



SPECIES STATUS REPORT

Boreal Caribou

(Rangifer tarandus caribou)

Vadzaih

Mbedzih

Tɔdzi

Tuktut

ɛtthen

Tuttut

Sakaw atihk

la population boréale du caribou des bois
in the Northwest Territories

Status of Boreal Caribou in the NWT

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 Aboriginal traditional 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. This status report was prepared in two parts: a traditional and community knowledge component and a scientific knowledge component. Both components together form the complete status report. Full guidelines for the preparation of species status reports, including a description of the review process, may be found at www.nwt-speciesatrisk.ca.



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

Cover illustration photo credit: John A. Nagy, GNWT

Assessment of Boreal Caribou

The Northwest Territories Species at Risk Committee met in Behchokò, Northwest Territories on December 5, 2012 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 available at www.nwt-species-at-risk.ca.

Status: Threatened in the Northwest Territories

Likely to become endangered in the Northwest Territories if nothing is done to reverse the factors leading to its extirpation or extinction

Reasons for the assessment: Boreal Caribou fits criterion (c) for Threatened

(c) – There is evidence that the population size is small and there is a decline in population size such that it could disappear from the Northwest Territories in our children’s lifetime

- Boreal caribou need large tracts of undisturbed habitat so they can spread out to minimize predation risk. This adaptation results in naturally low densities across a large area, making them more vulnerable to systematic habitat fragmentation.
- Population size is small: about 5,300 mature individuals, 6,500 total population. While there is uncertainty in the estimate (e.g. in the eastern Sahtu region), it is unlikely that the total population size is larger than 10,000 in the Northwest Territories.
- Currently, there is variation across the Northwest Territories in rates and direction of population change. There are documented population declines in parts of the southern Northwest Territories where the majority of boreal caribou occur.
- Current and future threats leading to habitat fragmentation are expected to increase.
- A continuing decline in the amount of secure habitat and in population size is projected.
- There is no foreseen possibility of rescue from outside populations due to severely declining populations in Alberta and British Columbia.

Threats to Boreal Caribou and its habitat:

- The main threat to boreal caribou is habitat loss, degradation and fragmentation from human-caused and natural disturbances that result in increased predation risk.

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- Human-caused disturbances, including extensive oil, gas and coal mining exploration activities and emerging forest uses, are expected to increase in the future.
- Predicted increases in fire disturbance as a result of climate change will likely reduce the amount of secure habitat.
- Separately or in combination, these human activities and natural processes will continue to fragment existing habitat and increase the vulnerability of boreal caribou to predation and hunting.
- Human activities and natural processes are also expected to contribute to increases in alternate prey which attracts and supports larger wolf populations, resulting in higher predation rates on boreal caribou.
- With climate change, loss of forest habitats due to permafrost thaw may have significant future effects on boreal caribou habitat.

Positive influences on Boreal Caribou and its habitat:

- The Northwest Territories Boreal Caribou Conservation Action Plan provides goals and direction for boreal caribou conservation, management and research.
- Through the Northwest Territories Protected Areas Strategy there is a possible establishment of a network of legislated protected areas in the range of Northwest Territories boreal caribou.
- Regional land use plans are being developed that may protect areas of boreal caribou habitat.
- The Dehcho Boreal Caribou Working Group and renewable resources boards are taking actions to help manage boreal caribou and their habitat.
- Listing of boreal caribou under the federal *Species at Risk Act* as a threatened species has helped focus attention on boreal caribou conservation, including work towards critical habitat protection.
- Traditional stewardship practices, hunting restrictions and voluntary limits on harvest have a positive influence on boreal caribou.

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Recommended measures to conserve Boreal Caribou and its habitat:

- Compile current information on the location, footprint and type of linear development, including seismic lines.
- Conduct research on seismic line regeneration in the boreal forest.
- Assess forest fire severity and boreal caribou use of habitat after a fire.
- Assess impacts of forest harvesting on boreal caribou populations and habitat.
- Manage boreal caribou and their habitat at a landscape level, regardless of political or administrative boundaries.
- Exploration and development must use current best practices to have the least possible impact on boreal caribou and their habitat.
- Manage the landscape to maintain large (>500km²) patches of secure habitat with connectivity, so that boreal caribou can persist.
- Fully implement the Northwest Territories Boreal Caribou Conservation Action Plan.
- Establish a network of legislated protected areas and regional land use plans in the range of Northwest Territories boreal caribou.
- Analyze data from Sahtu studies of boreal caribou and conduct studies in regions where data are limited.
- Collect more reliable harvest data and population estimates.

Executive Summary

Traditional and Community Knowledge	Scientific Knowledge
Description	
<p>Boreal caribou are a medium-sized member of the deer family, larger than barren-ground caribou but smaller than northern mountain caribou. Size may be different in different regions of the Northwest Territories (NWT). They are generally distinguishable from other caribou based on size, but markings, tracks (and hoof shape), and location 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.</p>	<p>Boreal caribou (Woodland Caribou [Boreal population]; <i>Rangifer tarandus caribou</i>) are a medium-sized member of the deer family. Many of their physical and behavioural traits are adaptations to living in the boreal forest.</p>
Distribution	
<p>NWT Distribution</p> <p>In the NWT, boreal caribou are found in small groups loosely dispersed across a range covering an extensive area of boreal forest, from as far north as Tuktoyaktuk, to northern British Columbia and Alberta in the south. The western edge of their range 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.</p>	<p>NWT Distribution</p> <p>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 Northwest Territories (NWT) their range largely conforms 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</p>

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Traditional and Community Knowledge	Scientific Knowledge
<p>Distribution Trends</p> <p>Changes in the distribution of boreal caribou are not well described in traditional and community knowledge sources. Where changes are recorded, they are variable and local: some specific areas in the NWT that used to have boreal caribou do not anymore, or do not have many. Their distribution may have cycles with decades between the highs and lows. It is hard to separate population trends from distribution trends; when boreal caribou are no longer seen in an area where they were in the past, it could be due to population declines or movement to other areas.</p>	<p>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 British Columbia. 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.</p> <p>Distribution Trends</p> <p>It is not possible to determine if changes in the distribution of boreal caribou have occurred at the range level relative to any time in the past.</p>
<p>Habitat</p>	
<p>Habitat Requirements</p> <p>Boreal caribou generally tend to spend time in dense pine or spruce forests (with ground and tree lichens) and/or areas of muskeg. They make use of forested uplands, hills and ridges. They are extremely difficult to spot in the brush and this is a likely reason for more frequent sightings in open areas. They use wallows and they seek mineral and salt licks and muskrat push-ups for supplementing their diets. They eat a broad variety of foods in</p>	<p>Habitat Requirements</p> <p>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.</p> <p>Population growth rates are determined by</p>

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<p>addition to lichens, including willows, willow leaves, sedges, tree buds, grasses, mushrooms, shrubs, and aquatic vegetation.</p> <p>In the winter, boreal caribou are found in thicker pine and spruce forests where arboreal and terrestrial lichens are present, and where these lichens and other forage are accessible (less snow and/or softer snow). Late winter habitat is very important because it provides conditions that are more favourable for feeding and mobility. In the spring, predator avoidance during the calving period is a major factor influencing boreal caribou habitat choice. Spring calving and summer grazing habitat preferences include higher ridges, river edges, swamps, islands, burned areas, and meadows where the boreal caribou spread out and separate. They seek water or open breezy areas to avoid insects, and in some areas will remain where spring ice persists. In the fall, during and after the rut, boreal caribou move through various habitats.</p> <p>Habitat Fragmentation</p> <p>Habitat fragmentation (breaking up of habitat into isolated sections) can be caused by human influences such as roads, pipelines and seismic cutlines, or by natural factors such as forest fire.</p>	<p>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.</p> <p>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 densities of these features increase. In addition, the amount of functional habitat available to boreal caribou is inversely related to the density of anthropogenic 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 km²) where caribou could reduce their risk of predation.</p> <p>Habitat Availability</p> <p>Fires and anthropogenic 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.</p>

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<p>Habitat Trends</p> <p>Generally, boreal caribou in the NWT have not been impacted by habitat disturbances as much as populations further south in more developed areas. Much of their NWT habitat is still relatively intact, although development and recent forest fires have caused some habitat loss. Current and future habitat trends that are cause for concern include an increasing incidence of fires; increasing patterns of human disturbance on the landscape; and climate change impacting boreal caribou habitat.</p>	<p>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. Therefore, the NWT range was divided into southern and northern parts to assess habitat conditions. Approximately 44% of the habitat in the southern part of the NWT is currently affected by fires and anthropogenic disturbances, while 31% is affected in the northern part. The southern and northern parts cover approximately 56% and 44% of the NWT range, respectively.</p> <p>Habitat Fragmentation</p> <p>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.</p> <p>Habitat Trends</p> <p>NWT boreal caribou habitat is experiencing warmer and more variable weather in all seasons, compared to in the past.</p> <p>Much of the NWT current range has an anthropogenic and fire disturbance footprint (i.e. approximately 31% or 38%, depending on</p>

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	<p>the analysis), the majority of which is caused by fire. Additional anthropogenic and fire disturbance will likely increase that footprint and thus increase the area of unsuitable habitat.</p> <p>The future trend for boreal caribou habitat in the NWT will be determined by whether or not i) habitat management models that consider patch size, distribution, and connectedness of undisturbed preferred boreal caribou habitats are used; ii) existing anthropogenic linear disturbances are restored to states that discourage predators from using them as travel corridors; and iii) existing large areas of undisturbed habitat are protected from anthropogenic or fire disturbance.</p>
Biology	
<p>Life cycle and reproduction</p> <p>Boreal caribou give birth about one month earlier than barren-ground caribou in the Sahtu Settlement Area (SSA), and between May and June in the Tłı̄chǫ 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</p>	<p>Life cycle and reproduction</p> <p>Female boreal caribou disperse and are solitary during pre-calving and calving. Females produce their first calves at age 3 and may reproduce up to at least 17 years of age. The generation time (average age of parents of newborn individuals) is approximately 7 years. Calf mortality may be as high as 50% during the first 6 weeks of life.</p> <p>Physiology and adaptability</p> <p>Boreal caribou are adapted to feeding on</p>

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<p>environmental conditions, condition of the mothers, disturbances in calving habitat, and predators.</p> <p>Physiology and adaptability</p> <p>Boreal caribou are in general very sensitive to human disturbances such as noise and motorized vehicles. Over time, they can adapt to some disturbances of certain types, but there is a limit above which they will leave an area. They flee from hunters, especially on snowmobiles.</p> <p>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.</p> <p>Interactions</p> <p>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</p>	<p>lichens, and to travelling on and foraging in snow.</p> <p>Interactions</p> <p>Wolves are the primary predators of adult female boreal caribou in the NWT. The causes of calf mortalities in the NWT are largely unknown, but black bears and lynx may be important predators of calves.</p> <p>Anthropogenic 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.</p>

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<p>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. Predation is normal and important; however, populations of wolves and bears are considered to be rising.</p> <p>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.</p> <p>Boreal caribou are hunted opportunistically throughout their range, particularly in winter due to easier access.</p>	
Population	
<p>Movements</p> <p>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</p>	<p>Structure and Rates</p> <p>Most adult female boreal caribou are reproductive and produce calves. On average 26%, 56%, 2%, and 16% of the caribou observed in Dehcho study areas were bulls, cows, yearlings, and calves, respectively.</p>

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<p>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.</p> <p>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.</p> <p>Abundance</p> <p>Boreal caribou sightings tend to be less common than other ungulate sightings and their overall abundance in the NWT is not well understood.</p> <p>Fluctuations and trends</p> <p>In some areas, boreal caribou group sizes are considered to be smaller in recent years.</p> <p>Changes in the abundance of boreal caribou are local and variable. In the Inuvialuit Settlement Region (ISR) the information on boreal caribou abundance was inconclusive; in</p>	<p>Movements</p> <p>Boreal caribou movement rates vary during the year and reflect changes in activity. 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.</p> <p>Abundance</p> <p>The population estimate for boreal caribou in the NWT is 6,500. More reliable population estimates are needed.</p> <p>Fluctuations and Trends</p> <p>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%.</p> <p>Population growth rates for the entire NWT population of boreal caribou are not known. Recent short-term (≤ 7 year) growth rates (λ) have been measured in local study areas. These rates, combined with estimates of boreal caribou abundance in different parts of the NWT, suggest that 53% of NWT boreal caribou are found in areas where caribou</p>

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<p>the majority of areas numbers were thought to be stationary or increasing but there was little information available. In the Gwich'in Settlement Area (GSA), boreal caribou were seen to be increasing in some areas and decreasing in others. In the SSA, the most recent information indicated that numbers are stationary to increasing. In the Dehcho region, observations were mixed: numbers were increasing in some areas, stationary in most areas, and slowly decreasing in others. In the Tłı̄chq̄ and North Slave regions, most observations indicated a general trend of decline for boreal caribou populations. No information on trends or fluctuations was available for the South Slave region.</p> <p>This information should be interpreted with caution because many of the observations relate to specific, small geographic areas. As well, it is difficult to discern whether some observations represent real declines in abundance or cyclic changes in habitat use.</p>	<p>numbers have been declining or may have been stable (Dehcho and South Slave regions). Only 8% of NWT boreal caribou are found in areas where caribou numbers have been increasing (Gwich'in region). The remaining 39% are found in areas where the trend is unknown (Inuvialuit, Sahtu, and North Slave regions). The southern NWT, where boreal caribou seem to be declining, already has a large anthropogenic and fire disturbance footprint. The additive effects of new impacts may accelerate caribou declines in the southern NWT.</p>
Threats and limiting factors	
<p>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</p>	<p>The main limiting factors for boreal caribou are habitat loss, degradation and fragmentation resulting from anthropogenic and natural fire disturbances – including habitat change that increases predation risk.</p>

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<p>caribou. Threats and the perceived importance of various threats vary among the different regions of the NWT.</p> <p>Overall, boreal caribou are very sensitive to most types of human disturbance and habitat change. In particular, industrial development and forest fires can result in changes to the landscape that force boreal caribou to change their movements and can make them not use an area for many decades. Industrial development can also lead to stress and poor health. Forest fires are seen to destroy boreal caribou habitat. Although forest fires are natural, fires are thought to be increasing in many areas and are seen as a threat to boreal caribou. Industrial activities such as oil and gas exploration and development, mining and linear disturbances (e.g. roads, seismic lines) can negatively affect boreal caribou. Many of these industrial activities have increased in recent years. Negative effects include sensory disturbance (noise and light) as well as habitat change (habitat loss, fragmentation, barriers to movement, increased access for predators and hunters, and contaminants).</p> <p>Other factors that can have major negative impacts on boreal caribou population are predation and climate change. In addition to the increased predation that can result from</p>	<p>Currently, extensive petroleum exploration and coal mining activities are underway or planned in the Sahtu region; a pipeline and highway are proposed in the Mackenzie River Valley corridor; and increased harvest of sawlogs and wood in the NWT is being contemplated. If fire disturbance increases as a result of climate change, there will likely be a negative impact on boreal caribou. Separately or in combination, these human land-use activities and natural processes will continue to fragment existing habitat and increase the vulnerability of boreal caribou to predation and hunting.</p> <p>Boreal caribou are hunted in the NWT. The average number of boreal caribou harvested annually in the NWT could be as low as 80 (1% of the population), but could be higher than 200 (>3%). More reliable harvest data and population estimates are required to determine sustainable harvest levels.</p> <p>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.</p>

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<p>linear disturbances, increases in the number of predators are being observed and are seen as a threat to boreal caribou. As well, there are concerns about possible impacts of ‘new’ predators that are expanding their range northward such as cougars. Climate change is already impacting boreal caribou and further impacts are anticipated. Changes in habitat and food availability, snow conditions and weather conditions are being observed.</p> <p>Hunting pressure was identified as a moderate current threat to some boreal caribou populations in the NWT. There are concerns that it is increasing or will increase in the future. Non-traditional harvest practices such as reckless shooting; over-use of motorized vehicles; wasting meat and leaving carcasses on the ground; not sharing meat; and not using the entire carcass are also considered a threat.</p> <p>Parasites and disease are known to occur in boreal caribou but are not generally a cause for concern. Additional threats identified include invasive research techniques, tourism, increasing and excessive use of snowmobiles and all-terrain vehicles, negative interactions with wood bison, pollution and contamination. Beyond looking at threats individually, it is also important to consider the combined impact of multiple threats (cumulative effects).</p>	<p>Parasites and diseases, noise and light disturbance, accidental mortalities from collisions, and pollution are not considered as significant threats in the NWT at the present time.</p>

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Positive Influences	
<p>Hunting restrictions such as voluntary limits on the harvest of boreal caribou are currently having a positive influence on boreal caribou populations in the GSA by helping to keep the harvest low. Traditional stewardship practices that include rules and guidance for a respectful relationship with caribou also have a positive influence.</p> <p>Land use planning and habitat protection initiatives are underway where the protection of boreal caribou habitat is one of the primary goals.</p> <p>Traditional and community knowledge holders have also made many suggestions on specific practises for the protection of boreal caribou, areas to protect, research and monitoring.</p>	<p>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. An <i>Action Plan for Boreal caribou Conservation in the Northwest Territories</i> is being implemented.</p> <p>A national recovery strategy for boreal caribou was completed in 2012. The strategy identifies critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat; under the federal <i>Species at Risk Act</i> critical habitat is protected from destruction.</p> <p>There is some current and proposed habitat protection in place for boreal caribou in the NWT through existing protected areas, proposed protected areas moving forward through the Protected Areas Strategy, an approved land use plan in the Gwich'in Settlement Area, and land use planning processes underway in other regions. Land management regimes vary among these areas but many include restrictions on resource development, on either a permanent or interim basis. Habitat protection has the potential to be an important positive influence on boreal caribou. However, because many of the</p>

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	protected areas and land use plans are not yet established or finalized, their ultimate long-term impact is unknown.

