lake study areas all showed positive population growth rates between 2017-18 and 2019-2020 (Figure 21b).

Based on available data (ENR unpubl. data 2020d), population growth rate for Gwich'in North and South combined could only be calculated for two years (Figure 22). In 2006/07, there was a slight decrease in the population, while in 2008/09 the growth rate suggested an increase (Figure 22). Population growth rate for these study areas were 1.20 and 1.08, respectively, during 2005-2007 (Gwich'in North) and 2003-2007 (Gwich'in South), indicating that boreal caribou was

increasing during those years (Nagy 2011). The most recent estimate is now over 10 years old and does not necessarily represent the current situation.

During the last three years, growth rates for all study areas with current population monitoring projects indicated increasing population trends (Figure 21a, b and Figure 22; ENR unpubl. data 2020b,c).

Despite the recent increasing trend, the relative size of the Dehcho population is still well below the initial relative population size at the beginning of the study in 2005/06 (Figure 21a). This is consistent with data from Alberta for the two populations in Alberta that are adjacent/overlapping with the NWT (Appendix B; Alberta Environment and Parks, unpubl. data 2020). Estimates of population growth rates of boreal caribou in the Bistcho/Cameron Hills range suggested primarily a decreasing population prior to 2014/2015, and in the Yates range, suggested a slightly increasing population between 2007/08 and 2010/11, then a decreasing population from 2011/12 to 2014/15 (Appendix B; Alberta Environment and Parks, unpubl. data 2020). For both populations, growth rates indicated population increases during four of the most recent five years (2015/16 to 2019/20; Appendix B; Alberta Environment and Parks, unpubl. data 2020). Again, despite the more recent increasing trends, the Bistcho/Cameron Hills population is still about 50% of the initial population size, while the Yates population is about 80% of the initial population size. Therefore, recent short-term population trends in boreal caribou study areas in the NWT may not be indicative of long-term population trends.

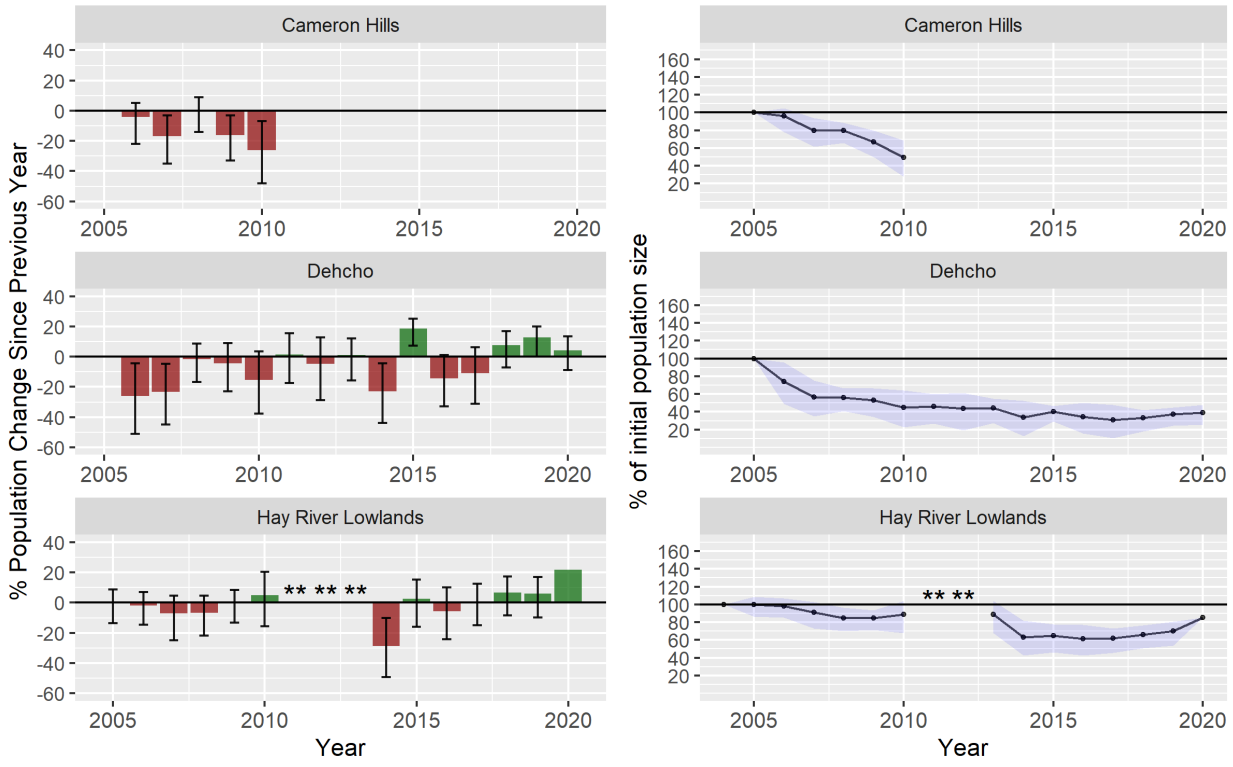

Figure 21a. Percent population change from previous year (left) and realized population change (right) for the Cameron Hills, Dehcho and Hay River Lowlands study areas in the NWT from 2004/05 to 2019/20. For percent population change from previous years (left), green bars indicate % increase, red bars indicate % decrease, and years without bars indicate years without data, except years with a double asterix (**), which indicate years where monitoring did not occur. Black vertical bars represent the 95% confidence intervals for the annual estimates of percent population change. For realized population change (right), points below 100 indicate population size less than the initial population and points above 100 indicate population size greater than the initial population. Pale blue bands represent the 95% confidence intervals. Confidence intervals could not be calculated for years with 100% adult female survival. For Hay River Lowlands, data for population change was not collected from 2010/11 to 2012/13 (indicated with **); for this figure it is assumed that there was no population change during that period (i.e. the graph picks up where it left off in 2010). Based on population change data from ENR (unpubl. data 2020b,c, 2021a).

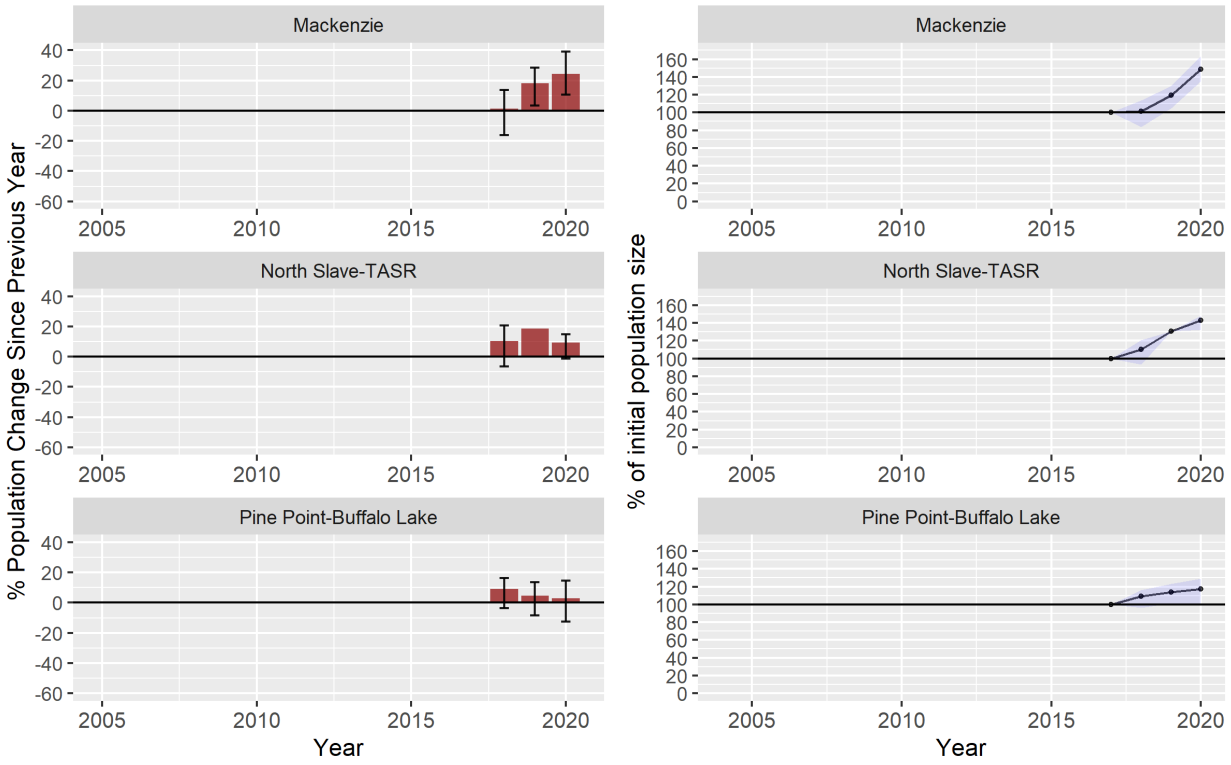

Figure 21b. Percent population change from previous year (left) and realized population change (right) for the Mackenzie, North Slave (TASR) and Pine Point-Buffalo Lake study areas in the NWT from 2004/05 to 2019/20. For percent population change from previous years (left), green bars indicate % increase, red bars indicate % decrease. Black vertical bars represent the 95% confidence intervals for the annual estimates of percent population change. For realized population change (right), points below 100 indicate population size less than the initial population and points above 100 indicate population size greater than the initial population. Pale blue bands represent the 95% confidence intervals. Confidence intervals could not be calculated for years with 100% adult female survival. Based on population change data from ENR (unpubl. data 2020b,c, 2021a).

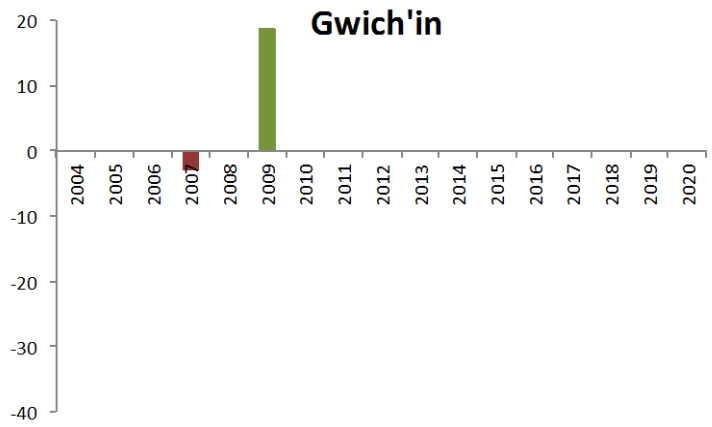

Figure 22. Percent population change from previous year for the Gwich'in study area in the NWT from 2003/04 to 2019/20. Green bars indicate % increase, red bars indicate % decrease, and years without bars indicate years without data. Based on data from ENR (unpubl. data 2020d).

In the NWT, longer-term population trend is only available for the Dehcho and Hay River Lowlands study areas, dating back to 2005/06 and 2004/05 respectively. Although neither of the datasets extends back three generations (27 years), data suggest an overall decline in both study areas since the early to mid 2000s. Due to the variability in annual estimated rates of population change across study areas, it is not possible to extrapolate trends from those two study areas to study areas without population growth estimates, or to study areas with only recent population growth estimates.

Currently, there is no estimate of overall population change available for the whole boreal caribou population in the NWT. Approximately half of the estimated number of NWT boreal caribou (see Figure 20) are found in areas where caribou numbers have exhibited an overall long-term decline or where long-term trend is unknown (Dehcho and South Slave regions). The remaining caribou are found in areas where the long-term trend is unknown (Gwich'in, Inuvialuit, Sahtu and North Slave areas).

No population viability analyses have been conducted to predict future population trends.

Although boreal caribou in some of the study areas were recently increasing, this trend may not continue if levels of anthropogenic and fire disturbance increase in future. The southern NWT, where population growth rates in some study areas suggest an overall long-term decline, already has a large anthropogenic and fire disturbance footprint (see Figure 17). The additive effects of new impacts may affect caribou populations in those areas.

Currently, there is not enough information to evaluate whether there has been a continuing decline in boreal caribou numbers across boreal caribou range in the NWT. Population growth information from the last three years suggests that boreal caribou in all study areas have been increasing, although numbers had previously been declining in two of those study areas. No other longer-term data from other study areas were available.

There is no evidence of extreme fluctuations in the number of mature individuals based on available data. Extreme fluctuations in the total number of mature individuals or distribution of boreal caribou are not expected unless i) large areas of habitat are lost or affected by fire or anthropogenic disturbances, ii) there is no recruitment for a number of years, or iii) harvest rates are excessive and unrecorded.