Technical Summary

Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
Population trends		
Generation time (<i>average age of parents in the population</i>) (indicate years, months, days, etc.)	Information not available in sources	Approximately 7 years
Number of mature individuals in the NWT (or give a range of estimates)	Sightings tend to be less common than other ungulate sightings; abundance not well known	Approximately 5300 mature individuals (based on a total estimate of 6500 for the NWT, and composition information only available from the Dehcho study areas)
Amount of change in numbers in the recent past; <i>Percent change in total number of mature individuals over the last 10 years or 3 generations, whichever is longer</i>	Inuvialuit Settlement Region: thought to be stationary or increasing in the majority of areas, but little information available. Gwich'in Settlement Area: increasing in some areas and decreasing in others. Sahtu Settlement Area: stationary to increasing. Dehcho region: increasing in some areas, stationary in most areas, and slowly decreasing in others.	Estimated growth rates for the entire NWT population of boreal caribou are not available. Based on growth rates measured in local study areas over the short term (2 to 7 years), 53% of NWT boreal caribou are found in areas where caribou numbers have been declining or may have been stable (Dehcho and South Slave regions). Only 8% of NWT boreal caribou are found in areas where caribou numbers have been increasing (Gwich'in region). The

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Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
	<p>Tłı̨chǫ and North Slave regions: most observations indicated a general trend of decline for boreal caribou populations.</p> <p>South Slave region: no information available.</p> <p>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 they are real declines in abundance or cyclic changes in habitat use.</p>	<p>remaining 39% are found in areas where the trend is unknown (Inuvialuit, Sahtu and North Slave regions).</p>
<p>Amount of change in numbers predicted in the near future; Percent change in total number of mature individuals over the next 10 years or 3 generations, whichever is longer</p>	<p>Information not available in sources</p>	<p>An analysis based on the level of total range disturbance (31%) indicates that the probability of observing stable or positive population growth over a 20 year period is approximately 65%.</p>
<p>Amount of change happening now; Percent change in total number of mature individuals over any 10 year or 3 generation period which includes both the past and the future</p>	<p>Difficult to distinguish from changes in the recent past – see above</p>	<p>Unknown, but see above for information on changes in the recent past</p>

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Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
<p>If there is a decline (in the number of mature individuals), is the decline likely to continue if nothing is done?</p>	<p>Varies depending on the area; generally, if industrial activities, forest fires and climate change continue to increase then declines will likely continue</p>	<p>Aggressive conservation management may be required to reverse population trends in the southern NWT. Effective habitat management is required to maintain self-sustaining population growth rates in the northern NWT.</p>
<p>If there is a decline, are the causes of the decline reversible?</p>	<p>Many threats can be reduced or managed to some degree (industrial activities, forest fires, predation, overharvesting, and others). Suggestions on specific practises for the protection of boreal caribou are included in Appendix A.</p>	<p>Causes of declines in the southern NWT can be reversed. Important factors are whether or not i) habitat management models that consider patch size, distribution, and connectedness of undisturbed preferred boreal caribou habitats are used; ii) existing anthropogenic linear disturbances are restored to states that discourage predators from using them as travel corridors; and iii) existing large areas of undisturbed habitat are protected from anthropogenic or fire disturbance.</p>
<p>If there is a decline, are the causes of the decline clearly understood?</p>	<p>Individual threats are well understood, however causes of decline in a particular area are not always well understood. Cumulative effects are not well</p>	<p>Largely yes. Declines are largely due to high mortalities and low recruitment rates. The likely ultimate cause of declines is increased predation facilitated</p>

Status of Boreal Caribou in the NWT

Question TK/CK; <i>Science</i>	Traditional & Community Knowledge	Scientific Knowledge
	understood.	by moderate to high densities of seismic lines.
If there is a decline, have the causes of the decline been removed?	In the Dehcho region, reduction in oil and gas development in recent decades has preserved habitat. Otherwise causes have not 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 the state of regeneration to preferred boreal caribou habitat on these lines is largely unknown. Many proposed protected areas and land use plans are not yet established or finalized.
Are there extreme changes in the number of mature individuals?	Extreme fluctuations not evident from the available information	Unknown, but unlikely.
Distribution Trends		
Where is the species found in the NWT?; <i>Estimated extent of occurrence in the NWT (in km²)</i>	Boreal forest from Tuktoyaktuk to the border with northern British Columbia and Alberta; the western edge roughly follows the foothills of the Mackenzie Mountains and the eastern edge is defined by Great	Extent of occurrence is approximately 659,714 km ² Note: Extent of occurrence is larger than NWT current range (432,916 km ²) because it is calculated by drawing a minimum convex polygon

Status of Boreal Caribou in the NWT

Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
	Bear Lake, Great Slave Lake and the Little Buffalo River	around the range. (Extent of occurrence is defined on p. 71).
How much of its range is suitable habitat?; Index of area of occupancy (IAO) in the NWT (in km²; based on 2 × 2 grid)	Information not available in sources	IAO is approximately 444,484 km ² Note: IAO is estimated as the surface area of 2 x 2 km grid cells that intersect the NWT current range. (IAO is defined on p. 71).
How many populations are there? To what degree would the different populations be likely to be impacted by a single threat?; Number of extant ‘locations’ in the NWT – based on SARC definition of ‘locations’	There is one continuous population of boreal caribou in the NWT, although several populations have been possibly identified in Dehcho region.	There is one continuous population of boreal caribou in the NWT that may be subject to several different land management regimes; some of these regimes may be visualized in Figure 11 (p. 106). Using land management regimes as a proxy for how the most serious plausible threat (habitat alteration) may affect boreal caribou indicates that the number of ‘locations’ exceeds the threshold of 10. (‘Locations’ are defined on p. 71).
Is the distribution (range), habitat or habitat quality showing a decline that is likely to continue if nothing is done? ; Is there a continuing	Much of the habitat in the NWT is still relatively intact, although development and recent forest fires have caused some habitat loss. To date, the majority of	Yes. Much of the NWT current range has an anthropogenic and fire disturbance footprint (i.e. approximately 31% or 38%, depending on the analysis), the

Status of Boreal Caribou in the NWT

Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
<i>decline in area, extent and/or quality of habitat?</i>	habitat disturbance in the NWT has been caused by fire. Current and future habitat trends include an increasing incidence of fires; increasing patterns of human disturbance on the landscape; and climate change impacting boreal caribou habitat.	majority of which is caused by fire. 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. The additive effects of new impacts may accelerate caribou declines in the southern NWT.
Is the number of populations or amount of occupied area showing a decline that is likely to continue if nothing is done?; <i>Is there a continuing decline in number of locations, number of populations, extent of occupancy and/or IAO?</i>	Recorded changes in the distribution are variable and local and hard to distinguish from population changes. Some specific areas in the NWT that used to have boreal caribou do not anymore, or do not have many.	Unknown.
Are there extreme fluctuations in the range or the number of populations? ; <i>Are there extreme fluctuations (>1 order of magnitude) in number of locations, extent of occupancy and/or IAO?</i>	No	No
Are most individuals found	No. There is a continuous	No. There is a continuous

Status of Boreal Caribou in the NWT

Question TK/CK; <i>Science</i>	Traditional & Community Knowledge	Scientific Knowledge
within small and isolated populations? ; <i>Is the total population severely fragmented (most individuals found within small and isolated populations)?</i>	distribution of individuals in the NWT.	distribution of individuals in the NWT.
Immigration from populations elsewhere		
Does the species exist elsewhere?	Yes	Yes
Status of the outside population(s)	Information not available in sources	South of the NWT current range, all local populations in British Columbia and Alberta are not self-sustaining. Further east, most local populations in are self-sustaining, as likely as not self-sustaining, or of unknown status.
Is immigration known or possible?	Likely, as boreal caribou are known to move between NWT and Alberta/British Columbia	Yes
Would immigrants be adapted to survive and reproduce in the NWT?	Likely, as boreal caribou are known to move between NWT and Alberta/British Columbia	Yes
Is there enough good habitat for immigrants in the NWT?	Likely, as much of the habitat in the NWT is still relatively pristine	Yes
Is the NWT population self-sustaining or does it depend	Self-sustaining implied, though topic not covered in sources	The NWT population of boreal caribou is likely self-sustaining

Status of Boreal Caribou in the NWT

Question TK/CK; <i>Science</i>	Traditional & Community Knowledge	Scientific Knowledge
on immigration for long-term survival?		(see p. 96). Boreal caribou populations south of the NWT in Alberta and British Columbia are not self-sustaining and should not be relied on to augment the NWT population.
Threats and limiting factors		
Briefly summarize negative influences and indicate the magnitude and imminence for each	<p>Primary threats are habitat change and human disturbance due to industrial activities and forest fires; both are increasing in many parts of the NWT. Negative effects are many and can be long term.</p> <p>Other major threats are predation and climate change. Predator numbers are increasing and linear disturbances from development can cause further increases in predation. Climate change is already changing habitat, food availability, snow conditions, and weather conditions, and further impacts are anticipated.</p> <p>Hunting pressure is a moderate threat to some populations but</p>	<p>1) Habitat alteration (loss, degradation, or fragmentation) as a result of human land-use activities: level of concern high, magnitude high, immediacy high</p> <p>2) Habitat alteration (loss, degradation, or fragmentation) as a result of natural processes (i.e., fire, permafrost changes): level of concern high, magnitude moderate, immediacy high</p> <p>3) Predation: level of concern high, magnitude high, immediacy high</p> <p>4) Biological resource use, i.e., harvest: level of concern high, magnitude low, immediacy high</p> <p>5) Climate change: level of</p>

Status of Boreal Caribou in the NWT

Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
	<p>there are indications that it could be rising.</p> <p>Parasites and disease are known to occur.</p> <p>Additional threats include invasive research techniques, tourism, snowmobile and all-terrain vehicle use, negative interactions with wood bison, pollution and contamination.</p> <p>It is important to consider the combined impact of multiple threats (cumulative effects).</p>	<p>concern moderate, magnitude high, immediacy moderate</p> <p>6) Parasites and disease: level of concern low, magnitude low, immediacy low</p> <p>7) Noise and light disturbance: level of concern low, magnitude low, immediacy low</p> <p>8) Accidental mortality from vehicle collisions: level of concern low, magnitude low, immediacy low</p> <p>9) Pollution: level of concern low, magnitude low, immediacy low</p>
<p>Positive influences</p>		
<p>Briefly summarize positive influences and indicate the magnitude and imminence for each</p>	<p>Hunting restrictions and voluntary limits are helping to keep the harvest low in GSA.</p> <p>Traditional stewardship practices can have a positive influence when they are followed.</p> <p>Land use planning and habitat protection initiatives are underway where the protection of boreal caribou habitat is one</p>	<p>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.</p> <p>An Action Plan for Boreal caribou Conservation in the Northwest Territories is being implemented.</p> <p>A national recovery strategy for</p>

Status of Boreal Caribou in the NWT

Question TK/CK; Science	Traditional & Community Knowledge	Scientific Knowledge
	<p>of the primary goals.</p>	<p>boreal caribou was completed in 2012. The strategy identifies critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat; under the federal <i>Species at Risk Act</i> critical habitat is protected from destruction.</p> <p>There is some current and proposed habitat protection in place for boreal caribou in the NWT through existing protected areas, the Protected Areas Strategy, and land use plans. Habitat protection has the potential to be an important positive influence on boreal caribou, however many of the protected areas and land use plans are not yet established or finalized.</p>

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Acronyms

COSEWIC	Committee on the Status of Endangered Wildlife in 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 Species at Risk Committee
SSA	Sahtu Settlement Area
WMIS	Wildlife Management Information System
WRRB	Wek'èezhii Renewable Resources Board

TRADITIONAL AND COMMUNITY KNOWLEDGE COMPONENT

Names and classification

There are two generally recognized populations of woodland caribou in the Northwest Territories: the boreal population and the northern mountain population. They are both considered the same species, however they are known to be distinct types based on where they live (either in the boreal forest or the Mackenzie Mountains). Only information relating to the boreal population is included in this status report. Aboriginal groups point to the presence of different ways that caribou could be classified (see for example COSEWIC 2002; Wek'èezhii Renewable Resources Board (WRRB) 2010). A well-documented Aboriginal classification of *Rangifer tarandus* (including barren-ground, woodland, and any intermediate types) would assist in the classification of caribou in the NWT.

Aboriginal names for the boreal population of *Rangifer tarandus* include:

- Mbedzih (Dehcho) (Dehcho First Nations 2011)
- Ṯḏzi (Ṯìcẖ) (Chocolate 2011)
- Ṯḏzi (Sahtu region) (Sahtu Renewable Resources Board pers. comm. 2012; Bayha pers. comm. 2012a)
- Vadzaih (Gwich'in) (Benson 2011)
- Tuktut (Siglitun) (Community Corporations of Aklavik, Inuvik and Tuktoyaktuk 2006)
- Tuttut (Uummarmiutun) (Community Corporations of Aklavik, Inuvik and Tuktoyaktuk 2006)
- eṯtẖhi (Chipewyan, caribou; Redish and Lewis 2009)
- sakaw atihk (Cree) (Schramm 2005; Saskatchewan Ministry of Environment pers. comm. 2012)

However, naming conventions for caribou are complex (additional details are provided in points (1) to (4) in Appendix A, p.134).

Life Form

Boreal caribou are a large land mammal.

Description



Figure 1. Boreal caribou. Photo: John A. Nagy, GNWT.

Boreal caribou are a medium-sized member of the deer family (Figure 1). They are larger than barren-ground caribou but smaller than the mountain type of woodland caribou (McDonald 2010). It is possible that boreal caribou size may differ between areas – some areas are reported to have larger caribou than others (Benson 2011). 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]).

Status of Boreal Caribou in the NWT – Traditional and Community Knowledge Component

While size is usually the first characteristic that people use to distinguish between the different types of caribou, they can also be distinguished by different markings, tracks, location, behaviour, and taste of the meat (Gunn 2009; McDonald 2010; Benson 2011; Bayha pers. comm. 2012c). Woodland caribou are described as being taller than their barren-ground counterparts, with longer legs, and are usually darker in colour with some white around the throat area, belly or underside (Johnson and Ruttan 1993; Zimmer *et al.* 2002; Benson 2011; Chocolate 2011; WRRB 2012). 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). The two types have different hooves; boreal caribou have larger hooves that help them stay on top of soft surfaces like snow or muskeg (Cluff *et al.* 2006; Gunn 2009).

Boreal caribou have distinctive behaviours and abilities when compared to barren-ground caribou. They are described as smart and fast animals that are always on the move (Zimmer *et al.* 2002). They startle easily, are quick to run away and can jump large distances (Cluff *et al.* 2006). Elders and hunters in the Sahtu Settlement Area (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). They are known for their ability to move quickly over rough or snowy ground (Benson 2011).

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). The biggest groups of boreal caribou reported by participants in workshops and traditional knowledge studies were of 30-40 animals but those group sizes are not seen today (ENR 2007k [NWT Métis Nation Board]; Gunn 2009; Dehcho First Nations 2011).

Zimmer *et al.* (2002) identified some issues around caribou classification and differentiation that remain unresolved; this is a knowledge gap. Differentiation between woodland and barren-ground caribou can be complicated at times by geography 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). Some adult male barren-ground caribou remain below treeline in the summer and are darker brown once they shed their winter coat, similar to boreal caribou. Participants at a meeting in Wrigley also 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]).

Distribution

NWT Distribution

In the Northwest Territories (NWT), the boreal caribou population covers an extensive area of boreal forest, from as far north as Tuktoyaktuk to northern British Columbia and Alberta in the south. 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. The current known distribution of boreal caribou, based on a combination of local knowledge from community meetings and scientific knowledge, is shown in Figure 2 (p.9), in relation to the cultural groups and communities discussed in this report.

There is one continuous population of boreal caribou in the NWT (Bayha pers. comm. 2012b), although several distinct ‘populations’ were noted in the Dehcho region (Dehcho First Nations 2011). Traditional and/or community knowledge sources from other regions did not address numbers of populations.

Inuvialuit Settlement Region (ISR)

There is relatively little information on the current or past distribution of boreal caribou in the ISR available in the published sources reviewed for this report. Boreal caribou are reported to occur within the ISR around Sitidgi Lake, Parsons Lake, Miner River, Kugalik, Makalik, Husky Lake, Parry Peninsula, and Tuktoyaktuk, and 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 of which 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]).

Status of Boreal Caribou in the NWT – Traditional and Community Knowledge Component

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. Recent observations or harvests were recorded in five geographic regions, but all were said to have few boreal caribou.

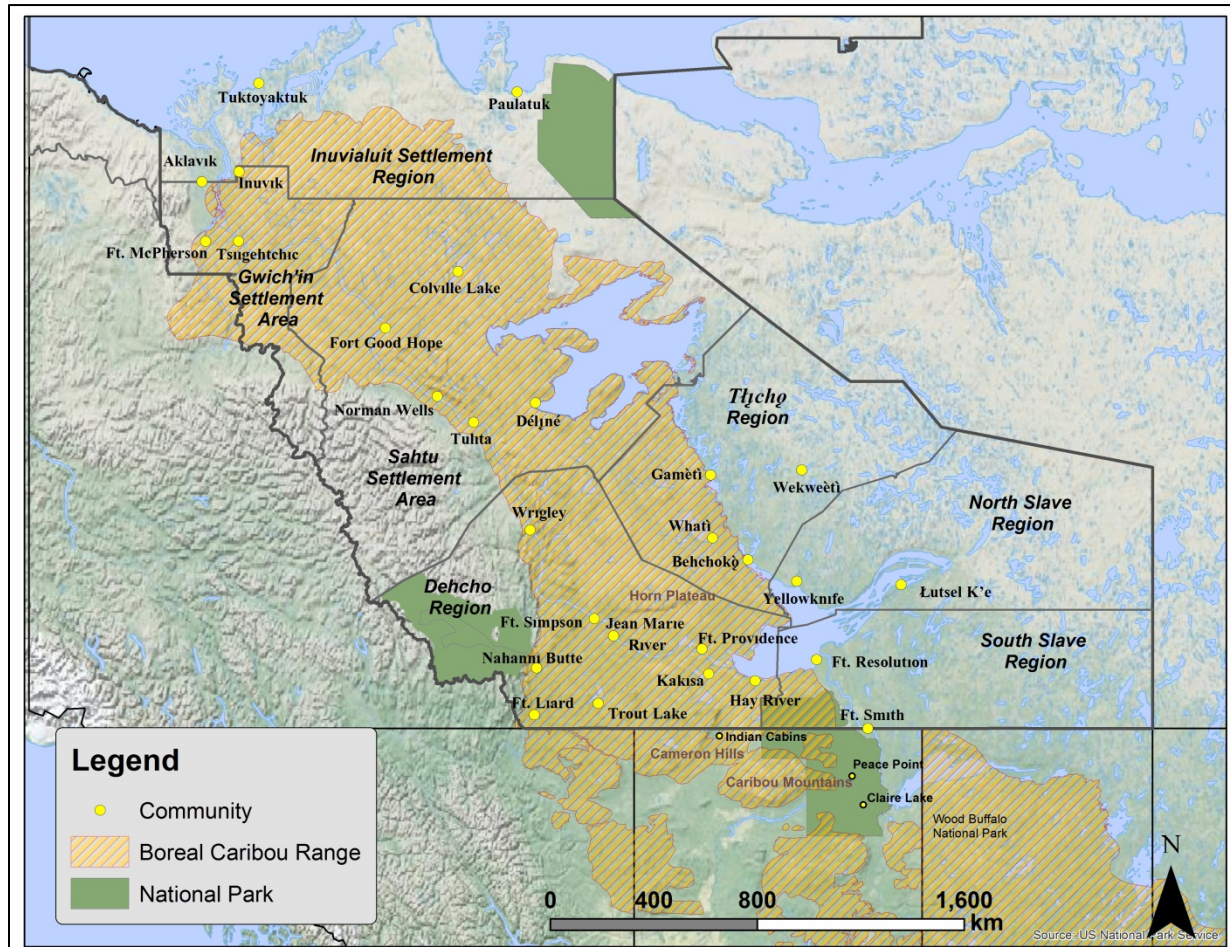


Figure 2. Map of Northwest Territories showing the regions mentioned in this report, communities, and the range of boreal caribou (ENR unpubl. data 2009). More information is needed to verify the eastern boundary of the range in the Sahtu Settlement Area; the range map could change as new information becomes available. Regions used in this report are not based on the Environment and Natural Resources administrative regions, except for the boundary between North Slave and South Slave regions. The 'Tłı̄chq Region' is Wek'èezhii, established under the Tłı̄chq Agreement. 'North Slave Region' is used to refer to parts of the North Slave administrative region that fall outside Wek'èezhii. The Dehcho region boundary follows the Dehcho Interim Measures Agreement.

Gwich'in Settlement Area (GSA)

There is well-documented Gwich'in knowledge on the current and past distribution of boreal caribou in the GSA. 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 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).

Figure 12, Figure 13, Figure 14, and Figure 15 (in confidential Appendix B, p.147) 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 (p.9) (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).

Sahtu Settlement Area (SSA)

There is patchy information on the distribution of boreal caribou in the SSA available in the published sources reviewed for this report. The eastern boundary of the boreal caribou range map (Figure 2) currently follows the boundary of the Taiga Plains Ecoregion (Ecosystem Classification Group 2007), however more information is needed to verify the distribution of boreal caribou in this area (Bayha pers. comm. 2012a).

Boreal caribou are found in two general areas on either side of the Mackenzie River (McDonald 2010). Hunters from Tulita 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

Status of Boreal Caribou in the NWT – Traditional and Community Knowledge Component

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 seems 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). People from Fort Good Hope report boreal caribou along the Mackenzie River (Olsen *et al.* 2001). Johnson and Ruttan's (1993) traditional 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].

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

Figure 16 (in Appendix B, p.147) 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 recent Sahtu traditional knowledge study in this area in McDonald 2010.

Dehcho Region

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 Trout Lake area, and the Wrigley area. They are seen to the east of the Franklin Mountains. Boreal caribou are also seen throughout the Fort Simpson area, including the Horn Plateau, and the foothills and lowlands around Sibbeston Lake. Boreal caribou have been seen in the Jean Marie River area, and in the Fort Providence area, including the Horn Plateau, north of the Mackenzie River, and the

Status of Boreal Caribou in the NWT – Traditional and Community Knowledge Component

Mackenzie Wood Bison Sanctuary. They are distributed in the Kakisa area throughout the Tathlina and Kakisa lakes areas, and on the Cameron Hills. Boreal caribou are seen throughout the Hay River area. They are found in the area around the Hay River Dene Reserve and surrounding the north and west sides of Buffalo Lake (Dehcho First Nations 2011). Further specific information on distribution in the Dehcho region is included in confidential Appendix B.

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*, p.28.

Participants in a traditional 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 Figure 17 and Figure 18 in Appendix B, p.147). Because study participants reported a lot of movement of boreal caribou 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).

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).

A lot of boreal caribou were documented in areas such as Fish Lake, Blackwater, Pine Point, and Hay River (ENR 2006c [Wrigley]; ENR 2007b [Fort Resolution Métis Council]; ENR 2007k [NWT Métis Nation Board]).

It was noted during the Joint Review Panel hearings for the Mackenzie Gas Project at 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 are known as an area where boreal caribou are consistently seen (Gau 2006 [Kakisa]).

Status of Boreal Caribou in the NWT – Traditional and Community Knowledge Component

The Horn Plateau is known to have one or more boreal caribou populations. The southeast portion of the Horn Plateau is known to be used by boreal caribou in the 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 the Horn Plateau, and the area to the east, are known as calving areas, possibly of separate populations (Deh Cho First Nations 2001). “It was the opinion of the Liidlii Kue First Nation harvesters and Elders that the woodland 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 Samba 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).

Tłı̨chǫ and North Slave Regions

Relatively little published traditional or community knowledge of boreal caribou distribution is available for the Tłı̨chǫ and North Slave regions. Bartlett and Weyburn Lakes have been noted as very important areas for boreal caribou; people from Whatı̨ say they see boreal caribou there frequently (Environment Canada 2010b [Whatı̨]). The 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 Nǫdii Plateau on the west side of Whatı̨ (Chocolate 2011; WRRB 2012).

Boreal caribou have been found throughout the Tłı̨chǫ region since at least the 1940s, although in low numbers (Cluff *et al.* 2006). They live in forested habitat between the Mackenzie Mountains and the Canadian Shield (Chocolate 2011). Boreal caribou are seen west of Gamèti towards the Keller Lake area, and from the Horn Plateau area extending north. Participants in a 2010 meeting in Gamèti to discuss boreal caribou recovery planning agreed with a range boundary that showed the edge of the boreal caribou range at Gamèti; no one at the meeting reported seeing boreal caribou east of Gamèti (Environment Canada 2010d [Gamèti]). 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 [Behchokq]).

According to workshop participants in N'Dilo and Detah, boreal caribou are found in low numbers throughout the region (Cluff *et al.* 2006).

South Slave Region

There is very little information on the current or past distribution of boreal caribou for the South Slave region available in the published traditional 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 pers. comm. 2011). However, this topic is considered an information gap in this report.

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 traditional 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'atl'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 may be harvested if seen while travelling along trails and roads, or taken while hunting or trapping other species. Similar hunting patterns (opportunistic harvests and relatively low harvest rates) were documented for Behchokq, 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 [Behchokq]).

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 Sahtu region called Bedzikatjñə 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. The stories

document the distribution and numbers of boreal caribou around Great Bear Lake (Bayha pers. comm. 2012b,c).

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.

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).

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]).

These observations are directly relevant to the following discussion of distribution trends.

Distribution trends

There is relatively little community or traditional 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 traditional knowledge studies. As noted above, boreal caribou are 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, ISR and 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

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Mackenzie Delta at all, so perhaps the observations in the 1970s and 1980s were of Porcupine caribou near Aklavik (Benson 2011). Colville Lake residents indicated that they had not seen boreal caribou near their community since the 1960s (Zimmer *et al.* 2002). During Environment Canada meetings in Whatì 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 Behchokò indicated that they used to see boreal caribou in the Mackenzie Bison Sanctuary but do not see them there in more recent times; the wood bison population has increased in this area (Environment Canada 2010c [Behchokò]). In the Tłı̨chò region, it was reported that fires since the mid-1990s have caused boreal caribou to move north and west closer to the Mackenzie River (WRRB 2012).

There were no specific observations recorded of areas where boreal caribou now live, that they did not in the past.

Habitat

Habitat requirements

Dietary needs/Foods

The availability of lichen is thought to be critical to suitable habitat for boreal caribou (Ruttan pers. comm. 2011). In the Dehcho region, boreal caribou broadly rely on ground and hanging lichens as well as sedge grasses for food (Dehcho First Nations 2011). Members of the K'átl'odeeche First Nation said that boreal caribou in the area of Wood Buffalo National Park mostly eat lichens – known as ‘caribou food’ in the area – 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 traditional knowledge study, hunters and elders indicated that boreal caribou eat a variety of foods throughout the year. In the summer they eat willows, willow leaves, sedges, and grass. Gwich'in elders have seen signs of boreal caribou eating aquatic vegetation in the spring. However, when hunted in the winter they tend to have only lichen in their stomachs. They are known to have a special ability to find lichen in the winter, perhaps by scent (Benson 2011). They will also eat tree buds in the 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 Tẖcẖo 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). Trout Lake residents 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 wasn’t 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 Gunn’s (2009) study (in the South Slave region) said that boreal caribou sought out unburned areas when foraging, and one traditional 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 pers. comm. 2012). It is possible that the type of controlled fire described by people in Trout Lake differs from a natural forest fire, after which the return of caribou may take decades; meeting participants indicated that after a 1994 burn at Trainor Lake, caribou tracks were seen in the area in the mid-2000s (ENR 2006b [Trout Lake]).

Salt licks are also actively sought by boreal caribou. Sahtu elders say they see the caribou near rivers in the 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).

General habitat characteristics

In most of their range within the NWT, boreal caribou tend to spend time in habitat characterized by dense pine or spruce 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

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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. He 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 Sahtu, 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 1.

Table 1. Habitat types used by boreal caribou in the Sahtu 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

K'átl'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. South from K'átl'odeeche and around the west end of Buffalo Lake, the landscape resembles prairie with few small trees creating habitat described like “little islands”. Travellers often saw boreal caribou and/or their sign in this open country. They report that the caribou like to go where the habitat is open like this, and are seen using prairie-like habitat west of Buffalo Lake. This is an area where some K'átl'odeeche First Nation members hunt boreal caribou (Gunn 2009). The spatial data showed concentrations around Swan Lake, and north and west of Buffalo Lake (see Figure 17 and Figure 18 in Appendix B, p.147). 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*, p.43). It was suggested at a public meeting that boreal caribou will also seek out the water and go in it if there are too many bugs (ENR 2007k [NWT Métis Nation Board]).

Although boreal caribou are known to generally avoid linear features on the landscape (discussed in *Industrial activities*, p.47), caribou and tracks were also 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 movement (discussed in *Barriers to Movement*, p.36).

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 pers. comm. 2012b). 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*, p.34.

In general, boreal caribou spread out across marsh and wetlands in the spring for calving, remain in wetland areas in the summer, and move through a broader range of habitat in the fall and early winter (Dehcho First Nations 2011). They gather into larger groups in the winter, when they seek out thicker black spruce and pine forests close to muskeg and ‘willow prairie’ areas that have ground lichens and sedge grasses (Dehcho First Nations 2011). Similar patterns are seen in the GSA, where boreal caribou are thought to separate to calve, and then group in the winter for predator protection (Benson 2011). They tend to remain close to areas where there are ground and arboreal lichens and sedge grasses, such as white muskeg areas (Dehcho First Nations 2011).

Winter habitat

In winter, boreal caribou prefer thick bush (WRRB 2012). 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. They spend less time in open and muskeg areas and they concentrate in larger groups during this time. 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 the 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 the winter months (Sambaa K'e Dene Band 2009; Allaire *et al.* 2010). Based on two seasons of field surveys, and taking into account traditional 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 the early winter (October through December) than late winter (January through March). This movement appears to decrease and become more concentrated throughout the 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 habitat in the Tłı̨cho and North Slave regions is characterized by both ground and tree lichens, and in the winter the boreal caribou are said to favour uplands and slopes where they can kick the snow away to feed (Chocolate 2011). A Gwich'in hunter similarly observed that the lesser amount of snow on hillocks in the winter makes it easier for the boreal caribou to dig food out; however, within the GSA, boreal caribou generally tend to move to forested areas in the winter, especially when it is foggy (Benson 2011). The forest also provides shelter from winter winds and snow storms (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*, p.28 and *Threats and limiting factors*, p.43.

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). For example, in the Th̄chō region some boreal caribou move onto islands to calve (WRRB 2012); some females migrate to islands in Great Slave Lake when there is still lake ice in the spring. They also migrate toward Horn Plateau to higher mountain areas to calve (Chocolate 2011). One harvester stated that several islands on a large lake may be used by boreal caribou for calving; he said that they will go to these islands to calve in order to avoid predators (Environment Canada 2010b [Whatì]). Boreal caribou are highly secretive when calving and they will stay near swampy areas with lots of water and hide their young (Gunn 2009).

Gwich'in harvesters felt it is likely that boreal caribou calve throughout their range in the GSA, but also said that they do seem to seek areas where they can escape flies and mosquitoes by staying in the wind – such as elevation heights or near water (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 pers. comm. 2012a).

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Calving areas in the Dehcho region are also generally in wetlands and marshes, but traditional knowledge also 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 17, Figure 18, and Figure 19 in Appendix B, p.147; 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 Sahtu 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

Less information was available regarding specific boreal caribou habitat requirements during the summer months. There may be some similar habitat requirements as in spring, with habitat selection being driven by minimizing predation on young calves and avoiding insects. 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).

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

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moose) will move up into higher elevations at this time, partly to get away from the fog and poor visibility, and partly because temperatures are generally warmer at higher elevations in the fall (Bayha pers. comm. 2012c).

It was also reported that boreal caribou use various habitats as they move around during the fall rut and post-rutting time. 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 the fall as they cross or move along water bodies. Open grassy areas are also used, but the boreal caribou will still spend considerable time in muskeg areas (Dehcho First Nations 2011).

Habitat availability

The question of how much of the suitable habitat in the NWT is actually occupied by boreal caribou was not generally discussed in the studies or records reviewed for this document. There was no indication of areas in the NWT that seem to have suitable habitat but are not occupied in the traditional and community knowledge sources consulted. This topic is an information gap.

Forest fires were identified as an important factor influencing the availability of boreal caribou habitat in the NWT. Examples were given in the SSA, the GSA and the Th̄chō region, and impacts are discussed further in *Threats and limiting factors*, p.43.

Habitat fragmentation

There was very little information on boreal caribou habitat fragmentation in the available traditional and community knowledge sources. One hunter in the GSA identified habitat fragmentation as a concern (Benson 2011). Otherwise, there was no indication as to how much boreal caribou habitat is fragmented in the NWT, nor the magnitude of the impact that habitat fragmentation may present to boreal caribou populations. Overall, it appears that questions of habitat fragmentation were not effectively asked in recent traditional knowledge studies and this topic is an information gap.

Fragmentation (breaking up of habitat into isolated sections) can be caused by human influences. Human-made features such as roads and pipelines may be at least a partial barrier to movement in some cases (discussed in *Barriers to movement*, p.36). Many studies and study participants suggested that roads, seismic cutlines, and human activities that disturb habitat – such as seismic

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work or logging – can negatively impact boreal caribou. Boreal caribou are seen to avoid linear features in the landscape, with the result that roads and seismic cutlines can affect movement patterns and habitat use (discussed further in *Industrial activities*, p.47). Both the physical impacts on the ecosystem, as well as the increased noise and activity, could effectively fragment habitat for boreal caribou.

Fragmentation can also be caused by natural factors. There are some suggestions that certain rivers can act as barriers to movement, and because boreal caribou are often thought to avoid areas that have burned, forest fires could potentially create ‘barriers’ that impact boreal caribou movement patterns (both topics are discussed more fully in *Barriers to movement*, p.36).

Habitat trends

Very little information regarding changes to the amount of boreal caribou habitat available in the NWT was found in the traditional and community knowledge sources reviewed for this report. Regarding habitat quality, participants in traditional knowledge studies and those attending boreal caribou meetings generally indicated that boreal caribou populations in the NWT have not been impacted by habitat disturbances as much as populations further south in more developed areas (see for example Environment Canada 2010a-d; Benson 2011; Dehcho First Nations 2011). However, no available studies focussed on topics related to habitat trends in a way that allows conclusions to be drawn regarding the amount or quality of suitable boreal caribou habitat in the NWT.

Some information was available for the Dehcho region, which is considered by participants in a traditional knowledge study to be relatively intact boreal caribou habitat. With the exception of the Cameron Hills and Mackenzie Bison Sanctuary, there has been minimal change to habitat since the halt of oil and gas activities in the 1970s and many seismic lines have now grown in. Participants indicated that boreal caribou seem to have re-adapted to the landscape and that re-grown lines do not seem to be a deterrent to use (Dehcho First Nations 2011); although re-vegetation of seismic cutlines may not necessarily produce boreal caribou habitat. Specific areas impacted by forest fires include south of Bulmer Lake, between Mills Lake and the base of the Horn Plateau, and immediately southeast of Beaver Lake (Dehcho First Nations 2011). In the SSA, there were ‘drastic habitat losses due to abundant forest fires’ in the mid-1990s, but primary boreal caribou habitat has remained fairly stable in recent years due to the low incidence of disturbance by fire (McDonald 2010: 4). Several meeting participants stressed that forest fires

are the main cause of habitat loss in the Tłı̄chǫ region (Environment Canada 2010b [What]). Comments from Gwich'in hunters indicate that forest fires in the GSA have been allowed to burn in recent decades and have destroyed some boreal caribou habitat (Benson 2011).

Some specific concerns regarding current and future habitat trends include an increasing incidence of fires; increasing patterns of human disturbance on the landscape; and climate change impacting boreal caribou habitat. Details on these trends are included in *Threats and limiting factors* (p.43) as well as Appendix A (p.134).

Biology

Life cycle and reproduction

There is very little traditional or community knowledge documented concerning aspects of the boreal caribou life cycle and reproduction. This is likely due to the type and timing of human use of these animals, their secretive nature, their selection of dense forest habitat, and because these questions were not the focus of many of the studies and consultation meetings that have been conducted.

Some relevant details were documented by Johnson and Ruttan (1993) in parts of the SSA, but information concerning the migrations, movements and calving habits of boreal caribou were considered 'fragmentary'. 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 Tłı̄chǫ 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). 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]).

A Dehcho study suggested that traditional knowledge about calving is not extensive. This is likely because 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). However, it is likely that calf survival is an important determinant in boreal caribou local populations. 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).

Physiology and adaptability

A study of Gwich'in traditional 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'atl'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).

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's study, 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 (Gunn 2009).

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).

Interactions

Information on boreal caribou interactions with their food species, such as lichens, can be found in *Habitat requirements*, p.17.

Interactions with 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 Tłı̄chǫ and Dehcho regions (ENR 2006c [Wrigley]; Gunn 2009; Chocolate 2011; Dehcho First Nations 2011). Participants in an Inuvialuit traditional knowledge study reported they have seen wolves and other predators in areas where they see boreal caribou (Nagy *et al.* 2002), and Dehcho participants said that they see wolf tracks in areas near the Cameron Hills

where boreal caribou calve (Gunn 2009). West Point and K'átl'odeeche First Nations members report more wolves in boreal caribou habitat than barren-ground caribou habitat (ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]). Increases in wolf populations were noted in many studies (Olsen *et al.* 2001; ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]; McDonald 2010; Benson 2011; Dehcho First Nations 2011). This trend is discussed further in the *Predation* section of *Threats and limiting factors*, p.50.

In addition to wolves, black bears and grizzly bears also prey on boreal caribou. Although traditional 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 Tẖcho̱ 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 Tulita 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 pers. comm. 2012c). 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*, p.43.

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'átl'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). Samba 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

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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*, p.17. Information on the impact and importance of predation as a threat to boreal caribou can be found in *Threats and limiting factors*, p.43. 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.

Interactions with other types of caribou

Traditional 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, Tłı̄chǫ 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 pers. comm. 2012a). Most studies indicate that the two types of caribou share habitat primarily in the winter months, when both are mainly feeding on lichens. Participants in one traditional 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).

In Behchokǫ̀, an elder 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 of seeing one boreal caribou follow a group of 30 barren-ground caribou (Environment Canada 2010c [Behchokǫ̀]). However, one elder indicated that boreal caribou in the Tłı̄chǫ 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).

In the Sahtu, it is 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

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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 west 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).

Interactions with other ungulates

Many traditional and community knowledge sources indicated that boreal caribou interact with moose, muskoxen, wood bison, and white-tailed deer. In some cases the interactions are described as competition. However, participants in a Dehcho traditional 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 2, p.32 (Zimmer *et al.* 2002).

Some interactions are considered relatively recent phenomena. Members of K’átl’odeeche First Nation indicated that they have seen white-tailed deer in areas where they previously were not seen (ENR 2007a [K’átl’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 recently been seen as far south as the Talston Dam, approximately 50 miles from Fort Smith (Kelly pers. comm. 2011).

Inuvialuit study participants observed that moose populations were increasing in areas where boreal caribou were decreasing. However, participants also reported that moose and boreal

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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).

Table 2. Occurrence of other wildlife species with boreal caribou in the Sahtu Settlement Area as recorded during interviews in Fort Good Hope, Colville Lake, Norman Wells, and Tulita 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

Observations from the Tulita and Norman Wells area indicate that there are more moose in the Mackenzie valley than before (Olsen *et al.* 2001). Many forest fires 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 relates to how muskoxen will pull an entire plant, roots and all, from the ground when grazing. This impacts the caribou's ability to feed in the area. It has also been observed that the urine of muskoxen will

keep caribou away from an area (Benson 2011). Participants in an Inuvialuit traditional knowledge study observed that muskoxen were ‘taking over’ on Parry Peninsula (Nagy *et al.* 2002).

Negative interactions with wood bison are of concern to people in the North Slave, Tłı̄chǫ 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 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 (Environment Canada 2010c [Behchokǫ̀]). In a Tłı̄chǫ study, one elder indicated that boreal caribou are reported to ‘dislike’ wood bison (Chocolate 2011). Meeting participants from West Point First Nation and K’átl’odeeche First Nation also said that wood bison displace caribou when they increase in abundance (ENR 2007c [West Point First Nation and K’átl’odeeche First Nation]).