Possibility of Rescue

It is unlikely that dispersal from boreal caribou in adjacent jurisdictions would augment or repopulate the NWT boreal caribou population should it decline or become extirpated. The home ranges of some adult female boreal caribou captured in the NWT extended well into Alberta, BC and Yukon indicating that boreal caribou regularly travel across the boundaries between those jurisdictions (Nagy *et al*. 2005; Kelly and Cox 2011; Alberta Government 2017; Larter *et al*. 2019). However, with the exception of boreal caribou on the Peel River Plateau in Yukon, boreal caribou do not occur east, north, or west of the NWT current range (see Figure 11). Although boreal caribou are capable of moving long distances (see *Place – Movements*) and in the southern part of the NWT current range are contiguous with those in northern Alberta and BC (see Figure 11), populations in Alberta and BC have been assessed as not self-sustaining (ECCC 2020a). If boreal caribou numbers decline in the NWT and adjacent provinces, the level of exchange of individuals between the three jurisdictions will likely also decline. The closest boreal caribou population to the NWT that has been assessed as "Likely self-sustaining" is the SK1 population, which is located in the Boreal Shield Ecoregion in northern Saskatchewan (ECCC 2020a). The northwestern extent of the SK1 range lies approximately 250 km to the southeast of the southeastern portion of the NWT range. However, boreal caribou do not occupy the area between the two ranges and there have not been any known movements between the ranges.

There is no evidence that boreal caribou in the NWT have special adaptations that are different from those that occur elsewhere. Current boreal caribou range condition in the NWT (≤ 35% total disturbance) is considered adequate to support a self-sustaining population (ECCC 2020a), and is therefore suitable for boreal caribou from elsewhere to survive and reproduce, although habitat disturbance levels are relatively higher in the southern portion of the NWT range than in the northern portion. Recovery of areas disturbed by fire and industrial activities occurring through natural regeneration is expected to result in improved habitat conditions in the future.

Habitat alteration due to industrial activities is a significant threat to boreal caribou through impacts on predator/prey relationships and has led to declines in boreal caribou numbers (Festa-Bianchet *et al*. 2011). Habitat alteration level in boreal caribou range in the NWT is lower than in boreal caribou ranges in Alberta and BC, where populations are considered "Not self-sustaining" (ECCC 2020a). Because boreal caribou range condition in the NWT is more favourable for boreal

caribou persistence than range conditions in BC and Alberta, it is more likely that the NWT boreal caribou population will act as a source population to rescue neighbouring populations, rather than BC and Alberta populations acting as sources for rescuing the NWT population.

THREATS AND LIMITING FACTORS

There are a number of threats that directly or indirectly affect boreal caribou and their habitat. The most important threat to the persistence of boreal caribou across their distribution in Canada is habitat alteration, especially from human activities, and the resulting effects on predator-prey relationships (Festa-Bianchet *et al*. 2011; COSEWIC 2014). The following sections summarize threats individually; however, threats are interconnected and therefore some sections include discussions on how threats interact.

The main threats to boreal caribou in the NWT are habitat alteration due to fire and human-caused disturbances, predation and climate change.

Habitat loss, Degradation, or Fragmentation resulting from Human Land-Use Activities and Natural Processes

As described in *Habitat Requirements*, boreal caribou require large tracts of contiguous old boreal forests that have not been altered by natural or human-caused disturbances (EC 2011; Nagy 2011). Habitat alteration can affect boreal caribou directly through impacts to their habitat, or indirectly through changes in distribution and numbers of other prey species and predators, and/or increased predator efficiency (Festa-Bianchet *et al*. 2011). Both natural and human-caused disturbances convert mature forests to early seral habitats, but human-caused disturbances also result in increased access from roads and other linear features such as seismic lines. In the NWT, fire is the dominant cause of habitat disturbance on boreal caribou range covering 22% of the range, with human-caused disturbance (including a 500 m buffer) covering 9% (see *Habitat Availability*).

Effects on Habitat

Fire

In the NWT, post-fire vegetation response in the Taiga Plain is influenced by fire severity and site type. On moister sites with deeper soil organic layers and low fire severity, vegetation that resprouts from roots was most common, while vegetation regenerating from seeds was more common on drier sites with more severe fires (Day *et al*. 2020). Post-fire vegetation was more similar to pre-fire composition on moister sites, that on drier sites (Day *et al*. 2020). Severe fires can lead to transitions from black spruce forests to trembling aspen (*Populus tremuloides*) or jack pine (*Pinus banksiana*) stands, with a higher degree of combustion of the soil organic layer resulting in a higher likelihood of transition (Baltzer *et al*. 2021). Black spruce transition to other

states was higher in the Taiga Plain than in the Taiga Shield, with loss of black spruce resilience observed in 60% of sites sampled in the Taiga Plain (Baltzer and Cumming 2019). Combustion of the soil layer depends on stand age, with greater combustion of soil in younger stands (Walker *et al*. 2019), suggesting that as boreal wildfires increase in frequency and intensity, more soil will be removed, which could result in more area and a higher likelihood of black spruce forests transitioning into aspen or jack pine stands. Higher severity fires also affect soil fungal community structure, which influences post-fire vegetation recovery and composition (Day *et al*. 2019).

Fire interval also influences post-fire vegetation structure and composition. Conifer and total tree density is lower on post-fire sites with shorter intervals between fires and a higher proportion of deciduous trees (Whitman *et al*. 2019). Sites with shorter intervals between fires also have less residual organic material, lower understory herbaceous cover, and increased presence of deciduous and re-sprouting understory species (Whitman *et al*. 2019). Effects of shorter fire intervals were more pronounced on well-drained upland sites than wetlands (Whitman *et al*. 2019). Because lichens are poor competitors against other vegetation, the reduction in tree canopy and herbaceous vegetation could potentially provide conditions that are favourable for lichen re-establishment; however, recovery of lichens post-fire may take several decades in the Taiga Plain (Greuel *et al*. in review; Gibson *et al*. 2018), which may be too long if the interval between fires is shorter, and increased shrub cover (Whitman *et al*. 2019) could negate the benefits of reduced herbaceous cover. Understory vegetation composition is also influenced by pre-fire forest structure and composition, climate and topoedaphic [soil and topography] conditions (Whitman *et al*. 2018).

Fire also results in permafrost thaw (Gibson *et al*. 2018, Holloway *et al*. 2020). Following fire on peat plateaus, active layer thickness (top layer of soil that thaws each summer) and extent of permanently thawed soil increases, but under recent climate conditions, pre-fire vegetation and soil thermal conditions have been able to recover after 30 years (Gibson *et al*. 2018). However, fire at the edge of peat plateaus results in conversion to thermokarst bogs, which is considered irreversible (Gibson *et al*. 2018). Lowland forests are predicted to be more resilient to permafrost thaw following fire than upland areas, which are expected to undergo permanent permafrost thaw (Holloway *et al*. 2020). Climate change is expected to reduce resilience of permafrost to the effects of fire, which could result in longer recovery time and/or permanent loss, especially in the southern extent of the discontinuous permafrost zone (Holloway *et al*. 2020).

Seismic Lines

Vegetation regeneration on seismic lines is very slow and therefore the effects of linear feature could persist for a long time. In the Gwich'in area, mean time for seedlings to re-establish in black spruce and white spruce forests was 16-17 years (Seccombe-Hett and Walker-Larsen 2014). In the southern NWT and Sahtú regions, it took at least 20 years for the five most common

vegetation species to re-establish and only 40% of seismic lines had recovered floristically or had the potential for floristic recovery (Olesinski *et al*. 2016). In northeastern Alberta, regeneration was higher on seismic lines further away from roads, and approximately one-third of conventional seismic lines were predicted to fail to regenerate to 3 meters in height after 50 years (van Rensen *et al*. 2015). Also in northeastern Alberta, after 35 years, only 8% of seismic lines recovered to 50% cover; 64% did not. While, about 21% transitioned into vehicle tracks and 6% transitioned to gravel/paved roads or other industrial uses (Lee and Boutin 2006). One of the most consistent effects of seismic lines on vegetation is poor or no recovery in wet lowland areas (Seccombe-Hett and Walker-Larsen 2004; Lee and Boutin 2006; Bayne et al. 2011; van Rensen et al. 2015; Kansas *et al*. 2015), even up to 37 years post-disturbance (Seccombe-Hett and Walker-Larsen 2004; Lee and Boutin 2006).

In west-central and northwestern Alberta, seismic lines and edges of seismic lines contained more moose forage than adjacent forests, and moister seismic lines and edges contained important bear foods (Finnegan *et al*. 2018).

Effects on Caribou

Fire

In the NWT, boreal caribou are found most frequently in unburned habitats throughout the year, although use of burned habitats generally occurs during snow-free months, in younger and older burns, and in areas of lower burn severity (see *Habitat requirements*). In addition to recent and ongoing studies in the NWT (see *Habitat requirements*), results from studies elsewhere provide insight into the understanding of the role that fire plays in boreal caribou habitat use and dynamics. In northeastern BC, where burns <40 years made up <3% of the area, boreal caribou selected new and old burns (Mumma *et al*. 2018), whereas in northern Saskatchewan, despite recent burns (<4 years) covering 8% of the study area, use of burns was low except during calving/early summer (Silva *et al*. 2020).

The effects of fire will in part depend on the capability of boreal caribou range to support habitat for other prey, and consequently predators. In northern Saskatchewan (SK1 boreal caribou range), despite burns <40 years old covering 57% of the range and human-caused disturbances playing a minor role in disturbance (~3%), moose densities (and wolf densities) are low, likely due to a lack of deciduous or mixed-wood stands, and low abundance of moose browse species in young, post-fire conifer stands (Neufeld *et al*. 2021). In boreal caribou ranges in northeastern BC, moose selection of burns varied between sexes and seasons (Mumma *et al*. 2018). Adult female moose avoided new burns (1-15 years) and old burns (16-40 years) throughout the year except in summer when they selected new burns. Conversely, adult male moose selected new burns throughout the year and selected old burns during calving and late summer. In an assessment of moose response to fire in boreal caribou ranges in Alberta and northeastern BC,

DeMars *et al*. (2019) found that moose avoided burns ≤25 years throughout the year. They suggested that the low use of burns may have been linked to a high proportion of peatlands in boreal caribou ranges, which may not have supported abundant moose browse when burned. Although moose avoided burns ≤25 years regardless of burn age, season and type of land cover, they avoided burned peatlands more than other burned habitats (DeMars *et al*. 2019). In addition, DeMars *et al*. (2019) found no relationship between area of burns ≤40 years and moose density.

Indeed, the updated analysis of disturbance on boreal caribou ranges suggests that fire plays a much smaller role than human-caused disturbance in the negative relationship between total disturbance (fire + human-caused) and boreal caribou calf recruitment, and that human-caused disturbance was the primary driver in the negative relationship between total disturbance and adult female survival (Johnson *et al*. 2020; see *Habitat requirements*). Therefore, fire affects calf recruitment more than it does adult survival. In Manitoba, Schindler (2018) could not find a significant relationship between lambda and total disturbance, but did detect a weak relationship between lambda and human-caused disturbance, and suggested that spatial pattern of disturbance may play a role since a relationship could not be established based on percent disturbance alone.

Human-caused disturbances

In the NWT, the dominant human-caused habitat alteration on boreal caribou ranges is seismic lines, with over 100,000 km cut between 1960 and 1990 (Nagy 2011). Boreal caribou response to seismic lines varied seasonally and among study areas in the NWT and northern Alberta where average seismic line densities ranged from 0.12 to 3.33 km per km^2 (Nagy 2011). The most important responses are as follows.

1) Females avoided areas near seismic lines during periods when females and calves were most vulnerable to predators or hunters (i.e. avoidance period), and did not avoid seismic lines during the rest of the year (i.e. non-avoidance period).
2) Females avoided seismic lines for longer periods in areas with higher densities of seismic lines and where predator and alternate prey diversity was greatest, compared to areas with lower densities of seismic lines and where predator and alternate prey diversity was lower.
3) Where females had access to areas that were >400 m from seismic lines (areas with low seismic line densities), they used these areas more than expected during the avoidance period.
4) The avoidance responses were graded, i.e., use of areas increased as the distance from seismic lines increased.
5) Use of areas near seismic lines by females during the non-avoidance period was variable.

6) Females crossed significantly fewer seismic lines than expected if their movements were random (during the avoidance period only).
7) Females travelled at faster rates during all times of the year when they crossed seismic lines than they did before or after crossing them.
8) Females travelled at slower rates during periods before and after crossing seismic lines as seismic line densities increased, indicating that the local movements of caribou may be increasingly constrained as seismic line densities increase and that seismic lines are permeable barriers to caribou movement throughout the year.

In combination, these boreal caribou behavioural responses have led to functional habitat loss in areas around seismic lines and other linear features in the NWT and in other areas (Dyer *et al*. 2002; Latham *et al.* 2011b; Nagy 2011). Functional habitat loss refers to the situation where habitats are not destroyed or reduced in quality but are lost to caribou because they avoid using them (e.g. areas near linear features).

In addition, boreal caribou in the NWT avoided areas with high densities of linear features during the snow-free season, but selected them during mid to late winter (De Mars *et al*. 2020). Boreal caribou also selected areas farther away from major roads, cutblocks and well pads. In boreal caribou range in northeastern BC, throughout the year, caribou also avoided new (1-15 years) and old (16-40 years) cutblocks and areas with higher road densities (Mumma *et al*. 2018, 2019). They also avoided areas with high densities of seismic lines in all seasons except early winter. Boreal caribou home range size is negatively correlated with the amount of human-caused habitat alteration in the population's range; smaller home ranges may reduce the risk of encountering predators (Wilson *et al*. 2019).