Traditional and community knowledge sources also indicate that moose, muskoxen, wood bison, barren-ground caribou, and other prey species can impact the interactions between boreal 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’átl’odeeche First Nation]). Large wolf packs seen in the Fort Providence area seem to be due 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 Délı̄ne were relatively rare, but today wolves are regularly sighted and there are wolf dens near the community. This noted increase in wolf numbers around Délı̄ne since 1983 coincides with the return of both the Bluenose-East and Bluenose-West herds of barren-ground caribou to the Délı̄ne area; wolves come with the herds (Bayha pers. comm. 2012a). Participants in a Sahtu traditional knowledge study also said they have observed an increase in wolf populations in recent years, 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 can result in fewer boreal caribou being taken by predators, and that this is having an effect on the boreal caribou populations. If there is a decrease in the number of other prey, then predators will hunt boreal caribou (McDonald 2010). It is unclear if an increase in alternate prey is supporting more predators in an area.

Population

Structure and rates

Traditional and community knowledge on population structure and rates, such as age of parents and life span, does exist (Bayha pers. comm. 2012a) but was not available in the sources reviewed for this report.

Movements

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*, p.20). 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]).

Boreal caribou movements tend to be most restricted in later winter months when they concentrate in larger groups in patches of suitable habitat. 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 spring, there is generally a movement to suitable calving habitat. It is possible that females that will be calving have different movement patterns than barren females (Ruttan pers. comm. 2011). 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 Tulita 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

km²; the group of boreal caribou hunted by Déljine Dene are an example of this (Bayha pers. comm. 2012b).

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 Horn Plateau, 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 the Horn Plateau in late summer and early fall, returning in the early spring. However, participants in a traditional knowledge study 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 recently confirmed in Gunn’s 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 17, 18, and 20 in Appendix B, p.147). 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 as having 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 traditional 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'átl'odeeche First Nation study participant reported that boreal caribou will lay down for the night along a line of spruce trees (Gunn 2009).

Travel routes and preferences

In the winter, boreal caribou travel wherever there is hard ground and adequate cover provided by forest growth (McDonald 2010). Participants in a meeting in 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 Déline (Great Bear Lake Working Group 2005). It has also been noted that on the Horn Plateau, boreal caribou trails are embedded in the moss due to ongoing use (Dehcho First Nations 2011). There are movement corridors on the Horn Plateau 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 was noted in particular in the summer (Gunn 2009; Benson 2011).

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'átl'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).

Forest fires in the 1990s and 2000s were said to drive boreal caribou from the Tẖcho̱ 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 *Forest fires*, p.46), forest fires could potentially create ‘barriers’ that change boreal caribou movement patterns.

Likelihood of immigration

Dispersal and immigration of boreal caribou were not specifically addressed in the available traditional 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 pers. comm. 2011; see confidential Figures 17, 18, and 20 in Appendix B, p.147). As well, 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). It is likely that immigration or emigration between British Columbia, Alberta and NWT could occur.

Abundance

Boreal caribou sightings tend to be less common than sightings of other ungulates in all regions of the NWT. The available traditional and community knowledge sources did not include estimates of total abundance. Because of the nature of traditional knowledge and the species of interest, traditional knowledge “may not be as helpful for establishing abundance of boreal caribou as for establishing range extent and areas of concentration,” (Gunn 2009: 142). This

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

Fluctuations and trends

In this section, traditional and community knowledge on trends and fluctuations in boreal caribou abundance are presented for each region of the NWT. Generally, in the ISR the information on boreal caribou abundance was inconclusive. In the majority of areas numbers were thought to be stationary or increasing but there was little information available. In the GSA, boreal caribou were seen to be increasing in some areas and decreasing in others. In the SSA, the most recent information indicated that numbers are stable to increasing. In the Dehcho region observations were mixed: numbers were increasing in some areas, unchanging in most areas, and slowly decreasing in others. In the Tłı̨chǫ and North Slave regions most observations indicated a general trend of decline for boreal caribou populations. No information on trends or fluctuations was available for the South Slave region.

This information should be interpreted with caution because many of the observations relate to specific, small geographic areas. In addition, 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. They 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).

Inuvialuit Settlement Region (ISR)

Boreal caribou population trends in the majority of areas of the ISR appear 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. In one region, there was an observation that boreal caribou are 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 the trend information (as presented) is inconclusive (Nagy *et al.* 2002).

Gwich'in Settlement Area (GSA)

Boreal caribou population trends in the GSA are increasing in some areas and decreasing in others. Population levels have increased around Fort McPherson (ENR 2007h [Fort McPherson]; Benson 2011). Although boreal caribou have always been present on the Peel River Preserve, they are reported 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, and movement due to forest fires 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 were thought to possibly be decreasing in the areas east and southeast of Inuvik, in part due to hunting pressure from increased access due to the Canadian National railway line. There are also fewer boreal caribou around North Caribou Lake than there were in the past (Benson 2011).

Sahtu Settlement Area (SSA)

In the SSA, a recent study reported that boreal caribou populations have been 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 also noted that primary habitat for boreal caribou has remained fairly stable in recent years due to the low incidence of disturbance by fire (McDonald 2010).

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These findings differ somewhat from the conclusions of two studies conducted almost ten years earlier (Olsen *et al.* 2001; Zimmer *et al.* 2002). Both of these studies reported mixed impressions in regards to trends in abundance. At that time, Sahtu 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 Tulita 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).

Dehcho Region

Observations of boreal caribou population trends in the Dehcho Region are mixed. The population is noted as being stable in most areas and in a slow decline in areas where forest fires, introduced wood bison and other threats are 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 region, as presented in a recent traditional knowledge report, are summarized in Table 3, p.41 (Dehcho First Nations 2011). Group sightings in fall and winter generally include a mix of adult and younger animals, with adults being the majority of the group. In some areas, group sizes are considered to be smaller in recent years (Dehcho First Nations 2011).

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Table 3. Observations on boreal caribou population level, trend and group size in different parts of the Dehcho region (Dehcho First Nations 2011).

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 has been 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
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 is some decline	Group sizes of 6-7 animals are 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 (Horn Plateau; lowlands and foothills around Sibbeston Lake) have relatively strong populations	Stable	Group sizes of 5-7 animals are not uncommon; groups of up to 17-19 observed in mid to late winter
Jean Marie River area	Common but not abundant	Appear to be in slow decline	Groups of 2-3 animals are most common in recent years; 5-7 not uncommon; up to 15 seen in late winter. Group sizes used to be larger.

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Area	Population level	Population trend	Group size
Fort Providence area	Horn Plateau population remains the strongest in the area	Generally and slowly declining, likely due to forest fires, expansion of wood bison and increased sensory disturbance; decline is most noticeable south and southeast of the Horn Plateau, north of Mackenzie River, and in and around the Mackenzie Wood Bison Sanctuary	Groups of 2-3 animals are common today; larger groups were more common in the past but are less common today
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 are not uncommon northwest of Tathlina Lake; groups of 5-7 occasionally sighted inland from the south shore of Beaver Lake
Cameron Hills plateau		Declined due to development pressures	Not available
Hay River area	Generally stable	Some recent decline 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, are most common; 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'átl'odeeche First Nation and that populations have declined over the decades (Gunn 2009). One very knowledgeable K'átl'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'átl'odeeche and West Point First Nations said that

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the boreal caribou population has decreased significantly in the last 20-30 years (ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]).

Members of the K'átl'odeeche First Nation have reported that there are more boreal caribou near Cameron Hills and Buffalo Lake now 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 now there are not as many (ENR 2007a [K'átl'odeeche First Nation]). One K'átl'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).

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]).

Tłı̄chǫ and North Slave Regions

Most observations from the Tłı̄chǫ and North Slave regions indicate a general trend of decline for boreal caribou populations. Some observations indicate that boreal caribou seem 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 said that he agrees populations are declining in the south but does not think that the boreal caribou population is declining in the NWT (Environment Canada 2010d [Gamètì]).

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.

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The available traditional 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 forest fires 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 and climate change. Overharvesting is not currently a major threat but there is concern about potential future impacts. Parasites and disease are known to occur but are not generally a cause for concern. Additional threats identified include invasive research, 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).

Regional assessment of threats

Although threats to boreal caribou were often identified and described in traditional and community knowledge sources, there was 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.

In the ISR, threats to boreal caribou habitat include oil and gas exploration and development, road and hydro development, increased tourism and other non-consumptive human activity, forest fire, and climate change (Nagy *et al.* 2002). In the GSA, hunters feel that wolf predation and over-harvesting are the main threats, although they do not feel that boreal caribou are decreasing in the GSA (see *Population Trends*, p.34) (Benson 2011).

In the SSA, people indicated that boreal caribou populations are currently healthy, but cautioned that climate change, industrial activities and predation may negatively impact them in the future (McDonald 2010). The biggest impact on boreal caribou in the Sahtu Settlement Area may be from habitat change, and it was stressed that habitat changes need to be addressed first. Both hunting and predation tend to increase as habitats become fragmented and access increases. People 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).

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At a 2001 workshop in the SSA, participants were asked to indicate which specific factors have a major impact, minor impact, or no impact on boreal caribou. The percentage of responses in each category was calculated (Table A1 in Appendix A, p.134). The respondents indicated that predators and seismic explorations have a major impact on boreal caribou. Pollution, contaminants, and climate change were considered to have a minor impact. Hunting and tourism were considered to have no impact. For pipeline construction, forestry and logging, and highway construction, the results were inconclusive (Wynes 2001 in Olsen et al. 2001). In the Dehcho region, boreal caribou numbers are considered stable in general except where forest fires, introduced wood bison populations, industrial development, or other threats are causing a slow decline, particularly in the Fort Providence area (attributed to bison, wolf predation and forest fire) and on the Cameron Hills plateau (attributed to oil and gas activity). A recent decline southwest of Buffalo Lake may relate to increased skidoo access and hunting pressure. Participants in a Dehcho traditional knowledge study indicated that there is minimal resource development activity occurring at this time in the Dehcho, with the exception of the Cameron Hills. However, a few major projects are pending (Dehcho First Nations 2011). 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).

In the Tłı̨cho region, participants said the increased frequency of forest fires, an increasing wolf population, climate change, tourism, as well as increase in levels of noise and light disturbance have all contributed to a decline in boreal caribou (Environment Canada 2010b [Whatì]; Chocolate 2011).

Very little information on threats in the South Slave region was available in the sources reviewed for this report. It was noted that muskoxen are moving further south from around Lutselk'e, moose and white-tailed deer are increasing in the Fort Resolution area, and cougars are reported between Fort Resolution and Hay River. Muskoxen have been seen 50 miles from Fort Smith (Kelly pers. comm. 2011). However, potential impacts of these factors on boreal caribou were not discussed (ENR 2007b [Fort Resolution Métis Council]).

Further information on threats to boreal caribou is summarized below by cause.

Causes of negative impacts

Forest fires

The impact of forest fires on boreal caribou was considered significant in many of the sources reviewed for this report. There was a general theme that fires destroy habitat, and the effects can last for many years, if not decades. Forest fires can impact the ability of caribou to acquire food and can even force boreal caribou to relocate to more desirable locations (McDonald 2010).

Some of the most detailed information on the impacts of fire comes from a 2010 traditional knowledge study in the GSA (Benson 2011). Boreal caribou in the GSA will avoid burned-out areas longer than other large species such as moose (Benson 2011). Gwich'in hunters 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. The timeline for return by boreal caribou likely 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). This is also supported by anecdotal information from the Dehcho region, and underpins why controlled burning in spring and fall months was traditionally used to reduce the possibility of hot summer burns (Redvers pers. comm. 2011).

There were differing opinions on how long burns may affect boreal caribou in studies done in the SSA. 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]). 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 [Behchokq]).

It is recognized that fires are natural occurrences and can have a rejuvenating effect on the land (Benson 2011). However, forest fires are thought to be increasing in many areas and impacting boreal caribou habitat as a result. Fires are seen as a definite threat to boreal caribou populations (Zimmer *et al.* 2002; ENR 2007b [Fort Resolution Métis Council]; ENR 2007c [West Point First

Nation and K'átl'odeeche First Nation]; Benson 2011). Forest fires are believed to be the main cause of habitat loss and boreal caribou population decline in the Th̄chō region (Environment Canada 2010b [Whatì], 2010c [Behchok̄], 2010d [Gamètì]). Increases in fires may be related to climate change, with more lightning and drier summers being reported (ENR 2007j [Tsiigehtchic]).

In addition to impacts through habitat change, forest fires can also impact boreal caribou directly by burning the animals or through smoke inhalation (Benson 2011). It has been noted that boreal caribou will stay in burning areas to protect their young instead of trying to escape a fire (Environment Canada 2010b [Whatì]).

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. Traditional 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). 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 said that he is seeing an overall change in boreal caribou behaviour as a result of increased disturbance and noise. He said that the animals do not seem rested, and that they are 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).

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 also commented that since these extensive disturbances, boreal caribou

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have become more wary and do not linger as long in open areas as before (Dehcho First Nations 2011). Besides the primary disturbance sites, there are also associated developments that boreal caribou tend to avoid, such as winter field camps and access roads (Zimmer *et al.* 2002). In addition, secondary impacts such as hunting and predation, that tend to increase as habitats become fragmented and access increases, may ultimately be more significant than those resulting from the initial construction or development work (Olsen *et al.* 2001).

Because of these impacts, 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 have increased in recent years and some communities have concerns that these activities disturb boreal caribou feeding areas. The impacts 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 has 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 seismic cutlines 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). Presence of roads, road construction, traffic, and pipeline right-of-ways 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. At meetings held in Whatì, people stressed that they are concerned about future development, such as an all-weather road, and how it may impact boreal caribou (Environment Canada 2010b [Whatì]).

While elders and active hunters in the Tulita 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'átl'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 may impact boreal caribou even one kilometre into the bush. 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'átl'odeeche First Nation]; Environment Canada 2010c [Behchokò]; 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 Behchokò and Gamètì stated that since the highway 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 [Behchokò]; Environment Canada 2010d [Gamètì]).

Further concerns about specific linear disturbances and developments are included in Appendix A, points (5) and (6) (p.134).

Other industrial activities

Mining can also affect boreal caribou habitat and habitat use (ENR 2007a [K'atł'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 Behchokò also raised concerns about pollution and contamination from mining. Tailings ponds and hazardous waste (arsenic) have not been adequately managed in the past, so there is concern about future mining activities. A new mine (Fortune Minerals; gold-cobalt- bismuth-copper mine) 80 km north of Behchokò and within boreal caribou range was raised as a specific concern (Environment Canada 2010c [Behchokò]). 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, p.134.

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 the section on *Interactions with predators*, p.28), increases in predator abundance are 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), and wolf predation was identified one of the main threats to boreal caribou in the Tłı̄chò region (Environment Canada 2010c [Behchokò]; Environment Canada 2010d [Gamètì]). Some communities think the increase in numbers of wolves may be due to decreases in hunting and trapping activities (McDonald 2010; Dehcho First Nations 2011). However, 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 Sahtu, where communities report not just an increase in wolves, but a general increase in the abundance of moose, muskoxen and beavers. This is thought to 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).

While wolf populations appear to be increasing throughout the Dehcho region, harvesters say numbers are especially high in southern areas of the NWT (Dehcho First Nations 2011). An increase in wolves has been seen 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 are 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 is no evidence of increased killing of boreal caribou by wolves in the Dehcho region (Dehcho First Nations 2011). The Fort Providence area appears to have large wolf packs due to the increased wood bison population, and has also seen the biggest decline in boreal caribou in the Dehcho region; wolf predation may be one of the factors involved in this decline (Dehcho First Nations 2011).

In the GSA, wolf populations are thought to be negatively affecting prey populations in most areas where boreal caribou are 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 is 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 is a need to control predators (ENR 2006c [Wrigley]).

Grizzly bears and black bears also prey on boreal caribou, and bear populations are increasing as a result of less hunting pressure (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 water breaks and take the calves; they may also take the female at these times (ENR 2007k [NWT Métis Nation Board]). Gwich'in hunters say bear behaviour is changing as well – they are becoming less timid of human activity (Benson 2011).

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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 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 pers. comm. 2011).

There are additional concerns about possible impacts of ‘new’ predators that are expanding their range northward (Benson 2011). An increase in cougar numbers in the Tłı̨chó region was stated as a concern for boreal caribou (Environment Canada 2010c [Behchok̓]). Cougars or their tracks have increasingly been seen throughout the Dehcho region over the past decade, 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 cougar was noted around Fort McPherson recently (Benson 2011). Coyotes may also be moving northward and some people feel they may present a threat to boreal caribou: several workshop participants in Behchok̓ noted that coyote populations and distribution are expanding in their area (Environment Canada 2010c [Behchok̓]), and one Gwich’in hunter may have seen coyote tracks in the Mackenzie Delta (Benson 2011).

Further details on predation as a threat and associated implications for boreal caribou habitat management are included in points (9) to (11) in Appendix A, p.134.

Climate change

Climate change is another factor that is thought to be impacting boreal caribou. In some areas it is reported that snow conditions are changing (Nagy *et al.* 2002; Zimmer *et al.* 2002; ENR 2007c [West Point First Nation and K’átl’odeeche First Nation]; ENR 2007e [Paulatuk]; Dehcho First Nations 2011); that summers and winters may be warmer now (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); that distribution and abundance of predators are changing (ENR 2007a [K’átl’odeeche First Nation]); and that habitat is changing due to melting permafrost (Benson 2011; Dehcho First Nations 2011).

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).

Additional details on climate change are found in points (12) through (20) in Appendix A, p.134.

Overharvesting and non-traditional harvest practices

Hunting pressure was identified as a moderate current threat to some boreal caribou populations in the NWT. It was also identified as a possible future threat in other areas.

The available evidence suggests that the current harvest of boreal caribou is relatively low. Aboriginal 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 Surveys from 1996-2009, resident hunters take approximately 30 woodland caribou per year, and on average about half of their reported kills (about 15 per year) are likely boreal caribou based on location of the hunt. This estimate is based on the assumption that boreal and northern mountain caribou kills are equally likely to be reported (ENR unpubl. data 2011). Outfitters generally focus on other species or types; they do harvest northern mountain caribou.

Although current harvest is low, it has been noted 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 regards to potential future impacts of hunting on the boreal caribou population.

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 is 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 *mbedzihcho* – 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* (p.48), 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 Sahtu 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 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 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 [Behchok]).

For more details on overharvesting and non-traditional harvest practices that have potential implications for the management of boreal caribou, see points (22) to (24) in Appendix A (p.134).

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 have fewer diseases than moose (ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]). Only nine instances of sick or dead boreal caribou were documented in a traditional 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 a traditional 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).

There is relatively little information on boreal caribou parasites or disease available in the sources reviewed. Boreal caribou in the GSA occasionally have brucellosis or pus in their joints. They have nose bots in the spring, which are expelled through sneezing. They have warble flies in the 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.

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- 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 Sahtu 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 research, and in particular collaring and sedating caribou, may affect boreal caribou negatively. These practices remain controversial in many communities; while elders express concern, many agree that baseline data gathered using these methods is necessary (Dehcho First Nations 2011). Once baseline data is 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'átl'odeeche First Nation]; ENR 2007h [Fort McPherson]; Environment Canada 2010c [Behchokq]; Dehcho First Nations 2011). In addition to the behavioural changes, the area around the neck where the collar sits is 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).