Boreal caribou response to human habitat alteration may contribute to spatial separation between boreal caribou and other prey and predators. In northeastern BC, female moose selected new cutblocks throughout the year, old cutblocks during calving and early winter, and areas with high density of seismic lines in summer (Mumma *et al*. 2018). Male moose selected new cutblocks throughout the year, old cutblocks during calving and summer, areas of with high densities of roads during calving, and areas with a high density of seismic lines in early and late winter.

In northern Alberta, linear features are important movement corridors for wolves during the snow-free period (April-September; caribou seismic line avoidance period), when wolves hunt in smaller groups (rather than hunting as a pack) and as a result form the greatest number of hunting units (Latham *et al*. 2011b). Seismic lines allow wolves to travel further and faster on seismic lines with lower vegetation heights, and to increase their hunting efficiency in caribou habitat (James 1999; James and Stuart-Smith 2000; Neufeld 2006; Dickie *et al*. 2016). In northeastern BC, wolves generally selected areas with higher seismic line density, particularly in

peatlands when availability was high (Mumma *et al*. 2019), and caribou-wolf encounters were higher near linear features (Mumma *et al*. 2017). Wolf use of seismic lines was greater on lines used by humans (Tigner *et al*. 2014; Dickie *et al*. 2017; Tattersall *et al*. 2020).

Bears also use seismic lines. In northeastern BC, Alberta and the NWT, black bears in boreal caribou ranges used most types of seismic lines more frequently than undisturbed forest (Tigner *et al*. 2014). In northeastern BC, black bears generally selected areas with high linear feature density and were closer to early seral vegetation; early boreal caribou calf survival was best explained by predation risk from black bears (DeMars and Boutin 2014). In Alberta, grizzly bears preferred seismic lines with shorter vegetation during spring and summer and may be using seismic lines for movement and/or for foraging on vegetation or ungulate prey (Finnegan *et al*. 2018b).

Mumma *et al*. (2018) found for boreal caribou in northeastern BC, that the strongest effect of linear features on caribou was due to increased spatial overlap between caribou and wolves, leading to higher risk to caribou, rather than due to increased moose densities or increased spatial overlap between caribou and moose. In that area, disturbance due to both fire (<3%) and cutblocks (<2%) was low.

Functional and structural restoration of seismic lines could reduce the impacts of linear features (Ray 2014). Effects of restoration activities have been variable. In Alberta, a combination of site preparation (mounding), tree planting and application of coarse woody debris, did not appear to decrease wolf and black bear use of seismic lines within three to six years after treatment, but did reduce white-tailed deer use (Tattersall *et al*. 2020). Wolf travel speeds are reduced when vegetation on seismic lines reach 0.5 m in height, yet vegetation height must exceed 4.1 m to successfully reduce wolf movement rates to those observed within undisturbed forests (Dickie et al. 2017). Thus, coarse woody debris applications may not have been effective since there was insufficient material to reach target application levels for movement barriers and planted trees may not have reached the targeted height (Tattersall *et al*. 2020). Canopy closure may not be a sufficient metric for assessing predator use of seismic lines, in that Tigner *et al*. (2014) found distinct game trails on half of the seismic lines they sampled, and on 64% of seismic lines they classified as "closed".

Habitat alteration could also affect biting insects and boreal caribou health. In Ontario, biting flies were more abundant in young harvested stands (25-35 years old) than in unharvested intermediate (36-69 years) and older (>70 years old) stands, and boreal caribou were less active when biting insects were more abundant (Raponi *et al*. 2018). In northeastern BC, seroprevalence of the protozoan parasite *Besnoitia tarandi* in boreal caribou was significantly associated with level of habitat disturbance and road and seismic line density (Bondo *et al*. 2018). In Manitoba, the cortisol concentrations were higher for boreal caribou with higher proportions of home ranges disturbed by forest harvesting in the previous 6-21 years (Ewacha *et al*. 2017).

Although cortisol is an indicator of stress, the effects of increased cortisol levels on boreal caribou survival and reproduction are not known (Ewacha *et al*. 2017).

Predation

While wide-scale habitat alteration and associated linear features resulting from human activities is the ultimate cause of boreal caribou population declines, predation is the proximate cause of mortality (Festa-Bianchet *et al*. 2011). Wolves are the primary predators of adult female boreal caribou in the NWT (Kelly 2020b), but no information is available on predation on boreal caribou calves in the NWT. In northeastern BC, predation risk from black bears best explained calf survival (DeMars and Boutin 2014) and in Manitoba, black bears were present in calving areas during the period of high calf mortality, while wolves were spatially separated from boreal caribou (Schindler 2018). In northern Saskatchewan, during calving and post-calving, black bears selected small patches of mixed-wood and deciduous forest, and avoided habitats preferred by caribou such as black spruce swamps, mature black spruce stands, and open muskeg (McLoughlin *et al*. 2019).

Predator density and diversity vary within the boreal caribou range (see *Interactions*). In the southern NWT, northwestern AB, and northeastern BC, predators including wolves, black bears, and lynx are locally abundant and cougars are rare. These predators are supported by alternate prey including moose, bison, white-tailed deer, elk, beaver, and snowshoe hares. Bison and moose are locally abundant in the southwestern NWT, while white-tailed deer and elk are rare. In the northern NWT, predators include wolves, grizzly bears, black bears, and lynx; wolves, grizzly bears and black bears occur in low numbers and are hunted; lynx are cyclic and locally abundant (Nagy 2011). Predator and prey species diversity is higher in the southern than northern NWT. Predator hunting efficiency may be enhanced by anthropogenic linear features such as seismic lines (see *Human disturbances*). As a result, predation rates may be high in areas where predator densities and alternate prey diversity and abundance are low, but seismic line densities are high. Serrouya *et al*. (2016, 2021) found a weak (not significant) positive relationship between wolf density and the amount of human-caused disturbance, and weak negative relationships between caribou population growth rate and human-caused disturbance, and between caribou population growth rate and wolf density.

Climate change could lead to changes in ecological conditions on boreal caribou ranges that are more favourable for supporting habitats preferred by other prey (see *Climate change*), which could lead to increased distribution and abundance of other prey and wolves, and consequently to greater predation risk for boreal caribou.

Hunting

Based on the 2019 estimate of Indigenous and resident harvest of boreal caribou in the NWT (see *Interactions*), the total annual harvest could be as low as ~85 (1.3% of the estimated

population) or as high as ~210 (3.2% of the estimated population) (Canada and the GNWT 2019). In 2020, ENR reported that the average annual harvest by resident hunters was 19 across the NWT and the average annual harvest by Indigenous harvesters was between 65 and 195 across the NWT (ENR 2021e). However, both estimates of population size and total annual harvest are imprecise, making it difficult to assess the extent or whether hunting is a threat to boreal caribou in the NWT.

Because mortality is additive, the current level of harvest in combination with those killed by predators may be enough to cause local declines and this may have contributed to boreal caribou declines in some portions of the southern NWT. Reliable population estimates and harvest numbers (resident and Indigenous) would allow for a better understanding of population growth rates and the potential effects of hunting. Reliable estimates of harvest are required to determine sustainable harvest levels (ENR 2021f).

In order to provide perspective on the relationships between hunter harvest levels and NWT boreal caribou population growth rates, the GNWT completed a population and harvest model for boreal caribou in the NWT (GNWT 2020c). The model used six study areas in the southern NWT including Dehcho North, Dehcho South, North Slave (Tłı̨chǫ All-Season Road [TASR]), Mackenzie, Hay River Lowlands, and Pine Point/Buffalo Lake. Two NWT Wildlife Management Zones (WMZs), Zone D and Zone R were also included in the study.

The monitoring data indicate that without human harvest, NWT boreal caribou are stable or have the capacity for small levels of annual population growth in the areas of interest and Wildlife Management Zones being studied (ENR 2020c; ENR 2021e, f). Southern areas in boreal caribou range (Dehcho South, Hay River Lowlands, Pine Point / Buffalo Lake) do not appear to have any capacity to withstand human harvest and northern areas (Dehcho North, North Slave [TASR], Mackenzie) can support only a limited harvest (ENR 2020c). The ability to withstand human harvest depends on the size, location, and sex-ratio of the harvest (ENR 2020c).

Climate Change and Severe Weather

In northern Canada, climate change has already contributed to increased temperatures and increased precipitation throughout the year, but especially during winter and spring. Annual and winter temperatures have increased an average of 2.3°C and 4.3°C, respectively from 1948 to 2016 (among the greatest changes in Canada) (Zhang *et al*. 2019). Temperatures are projected to increase another 2-3°C by 2050 (Zhang *et al*. 2019). Despite increased precipitation, snow cover during early winter (October to December) and late winter/spring (April to June) has decreased and further decreases are projected (Derksen *et al*. 2019). Permafrost temperature and thickness of the active layer (top layer of soil that thaws each summer) has increased and the extent of permafrost in Canada is expected to decrease by 16-20% by 2090 (Zhang *et al*. 2019).

Climate change may result in changes in frequency and severity of natural disturbances, changes in vegetation composition, changes in distribution of other ungulates, increased incidence of icing, and increased incidence of disease and parasites (Vors and Boyce 2009). Other potential effects of climate change include degradation of permafrost and heat stress for caribou in summer. With warmer drier summers, an increase in wildfire frequency and severity is expected, resulting in abrupt changes in vegetation composition (de Groot *et al*. 2013; Price *et al*. 2013). Even without natural disturbance events, vegetation composition is expected to change as warmer conditions result in increased productivity, which could support vegetation favoured by other prey species. Increased shrub growth has already been observed in Arctic tundra ecosystems. Increased shrub abundance could out compete lichens and support higher densities of other ungulates. In the Gwich'in Settlement Area and the Dehcho, extreme changes in winter temperatures have caused deeper snow and/or rain or freeze-thaw events that resulted in the formation of ice lenses in the snow making travel, detecting and foraging for terrestrial lichens, and predator avoidance more difficult for boreal caribou (Nagy *et al*. 2005; Larter *in* SARC 2012: 102). Icing could be advantageous for wolves, if snow conditions allow wolves to run on top of the crust but not caribou. Climate change could also alter the parasites and diseases that affect caribou. For some parasites, life cycles could potentially be shortened, and/or ranges could extend northward. Biting insects are most active during periods of warm temperatures (Russell *et al*. 1993), therefore, longer warmer summers may lead to longer periods of insect harassment and, as a result, increased energy expenditure and/or reduced body condition for boreal caribou.

Vors and Boyce (2009) suggested another potential effect of climate change on caribou: a 'trophic mismatch' in which warmer springs lead to an earlier onset of plant green-up without caribou parturition shifting to match the peak of forage availability. However, caribou appear to be able to adjust their reproductive behaviour to adapt to an earlier green-up. In the Dehcho area, Larter *et al*. (2019) documented a trend in mean calving dates over time, with boreal caribou calving earlier in 2018 than in 2004. Similarly, for barren-ground caribou, earlier green-up coincided with earlier migration and calving (Mallory *et al*. 2020). Another behavioural response to climate change by boreal caribou is a decrease in mean group size in response to decreased late winter snow depths (Jung *et al*. 2019). In deeper snow conditions, boreal caribou may form larger groups to reduce energetic costs, predation risk or both; however, it is not known if a shift to smaller groups in winter will have any long-term effects on caribou persistence (Jung *et al*. 2019).

The boreal caribou range in the NWT overlaps the discontinuous permafrost zone in the south, and the continuous permafrost zone in the area north and northwest of Great Bear Lake (NRCan 1995). Climate change has already contributed to permafrost degradation, which could lead to

changes in vegetation species composition (Price *et al*. 2013). Habitat alteration due to fire and anthropogenic disturbances can further exacerbate permafrost degradation (Gibson *et al*. 2018).

Changes in permafrost underlying peat plateaus are causing mortality of overlaying vegetation and a change from forest to bog-fen habitat (Quinton *et al*. 2010, 2011). Rates of permafrost reduction have been measured at 0.5% (area cover) per year (Chasmer *et al*. 2010). Changes in the permafrost layer in peatland landscapes have led to deeper water tables and consequently drought stress and reduced growth in shallow-rooted black spruce in the Dehcho area (Sniderhan and Baltzer 2016).

Parasites and Diseases

Viral, parasitic, and bacterial diseases are not thought to be one of the major threats affecting boreal caribou at the national level (EC 2012), nor is there evidence that they pose a major threat to boreal caribou in the NWT. A recent study found mostly parasites and diseases that had been previously reported in boreal caribou and did not appear to significantly affect their health (Johnson *et al*. 2010).

In the Dehcho area, detection of exposure to the bacterium *Erysipelothrix rhusiopathiae* may be a potential concern. *E. rhusiopathiae* has been associated with moose and boreal caribou mortalities in BC (Forde *et al*. 2016; Bondo *et al*. 2019), and high numbers of mortalities of muskoxen on Canadian Arctic Islands that coincided with population declines (Kutz *et al*. 2015; Mavrot *et al*. 2020). The prevalence of winter ticks on boreal caribou in the southern portion of the NWT has increased since they were first detected in 2013 (see *Interactions*). The meningeal worm (*Parelaphostrongylus tenuis*) and CWD are also concerns if affected cervids from Alberta or Saskatchewan disperse into the NWT (see also *Interactions – Parasites and Disease;* ENR 2019; CWHC 2022). These parasites and diseases have caused ungulate population declines in other areas.

Other Threats

Noise and light disturb caribou leading to functional habitat loss (McDonald 2010; EC 2012). However, there is no scientific evidence that noise and light pose a major threat to boreal caribou in the NWT. The NWT is sparsely populated with hamlets, towns, and cities dispersed over a large area. Issues related to noise and light disturbance are local and may be most associated with populated centers, near roads and trails, and some mining and industry (oil and gas) developments.

Collisions with vehicles are not thought to be one of the major threats affecting boreal caribou at the national level (EC 2012), nor is there evidence that they pose a major threat to boreal caribou in the NWT. Very few mortalities caused by vehicle collisions have been reported to ENR (Armstrong pers. comm. 2021). In the Dehcho area, from 2002 to 2018, there were only two

motor vehicle collisions with boreal caribou, resulting in one caribou that was put down (Larter pers. comm. 2021). Caribou road warning signs were installed on the Mackenzie Highway in the Dehcho in 2018 (ENR 2019b).

Currently there are no large-scale developments that generate pollutants within boreal caribou range in the NWT. Pollution from oil and gas contaminated sites have been shown to negatively affect the health of boreal caribou and may result in mortality if individuals consume toxins (EC 2012). However, little is known about the effects of pollution on the recovery of boreal caribou (EC 2012).

Interactions between Threats and Their Effects on the NWT Boreal Caribou Population

In the NWT, boreal caribou face a number of threats including habitat alteration due to human activities and fire, and their effects on predator/prey dynamics, and climate change. In the last three years (2017/18 to 2019/20), boreal caribou population growth rate data in the southern NWT study areas suggests that populations are likely increasing or at least stable (see *Population trend*). Moose densities in the NWT are low relative to areas in boreal caribou ranges further south. Where moose are the only other prey species wolf densiy is low, density is higher in areas where other species, such as wood bison are more abundant.

Habitat alteration can indirectly affect boreal caribou through: 1) creating habitat conditions that are favoured by other prey species, resulting in changes in distribution and/or abundance of other prey species, and subsequently, changes in distribution and/or abundance of predators; and, 2) increasing predator efficiency. Across the distribution of boreal caribou in Canada, there is a negative relationship between the amount of human-caused disturbance and both adult female boreal caribou survival and calf recruitment. Calf recruitment is also negatively affected by the amount of fire disturbance, but the relative effect of fire is three to four times less than that of human-caused disturbance. Boreal caribou populations are considered likely to be self-sustaining where the combination of fire and human-caused disturbance is ≤35% of the range. However, in northern Saskatchewan, the population was found to be self-sustaining where fire had disturbed 57%, and human activities 3% of the range. In that area, the densities of moose and wolves is low, despite large areas of young post-fire landscapes. This may in part be due to the low ecological capability of the range to support high quality moose habitat. However, an 8-9% increase in human-caused disturbance on that range could result in range conditions unlikely to be self-sustaining for caribou.

While both fire and human-caused habitat alteration can affect boreal caribou through changes to the range that could create habitat conditions favoured by other prey species, human-caused disturbances have the added effect of linear features. Roads and seismic lines provide increased

predator travel rates and increased encounters with boreal caribou which lead to increased predator efficiency.

In the NWT, the boreal caribou range currently includes 22% fire disturbance, 9% human-caused, and 29%[11] combined disturbance. Ecologically, boreal caribou range in the NWT may be similar to northern Saskatchewan in that the ecological capability of the range may not be sufficient to support large areas of preferred moose habitat, which may explain why moose densities are low. Although habitat alteration may not result in increased prey numbers, increased predator efficiency on linear features would still have an effect. In the NWT, unlike the Saskatchewan range, there is a legacy of seismic lines, which could take decades to restore through natural processes. Some seismic lines have been permanently converted to non-forested habitats, making them difficult if not impossible to restore. If climate change results in changes to boreal caribou ranges in the NWT that increase their capability to support preferred habitat for other prey species, it will be important to reduce the impacts of seismic lines and predator efficiency so that boreal caribou can continue to persist. Also, lichen recovery post-fire is slower in the NWT than in Saskatchewan so recovery to a state that supports caribou foraging will take longer (Greuel et al. 2021).

POSITIVE INFLUENCES

Boreal caribou were listed as *Threatened* under the federal *Species at Risk Act (*SARA*)* in 2003 and a national recovery strategy for boreal caribou was completed in 2012 (EC 2012) and updated in 2020 (ECCC 2020a). The recovery strategy identified critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat. The federal SARA requires that critical habitat, once identified, must be protected from destruction regardless of where the critical habitat is located (i.e. on federal lands or non-federal lands). Critical habitat on federal land must be legally protected. SARA requires that critical habitat on non-federal land be protected, and Environment Canada looks to provincial/territorial jurisdictions to provide effective protection for critical habitat on non-federal lands. If the federal Minister of the Environment is of the opinion, after consultation with the appropriate provincial or territorial minister, that critical habitat is not effectively protected, the federal Minister must recommend to the Governor in Council that a protection order be made under section 61 of SARA (CMA 2017).

The recovery objective for the NWT population is to maintain its self-sustaining status and ensure that at least 65% of boreal caribou range remains undisturbed. Agencies responsible for managing boreal caribou and their habitat in the NWT will develop and implement range management plans to ensure this objective is met.

[11] Due to overlap between fire and human-caused disturbances, the total area of the two disturbances combined is less than the sum of the areas of the two disturbances.

Since 2003, conservation planning and research efforts have accelerated the acquisition of the information required to better manage boreal caribou and their habitats in the NWT. These efforts are partly a result of the implementation of the *Action Plan for Boreal caribou Conservation in the Northwest Territories*, the Western NWT Biophysical Study, and projects supported by various co-management boards and government agencies. As a result, research has been conducted on the distribution, movements, primary mortality factors, productivity, recruitment, adult female survival, habitat selection, parasites, diseases, response to human-caused disturbances (seismic lines, etc.), and identification of critical habitats of boreal caribou in the NWT.

The GNWT and its co-management partners have taken a number of steps to manage boreal caribou. In 2007, the GNWT signed the *Memorandum of Understanding for Cooperation on Managing Shared Boreal Populations of Woodland Caribou* with the Government of Alberta. With the formation of the Dehcho Boreal Caribou Working Group, candidate areas were selected for the first comprehensive boreal caribou range management plan in the southern NWT. In 2014, boreal caribou were formally listed as *Threatened* under the *Species at Risk (NWT) Act*. In 2017, the Conference of Management Authorities (CMA) developed and published the *Recovery Strategy for the Boreal Caribou (*Rangifer tarandus caribou*) in the Northwest Territories* and a Consensus Agreement Respecting the Implementation of the Recovery Strategy for Boreal Caribou in the Northwest Territories. In 2019, a Conservation Agreement for the conservation of boreal caribou was signed between the Government of Canada and the GNWT under Section 11 of the federal *Species at Risk Act*. The agreement sets out how the governments of the Northwest Territories and Canada, the Conference of Management Authorities (CMA) and Indigenous governments, organizations and communities will work together to support a healthy and sustainable boreal caribou population in the Northwest Territories, including commitments to engaging and consulting on the range-planning framework, developing regional range plans, implementing range plans, and evaluating sustainable harvest rates. Under section 63 of SARA, the Government of Canada is also obliged to track and report on actions taken and measures put in place to protect identified critical habitat of species at risk every 180 days (ECCC 2020b).

In 2019, *A Framework for Boreal Caribou Range Planning* was completed, which will guide the development of five regional caribou range plans that will address habitat alteration at the regional level (GNWT 2019b). Range planning in the Southern NWT and Wek'èezhìı regions started in 2019. The Interim Wek'èezhìı Range Plan was posted for public review in August 2021 and was submitted to the Wek'èezhìı Renewable Resources Board as a management proposal in accordance with Section 12.5.1 of the Tłı̨chǫ Agreement (GNWT 2021). The public review period for the interim Wek'èezhìı boreal caribou range plan was completed in October 2021 and the Wek'èezhìı Renewable Resources Board approved the interim range plan in December 2021

(Wilson pers. comm. 2022; GNWT 2021). The interim range plan will be in effect until the full range plan is approved and begins to be implemented (GNWT 2021). Range planning in the Sahtú, Gwich'in and Inuvialuit regions began in fall 2020. In 2019, an establishment agreement was signed for Ts'udé Niljné Tuyeta – a future territorial protected area that lies west of the Mackenzie River and the community of Fort Good Hope and is 10,060 km² in size (ENR 2022c). In addition, until land claim negotiations and land use planning are complete, and pursuant to relevant acts, an additional approximately 59,404 km² of land in the southern NWT is currently under a combination of surface and sub-surface land withdrawals, under interim measures agreements and the *NWT Lands Act*, which prevent certain activities that could destroy critical habitat in the NT1 range (ECCC 2020b). Depending on how much of these lands become protected, the protection of habitat for boreal caribou has the potential to have a large positive influence.

In the Northwest Territories, regional land use plans contribute to conservation of boreal caribou habitat through mechanisms such as conformity requirements, land protection directives, and zoning that regulates or restricts industrial development activity in certain areas. Approved land use plans are implemented through comprehensive land claim agreements and the *Mackenzie Valley Resource Management Act*. Together, completed and draft land use plans apply to approximately 80% of the Northwest Territories range (NT1). Additionally, community conservation plans formalizing conservation priorities for the Inuvialuit Settlement Region have been in place since 1993 and were updated in 2016 (ECCC 2020b).

A habitat offset plan was developed for the Tłı̨chǫ Highway, which proposes some offsets that will account for potential indirect disturbance effects within a 500 m zone of influence (ZOI) of the footprint (DOI 2021).

The GNWT also developed an online mapping tool called the "NWT Species and Habitat Viewer" that includes a Boreal Caribou tab which can be used by the public to explore spatial data related to boreal caribou and their habitat in the NWT. Geospatial tools can calculate habitat disturbance within a user-defined area of interest or calculate the amount of new disturbance from a proposed development project. In the future, this Viewer will be used to disseminate spatial information related to boreal caribou range plans once completed.[12]

Currently, the density of moose and other ungulate species is low across much of the boreal caribou range in the NWT. The low densities of other ungulates, which may reflect the capability of the land to support these ungulates, contribute to relatively low densities of wolves, which is more favourable for caribou persistence.

[12] The NWT Species and Habitat Viewer is available online (2020a): https://www.maps.geomatics.gov.nt.ca/Html5Viewer/index.html?viewer=NWT_SHV

Established and Proposed Conservation Network in the Northwest Territories

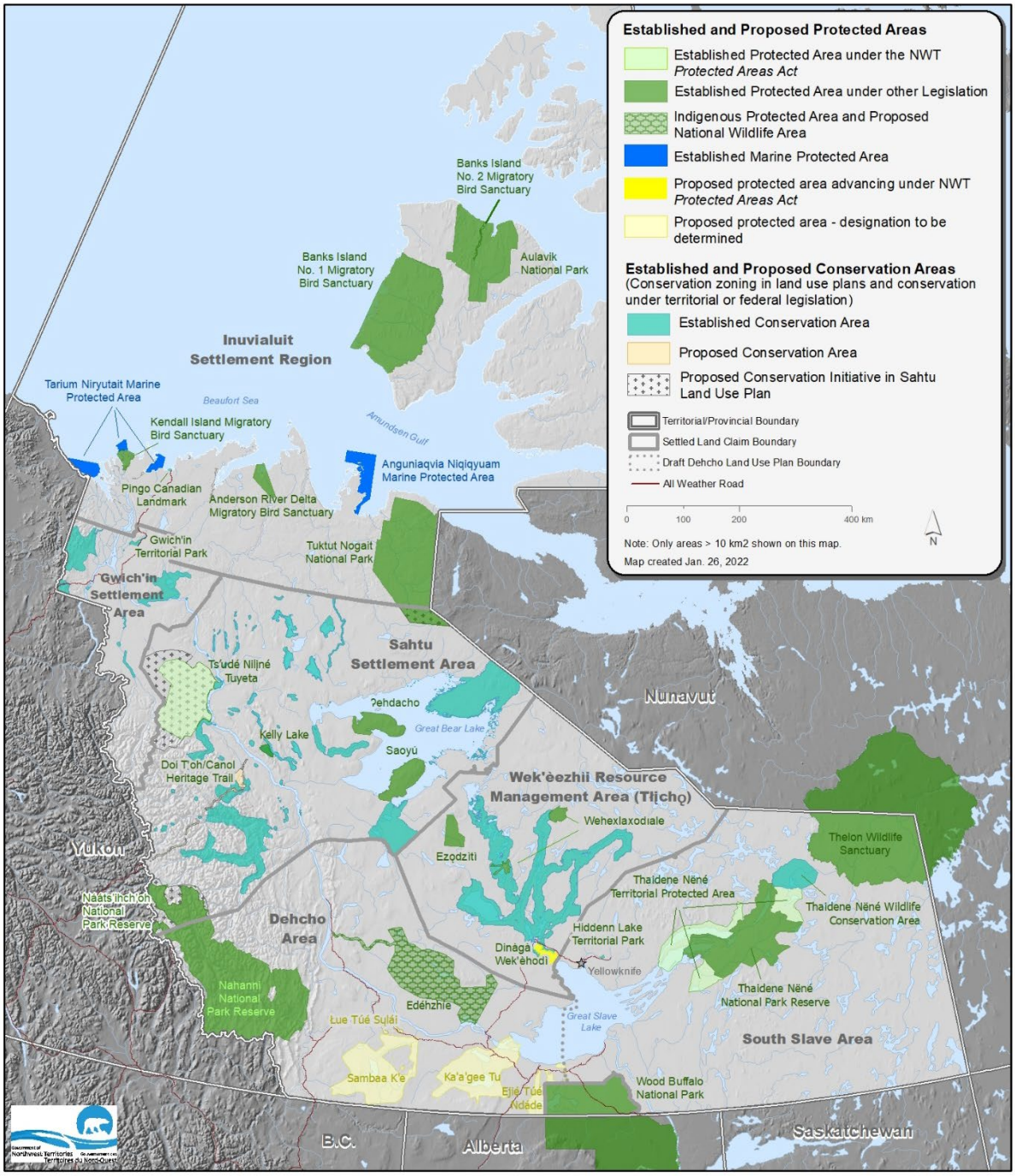

Figure 23. Established and Proposed Conservation Network in the Northwest Territories as of January 2022, including Established and Candidate Protected Areas under the *Protected Areas Act*. (ENR 2022d).