Tourism is also cause for some concern with respect to boreal caribou. Increased tourism has attracted an influx of people into the Tłı̄chǫ 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 [Whatı̄]; 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'átl'odeeche First Nation]). One harvester in Behchokǫ̀ reported that there has been increased ATV use in the Tłı̄chǫ 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 also led to more wolves in the region (Environment Canada 2010c [Behchokǫ̀]).

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). In the SSA, it has been noted that if highway access and oil and gas development proceeds without adequate 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).

Positive Influences

Traditional and community knowledge study participants often talked about ways in which boreal caribou should be paid respect and how to respectfully steward and harvest the species. Although there are land use planning and habitat protection initiatives underway in the NWT (see the *Scientific Knowledge Component*, p.68), these were not usually mentioned as positive influences in the traditional and community knowledge sources. However, 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 pers. comm. 2011; Bayha pers. comm. 2012a). As well, Dehcho First Nations' (2011) recommendations for boreal caribou management include the finalization of the Dehcho Land Use Plan and the establishment of National Wildlife Areas.

This section only addresses actual and/or imminent positive influences that may currently be affecting boreal caribou. The available sources rarely contained information on the relative importance or magnitude of the positive influences. There are two main ways in which stewardship approaches may currently be having a positive influence on boreal caribou in the NWT: hunting bans and voluntary restrictions on harvest; and traditional stewardship practices.

Hunting bans and voluntary restrictions

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). K'átł'odeeche elders indicated that they knew 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

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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 traditional knowledge study indicated that hunting regulations in the GSA (which include bans on hunting boreal caribou for resident hunters in certain zones) have produced noticeable increases of boreal caribou numbers in some areas. According to Gwich’in traditional knowledge, prior to the hunting regulations, boreal caribou numbers in now-regulated areas were seen to be declining or lower although the mechanisms were not understood. Gwich’in traditional knowledge suggests that the result of hunting regulation is that now boreal caribou are being seen in areas where they had not been for some time (Benson 2011).

Traditional stewardship practices

Traditional practices of Aboriginal cultures in the NWT often include rules and guidance for a respectful relationship with caribou. When followed, these traditional practices can be a positive influence on boreal caribou populations (Benson 2011).

K’átl’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 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. Sharing harvests is another way of respecting the land and the animals. Resource distribution and management was traditionally conducted through well-defined rules and practices, often coming from an area’s chief (Gunn 2009).

Dene in the Dehcho region have a spiritual relationship with mbedzih. This carries with it obligations not to unduly harm or disrespect the animals, which include offerings and rules about the use of the meat and hide (Dehcho First Nations 2011). 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).

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Additional details on traditional stewardship practices are found in points (25) and (26) of Appendix A, p.134. Suggestions from traditional and community knowledge sources on specific practises for protection of boreal caribou, habitat areas to protect, as well as suggestions for research and monitoring, are included in points (27) through (45).

Acknowledgements

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Biography of Preparers

Two preparers were involved in compiling the information for this report. Ms. Benson and Ms. Winbourne both have experience assessing published and unpublished local and traditional knowledge for appropriate quality in methodology, reporting, and ethical considerations. They are also both familiar with the requirements of traditional knowledge policies and procedures. Their individual strengths are outlined below.

Kristi Benson, B.A., M.A. *Heritage Specialist* Ms. Benson has over ten years of experience in conducting anthropological, oral history, traditional knowledge, archaeological, heritage policy, GIS, and other heritage projects. Her experience in the heritage field has taken place primarily in Canada's western Arctic. Ms. Benson has acted as research manager for two projects specifically relating to species at risk. She conducted research, prepared relevant reports, and managed the review process (including verification sessions) for the *Gwich'in Traditional Knowledge of the Rat River Char* study. She also managed the recent *Gwich'in Traditional Knowledge of Boreal caribou* study. During this project she conducted interviews, managed information and files, and trained and supervised a local interviewer. Ms. Benson also has experience as the project director for a multi-year Gwich'in Traditional Knowledge study relating to the Mackenzie Gas Project, where she managed the budget, participated in the hiring committee for assistants, conducted community consultation, conducted interviews, handled contracts for transcribing, wrote reports, and many other tasks. Ms. Benson has conducted numerous studies with the Gwich'in Social and Cultural Institute since her first association with them in 2004. She has also worked with the Inuvialuit and in the Sahtu; and worked with the International Polar Year with scientists and communities across the NWT.

Janet Winbourne B. Sc., M.E.S., R.P.Bio. *Ethnobiologist* Over the last 15 years, Ms. Winbourne has conducted TK research amongst and for many Aboriginal groups, including numerous First Nations on the BC coast, as well as Inuvialuit and Gwich'in communities in the western Arctic. She is primarily a research ethnobiologist, but also worked as Community Knowledge Coordinator for the Gwich'in Renewable Resource Board in Inuvik in 2003-2004, managing all traditional and local knowledge research conducted by the GRRB, as well as the Gwich'in Harvest Study. Ms. Winbourne has previous experience compiling TK specific to species at risk planning. In 2009 she prepared **Haida Traditional Knowledge of Abalone** for

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use in the *2010 SARA Draft Abalone Action Plan*. She was the principal researcher on the Haida Marine Traditional Knowledge Study, responsible for collecting, compiling, analyzing and reporting information from hundreds of hours of interviews on approximately 200 species topics. This information was summarized in three report volumes, a TK database and GIS maps. Most recently, she has assisted on processing information for the *Gwich'in Traditional Knowledge of Boreal caribou* study.

SCIENTIFIC KNOWLEDGE COMPONENT

Names and classification

Rangifer tarandus (Lin.), subspecies *caribou* (Gmelin 1788; Banfield 1961, 1974), boreal ecotype

Common name used in this report: Boreal caribou

Other common names: Boreal woodland caribou, woodland caribou (boreal population)

Subpopulations: Northwest Territories

Synonyms: None

LIFE FORM: Animal, vertebrate, mammal, deer, caribou

The species under assessment is synonymous to “Boreal caribou (DU6)” under the designatable unit framework for caribou in Canada adopted by COSEWIC in November 2011 (COSEWIC 2011).

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; Environment Canada 2008; COSEWIC 2011). They are dark to tawny brown with white manes and sides, with a white area on the rump below the tail. Females will often flag their tails like white-tailed deer when alarmed (Figure 3, p.70). 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 3. Two adult female boreal caribou (*Rangifer tarandus caribou*) 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, GNWT.

Distribution

Continental distribution

Boreal caribou are native to Canada and are found nowhere else (Figure 4, p.73). 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) (Environment Canada 2011, 2012; COSEWIC 2011). Although the biological distribution of boreal caribou extends across political borders, boreal caribou in AB, BC and SK are recognized as separate local populations while those in YT are considered part of the NWT local population (Environment Canada 2012).

NWT distribution

The distribution of boreal caribou in the NWT was recently mapped in the national recovery strategy for boreal caribou (Environment Canada 2012). The distribution was based on the best available information provided by the Government of the Northwest Territories, including

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observational and telemetry data and biophysical characteristics (Environment Canada 2011, 2012). The distribution is largely known, although the distribution in the eastern part of the Sahtu Settlement Area requires verification (see *Search Effort*, p.72), and range boundaries may change with additional information.

The current distribution of boreal caribou in the NWT (hereafter referred to as the NWT current range) is shown in Figure 5 (p.74). The NWT current range is approximately 432,916 km². The boundary follows that of the Northwest Territories Range (NT1) identified in the national recovery strategy for boreal caribou (Environment Canada 2012), however the size is slightly smaller because the Yukon portion of NT1 is excluded. 95% of the NWT current range falls within the Taiga Plains Ecoregion (Ecosystem Classification Group 2007).

‘Extent of occurrence’ is an additional parameter used by the Species at Risk Committee to measure the spatial spread of the occupied areas in a standard way that can be applied to criteria for determining status. ‘Extent of occurrence’ is calculated as the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations (Species at Risk Committee 2010). The estimated ‘Extent of occurrence’ of boreal caribou in the NWT, calculated by drawing a minimum convex polygon around the NWT current range, is 659,714 km².

The ‘Biological area of occupancy’ is a parameter that represents the area of suitable habitat currently occupied. It is defined as the area within the extent of occurrence that is occupied by the species, excluding cases of vagrancy (Species at Risk Committee 2010). For boreal caribou in the NWT, which are mobile and dispersed at low densities, the ‘Biological area of occupancy’ is estimated at approximately the same as the NWT current 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 and that can be compared across taxonomic groups. The IAO is measured as the surface area of 2 x 2 km grid cells that intersect the actual area occupied by the species (i.e., the Biological area of occupancy; Species at Risk Committee 2010). For boreal caribou in the NWT, the IAO is 444,484 km².

A ‘location’ is defined by SARC 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

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should be defined by considering the most serious plausible threat (SARC 2010). The most serious plausible threat for boreal caribou in the NWT is habitat alteration (see *Threats and Limiting Factors*, p.98). Land management regimes may be used as a proxy for how habitat alteration may affect boreal caribou, since habitat management decisions affecting caribou may differ among these regimes. Some of the relevant land management regimes may be visualized in Figure 11 (p. 106). Within the current range of boreal caribou in the NWT there are four settled land claim areas, multiple unsettled land claims, and multiple protected areas, conservation zones and special management zones, both existing and proposed. Therefore, the number of ‘locations’ that are possible exceeds the threshold of 10.

Boreal caribou on the northern portion of the NWT current range are contiguous with those in the Peel River watershed, YT; those on the southern portion of the NWT current range are contiguous with boreal caribou in the Maxhamish and Calendar ranges in north eastern British Columbia and the Bistcho and Yates ranges in northern Alberta (Environment Canada 2011). Mountainous areas to the west of the Taiga Plains Ecoregion are occupied by the northern mountain woodland caribou ecotype; areas to the north and east are occupied by the migratory barren-ground caribou ecotype.

Search effort

The current distribution of boreal caribou in the NWT is largely known from collared caribou and incidental observations as described below.

Female boreal caribou (n=256) were tracked in portions of the NWT using Global Positioning (GPS) and Doppler shift (DS) satellite or very high frequency (VHF) radio-collars in the Gwich’in-north, Gwich’in-south, Sahtu, Dehcho-north, Dehcho-south, South Slave, and Cameron Hills/Bistcho Lake study areas (Figure 6, p.75) (Nagy *et al.* 2005; ENR 2006a, b, 2007; Larter and Allaire 2010; Kelly and Cox 2011; ENR 2011c). A total of 261,884 satellite locations were obtained during 2002-2011; 2,316 VHF locations were obtained during 2003-2008.

Government of the Northwest Territories (GNWT) and Environment Canada biologists and other people working or travelling in the NWT report incidental sightings of wildlife to the GNWT Wildlife Management Information System (WMIS). A total of 1924 observations of boreal caribou were recorded during 1978-2011. In addition, much of the northern NWT was surveyed in late winter 2005 and 2006 (Nagy *in review*) in preparation for a large scale deployment of

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satellite collars on barren-ground caribou and most boreal caribou observed were within the Mackenzie River Valley.

Parks Canada provided a map of boreal caribou observations within Wood Buffalo National Park (Parks Canada unpubl. data 2011).



Figure 4. Distribution of boreal caribou in Canada. The current distribution of boreal caribou is shown in brown. The estimated southern extent of historical woodland caribou distribution is indicated by the dashed line. Reproduced from Environment Canada (2012).

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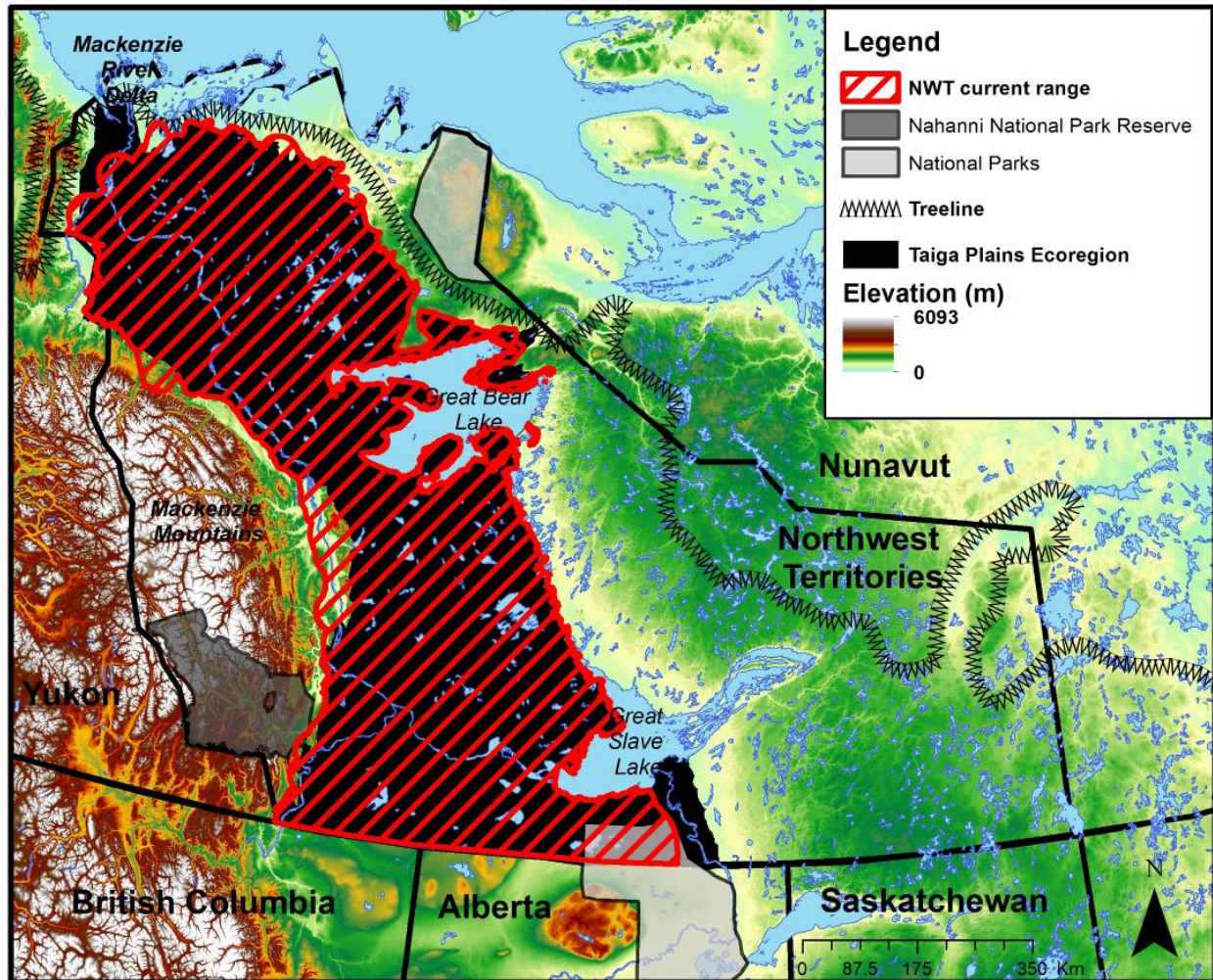


Figure 5. Current range of boreal caribou in Northwest Territories (based on the NT1 range defined by Environment Canada (2012) with Yukon excluded).

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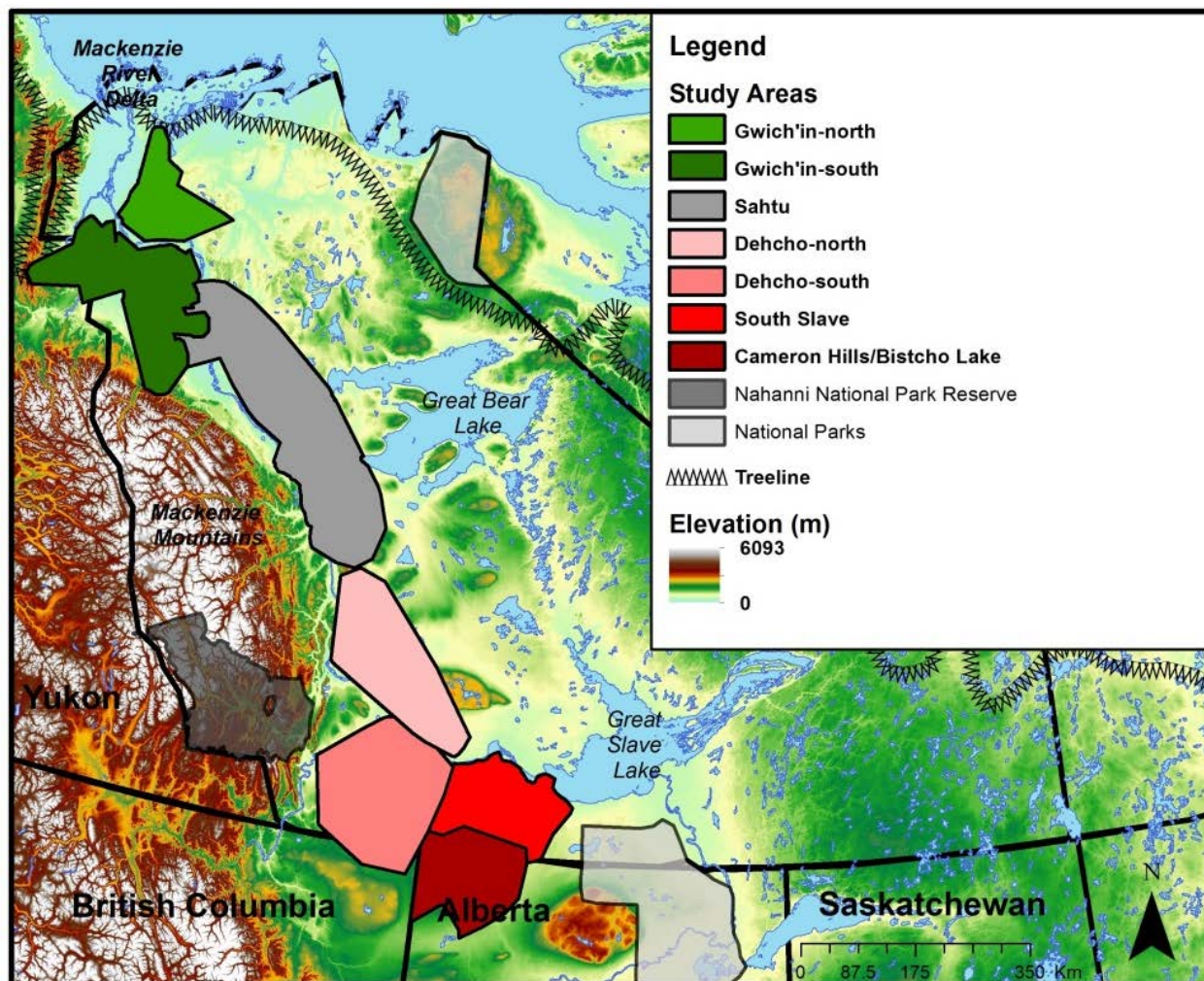


Figure 6. Boreal caribou study areas in the Northwest Territories.