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2021 Update

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2012 SARC Report

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Deborah Cichowski is an independent consultant based in Smithers, British Columbia. She received her BSc and MSc degrees from the University of British Columbia and has been involved with research, inventory, planning and management of caribou in British Columbia since 1985. Deborah has been involved with recovery planning for northern mountain, southern mountain, central mountain and boreal caribou in British Columbia and Alberta and has prepared a number of documents that summarize the current state of knowledge and issues facing caribou populations, including the 2014 COSEWIC Status Report on caribou in the Northern Mountain, Central Mountain and Southern Mountain Designatable Units and the scientific knowledge component of the 2020 SARC Species Status Report for Northern Mountain Caribou in the NWT.

STATUS AND RANKS

Region	Coarse Filter (Ranks)[13] To prioritize	Fine Filter (Status) To provide advice	Legal Listings (Status) To protect under species at risk legislation
Global	G5 – Secure (NatureServe 2016[14])	A2a – Vulnerable (IUCN 2016[15])	Not Applicable
Canada	N5 – Secure (NatureServe 2016)	Threatened (COSEWIC – 2014)	Threatened (*Species at Risk Act* – 2003)
Northwest Territories	At Risk (NWT General Status Ranking Program – 2020)	Threatened (Species at Risk Committee – 2012)	Threatened (*Species at Risk [NWT] Act* – 2014)
Adjacent Jurisdictions			
Alberta	S1S2 – Imperiled to Critically Imperiled (NatureServe 2016)	Endangered (Endangered Species Conservation Committee – 2010)	Threatened (Alberta *Wildlife Act* – 1985)
British Columbia	SNR – Unranked (NatureServce 2016)	S2 – Red List (British Columbia Conservation Data Centre – 2006)	Not Listed under the British Columbia *Wildlife Act*
Manitoba	S2S3 – Vulnerable to Imperiled (NatureServe 2016)	Threatened (Endangered Species Advisory Committee – 2002)	Threatened (Manitoba *Endangered Species and Ecosystems Act* – 2006)

[13] All NatureServe codes are as defined in Definitions of NatureServe Conservation Status Ranks: http://help.natureserve.org/biotics/Content/Record_Management/Element_Files/Element_Tracking/ETRACK_Definitions_of_Heritage_Conservation_Status_Ranks.htm#NatureSe

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Ontario	SNR – Unranked (NatureServe 2016)	Threatened (COSSARO – 2015)	Threatened (Ontario *Endangered Species Act* – 2007)
Québec	S5 – Secure (NatureServe 2016)	Vulnérable (Société de la faune et des parcs du Québec – 2003)	Vulnérable (*Loi sur les espèces menacées ou vulnérables* du Québec – 2005)
Newfoundland and Labrador	Unavailable	Not Applicable	Threatened (Newfoundland and Labrador *Endangered Species Act* – 2002)
Saskatchewan	S3 – Vulnerable (NatureServe 2016)	Not Applicable	Not Applicable
Yukon	SNR – Unranked (NatureServe 2016)	Not Applicable	Not Applicable

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APPENDIX A – ADDITIONAL INFORMATION

Threats Assessment[16]

Threats have been classified for boreal caribou as a whole, insofar as those threats may be relevant to the status of the population in the NWT. The threats assessment is based on whether threats are considered to be of concern for the sustainability of the species over approximately the next 10 years.

This threats assessment was completed collaboratively by members of the NWT Species at Risk Committee, at a meeting on June 15, 2021. The threats assessment will be reviewed and revised as required when the status report is reviewed, in 10 years or at the request of a Management Authority or the Conference of Management Authorities. Parameters used to assess threats are listed in Table A1.

Table A1. Parameters used in threats assessment.

Parameter	Description	Categories
LIKELIHOOD		
Timing (i.e., immediacy)	Indicates if the threat is presently happening, expected in the short term (<10 years), expected in the long term (>10 years), or not expected to happen.	Happening now Short-term future Long-term future Not expected
Probability of event within 10 years	Indicates the likelihood of the threat to occur over the next 10 years.	High Medium Low
CAUSAL CERTAINTY		
Certainty	Indicates the confidence that the threat will have an impact on the population.	High Medium Low

[16] This approach to threats assessment represents a modification of the International Union for the Conservation of Nature's (IUCN) traditional threats calculator. It was originally modified for use in the Inuvialuit Settlement Region Polar Bear Joint Management Plan (Joint Secretariat 2017). This modified threats assessment approach was adopted as the standard threats assessment method by the Species at Risk Committee and Conference of Management Authorities in 2019.

MAGNITUDE		
Extent (scope)	Indicates the spatial extent of the threat (based on percentage of population area affected)	Widespread (>50%) Localized (<50%)
Severity of population-level effect	Indicates how severe the impact of the threat would be at a population level if it occurred.	High Medium Low Unknown
Temporality	Indicates the frequency with which the threat occurs.	Seasonal Continuous
Overall level of concern	**Indicates the overall threat to the population (considering the above).**	**High** **Medium** **Low**

Overall Level of Concern

The overall level of concern for threats to boreal caribou are noted below. Please note that combinations of individual threats could result in cumulative impacts to boreal caribou in the NWT. Details can be found in the *Detailed Threats Assessment*.

Overall level of concern:

- **Threat 1 – Habitat alteration (anthropogenic disturbances) Medium-High**
- **Threat 2 – Habitat alteration (natural disturbances) Medium**
- **Threat 3 – Hunting and over-harvesting Medium**
- **Threat 4 – Climate change Medium**
- **Threat 5 – Predation Low**
- **Threat 6 – Apparent competition with other ungulates Low**
- **Threat 7 – Parasites and diseases Low**
- **Threat 8 – Noise and light disturbance Low**
- **Threat 9 – Human traffic and vehicle collisions Low**
- **Threat 10 – Invasive research techniques Low**
- **Threat 11 – Pollution and contamination Unknown-Low**

Detailed Threats Assessment

Threat #1. Habitat alteration (anthropogenic disturbances)	
Specific threat	Numerous anthropogenic disturbances are impacting boreal caribou in the NWT, either from forestry related activities (i.e., cutblocks) or oil and gas exploration and development (i.e., well pads, roads, seismic lines, pipelines, and transmission lines). While major anthropogenic disturbances occurred in the late 1950s to the early 1970s, it remains prevalent to this day. Indigenous communities in the Dehcho and Tłı̨chǫ regions are concerned about the impacts of anthropogenic disturbances on boreal caribou foraging areas and habitat, notably in the winter where seismic lines are known to increase predation and hunting pressures on boreal caribou.
Stress	Boreal caribou home range size is negatively correlated with the amount of anthropogenic disturbance present within its range. Linear disturbances, such as seismic lines, roads, pipelines, and transmission lines, can impact boreal caribou by destroying habitat, creating barriers to movement, and increasing predation risk. Boreal caribou responses to seismic lines vary seasonally and across regions in the NWT. The greatest avoidance of seismic lines by adult female boreal caribou occurs during the calving season and within areas of high seismic line density. Adult female boreal caribou tend to linearly select areas further away from seismic lines (typically >400 m), and their movements are increasingly constrained as seismic line density increases in an area. These trends have also been reported by several Indigenous communities. Major roads, cutblocks and well pads are avoided by boreal caribou, especially when these disturbances occur at higher densities. Direct impacts of roads on boreal caribou include contamination, dust, garbage, calcium use, toxic fumes, and chemicals. As a result, anthropogenic disturbances have resulted in functional habitat loss (i.e., high quality habitat that is avoided by boreal caribou).
Extent	Localized (<50%)
Severity	Low
Temporality	Continuous
Timing	Happening now
Probability	Medium
Causal certainty	High
Overall level of concern	**Medium-High**

Threat #2. Habitat alteration (natural disturbances)	
Specific threat	Wildfires destroy boreal caribou habitat and alters its distribution on the landscape, but the impacts of wildfires largely depend on burn severity. Low severity wildfires will typically burn slowly on the landscape and remove all ground and understory vegetation, including terrestrial lichen. High severity wildfires, however, often leave residual patches (i.e., patches of unburned forest or peatland) that may contain significant lichen cover for boreal caribou. Elders have noted that current wildfire behaviour is different from the past, therefore large and intense wildfires are not well understood by knowledge holders in comparison to small wildfires.
Stress	Wildfires are believed to be the main cause of habitat loss and boreal caribou population declines in the Tłı̨chǫ region. Wildfires in the thick vegetation of the Taiga Plain has led to fewer boreal caribou in the area. Also, calf recruitment and adult female survival are negatively impacted with wildfires, although anthropogenic disturbances are the primary driver of reduced adult female survival in boreal caribou. Knowledge holders have reported that large wildfires impact the ability of boreal caribou to acquire food, therefore boreal caribou are required to relocate into more desirable locations through large-scale population movements. Indigenous communities across the NWT have different opinions on the length of time required for boreal caribou to return to burned areas. Knowledge holders in the Gwich'in, Tłı̨chǫ and North Slave regions believe boreal caribou return 20 – 40 years post-wildfire. The latter is mainly explained by the lack of appropriate vegetation cover for shelter and protection from predators (i.e., takes 15 – 25 years post-wildfire for proper vegetation cover), as well as the lack of terrestrial lichen cover (i.e., takes a minimum of 20 – 30 years post-wildfire for lichens to recover). In the Sahtú region, knowledge holders have reported both extremes, where boreal caribou either return to burned areas once new growth is available or never return. Finally, knowledge holders from the West Point and K'átł'odeeche First Nations reported that boreal caribou utilize recently burned areas after 10 years post-wildfire. Wildfires can also directly impact boreal caribou by smoke inhalation and burning. Knowledge holders have reported that adult female caribou will stay in actively burning areas to protect their calves rather than fleeing the area, and smoke impedes the ability of boreal caribou to flee, especially if they are residing on islands.
Extent	Widespread (>50%)
Severity	Medium

Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low-Medium
Overall level of concern	**Medium**

Threat #3. Hunting and over-harvesting	
Specific threat	Indigenous harvest of boreal caribou ranges between 85 – 210 individuals (1.3 – 3.2% of the estimated population). Indigenous communities tend to harvest boreal caribou opportunistically, and sport hunting or non-Indigenous hunting is limited in most regions of the NWT. Yet, both the estimate of population size and total annual harvest are imprecise, therefore the extent to which hunting and over-harvesting is a major threat to boreal caribou is currently unknown. Knowledge holders across the NWT are concerned that new anthropogenic disturbances (i.e., roads, seismic lines) will increase hunting pressure for some boreal caribou populations as linear features allow more humans from outside the region or the NWT to hunt within the region, which could further exacerbate boreal caribou population declines. A slow increase in non-Dehcho and non-Dene hunters is causing moderate concern of over-harvesting in the Dehcho region, particularly in the following areas: southwest of Buffalo Lake, west of the community of Hay River, along the river systems near Fort Providence, and areas around Fish Lake and Willowlake River near Wrigley. The GNWT population modelling study found that the boreal caribou population south of the Mackenzie, in the Dehcho Region was decreasing, and, in the absence of hunting, the boreal caribou population in the South Slave south of Great Slave Lake was stable. Knowledge holders are stressing the need for better harvest data in the Dehcho region as current harvest information may be underestimating the actual harvest of boreal caribou.
Stress	Hunting pressure is considered continuous in the NWT as Indigenous harvesters can hunt year-round, regardless of the seasonal hunting periods imposed on resident and non-resident hunters. Since the initial assessment of boreal caribou in 2012, there have been additional anthropogenic disturbances in the NWT that have been linked to increased hunting pressure on boreal caribou due to the ease of year-round access. As a result, there is concern that Boreal caribou are declining in the Sahtú region, east and southeast of Inuvik (i.e., access by the decommissioned Canadian National Railway Line), Cardinal Lakes

	(i.e., access by an ice road in the Gwich'in region), and North Caribou Lake (as described in Benson 2011). Knowledge holders expect new developments, such as the Tłı̨chǫ All-Season Road (TASR) between Whatì and Behchokǫ̀ and the proposed Mackenzie Highway, to further increase hunting pressure on boreal caribou populations. Non-traditional or unlawful harvest practices, such as reckless shooting, over-use of motorized vehicles, wasting meat and leaving carcasses on the ground, may cause boreal caribou to shift to new areas. As barren-ground caribou (*Rangifer tarandus groenlandicus*) populations continue to decline in some areas of the NWT and new regulations are introduced associated with this population decline, hunters in the Inuvialuit Settlement Region are progressively harvesting more boreal caribou.
Extent	Widespread (>50%)
Severity	Unknown-Medium (knowledge gap on harvest information)
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Medium
Overall level of concern	**Medium**

Threat #4. Climate change	
Specific threat	Both scientific evidence and knowledge holders have found that recent climate change in northern Canada has increased annual, summer, and winter temperatures, as well as the number of warm winter days and annual precipitation (particularly in the fall). Climate change has also decreased snow cover in early (October to December) and late winter (April to June). Knowledge holders have reported earlier break-up and later freeze-up of waterbodies in many areas. In the Gwich'in and Dehcho regions, extreme winter temperatures have resulted in rainfall and freeze-thaw events creating ice lenses on the surface of the snow. These climate trends are projected to continue throughout the 21st century. Projected temperature increases are expected to increase the extent, frequency, and severity of wildfires in the boreal forest leading to a shift in vegetation composition (i.e., conifer-dominated to deciduous-dominated forests). Tłı̨chǫ Elders and knowledge holders have also reported more intense

	wildfires and changes in fire behaviour with climate change. Aside from the direct changes of climate-induced wildfires, higher summer temperatures will lead to greater plant productivity, which has been detected in the Arctic tundra (i.e., "shrubification"), where shrub growth and density have invaded Arctic vegetation. Permafrost temperature and thickness of the active layer (i.e., top layer of soil that thaws each summer) has decreased since 1948. Permafrost degradation in underlying peat plateaus has caused vegetation mortality and consequently a shift from forest to bog-fen habitat. Other peatlands have experienced a deeper water table, which has caused drought stress and reduced growth in shallow-rooted black spruce in the Dehcho region.
Stress	Higher summer temperatures can lead to a longer period of insect harassment, which has been shown to increase energy expenditure and/or reduced body condition for boreal caribou. Also, increased summer temperatures can cause significant heat stress for boreal caribou and other ungulates. Higher quantities of deciduous shrubs from climate-induced wildfires and higher summer temperatures will be nutritionally disadvantageous for boreal caribou who depend on an abundance of terrestrial lichens. Increased deciduous shrub abundance and cover in the boreal forest could impede terrestrial lichen growth and cover, which would result in an overall decrease in food availability for boreal caribou. Also, higher densities of deciduous shrubs in previously passable areas have been found to impede boreal caribou movements in the Gwich'in region. Warmer springs can lead to earlier plant green-up, and this can have major consequences for boreal caribou (i.e., 'trophic mismatch') if caribou parturition does not match with the peak of forage availability. However, this mismatch does not seem to be a major concern for boreal caribou as researchers in the Dehcho region have documented a trend of early mean calving dates over time (i.e., boreal caribou are calving earlier than in the past). Weather conditions are impacting the ability of boreal caribou to feed. Rainfall in the fall or winter covers vegetation with ice or creates a crust on the snow, which reduces boreal caribou's ability to detect and forage on terrestrial lichens, impedes boreal caribou movements, and in some cases, causes physical injury. Yet shallower snow depth in late winter has decreased boreal caribou mean group size; it is unclear if this shift will have long-term effects on boreal caribou persistence. Note that some aspects of climate change may be beneficial (e.g., greater plant productivity) while others may be detrimental (e.g., summer heat stress) to boreal caribou; overall, the impacts of climate change on boreal caribou remains largely unknown in the NWT.
Extent	Widespread (>50%)

Severity	Unknown-Medium (climate change will have both positive and negative effects on boreal caribou, but the extent is currently unknown)
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Medium
Overall level of concern	**Medium**

Threat #5. Predation	
Specific threat	Predation is the proximate cause of boreal caribou population declines across its range in Canada. Wolves are the primary predator of adult female boreal caribou in the NWT, whereas black bears (*Ursus americanus*) and grizzly bears (*Ursus arctos*) are the primary predators of boreal caribou calves. Grizzly bear can also hunt adult female boreal caribou and scavenge on carcasses. There is concern about the possible impacts of new predators expanding their range northward into the NWT. Cougar (*Puma concolor*) tracks are increasingly seen in the Dehcho, Tłı̨chǫ, and North Slave regions since the early 2000s, and in 2011, a cougar sighting was reported around Fort McPherson. Knowledge holders in Behchokǫ̀ have noted that coyote (*Canis latrans*) populations and distribution are moving northward in the NWT. A Gwich'in hunter saw coyote tracks in the Mackenzie Delta. However, there is currently no evidence suggesting that cougars or coyotes are preying on boreal caribou in the NWT. It is important to note that although numerous Indigenous communities have reported increases in predator populations and their distributions, there's a lack of consistent reporting on predator populations in the NWT.
Stress	Knowledge holders have reported an increase in wolf populations in the Gwich'in, Sahtú, and Dehcho regions, as well as an increase in bear populations in the Dehcho region. In the South Slave region, the Deninu Kue First Nation reported that wolf populations have remained stable, but there are more wolves in the area than in the past. High wolf predation has been the main cause of boreal caribou population declines west of Buffalo Lake and the Tłı̨chǫ region, while wolf and bear predation is suggested to be the main cause of boreal caribou population declines in the Dehcho region. Furthermore, linear disturbances are important movement corridors for wolves, black bears and grizzly bears. Caribou-wolf encounters are higher near linear

	features. Black bears and grizzly bears select seismic lines for greater foraging availability of early seral vegetation and potentially for opportunistic predation on ungulate prey.
Extent	Widespread (>50%)
Severity	Unknown-Low (knowledge gap on predation and its consequence on boreal caribou population dynamics)
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #6. Apparent competition with other ungulates	
Specific threat	Anthropogenic disturbances are the ultimate cause of boreal caribou population declines in some parts of its range (i.e., Alberta, British Columbia, and Québec) as they indirectly affect boreal caribou in two ways: 1) creation of early successional habitats that favour alternate prey species (i.e., moose [*Alces alces*] and white-tailed deer [*Odocoileus virginianus*]); and 2) linear disturbances from oil and gas development (i.e., seismic lines and roads) enhance predator efficiency on the landscape through higher travel and encounter rates. As a result, the numerical increase of alternate prey abundance from anthropogenic disturbances lead to a numerical response in predator abundance, resulting in greater spatial overlap between boreal caribou and wolves (*Canis lupus*) as well as a higher predation rate on boreal caribou. However, scientific evidence from the NWT suggest that apparent competition may not be a major threat to boreal caribou because anthropogenic disturbances fail to generate a great numerical increase in alternate prey abundance, and subsequently, in wolves. Wood bison (*Bison bison athabascae*) is another ungulate species that has been reported to compete with boreal caribou in the NWT. The overlap of wood bison in boreal caribou range may decrease their population numbers, and in some cases, extirpate boreal caribou from the area.
Stress	Knowledge holders from the Dehcho and Sahtú regions have noted an increase in the abundance of alternate prey (i.e., moose, white-tailed deer, wood bison, beaver, and muskoxen [*Ovibos moschatus*]) and predators (i.e., wolf and bear). Recent work from the Acho Dene Koe First Nation correlated boreal caribou

	population declines with increases in moose, white-tailed deer, wolf, and bear populations. Knowledge holders from Behchokǫ̀ have also reported that an increase in the population of wood bison in the Mackenzie Bison Sanctuary has led to more wolves in the region.
Extent	Widespread (>50%)
Severity	Low
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #7. Parasites and diseases	
Specific threat	Generally, parasites and diseases present in boreal caribou do not affect their health, Knowledge holders from various Indigenous communities have reported that brucellosis, besnoitiosis (*Besnoitia* spp.), liver cysts, lung cysts, and warts are rarely seen in boreal caribou and do not pose a problem to their health if they are detected. Warble flies (*Hypoderma* spp.) and nose bots are commonly seen in boreal caribou, but do not pose a problem to their health, and its prevalence has not changed over time. Although most boreal caribou individuals are considered healthy, knowledge holders from the Gwich'in and Tłı̨chǫ regions have expressed concerns that boreal caribou are increasingly showing signs of poor health from various parasites and diseases. Notably, yellow-green fluids found under the skin has been reported a few times in the Gwich'in and Sahtú regions, as well as muscle cysts in the Sahtú region. In the Dehcho region, the exposure of boreal caribou to the bacterium *Erysipelothrix rhusiopathiae* is a potential concern, as well as the increasing prevalence of winter ticks on boreal caribou in the southern portion of the NWT. Also, the expansion of white-tailed deer from Alberta into the NWT has raised concerns about the transmission of meningeal worm (*Parelaphostrongylus tenuis*) and chronic wasting disease (CWD) to boreal caribou.

Stress	Evidence of parasites and diseases on unhealthy boreal caribou individuals are identified as spots on organs, poor body condition, lack of fat, lumps and pus. The exposure to *Erysipelothrix rhusiopathiae* has been associated with moose and boreal caribou mortalities in British Columbia, as well as high numbers of mortalities of muskoxen on Canadian Arctic Islands. CWD has not been recorded in the NWT, however it is a concern and ENR is working with hunters and neighbouring jurisdictions to prevent the spread of CWD into the NWT. Direct and indirect effects of parasites and diseases on boreal caribou health and population demographic remains largely unknown; knowledge holders are asking future research to investigate the underlying causes and effects of parasites and diseases resulting in poor health in boreal caribou, particularly in the Tłı̨chǫ region.
Extent	Localized (<50%)
Severity	Unknown-Low (limited information on diseases and parasites in boreal caribou)
Temporality	Continuous
Timing	Happening now
Probability	Low
Causal certainty	Low
Overall level of concern	**Low**

Threat #8. Noise and light disturbance	
Specific threat	Noise and light disturbance are mainly concentrated and localized near populated areas (i.e., hamlets, towns, and cities), populated centers (i.e., roads and trails), and oil and gas developments (i.e., drilling, seismic cutline, slashing, and machinery).
Stress	Noise and light disturbance can change the behaviour of boreal caribou. Knowledge holders have reported that individuals are more restless and constantly on the move near areas of increased light and noise disturbance, and in some cases, this has led to functional habitat loss. Noise and light disturbance have been cited as a major threat to boreal caribou in several Indigenous and Community Knowledge Reports, although there is

	currently no scientific evidence supporting that noise and light disturbance is a major threat to boreal caribou in the NWT.
Extent	Localized (<50%)
Severity	Low
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #9. Human traffic and vehicle collisions	
Specific threat	A recent increase in human traffic on linear features (e.g., roads, trails, and seismic lines) from all-terrain vehicles (ATVs) and snowmobiles has raised concerns in many Indigenous communities across the NWT, particularly in the Tłı̨chǫ region. Vehicle collisions resulting in physical injury or death are not believed to be a major threat to boreal caribou; however, boreal caribou are still susceptible to vehicle collisions.
Stress	Knowledge holders have reported an increase in human activity in recent years between Hay River and Point de Roche, as well as in Behchokǫ̀, which has resulted in the displacement of boreal caribou in those area. In fact, an Indigenous harvester in Behchokǫ̀ has seen as many as ten ATVs traveling together in a group within boreal caribou habitat. A small number of boreal caribou mortalities resulting from vehicle collisions has been reported to the Department of Environment and Natural Resources (ENR). Two vehicle collisions, where one individual had to be put down, have been reported in the Dehcho area from 2002 to 2018.
Extent	Localized (<50%)
Severity	Unknown-Low
Temporality	Continuous
Timing	Happening now

Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #10. Invasive research techniques	
Specific threat	Elders and Indigenous harvesters have concerns about scientific research methods, whereby boreal caribou are netted, handled, and collared for monitoring and research purposes. Many Indigenous holders believe radio collars are disrespectful and culturally inappropriate, and radio collars can impact a boreal caribou's relationship with other individuals; radio collars should not be used to monitor boreal caribou once appropriate baseline data is collected.
Stress	Invasive research techniques may lead to physical injuries from direct handling, or infections from radio collars rubbing on fur. Invasive research techniques can also affect individual health, behaviour, and social interactions.
Extent	Localized (<50%)
Severity	Unknown-Low
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Low
Overall level of concern	**Low**

Threat #11. Pollution and contamination	
Specific threat	Pollution from contaminated oil and gas sites has been shown to negatively affect the health of boreal caribou and may result in mortality if individuals consume toxins. Knowledge holders in Behchokǫ̀ and Acho Dene Koe First Nation are also concerned that pollution, acid rain, and contaminated historical mining sites are posing a threat to boreal caribou health. Tailing ponds and hazardous waste (e.g., arsenic) have not been adequately managed in the past,

	therefore knowledge holders are also concerned about the impacts of future mining activities on boreal caribou. However, little is known about the effects of pollution on the recovery of boreal caribou.
Stress	Although large-scale developments that would generate pollutants or contaminants are absent within boreal caribou range in the NWT, direct and indirect effects of pollution and contamination on boreal caribou remains largely unknown.
Extent	Localized (<50%) (excluding airborne pollutants)
Severity	Low
Temporality	Continuous
Timing	Happening now
Probability	High
Causal certainty	Unknown-Low
Overall level of concern	**Unknown-Low**

APPENDIX B – INDIGENOUS AND COMMUNITY KNOWLEDGE ADDITIONAL INFORMATION

Table B1 provides a summary of data gaps within this report by topic. Note that all data in this report are summarized by regions and settlement areas within the NWT: Dehcho Region, South Slave Region (SSR), North Slave Region (NSR), Tłı̨chǫ Region, Inuvialut Settlement Region (ISR), Gwich'in Settlement Area (GSA), and Sahtu Settlement Area (SSA) (see Figure 1).