Cluster analyses of location data obtained for 140 boreal caribou tracked with satellite collars for more than one year during 2002-2009 revealed two distributions suggesting two boreal caribou subpopulations in the NWT (Nagy *et al.* 2011; Nagy 2011) that are separated by about a 50 km gap centered on the Bear River drainage between Great Bear Lake and the Mackenzie River. This apparent gap in distribution may be an artifact of a temporary fire disturbance (Environment Canada 2011; Nagy 2011) and/or a lack of collar deployments in the local area (Sayine-Crawford and Popko pers. comm. 2012). Nagy (2011) acknowledges that some results are limited by the proportionately small number of animals that have been tracked annually and thus an artifact of regional collar deployments. A later analysis of collar data from 2009-2011 revealed some

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movement of collared caribou across the gap, however interpretation of this is limited as there were only five collared caribou in the immediate 25,000 km² area around the gap (Environment and Natural Resources 2012a). Boreal caribou in the NWT are currently being managed as a single population unit (Environment Canada 2012); more data are needed to clarify whether a gap in distribution exists.

Boreal caribou are poorly surveyed in the northeastern portion of their NWT range, in the eastern part of the Sahtu Settlement Area. The databases of 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 of people in Fort Good Hope and Colville Lake and by R. Popko (Olsen *et al.* 2001; Popko pers. comm. 2012) 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 Sahtu. 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 evidence that subpopulations have disappeared or new ones have appeared for the whole of the NWT. It is not possible to determine if temporal changes in the distribution of boreal caribou have occurred at the range level.

Habitat

Habitat requirements

Boreal caribou use a variety of habitats during the year. These generally include bogs, fens, and areas around peat lands with low to moderate cover of lichen-bearing black (*Picea mariana*) and white (*P. glauca*) spruce forests (Rettie and Messier 1998; Anderson 1999; Brown *et al.* 2000; James and Stuart-Smith 2000). Open old growth lichen-bearing conifer forests are preferred during most of the year; lichens are selected during winter (Fischer and Gates 2005; Benson 2011).

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Boreal caribou generally select areas that have not been disturbed by fire (Schaefer and Pruitt 1991; Dalerum *et al.* 2007; ENR Dehcho Region 2010; Environment Canada 2011), likely because fire can destroy lichen and result in young seral stands (Environment Canada 2011). However, boreal caribou may use or even select recent burns in certain seasons (Nagy *et al.* 2005, 2006; Environment Canada 2011, 2012). For example, they may select open habitats (such as recent burns) during certain times of the year to access other high quality forage sources (herbaceous vegetation and shrubs), to avoid predators, for insect relief, or to rut (Nagy *et al.* 2005).

Nagy *et al.* (2006) assessed habitat use by satellite-collared female boreal caribou in the Gwich'in and Sahtu study areas (Figure 6, p.75) using resource selection function models (Manly *et al.* 2002). Open conifer lichen and open woodland needle-leaf land cover types (Ducks Unlimited 2002) were most highly selected during the early, mid, and late winter and pre-calving, calving, and post-calving periods (Nagy *et al.* 2006). Other cover types used during these periods included recent burns and riparian, tussock tundra, low shrub, and open mixed needle-leaf land cover types. Caribou may only use recent burns in winter to access unburned patches of preferred habitat. During summer and fall, tussock tundra and recent burns were the most highly selected land cover types. In addition, open habitats such as sparse/non-vegetated, lichen, low shrub, and open conifer were also used (Nagy *et al.* 2005). In the Dehcho, South Slave, and Cameron Hills/Bistcho Lake study areas, open conifer land cover classes (Earth Observation for Sustainable Development of Forests; EOSD) (Wulder and Nelson 2003) were most used throughout the year (ENR Dehcho Region 2010).

There is a negative relationship between cumulative habitat disturbance and boreal caribou calf recruitment. An analysis of information from 24 boreal caribou study areas across Canada found that nearly 70% of the variation in caribou recruitment was explained by a single composite measure of total disturbance (fire plus buffered anthropogenic). As total habitat disturbance increases, mean recruitment decreases (Environment Canada 2008, 2011).

A number of factors determine if available preferred land cover meets the habitat requirements for boreal caribou to maintain growth rates that are indicative of stable or increasing populations. Boreal caribou may either avoid fire-disturbed areas (Schaefer and Pruitt 1991) or use them less than expected during most of the year (Nagy *et al.* 2005; Nagy *et al.* 2006). In the southern NWT post-fire regeneration of vegetation to preferred lichen-bearing open conifer stands may take up to 100 years (ENR Dehcho Region 2010) while in the Mackenzie Delta area it may take 70-230

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years (Seccombe-Hett and Walker Larsen 2004). The likelihood of post-fire regeneration to lichen-bearing old growth stands is determined, in part, by the average fire-return interval or fire cycle (Thomas and Gray 2002); fire frequency in the Mackenzie River Basin is predicted to increase with climate warming (Cohen 1996). If the fire cycle is shorter than the regeneration time then areas that have been disturbed by fire may be held at earlier seral stages. Early seral habitats are favoured by moose (*Alces alces*), bison (*Bison bison*), deer (*Odocoileus virginianus*), elk (*Cervus canadensis*), and black bears (*Ursus americanus*) and, as a result, predator-prey dynamics may be altered for extended time periods in boreal caribou ranges that are frequently disturbed by fire (Latham *et al.* 2011a).

Many species avoid habitats with high densities of linear disturbances (such as seismic lines) (McLellan and Shackleton 1988; James and Stuart-Smith 2000) causing functional habitat loss (Dyer 1999). Linear features may have long lasting effects. Past studies have found varying effects of seismic lines on boreal caribou behaviour (James and Stuart-Smith 2000; Dyer *et al.* 2001, 2002). In the NWT and northern Alberta, where average seismic line densities ranged from 0.12 to 3.33 km per km², the response of satellite-collared female boreal caribou varied during the year (Nagy 2011; Nagy *et al. In prep-a*). These responses are provided below (Nagy 2011; Nagy *et al. In prep-a*).

1. Avoidance of seismic lines

- (i) Females avoided areas near seismic lines during periods when females and calves were most vulnerable to predators or hunters (hereafter the avoidance period). Females did not avoid seismic lines during the rest of the year (hereafter the non-avoidance period).
- (ii) 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.
- (iii) 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.
- (iv) The avoidance responses were graded, i.e., use of areas increased as the distance from seismic lines increased.

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(v) Use of areas near seismic lines by females during the non-avoidance period was variable.

2. Effects on movement

- (i) Females crossed significantly fewer seismic lines than expected if their movements were random (during the avoidance period only).
- (ii) Females travelled at faster rates during all times of the year when they crossed seismic lines than they did before or after crossing them.
- (iii) 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 increases and that seismic lines are permeable barriers to caribou movement throughout the year.

In combination, these boreal caribou behavioural responses have lead to functional habitat loss in areas around seismic lines and other anthropogenic linear features in the NWT and other areas (Dyer *et al.* 2002; Latham *et al.* 2011a; Nagy 2011; Nagy *et al. In prep-a*). Functional habitat loss means that habitats are not destroyed or reduced in quality but are lost to caribou because they avoid using areas near these linear features.

In northern Alberta, linear features are important movement corridors for wolves during the snow-free period (April-September; caribou seismic line avoidance period). This is the period when members of a pack, rather than hunting together as a pack, hunt in smaller groups and as a result form the greatest number of hunting units (Latham *et al.* 2011a). Seismic lines may allow wolves to travel faster and increase their hunting efficiency in caribou habitat (James 1999; James and Stuart-Smith 2000; Neufeld 2006). Although boreal caribou in the Cameron Hills/Bistcho Lake, South Slave, and Dehcho study areas avoided seismic lines during all or part of this period, most mortalities of adult females recorded in 2003-2010 occurred during this period, and most of these mortalities were due to wolf predation (Larter and Allaire 2010; Kelly and Cox 2011).

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

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(Stuart-Smith *et al.* 1997). Dyer *et al.* (2001) found that boreal caribou avoided areas ≤ 250 m from seismic lines in Alberta; Nagy (2011) and Nagy *et al.* (*In prep-a*) found that boreal caribou avoided areas ≤ 400 m from seismic lines in the NWT. Schaefer and Pruitt (1991) found that boreal caribou avoided areas disturbed by fires; Nagy *et al.* (2005) found that use of burned areas varied during the year but was lowest during winter; and ENR Dehcho Region (2010) reported that boreal caribou selected 100+ year old open conifer stands during most of the year. If boreal caribou avoid areas near seismic lines to reduce predation risk then they should perceive areas undisturbed by fire >400 m from seismic lines as preferred secure habitats and areas ≤ 400 m from seismic lines as risky habitats (Nagy 2011; Nagy *et al.* *In prep-a*; Nagy *et al.* *In prep-c*).

Nagy (2011) and Nagy *et al.* (*In prep-c*) found that boreal caribou population growth rates were highly correlated with the availability and use of patches of secure habitat >500 km²; boreal caribou that had access to large areas or “patches” of secure unburned habitat (>500 km²) during the seismic line avoidance period had higher population growth rates than those that did not. The spatial configuration of habitat at the range level, i.e. the size, shape, and distribution of patches of preferred habitats, is important when assessing habitat quality for boreal caribou (O'Brien *et al.* 2006). Boreal caribou require large patches (>500 km²) of secure boreal forest to effectively employ their anti-predator strategies to reduce predation risk (Nagy 2011; Nagy *et al.* *In prep-c*).

Habitat availability

Although boreal caribou in the NWT are currently being managed as a single population unit (Environment Canada 2012), there are broad differences in availability of habitat between the southern and northern portions of the NWT current range. These differences could affect boreal caribou population growth rates at a local or regional level. Therefore, the NWT current range was divided into a northern and southern study area to assess habitat conditions (Figure 7, p.82). This division was based on the northern limits of mixed-wood and jack pine forests, indicating a shift to colder climatic conditions around the Bear River drainage.

Categories of habitat available for boreal caribou in the NWT were defined using information presented above in the section on *Habitat requirements* (p.76). ‘Risk habitat’ was defined as areas ≤ 400 m from seismic lines, pipelines, and roads; ‘secure burned habitat’ was defined as areas >400 m from seismic lines and disturbed by wildfires during 1965-2010; and ‘secure unburned habitat’ was defined as undisturbed habitats >400 m from seismic lines. Fire data for this analysis were obtained from the NWT WMIS and Government of Alberta; seismic line data

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were obtained from the Canadian National Energy Board, National Topographic Series (NTS) map database, Dehcho Land Use Planning Board, and Government of Alberta; and road and pipeline data were obtained from the NTS map database.

The amount of undisturbed habitat available for boreal caribou in the NWT was determined by measuring the total amount of secure unburned habitat in the boreal caribou current range (Table 4). All areas of undisturbed habitat may not be preferred by boreal caribou, however they provide connectivity between habitats that are preferred.

Approximately 62% of the NWT current range (excluding water) was secure unburned habitat (Table 4). Approximately 69% of the northern study area (excluding water) was secure unburned habitat. In comparison, approximately 56% of the southern study area (excluding water) was secure unburned habitat. Overall, the northern part of the current range provides more secure habitat than the southern part.

Table 4. Percent of Northwest Territories boreal caribou current range that is comprised of risk, secure burned, and secure unburned habitat. Risk habitat=areas ≤ 400 m from seismic lines, pipelines, and roads; secure burned habitat=areas >400 m from seismic lines and disturbed by wildfires during 1965-2010; and secure unburned habitat=undisturbed habitats >400 m from seismic lines. Water (lakes and rivers visible on 1:2,000,000 NTS topographic maps) makes up approximately 6-7% of the current range. Water was removed from the habitat model, therefore areas and percentages reported are for terrestrial habitat only.

Area	NWT		NWT northern habitat assessment study area		NWT southern habitat assessment study area	
	area (km ²)	% of area	area (km ²)	% of area	area (km ²)	% of area
Current range (excluding water)	404,539		180,404		224,134	
Current range risk habitat	64,316	16	24,212	13	40,104	18
Current range secure burned habitat	90,050	22	31,886	18	58,164	26
Current range secure unburned habitat	250,173	62	124,306	69	125,866	56

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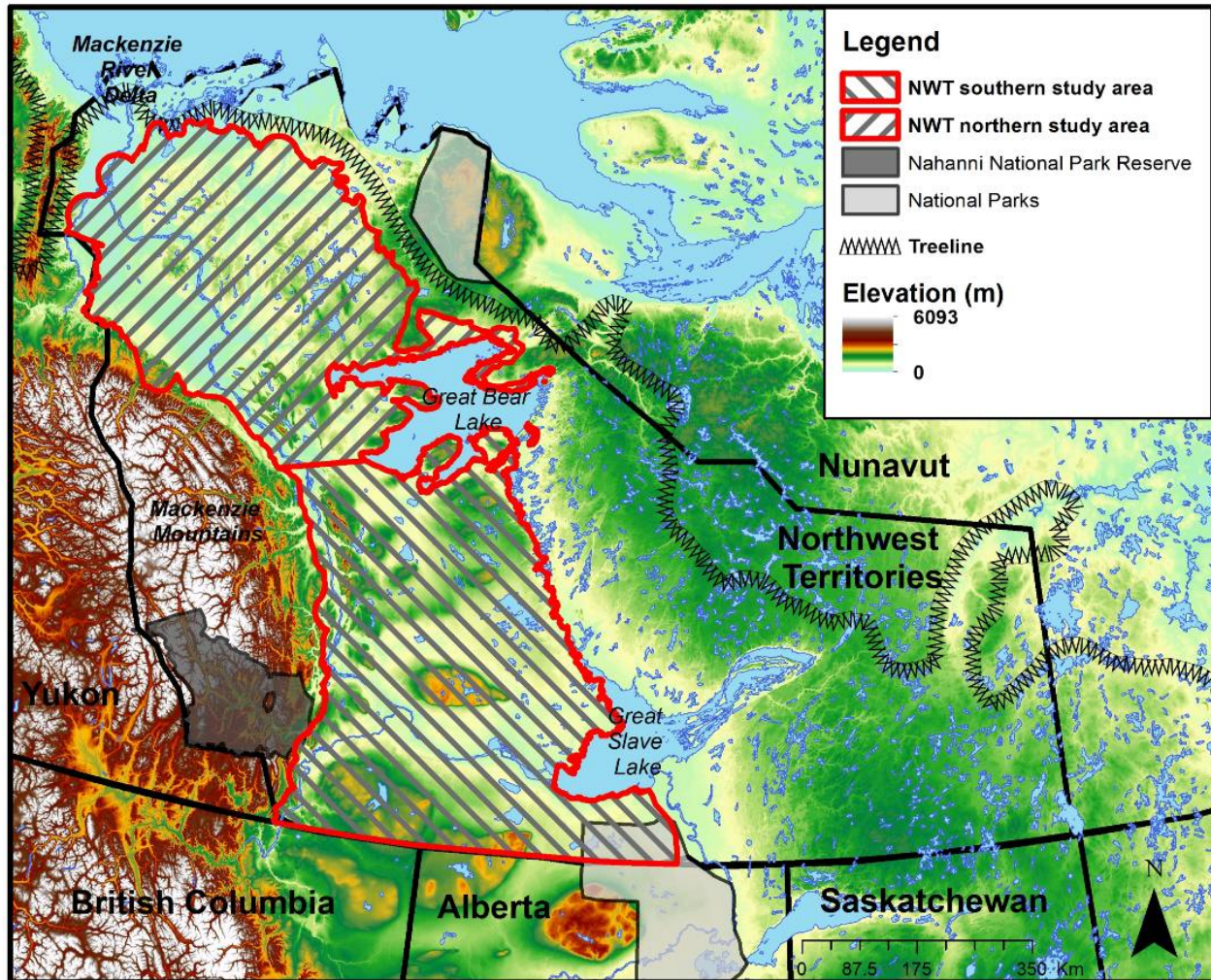


Figure 7. Boundaries of the northern and southern study areas used to assess habitat conditions in the Northwest Territories. The northern limits of mixed-wood and jack pine forests are at about 65° N latitude (Ecosystem Classification Group 2007) indicating a shift to colder climatic conditions to the north. Because the Bear River drainage is at this latitude, a line centered on this landmark was used to divide the two study areas. The northern habitat assessment study area covers approximately 44% of the NWT current range while the southern habitat assessment area covers approximately 56%.

Habitat fragmentation

Habitat fragmentation in the NWT has been caused by fires (natural disturbance) and development activities (seismic lines, pipelines, and roads). The majority of this habitat disturbance is natural. The recent analysis by Environment Canada (2011, 2012) found that 24% of NWT habitat was disturbed by fires within the last 40 years, whereas 8% was disturbed by

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anthropogenic disturbances buffered by 500m.

The analysis of habitat categories presented in *Habitat Availability* (p.80) found that secure unburned habitat patches >500 km² covered approximately 188,000 km² (43%) of the NWT current range. The degree of habitat fragmentation, based on variation in patch sizes of secure unburned habitats (Nagy *et al. In prep-c*) (Table 5), decreased from south to north. 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 km², with 56% of the secure unburned habitat in the Cameron Hills/Bistcho Lake study area in patches ≤10 km² (Table 5 and Figure 8, p.84). Secure unburned habitats in the Dehcho-north and Gwich'in-south study areas were moderately fragmented, with 46-54% occurring in patches >500 km² and 8-10% in patches ≤10 km². The Gwich'in-north study area was least fragmented with 88% of the secure unburned habitat in patches >500 km². Population growth rates in these study areas were strongly correlated with the availability of large patches of secure unburned habitat (>500 km²) (Nagy 2011; Nagy *et al. In prep-c*).

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

Table 5. Percent of boreal caribou study areas by unburned secure habitat patch size (km²) (Nagy 2011).

Study Areas ⁱ	Percent of area by secure unburned habitat patch size (km ²) ⁱⁱ												
	≤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	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

ⁱThe locations of the six study areas are shown in Figure 6.

ⁱⁱFire 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.