Table B1: Boreal caribou species status report Indigenous and community knowledge included a substantial amount of information useful for the assessment of the species, however the following research priorities, information gaps and omissions were identified.

Topic	Priorities/Gaps/Omissions
Distribution	Distribution of caribou in the South Slave Region remains an information gap in the Indigenous and community knowledge component of this report. There is relatively little community or Indigenous knowledge documented regarding trends in the distribution of boreal caribou. It is generally difficult to identify changes in the distribution of boreal caribou as this type of information is not typically sought in Indigenous knowledge studies.
Body Condition	Indigenous and community knowledge monitoring of caribou body condition and health is occurring; however, it was generally not captured in the studies used to inform this report.
Population Abundance	Current Indigenous and community knowledge information on population abundance is an information gap for most regions.
Population Dynamics	Population structure and rates, such as age of parents and life span is not included within the Indigenous and community knowledge component of this report.
Habitat	Amount of the boreal caribou range that is suitable habitat and the proportion of the suitable habitat in the NWT that is occupied by boreal caribou are not identified within the Indigenous and community knowledge component of this report. Based on the Indigenous and community knowledge sources consulted in this review, there was no indication of an absence of boreal caribou from areas of the NWT with suitable habitat. However, this topic remains an information gap.

	More research is needed to identify quantifiable trends in the amount of suitable boreal caribou habitat in the NWT based on Indigenous and community knowledge.
Habitat Fragmentation and Magnitude of Impacts	The extent of habitat fragmentation and magnitude of impact to boreal caribou populations from an Indigenous and community knowledge-based perspective remains a key information gap.
Threats and Limiting Factors	No recent update on threats within the North Slave region or South Slave region were available for the Indigenous and community knowledge component of this report, and it remains an important knowledge gap. The impacts of 'new predators' on boreal caribou such as cougars in NWT and overall predator populations in the regions of the NWT is an important knowledge gap.

Indigenous and Community Knowledge Component – Additional Details

Names and Classification

(1) Dehcho and South Slave Regions: In the Dene Zhatié (South Slavey), mbedzih refers to woodland caribou, both boreal and mountain types. This classification is distinct from the nódi, or the barren-ground caribou (Dehcho First Nations 2011).

(2) North Slave Region: North Slave Métis Alliance knowledge holders prefer to use the term "woodland caribou" when describing boreal caribou (Wong and Kiistoff 2020).

(3) Tłı̨chǫ Region: Within the Tłı̨chǫ Region, caribou that migrate between the barrenlands and the boreal forest are referred as hozi ekwǫ̀, as opposed to tǫdzı which refers to caribou living only within the forest (Wek'èezhìı Renewable Resources Board 2010; Chocolate 2011).

(4) Sahtú Settlement Area: Four different types of caribou are recognized by hunters in the Sahtú Settlement Area: barren-ground, boreal woodland, northern mountain, and "the fast runners". Shúhtagot'ı̨nę (Mountain Dene) Elders have identified a specific type of caribou called "tęnatł'əa" that live in the Mackenzie Mountains, migrate long distances, have particular markings and are unknown to Western science (Polfus 2015; Polfus *et al.* 2016).

(5) Gwich'in Settlement Area: Gwich'in hunters preferred to refer to all caribou as vadzaih but felt that a geographic modifier or size modifier could be used to refer specifically to woodland caribou. Use of a modifier would be context-specific and not used generally (Benson 2011).

(6) In general, NWT residents commonly use a variety of names to refer to boreal caribou. Common English names for the boreal population of *Rangifer tarandus caribou* include woodland caribou, woodland caribou (boreal type), and boreal caribou.

Threats and Limiting Factors

Regional Assessment of Threats

Table B2. Impact of various factors on boreal caribou in the Sahtú Settlement Area (% responses) * (Wynes 2001 in Olsen *et al.* 2001).

	Major Impact	Minor Impact	No Impact	Unknown
Predators	52	19	19	10
Seismic	43	24	24	10
Highways	38	33	24	5
Forestry	38	29	29	5
Climate Change	33	43	14	10
Hunting	29	19	48	5
Pipelines	24	38	24	14
Contaminants	14	48	29	10
Tourism	14	33	43	10

*Input was provided at a boreal caribou workshop by 21 participants including: Fort Good Hope Renewable Resource Council (RRC) (3), Déline RRC (3), Colville Lake RRC (2), Tulít'a RRC (3), Norman Wells RRC (1), Ross River (1), Yukon Renewable Resources (1), Resources, Wildlife and Economic Development (3), Boreal Caribou Research Program (1), Nahanni National Park Reserve (1), Association of Mackenzie Mountain Outfitters (2).

Linear Disturbances

(7) The Dempster Highway, road construction and traffic are other examples of key linear habitat disturbances noted by Gwich'in. Calcium applied to the Dempster Highway kills vegetation and is seen as an indirect threat to boreal caribou. Additionally, garbage such as wires or toxic chemicals left by developers or other land users are a threat to the caribou (Benson 2011).

(8) According to Elders and hunters in Sambaa K'e, the proposed Mackenzie Gas Project would disturb boreal boreal caribou, in particular in an important overwintering area at K'eotsee [Trainor Lake]. The caribou's movements in these areas in the winter mean that they are quite vulnerable in certain months, in particular during late winter (January to

March) when snow depths and crust are greatest and energy reserves are low. Relocation or disturbance during this time would have the most negative impact to the caribou (Allaire *et al.* 2010).

Other Industrial Activities

(9) There were concerns about the Tamerlane (new Pine Point mine) development that there will potentially be large amounts of both noise and dust pollution, and that caribou might not cross the development. There were additional concerns that dust covers caribou food. In the past there were no vehicles, highways, planes or airports in that area, and the newly introduced noise and light are impacting the caribou (ENR 2007b [Fort Resolution Métis Council]).

(10) In Gamètì, one workshop participant stated that mining and hydro-electric dams are examples of activities in the Tłı̨chǫ region that may affect boreal caribou habitat. However, he stated that at this time mining may be more of an issue for the barren-ground caribou. Members pointed out existing mines on the edge of the boreal caribou range: 1) North of Gamètì at Beaverlodge Lake; 2) at Hottah Lake (south side); and 3) south of Gamètì close to Sarah Lake. People have witnessed barren-ground caribou avoiding industrial activity close to the diamond mines; they suggested similar activities could affect boreal caribou within their range. The Fortune Minerals mine south of Gamètì is a further mining development proposed for this area (Environment Canada 2010d [Gamètì]).

Predation

(11) People from the West Point and K'átł'odeeche First Nations have seen signs that cougars have been seen in their area. They also report more wolves in the boreal caribou habitat than the barren-grounds. There are more predators because of fish remains left on the ice in the winter. Boreal caribou have a hard time travelling and eating when there is an ice crust on the snow, which makes it easier for wolves to hunt caribou. Unlike caribou, wolves can move easily on the crusty snow (not specific for boreal caribou). (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

(12) Sambaa K'e harvesters indicated that wolf populations are higher along linear disturbances such as seismic lines, resulting in lower caribou populations. The Dehcho Land Use Planning Committee has proposed thresholds or maximum disturbance amounts to mitigate this (Dehcho Land Use Planning Committee 2004 in AMEC Americas 2005).

(13) Dehcho participants reported that boreal caribou seem to choose wet areas as a means of predator avoidance during calving: three K'átł'odeeche Elders reported that boreal caribou tend to have their calves on small islands or in swampy areas, in order to protect

them from wolves, and that proximity to water is critical for protection from wolves during calving (Gunn 2009).

Climate Change

(14) Snow conditions are changing around Paulatuk; lately, there has been no snow on the peninsula (ENR 2007e [Paulatuk]). In the Inuvik area, summers are warmer (ENR 2007g [Inuvik]).

(15) In one Inuvialuit Indigenous and community knowledge study two-thirds of interviewees felt that winters are warmer now than in the past, but no impacts to caribou were identified. Some thought there was less snow than there used to be although others did not; one person observed that there is now more snow in the bush and less on the coast (Nagy *et al.* 2002).

(16) The impacts of climate change on caribou were recorded during recent Indigenous and community knowledge research specific to boreal caribou in the GSA (Benson 2011). Gwich'in participants observed changing habitat, habitat or food availability, and weather conditions that are seen to impact caribou. Climate change may impact the boreal caribou's ability to feed due to widespread slumping and melting permafrost. The ground can absorb more moisture than it used to, leaving less water on the surface of the land. Increased rainfall may cause river flow patterns to change, among many other changes. Warmer temperatures are changing vegetation which may decrease the amount of caribou food available. An increase in brushy growth such as willows in previously passable areas makes travel difficult for both caribou and Gwich'in hunters. The timing of the changing of the seasons is also noted to be shifting and these changes can directly or indirectly impact boreal caribou. A change in the timing of freeze-up or the spring thaw, for example, may no longer relate to when a caribou grows or sheds a winter coat. Rain in the winter, once very rare but increasingly seen, can produce a near-impassable crust on the snow which impedes caribou movements and causes injury to their legs. Freezing rain also covers vegetation with ice and is implicated in the death of some caribou in the recent past. Warm winter winds (which may be a regular occurrence instead of due to climate change) can also cause ice formation (Benson 2011).

(17) Ice formation can be particularly hard on caribou if it happens in the fall, as it affects their food all winter; this happened in the early 2000s. Climate change may bring an increase in insects, which will impact boreal caribou. Erosion may also impact caribou habitat (ENR 2007j [Tsiigehtchic]).

(18) Participants in a recent Indigenous and community knowledge study in the SSA said that weather plays a significant role in the health and well-being of boreal caribou, and that increasing extremes in annual temperatures and flooding can negatively impact groups.

Recent changes in climate were considered significant by study participants, and include warmer temperatures, increased rain in November, milder winters, and increasing summer storms. Boreal caribou and their food sources can be affected by fall and winter precipitation. During these times, food becomes less accessible as it is covered by more snow, making it harder for caribou to access (McDonald 2010).

(19) During recent meetings in Whatì, one Elder stated that weather is changing. He described summers which were extremely dry and hot, and winters that had extreme fluctuations in temperature. He believes these impacts are caused by climate change, which is having a negative impact on boreal caribou (Environment Canada 2010b [Whatì]).

(20) In a Sahtú study, 85% of participants said that winters are warmer now than in the past. Participants had differing opinions on whether snow accumulation patterns have changed, but there were numerous suggestions that the amount of snow that falls over the winter has decreased during the lifetimes of the participants, and that river and lake ice may not form as quickly nor as thick as in the past (Zimmer *et al.* 2002).

(21) Numerous examples of how climate change is affecting habitat and animal behaviour in the Dehcho region have been recorded. Among other observations, meeting participants said there are increases in the populations of coyotes and wolves; an increase in bears coming into town; cougar sightings; and foxes and coyotes with decreased fear of humans (ENR 2007a [K'átł'odeeche First Nation]).

(22) In meetings with the Fort Resolution Métis Council, participants indicated that climate change started in the 1950s. It is manifested through warmer temperatures; temperatures in the range of -50°, -60° or -70°C are no longer seen. Participants also reported that they used to have more daylight in May, and now the long daylight doesn't come until June. Some mentioned there are fewer mosquitoes now (ENR 2007b [Fort Resolution Métis Council]). At a separate meeting, participants indicated that deep snow and flash floods, both effects of climate change, can decrease caribou numbers (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

(23) Dehcho Elders and harvesters report that their region is becoming warmer and wetter, with more rainfall in the fall months. In the colder months, these conditions create more incidences of ice crusting, and can make it more difficult for the caribou to forage for ground lichens. Sudden thaws and winter melt events also create crusts on the snow, making it more difficult for boreal caribou to move and to avoid predators (Dehcho First Nations 2011). It has also been observed that frost heaves harbouring lichens are diminishing or melting entirely – reducing the availability of this type of habitat (Dehcho First Nations 2011).

Overharvesting and non-Traditional Harvest Practices

(24) Participants had different views about whether hunting pressure has increased or decreased in the SSA, but some people felt that resident populations of boreal caribou near communities are disappearing because of ease of year-round access. Elders mentioned a need for careful firearm use and harvesting only what is needed to feed the community (Zimmer *et al.* 2002).

(25) One Dehcho participant said it was a problem that newcomers only need to live in the Northwest Territories two years before they can hunt as residents. It was also stated that the now-defunct Pine Point mine was a problem – numerous caribou were killed by mine workers. In contrast, Fort Resolution residents stopped hunting boreal caribou around 2002 (ENR 2007k [NWT Métis Nation Board]).

(26) Over-harvesting of boreal caribou is of moderate concern in the Dehcho region, with most concerns being expressed about the following areas: to the southwest of Buffalo Lake; west of the community of Hay River; along the river systems around Fort Providence; and around the Fish Lake and Willowlake River areas near Wrigley (Dehcho First Nations 2011).

Positive Influences

(27) Many of the communities within the range of boreal caribou in the Northwest Territories are guided by Indigenous and community knowledge and belief systems in their approach to harvesting animals and using the land. "Management" as it refers to control of an animal like caribou was a concept found to be not acceptable to Dene Elders, and not considered possible in any case, as the caribou are a gift from the Creator (Johnson and Ruttan 1993). Traditional Dene culture has rules for showing respect for the caribou, which can include looking after the caribou head bones and bones of a foetus in a particular way; and correct procedures for butchering caribou and handling the meat (Johnson and Ruttan 1993). People also made statements about the importance of only hunting what you need, not leaving any wounded, not wasting any caribou, and controlling any over-hunting. Some Elders disagreed with modern management practices, saying that they didn't think caribou could be managed overall, but also that a sacred animal like caribou would suffer from too much human intervention. However, there were also indications that Dene hunters should work with biologists and scientists and cooperate about caribou and caribou habitat (Johnson and Ruttan 1993).

(28) The Sambaa K'e Dene are a very traditional community, and respect the animals and the land. One way they show respect for caribou is to bring the bones and hair from hunted animals back to the land when they are done with it (ENR 2006b [Trout Lake]).

(29) During meetings held by Environment Canada in numerous communities throughout the NWT, people stressed that boreal caribou are important to the Nations that harvest them, and that communities want adequate opportunities to accommodate their concerns and incorporate their input into the planning process. This message seemed to be particularly strong in Whatì, where it was stated that boreal caribou conservation is a very serious issue for the people of that community, and they are concerned about future development, such as an all-weather road, and how it may impact boreal caribou. People feel that with declining barren-ground caribou populations, it is vital to manage boreal caribou in the Tłı̨chǫ region before the population starts to decline, and Whatì wants to work closely with the government to find solutions (Environment Canada 2010b [Whatì]).

(30) Wildfire control could have a big impact on boreal caribou and their habitat. Wildfires should be fought when they are still small and should be extinguished immediately if located within boreal caribou habitat (ENR 2007k [NWT Métis Nation Board]).

(31) There were some meeting participants that questioned whether 'acts of God,' such as wildfires or climate change, should be 'managed', however overall, community members were in support of responding to wildfires more quickly (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

(32) Gwich'in Elders felt that an aggressive approach to fighting wildfires was appropriate. Although wildfires can have a rejuvenating effect on the land, they still need to be controlled (ENR 2007j [Tsiigehtchic]; Benson 2011).

(33) Several people at a Whatì meeting emphasized that habitat protection is crucial to maintaining caribou populations. They felt that wildfires were the main cause of decline for caribou in the region, and stressed the need to protect caribou habitat from wildfires. They felt that fires should be fought as soon as smoke is seen, and said there may need to be a change in fire-fighting policy to address this threat (Environment Canada 2010b [Whatì]). The same suggestions arose at meetings in Jean Marie River, where participants said they need to consult with fire management to decide which areas to protect from fire (ENR 2006a [Jean Marie River]).

(34) Suggestions for mitigation of industrial effects included planting seismic lines with willows to help with re-growth (ENR 2007g [Inuvik]); establishment and enforcement of strict rules around boreal caribou winter range, and protection of forests; avoidance of areas with lichen (ENR 2007f [Tuktoyaktuk]); changes to the shape of seismic cutlines, as meandering or winding seismic cutlines are harder to see along (and caribou do not travel down straight seismic cutlines) and large and straight seismic cutlines also act like wind tunnels (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]);

requirements for developers to use established or overgrown seismic cutlines to minimize new damage to boreal caribou habitat; constraining river access to decrease impact to habitat; enforcement of remediation of disturbed areas, with particular plantings to suit boreal caribou (ENR 2007j [Tsiigehtchic]); regulation of industrial activities to control the amount of damage done to the vegetation layer to prevent or mitigate damage to boreal caribou habitat and food; and regulating permitted industrial activities by season (Benson 2011).

(35) In the Dehcho region, harvesters suggested that because boreal caribou are sensitive to localized disturbances such as increased use of skidoos and motorized boats, heavy truck traffic and low flying aircraft, finding means to reduce these sensory disturbances would benefit the populations – especially at critical periods like calving and over-wintering (Dehcho First Nations 2011).

(36) There were many comments about controlling predators to affect boreal caribou populations. Many participants said that both wolves and bears used to be harvested more in the past, and some people indicated that there should be an incentive introduced (such as a bounty) to increase harvest of wolves in particular (ENR 2007g [Inuvik]; ENR 2007h [Fort McPherson]; Environment Canada 2010b [Whatì]; Benson 2011). However, there were also some participants that said wolves have a necessary part to play in maintaining caribou populations (ENR 2006c [Wrigley]).

(37) Some Gwich'in participants pointed out that wolves are hard to control because they are difficult to hunt and easily become trap-wise. Gwich'in participants said that in the past, the Game Wardens used poison to control wolves, which was more effective (Benson 2011).

(38) Suggestions to deal with overharvesting include wildlife monitors keeping track of when and where caribou are being harassed; local hunters are the best people to gather this type of information and could report to the Renewable Resource Councils (ENR 2007g [Inuvik]). Additionally, Land Use Planning processes and trespassing protection and laws need to be in place to avoid increased hunting pressure resulting from new access due to industry (ENR 2007j [Tsiigehtchic]; Benson 2011). Other suggestions include increased enforcement of hunting regulations (ENR 2007d [Fort Providence Resource Management Board]); if tags are used, once a certain amount of boreal caribou have been harvested then monitoring should start (ENR 2007j [Tsiigehtchic]); harvesters should not take cows (ENR 2006a [Jean Marie River]); efforts to hunt different animals (such as barren-ground caribou, muskox, and moose) could be proposed to 'even out' hunting pressure (ENR 2007j [Tsiigehtchic]); and on-the-land education of young hunters to hunt in a respectful and traditional manner (Benson 2011).

(39) A hunting quota system worked in the past when moose and marten populations were low, and may work again even though the idea is unpopular (ENR 2007j [Tsiigehtchic]).

(40) Information on why boreal caribou have declined in other areas should be provided to people who hunt boreal caribou (ENR 2007j [Tsiigehtchic]). Participants in studies and meetings have made general comments and suggestions in regards to how research might be more respectful of caribou. Overall, most people are in favour of less invasive techniques (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]; ENR 2007h [Fort McPherson]; Environment Canada 2010c [Behchokǫ̀]; McDonald 2010; Benson 2011; Dehcho First Nations 2011).

(41) Suggestions to mitigate the impacts of all-terrain vehicle and skidoo use include monitoring, education, and enforcement of rules about habitat damage caused by snowmobiles, and creation of laws about no off-road ATV use (ENR 2007g [Inuvik]).

(42) Several people suggested that First Nations could undertake land-based monitoring of caribou in their areas. Additionally, increasing the harvest of predators (possibly through a bounty or other incentive), controlling species that compete with boreal caribou (e.g. buffalo), controlling wildfires to protect caribou habitat, and considering caribou ranching (i.e. harvesting the captive herd instead of the wild) were suggested to reduce negative impacts and threats (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

(43) General suggestions for mitigation of threats include protection of water sources (Environment Canada 2010c [Behchokǫ̀]); protection of large enough portions of land left open or undeveloped as a buffer for disturbances such as wildfire, allowing animals to shift or move to other areas of suitable habitat (Gau 2006 [Fort Simpson]); management of forests such as issuing timber cutting permits to accommodate preservation of boreal caribou habitat (ENR 2007j [Tsiigehtchic]); keeping some areas inaccessible to human disturbance, keeping flights away and minimizing air traffic in these areas (ENR 2007e [Paulatuk]); and improved Department of Transportation signage if collisions are an issue (ENR 2007i [Aklavik]).

(44) Gwich'in hunters generally felt that boreal caribou are too dispersed to be able to identify specific areas to protect. However, the area south of North Caribou Lake and the Peel River Preserve may be a candidate area for protection. The area adjacent to the Dempster Highway between Frog Creek and Point Separation has important summer habitat for boreal caribou (Benson 2011).

(45) Around Wood Buffalo National Park in the Dehcho region, some level of protection was suggested for Buffalo River and the land outside of the park. People felt that monitoring and respecting these areas will ensure that the land will continue to provide the animals

and food. Protection may also entail clarifying traditional boundaries and possibly restricting non-Dene hunting. In northern Alberta, it was suggested that Caribou Mountain is a core area that needs special protection. People say it is an important area for raising juveniles of numerous species, and that they spread out from that area as their populations increase. It was also suggested that all of Buffalo Lake be protected (Gunn 2009).

(46) Some important areas are described in the Habitat section (page 8). Other specific areas suggested for protection of boreal caribou and their habitat in the NWT include:

- Bartlett Lake and Weyburn Lake are very important areas for boreal caribou (Environment Canada 2010b [Whatì]);
- Boreal caribou habitat is all along Nǫdìi plateau on the west side of Whatì (Chocolate 2011);
- Hay River Métis are mostly concerned with protecting Cameron Hills caribou and those around the Buffalo Lakes (ENR 2007k [NWT Métis Nation Board]);
- There is an escarpment near Hart Lake where caribou cross the road from north to south that would benefit from some kind of protection. People drop off lots of skidoos at this area to hunt or harass caribou (ENR 2007c [West Point First Nation and K'átł'odeeche First Nation]).

(47) Suggestions to improve research and monitoring related to boreal caribou include:

- Research needs to look at more than one species at a time (e.g. to answer questions about species interactions and whether some species effectively displace caribou) (ENR 2007d [Fort Providence Resource Management Board]);
- People are interested in seeing studies that look into whether caribou are contaminated in any way (ENR 2007b [Fort Resolution Métis Council]);
- Do boreal caribou research with skidoos instead of airplanes or helicopters (ENR 2007g [Inuvik]);
- Population counts by plane or helicopter may miss pockets of boreal caribou and numbers from these studies should be assessed with caution, and supplemented with other types of scientific studies (Benson 2011);
- People aren't getting out on the land as much, so there is a need to hire someone to go out and look at what the caribou are eating (ENR 2007g [Inuvik]);
- Need population estimates on wolves and extent of home ranges in boreal forest; seem to be more in delta and hills (ENR 2007g [Inuvik]);
- Do not publish caribou locations from collaring work (ENR 2007h [Fort McPherson]);

- Study the effects of noise on boreal caribou. The Sambaa K'e Dene Band would like to be involved in any baseline environmental studies (mentioned in context of proposed Mackenzie Gas Project), with a focus on water quality and boreal caribou, and boreal caribou use of the area from the winter road to K'e'otsee. There is no good data on the movement and use of boreal caribou in that corridor area, but Elders and harvesters indicate that is a heavy use area (Gau 2006 [Trout Lake]);
- The Gwich'in harvest study could be re-initiated to examine boreal caribou, although having the reporting every three months instead of every month would be better for hunters (ENR 2007j [Tsiigehtchic]).

(48) Benson and Winbourne (2015) provide a summary of the general rules for caribou research in the NWT based on Indigenous knowledge. These principles for caribou research include harvest appropriately – 'take only what you need, don't be picky"; behave respectfully towards the animal – 'don't make fun or be arrogant'; avoid chasing or otherwise pestering the animal; use as much of the caribou as possible, discard carefully, and do not waste; learn and teach the correct way to act in order to be respectful of caribou; and avoid discussing caribou negatively, or focusing only on the negative. Utilizing these principles in western science research projects will support in reducing any additional harm to boreal caribou populations during research activities.

(49) The Sahtú Renewable Resources Board recommended to the Minister that a new Hı̨dó Gogha Sę́né́gots"ıɔá ʔeɔa (Community Conservation Planning Regulation) be created under the Wildlife Act to entrench the community conservation planning approach in NWT law and that ɔehdzo got'ı̨nę (renewable resources councils), NWT Environment and Natural Resources, and the Sahtú Renewable Resources Board undertake community conservation planning workshops in each of the three Sahtú districts (K'áhsho Got'ı̨nę District; Tuĺit'a District; and Délı̨nę District) to develop proposals for implementation of special harvesting areas (Sahtú Renewable Resources Board 2020).