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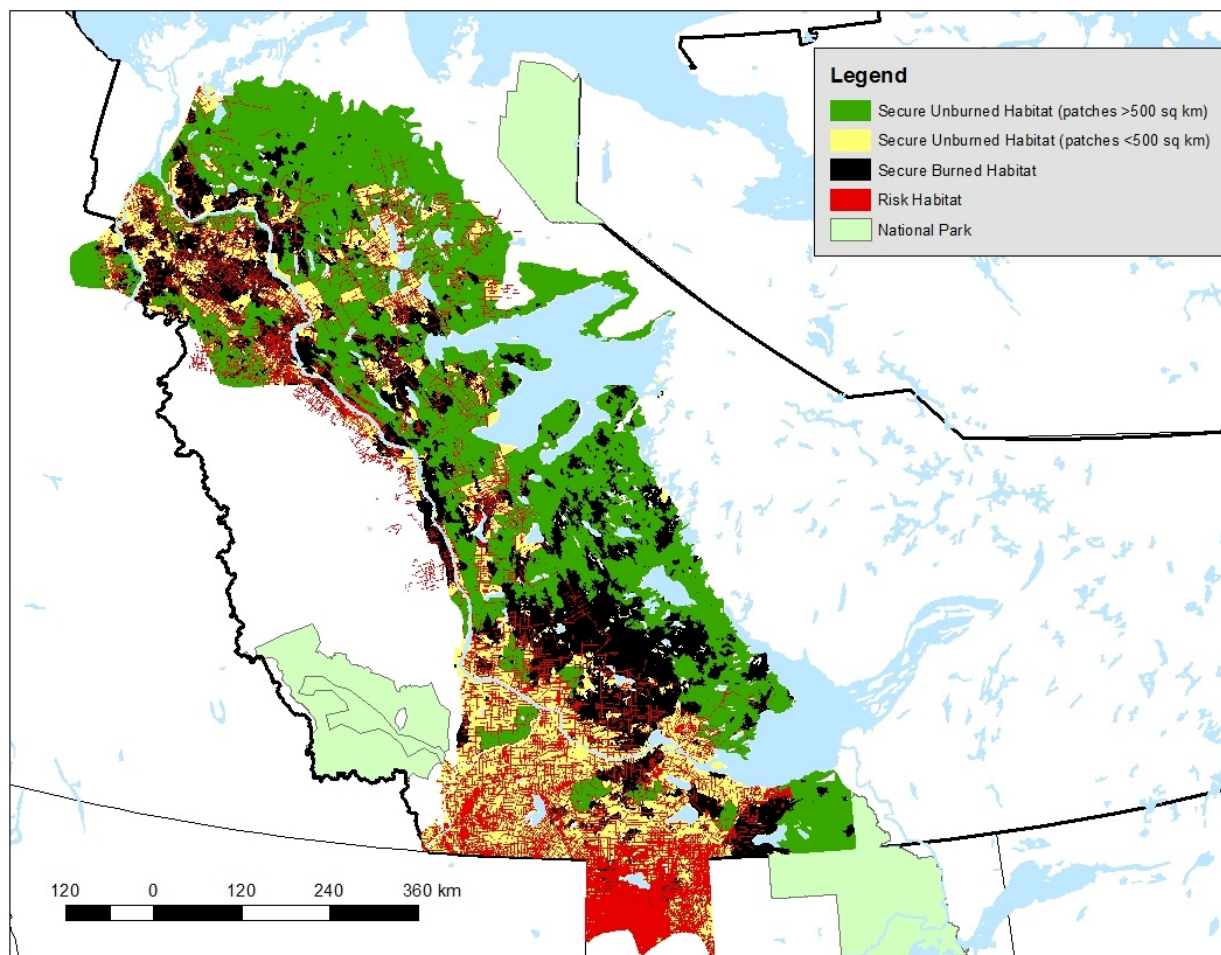


Figure 8. Distribution of secure unburned habitat, secure burned habitat, and risk habitat in the NWT current boreal caribou range and northern Alberta, Canada. Habitat classes include: i) secure unburned habitats (areas >400 m from seismic lines, pipelines, and roads that were not disturbed by wildfires during 1965-2010); patches >500 km² in green and patches <500 km² 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; Nagy *et al. In prep-c*). 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.

year but they are less likely to cross them during periods when cows are most vulnerable to predators (Nagy 2011; Nagy *et al. In prep-a*). The Mackenzie and Hay rivers may be significant barriers to caribou movement in the NWT; very few satellite-collared cows tracked in the NWT during 2002-2011 crossed the Mackenzie or Hay rivers.

Habitat trends

Fires and anthropogenic 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. The local availability and security value of boreal forests (Nagy 2011; Nagy *et al. In prep-c*) and as a result the local distribution of boreal caribou are influenced by disturbances caused by fire and human land-use activities (e.g., seismic lines, roads, etc.).

When fire and seismic lines are considered together, estimates of the amount of NWT habitat currently affected by these disturbances are approximately 44% (18% risk and 26% secure burned habitat) and 31% (13% risk and 18% secure burned habitat) in the southern and northern habitat assessment study areas, respectively (Table 5, p.83). Because there is a negative relationship between total habitat disturbance and boreal caribou recruitment (Environment Canada 2011), boreal caribou in the southern NWT would be expected to have lower recruitment than those in the northern NWT.

Additional information is needed to help inform boreal caribou-fire disturbance trends. Often fire is mapped as an overall range or polygon in the NWT and it is common that there may be habitat patches within the polygon that remain unburned. These may still be suitable habitat, if caribou can access them. Additionally, any one fire does not equal another in terms severity; however, information on the severity of fires is not available in the NWT database. Therefore, while these data can be used as an index of fire disturbance, they must be interpreted with caution.

Approximately 31% of the southern habitat assessment study area was disturbed by fire during 1965-2010 (ENR 2011a). In comparison, 21% of the northern habitat assessment study area was disturbed by fire during 1965-2010 (Figure 9, p.86).

There are approximately 35,416 km (average 0.18 km per km²) and 57,772 km (average 0.24 km per km²) of seismic lines in the northern and southern study areas, respectively (Nagy *et al. In prep-c*).

Although seismic lines are relatively narrow linear features, generally <8 m wide, their impact on boreal caribou is more significant when functional habitat loss up to 400 m on either side of these features is considered (see section *Habitat requirements*, p.76). Some seismic lines were cut in the 1960s and 1970s, but the state of regeneration to preferred boreal caribou habitat on these lines is largely unknown.

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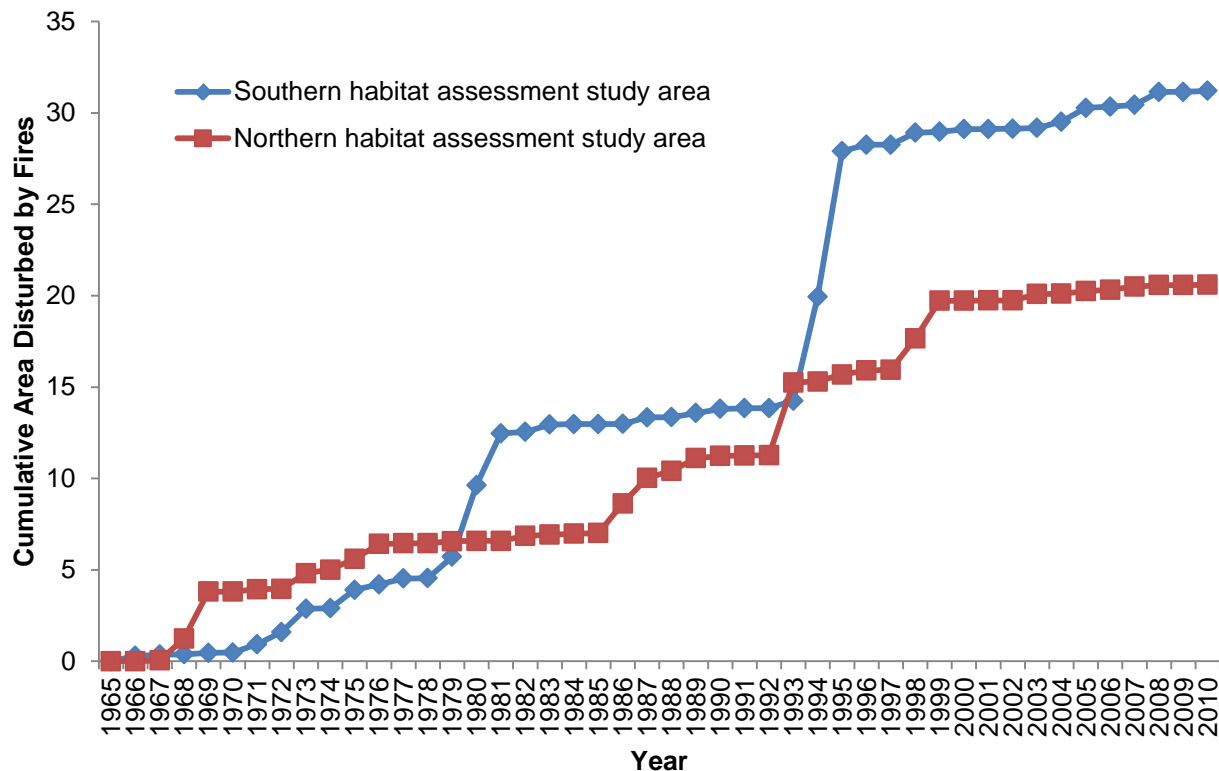


Figure 9. Cumulative percent of the southern and northern habitat assessment study areas that were disturbed by fires during 1965-2010 (based on data from ENR 2011a).

The future trend for boreal caribou habitat in the NWT will be determined over the next 5-10 years by how the most significant range-wide impacts on boreal caribou are managed. Important factors are whether or not i) habitat management models that consider patch size, distribution, and connectedness of undisturbed preferred boreal caribou habitats are used; ii) existing anthropogenic linear disturbances are restored to states that discourage predators from using them as travel corridors; and iii) existing large areas of undisturbed habitat are protected from anthropogenic or fire disturbance.

Climate change is occurring more rapidly in the Mackenzie Basin than in most other areas of North America. Anticipated regional effects include landslides from permafrost thaw, reduction in water levels, shorter winters (early spring melt, later freeze-up), more precipitation, lower forest yields, and more forest fires (changing vegetation cover) (Cohen 1996, Olsen *et al.* 2001, IPCC 2007). In the forested part of the NWT, warmer and more variable weather in all seasons is

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already being observed. However, winter snowfall appears to be declining, and the number and area of forest fires did not increase between 1990 and 2010 (ENR 2011b).

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). These changes in permafrost have been studied on a small-scale study area in the Dehcho region. How these changes scale up to the regional level or at the level of the entire boreal caribou range in the NWT is under investigation (research partners include Wilfred Laurier University, Canadian Forest Service and Environment and Natural Resources Forest Management Division). We may expect that permafrost thaw will change boreal caribou habitat, especially in areas of discontinuous permafrost.

There are specific projects planned that could have significant anthropogenic impacts on boreal caribou habitat over the next 5-10 years. In the Sahtu region, extensive petroleum exploration and coal mining activities are planned (Veitch pers. comm. 2011). Oil and gas exploration in the Sahtu in 2011 and 2012 has created a new disturbance footprint which has not been measured or included in the previous calculations of total habitat disturbance. In the Mackenzie River Valley corridor, the construction of the Mackenzie Valley Pipeline and Mackenzie Valley Highway are proposed. Petroleum exploration activities will likely accelerate in the current boreal caribou range once the decision to build the pipeline is made; an increase in human disturbance and hunter access within the Mackenzie River Valley corridor should be anticipated as the pipeline and highway would transect the current boreal caribou range in the NWT. A NWT Biomass Energy Strategy has been developed that promotes the increased use of wood and wood pellets as an alternative source of energy (ENR 2010a); related actions which promote the harvest of sawlogs and wood in the NWT could lead to habitat alteration for boreal caribou if implemented.

Biology

Life cycle and reproduction

Female boreal caribou first breed at age two (Bergerud 1974) and produce their first calves at age three. Females likely produce calves up to a maximum age of at least 17 years (Larter and Allaire 2010). The generation time (average age of parents of newborn individuals in the population) has

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been estimated at approximately 7 years by COSEWIC (Thomas and Gray 2002) and by Fuller and Keith (1981); detailed information for calculating generation time according to IUCN guidelines (IUCN Standards and Petitions Subcommittee 2011) was not available. Because females likely produce young up to maximum age, generations overlap.

The mating system is polygynous, with dominant bulls breeding with a number of cows (Ministry of Environment 2010). In the southern NWT (Cameron Hills, South Slave, and Dehcho study areas; Figure 6, p.75) females bred during 13 September - 20 October (peak 20 September - 4 October) and single calves were born during 30 April - 6 June (peak 7-21 May). In the northern NWT (Sahtu and Gwich'in study areas) females bred during 12 September - 22 October (peak 26 September - 10 October) and single calves were born during 29 April-8 June (peak 13-27 May) (Table 6, p.89) (Nagy 2011; Nagy *et al. In prep-b*). Females in the southern NWT were bred and calved approximately 6 days earlier than those in the north. Most calves were born over a 28 day period in both areas (Nagy 2011). Calf survival during the first six weeks of life is low, often 50% or less (Bergerud 1974).

Female boreal caribou disperse and are solitary during pre-calving and calving, a strategy that is used to reduce predation risk (James 1999; Dzus 2001; Schaefer *et al.* 2001; Bergerud *et al.* 2008). Unlike barren-ground caribou that congregate on distinct calving grounds, female boreal caribou space-away from each other during calving. As a result, large areas of secure calving habitat are required to reduce predation risk and facilitate survival of calves and females.

Figure 24 (in confidential Appendix B, p.147) shows the distribution of calving sites recorded for radio-collared boreal caribou in the NWT. Because females have not been radio-collared throughout the entire NWT current range, the full calving distribution of boreal caribou in the NWT is unknown. In the NWT, females exhibit a low degree of fidelity to sites where they previously calved, with an average distance of 25.3 km (range 0.1 to 234.5 km) between calving sites used by individual females (n=99; Table 7, p.89). The average distance from calving sites used by an individual radio-collared female to the nearest site used by other radio-collared females was 24.7 km (range 0 to 191.4 km; Table 7, p.89). 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; Nagy *et al. In prep-b*). However, these distance measures indicate that a wide range of dispersed calving sites are used.

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Table 6. Movement rates by activity period for boreal caribou in the southern study areas (Dehcho-north, Dehcho-south, South Slave, and Cameron Hills) and northern study areas (Gwich'in-north, Gwich'in-south, and Sahtu) in 1993-2009 (Nagy 2011; Nagy *et al. In prep-b*).

Activity period	Boreal caribou study areas					
	Southern			Northern		
	Dates	Daily mean (km)	Stdev	Dates	Daily mean (km)	Stdev
Pre-calving, calving, post-calving	5 Apr - 6 Jun	2.95	4.1	25 Apr - 8 Jun	3.08	4
Calving	30 Apr - 6 Jun			29 Apr - 8 Jun		
Peak calving	7 May - 21 May			13 May - 27 May		
Early/mid summer	7 Jun - 12 Aug	4.23	4	9 Jun - 23 Jul	3.16	2.71
Mid/late summer	13 Aug - 12 Sep	4.63	3.62	24 Jul - 11 Sep	3.62	2.76
Breeding	13 Sep - 20 Oct	4.63	4.52	12 Sep - 22 Oct	3.67	3.06
Peak breeding	20 Sep - 4 Oct			26 Sep - 10 Oct		
Late fall	21 Oct - 30 Nov	5.03	4.27	23 Oct - 30 Nov	4.89	4.22
Early winter	1 Dec - 25 Jan	3.25	3.12	1 Dec - 20 Jan	3.03	2.84
Midwinter	26 Jan - 15 Mar	2.22	2.55	21 Jan - 10 Mar	1.71	2.12
Late winter	16 Mar - 4 Apr	1.44	1.55	11 Mar - 24 Apr	1.12	1.64

Table 7. Boreal caribou calving site fidelity and distance to nearest adjacent calving site of a radio-collared individual¹.

Study Area	Fidelity (km between calving sites used by individual females)				Nearest calving site (km to the nearest site used by another radio-collared female)			
	N	Average	Min	Max	N	Average	Min	Max
Cameron Hills	23	30.3	0.2	234.5	36	14.3	0.2	77.9
Dehcho/South Slave	46	23.4	0.1	213.2	66	25.8	0	184.8
Gwich'in Settlement Area	16	33.8	0.8	107	25	23.7	1.2	96.6
Sahtu Settlement Area	14	17.9	0.5	50.6	27	36.7	3.7	191.4
Total	99	25.3	0.1	234.5	154	24.7	0	191.4

¹These calculations were made for this report using locations shown in Figure 21 (in confidential Appendix B, p.147).

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Calves remain with the maternal females until the next pre-calving dispersal period. Mixed sex groups begin to form in late summer (August) in preparation for the rut. In the Gwich'in study areas typical group sizes were about 12 in late winter (March-April), four in May, two in summer (June-mid August; female:calf pairs), and mixed sex groups of nine in fall (September-November). However, mixed sex groups of up to 26 were observed during the rut/post rut period (Nagy *et al.* 2005). Larter and Allaire (2009) found group sizes were largest during March and April in the Dehcho study areas, although some caribou were still found in small groups. 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 (Figure 22, in confidential Appendix B, p.147).

Physiology and adaptability

Boreal caribou are adapted to feeding on lichens but also consume a number of other plants (Thomas and Gray 2002). 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 (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).

Interactions

Wolves are the primary natural predators of adult female boreal caribou throughout most of Canada (Bergerud 1974; Seip 1992; McLoughlin *et al.* 2003; Latham *et al.* 2011a). In the Dehcho (2004-2009), Cameron Hills (2005-2008), and South Slave (2003-2010) study areas, 73% (24/33), 92% (12/13), and 68% (13/19) of radio-collared female mortalities, respectively, were caused by wolf predation (Kelly and Cox 2010; Larter and Allaire 2010). Although only three mortalities were observed among radio-collared females in the Gwich'in study areas during 2002-2004, one of these mortalities was caused by wolf predation (Nagy *et al.* 2005).

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

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high rates of wolf-caused caribou mortalities (Latham *et al.* 2011a). Early seral vegetation provides habitat for primary prey species such as moose, white-tailed deer, bison, and elk (Latham *et al.* 2011b) and for omnivores such as black bears (*Ursus americanus*). 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 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.* 2011b).

In addition to wolves, black bears and lynx (*Lynx lynx*) occur throughout the range of boreal caribou in the NWT. Black bears are known to kill boreal caribou females in the NWT (Kelly and Cox 2010; Larter and Allaire 2010). Although no population studies have been conducted on black bears in the NWT, the general view is that they occur at low densities relative to other jurisdictions. Lynx are known to attack caribou in Alaska and the Yukon (Stephenson 1991; Mowat and Slough 1998). Lynx are cyclic with densities reaching 30 per 100 km² when populations peak in some areas of the NWT (Poole 1994). Cougars do 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).

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. 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.* 2011c). One study in Quebec found that 57% of newborn boreal caribou calf mortality was caused by black bear predation (Pinard *et al.* 2012).

The role that migratory barren-ground caribou play as possible competitors with boreal caribou is unknown. Barren-ground caribou winter ranges (Nagy 2011; Nagy *et al.* *In prep-b*) 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*, p.72). It is possible that the two types of caribou may compete for space and resources in the zone of overlap.

Population

Structure and rates

Boreal caribou were classified during surveys conducted during late winter in most study areas in the NWT. Composition data for the Dehcho were summarized by Larter and Allaire (2010); data for the remaining study areas in the NWT have not yet been summarized. On average 26%, 56%, 2%, and 16% of the caribou observed in the Dehcho were bulls, cows, yearlings, and calves, respectively (Table 8, p.92).

Most adult female boreal caribou are reproductive and produce calves (Stuart-Smith *et al.* 1997; Rettie and Messier 1998; McLoughlin *et al.* 2003). In the NWT most mature females (95-100%) that were captured in late winter and tested for pregnancy were pregnant (Nagy 2011) and 95% (82/86) were predicted to have produced a calf during the calving period (Nagy 2011; Nagy *et al.* *In prep-b*).

Adult female survival, recruitment, and growth rates in the Cameron Hills, South Slave, Dehcho, and Gwich'in study areas (Figure 6, p.75) were documented by tracking radio-collared females. In the Cameron Hills study area, annual adult female survival (range 0.71-0.91), recruitment (range 0.10-0.21), and growth rates (range 0.74-1.0) varied during 2005-2009; in combination

Table 8. Late winter age-sex composition of boreal caribou in the Dehcho, Northwest Territories, Canada, 2006-2010 (Larter and Allaire 2010).

Age-sex class	Number and percent classified by year					Average
	2006	2007	2008	2009	2010	
Males	35	70	61	80	61	
Females	94	114	145	160	128	
Yearlings	13	6	1	1	1	
Calves	27	26	34	50	45	
Total	169	216	241	291	235	
% Males	21	32	25	27	26	26
% Females	56	53	60	55	54	56
% Yearlings	8	3	0	0	0	2
% Calves	16	12	14	17	19	16

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these values indicate that caribou in this area may have declined by about 50% during this period (Table 9, p.94) (Kelly and Cox 2011). In the South Slave study area, annual adult female survival (range 0.76-0.91), recruitment (range 0.16-0.50), and growth rates (range 0.83-1.0) varied during 2003-2009; in combination these values indicate that caribou in this area may have declined by about 25% or may have been stable (Table 9, p.94) (Kelly and Cox 2011). In the Dehcho-south study area adult female survival (range 0.63-0.94), recruitment (range 0.26-0.47), and growth rates (range 0.72-1.11) varied during 2005-2009. In the Dehcho-north study area adult female survival (range 0.60-1.00), recruitment (range 0.19-0.67), and growth rates (range 0.72-1.22) also varied during 2005-2009. In both the Dehcho-north and Dehcho-south study areas growth rates were improving in the later years of the study (since 2008), likely because female survival had remained consistent while the number of calves seen had increased. However the mean growth rate over the full 5 years studied was <1. The values indicate that caribou declined by about 40% in the Dehcho-south and 20% in the Dehcho-north over 5 years (Table 9, p.94) (Larter and Allaire 2010).

In comparison, growth rates based on adult female survival and calf recruitment in the Gwich'in-south and Gwich'in-north study areas were 1.08 and 1.20, respectively, during 2003-2007 (Gwich'in-south) and 2005-2007 (Gwich'in-north), indicating that caribou in these study areas increased at annual rates of 8 and 20% (Nagy 2011; Nagy *et al. In prep-c*). Data collected in the Sahtu study area have not yet been analyzed (Veitch pers. comm. 2011).

Movements

Movement rates (km travelled per day) vary during the year and reflect changes in activity. Nagy (2011) and Nagy *et al. (In prep-b)* defined eight activity periods for boreal caribou in the NWT based on significant changes in movement rates (Table 6, p.89); activities were largely synchronized among females in the southern and northern study areas. Movement rates progressively increased from post-calving until the late fall then progressively decreased during early through late winter. The lowest movement rates occurred during the first few days around calving and in late winter; the highest movement rates occurred during late fall when females search out the areas where they will winter (Table 6, p.89). The late winter period was 20 days for caribou in the southern study areas and 44 days for those in the northern study areas; this difference likely reflected latitudinal differences in winter length (Nagy 2011; Nagy *et al. In prep-b*).

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Table 9. Adult female survival, recruitment rates and growth rates (λ) for boreal caribou in the South Slave, Cameron Hills/Bistcho Lake, Dehcho-south, and Dehcho-north study areas, 2003/2004 to 2009/2010 (Larter and Allaire 2010, Kelly and Cox 2011). Number of females tracked for Dehcho study areas are from ENR (unpubl. data 2012c). Data analysis methods varied between studies therefore only means are reported.

Study areas and demographic parameter	Year						
	2003/ 2004	2004/ 2005	2005/ 2006	2006/ 2007	2007/ 2008	2008/ 2009	2009/ 2010
South Slave							
Mean adult female survival	0.76	0.90	0.90	0.86	0.84	0.91	0.84
No. females tracked	35	33	33	37	44	37	31
Mean recruitment	0.18	0.22	0.18	0.16	0.22	0.19	0.5
No. females tracked	33	46	44	33	38	38	19
Mean growth rate (λ)	0.83	1.00	0.98	0.93	0.93	1.00	1.06
No. females tracked	35	33	33	37	44	37	31
Cameron Hills/Bistcho Lake							
Mean adult female survival			0.90	0.76	0.91	0.79	0.71
No. females tracked			32	43	40	33	26
Mean recruitment			0.13	0.16	0.21	0.13	0.10
No. females tracked			32	47	51	23	18
Mean growth rate (λ)			0.96	0.83	1.00	0.84	0.74
No. females tracked			32	43	40	33	26
Dehcho- south							
Mean adult female survival			0.63	0.64	0.94	0.74	0.85
No. females tracked			16	14	16	23	20
Mean recruitment			0.26	0.27	0.26	0.44	0.47
No. females tracked			14	18	20	21	21
Growth rate (λ)			0.72	0.74	1.08	0.95	1.11
No. females tracked			16	14	16	23	20
Dehcho-north							
Mean adult female survival			0.60	0.75	0.81	1.00	0.81
No. females tracked			5	12	17	6	17
Mean recruitment			0.33	0.20	0.19	0.33	0.67
No. females tracked			10	15	15	16	18
Growth rate (λ)			0.72	0.83	0.90	1.20	1.22
No. females tracked			5	12	17	6	17

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The most effective barriers to dispersal of female boreal caribou appear to be the Mackenzie and Hay rivers (see *Habitat Fragmentation*, p.82). However, information on the movements of male boreal caribou is lacking.

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. The fidelity of individual boreal caribou to specific ranges in the NWT has not yet been investigated.

The concepts of 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; Nagy *et al.* 2011). There are insufficient data to measure immigration and emigration rates.

There is no evidence that boreal caribou in the NWT have special adaptations that are different from those that occur elsewhere. The home ranges of some adult female boreal caribou captured in the NWT extended well into Alberta, British Columbia, and Yukon indicating that boreal caribou regularly travel across the boundaries between these jurisdictions (Nagy *et al.* 2005; Larter and Allaire 2010; Kelly and Cox 2011). However, with the exception of boreal caribou on the Peel River Plateau, Yukon, boreal caribou do not occur east, north, or west of the NWT current range (Figure 4, p.73). Boreal caribou in the southern part of the NWT current range are contiguous with those in northern Alberta and British Columbia (Figure 4, p.73); however, local populations in Alberta and British Columbia are classified as not self-sustaining (Environment Canada 2012). Therefore, it is unlikely that immigration from elsewhere will augment boreal caribou numbers in the southern NWT or re-establish boreal caribou in the NWT should they disappear. If boreal caribou numbers continue to decline in the NWT and adjacent provinces, the level of exchange of individuals among areas will likely also decline.

Abundance

Based on population estimates provided by Government of the Northwest Territories (GNWT) biologists and presented by Environment Canada in their scientific review (Environment Canada 2011), there are likely between 6000 and 7000 (approximately 6500) boreal caribou in the NWT. This estimate was based on local and scientific knowledge, and estimated boreal caribou

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densities applied to known occupied boreal caribou areas outside active study or survey areas in the NWT (Environment Canada 2011; ENR 2012a; Figure 10, p.98). SARC requires the number of mature individuals to assess status (SARC 2010). In the NWT, composition information is only available for the Dehcho study areas (Table 8, p.92; Larter and Allaire 2010) where approximately 82% of boreal caribou seen during 2006-2010 late winter surveys were adults. Extrapolating this percentage to the entire NWT gives an estimate of approximately 5300 mature individuals.

More reliable methods are required to derive estimates of the number of boreal caribou in the NWT as their long term sustainability depends, in part, on population size (Environment Canada 2008, 2011). There are approximately 34,000 boreal caribou in Canada (Environment Canada 2011, 2012); if the estimate of 6500 in the NWT is correct then approximately 19% of the boreal caribou in Canada reside in the NWT.

Fluctuations and trends

In the national recovery strategy for boreal caribou (Environment Canada 2012), the NWT population of boreal caribou is classified as ‘likely self-sustaining’. This is based on a risk assessment that uses population size as well as 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 500m (Environment Canada 2011). For the NWT population of boreal caribou, with total range disturbance of 31%, the probability of observing stable or positive population growth over a 20 year period is approximately 65% (Environment Canada 2012). Environment Canada’s estimate of total range disturbance differs slightly from the 38% presented above (Nagy 2011; Nagy *et al. In prep-a*; Nagy *et al. In prep-c*) because a larger buffer size was used and fewer years of fire data were available.

Estimated population growth rates for the entire NWT population of boreal caribou are not available. Estimates of growth rates have been derived for boreal caribou in the Cameron Hills, South Slave, Dehcho, and Gwich’in study areas that are based on annual survival rates of radio-collared adult females and their calves (recruitment) (Hatter and Bergerud 1991; Larter and Allaire 2010; Kelly and Cox 2011; Nagy 2011) (see *Structure and rates*, p.92). 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

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estimates and uncertainty. Short-term trends (2 to 7 years) based on estimates of population growth rates in study areas indicate that boreal caribou numbers in the Gwich'in-north and Gwich'in-south study areas were recently increasing (Nagy 2011) while those in the Dehcho-south, Dehcho-north, and Cameron Hills study areas were decreasing (Larter and Allaire 2010; Kelly and Cox 2011) and those in the South Slave study area were decreasing or stable (Kelly and Cox 2011).

To interpret how local growth rates may affect the NWT population as a whole, it is important to understand how estimated density and abundance of boreal caribou vary in different parts of the NWT current range (Figure 10, p.98). 53% of NWT boreal caribou are found in areas where caribou numbers have been declining or may have been stable (Dehcho and South Slave regions). Only 8% of NWT boreal caribou are found in areas where caribou numbers have been increasing (Gwich'in region). The remaining 39% are found in areas where the trend is unknown (Inuvialuit, Sahtu and North Slave regions).

Although boreal caribou in the Gwich'in study areas were recently increasing, this trend may not continue if levels of anthropogenic and fire disturbance increase in future. The southern NWT, where growth rates in some study areas suggest declines, already has a large anthropogenic and fire disturbance foot print (Figure 8, p.84). The additive effects of new impacts may accelerate caribou declines in these areas. It is likely that boreal caribou numbers will continue to decline in the Cameron Hills/Bistcho Lake, South Slave, and Dehcho study areas unless remedial measures are taken. Possible remedial measures could include enhancement of adult female and calf survival through predator management, restrictions on development activities, habitat restoration, and harvest restrictions.

Extreme fluctuations in the distribution of boreal caribou or the total number of mature individuals should not be 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.

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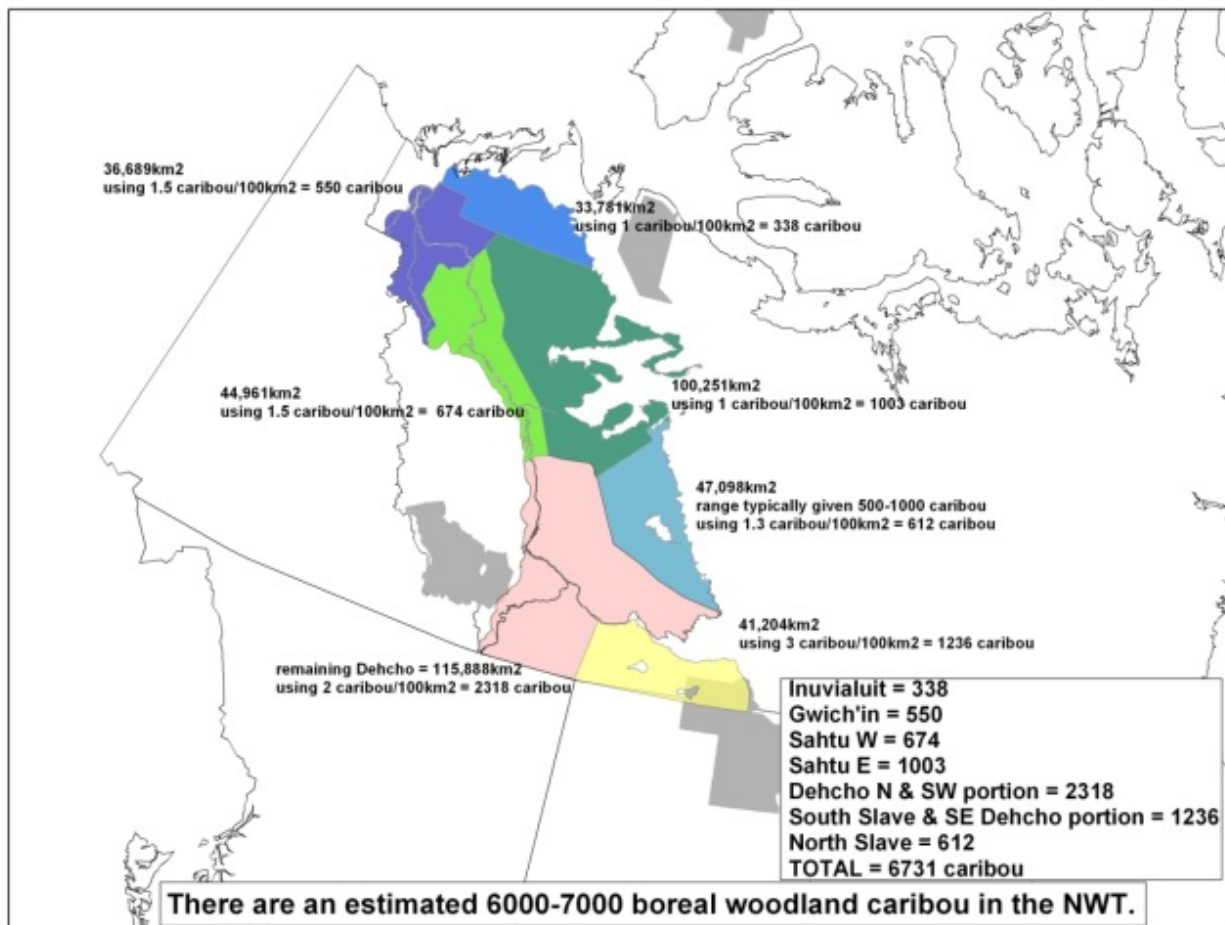


Figure 10. Estimated density and abundance of boreal caribou in different parts of the NWT current range. Reproduced with permission from ENR (2012a).

Threats and limiting factors

There are a number of threats that directly or indirectly affect boreal caribou and their habitat. These were recently summarized for Canada in the national recovery strategy for boreal caribou (Environment Canada 2012). For consistency, they are discussed here under the same categories. These threats are listed in order from highest to lowest magnitude and immediacy of concern for boreal caribou management in the NWT. A summary is provided in Table 10, p.99.

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Table 10. Threats assessment for boreal caribou in the southern and northern portions of the NWT current range⁴.

Threats	NWT southern portion			NWT northern portion		
	Level of concern ¹	Magnitude ²	Immediacy ³	Level of concern	Magnitude	Immediacy
Habitat alteration (loss, degradation, or fragmentation) as a result of human land-use activities.	High, given moderate to high degree of habitat fragmentation that has resulted from past oil and gas exploration and development activities. Boreal caribou need large tracts of contiguous old growth forest with connectivity among them.	High - approximately 18% of range has been affected by human land-use activities - approx. 44% has been affected by human land-use activities and fire combined	High	High, given low to moderate degree of habitat fragmentation that has resulted from past oil and gas exploration and development activities. Boreal caribou need large tracts of contiguous old growth forest with connectivity among them.	High - approximately 13% of range has been affected by human land-use activities - approx. 31% has been affected by human land-use activities and fire combined	High
Habitat alteration (loss, degradation, or fragmentation) as a result of natural processes	High Boreal caribou need large tracts of contiguous habitat that are protected from fire	Moderate - approximately 31% of the range has been disturbed by fire since 1965	High	High Boreal caribou need large tracts of contiguous habitat that are protected from fire	Moderate - approximately 21% of the range has been disturbed by fire since 1965	Moderate
Predation	High	High	High	High	Low-moderate	Low-moderate
Hunting	High, given current levels of predation - need reliable population estimates and harvest numbers to ensure harvest is sustainable	Unknown	High	High - need reliable population estimates and harvest numbers to ensure harvest is sustainable	Unknown	High
Climate change and severe weather	Moderate - long-term impact	High - entire Mackenzie River Basin affected	Moderate	Moderate - long-term impact	High - entire Mackenzie River Basin affected	Moderate
Parasites and Diseases	Low	Low	Low	Low	Low	Low
Noise and light disturbance	Low	Low	Low	Low	Low	Low
Vehicle collisions	Low	Low	Low	Low	Low	Low
Pollution	Low	Low	Low	Low	Low	Low

¹Level of concern: signifies that managing the threat is of (high, moderate, low) concern to either maintain existing numbers or promote recovery

²Magnitude: reflects the scale of the impact (high=range level effect, low=local effect)

³Immediacy: reflects the time frame/priority required to address threat (high=should be addressed immediately, low=should be addressed after moderate and high priority threats are addressed)

⁴Southern and northern portions are the study areas used to assess habitat conditions, as shown in Figure 7, p.82

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Threats 1 & 2 – Habitat loss, degradation, or fragmentation resulting from human land-use activities and natural processes

As described under *Habitat* (p.76), boreal caribou require large tracts of contiguous old growth boreal forests that have not been altered by natural or anthropogenic disturbances (Environment Canada 2011; Nagy 2011; Nagy *et al. In prep-c*). Either separately or in combination, human land-use activities and natural processes cause habitat loss, degradation, and/or fragmentation.

Significant portions of the NWT current range have already been impacted by petroleum exploration. Anthropogenic features created on the land during oil and gas exploration, timber harvesting, and road construction include seismic lines, pipelines, industrial infrastructures, cut blocks, and roads. Petroleum exploration and coal mining activities are underway and proposed in the Sahtu Region. Current leases, permits and licenses can be viewed at <http://ism-sid.inac.gc.ca>. Construction of the Mackenzie Valley Pipeline will result in more human activity within the Mackenzie Valley and facilitate more petroleum exploration activity in adjacent areas of some regions. Construction of the proposed Mackenzie Valley Highway will increase levels of human disturbance and access to a significant portion of the boreal caribou range in the NWT. There is also a high level of concern that the implementation of the NWT Biomass Energy Strategy and related actions, which promote the harvest of sawlogs and wood, will lead to habitat alteration in undisturbed patches of boreal caribou habitat.

Most of the current habitat disturbance in the NWT was caused by fire. From 1965-2010, approximately 31% of the southern portion and 21% of the northern portion of the NWT range was disturbed by fire. If fire disturbance increases as a result of climate change, there will likely be a negative impact on boreal caribou.

Separately or in combination, these human land-use activities and natural processes will continue to fragment existing habitat and increase the vulnerability of boreal caribou to predation and hunting. The future trend for boreal caribou habitat in the NWT will be determined by how these cumulative impacts are managed.

Threat 3 – Predation

Wolves are the primary predators of adult female boreal caribou in the NWT. The effect of wolf, black bear, grizzly bear, and lynx predation on calf survival is unknown. Predator density and diversity vary within the boreal caribou range. In the southern NWT, northwestern AB, and

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northeastern BC, predators including wolves, black bears, and lynx are locally abundant; cougars are rare (Larter pers. comm. 2010). 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 (Larter pers. comm. 2010). 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 (James and Stuart-Smith 2000; Neufeld 2006; Latham *et al.* 2011a). As a result, predation rates may be high in areas where predator densities and diversity are low but seismic line densities are high; however, examples of the latter types of areas may not occur in the NWT.

In the NWT southern current range, where habitat is highly fragmented and caribou have declined during the past 5 years, enhanced adult female and calf survival may not be possible without reduced predation rates.

Threat 4 – Hunting

Hunting has contributed to declines of boreal caribou in some southern Canada subpopulations (Environment Canada 2012). In the NWT, boreal caribou are harvested for subsistence use by Aboriginal people and resident hunters (Olsen *et al.* 2001; McDonald 2010; Benson 2011). 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. 2011). However, some General Hunting Licence holders actively hunt boreal caribou in the South Slave Region (Kelly pers. comm. 2012). 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. 2011). The average annual estimated harvest by NWT resident hunters during 2001-2009 was 15 (range 10-22), with an unusually high estimated harvest in 2010 (42) (ENR 2012b). Based on the Gwich'in harvest study, only 11 woodland caribou were taken in the Gwich'in Settlement Area during 1995-2001 (2 per year; Gwich'in Renewable Resource Board 2009). However, some Gwich'in believe that boreal caribou numbers have declined and some attribute

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local declines to overhunting (Benson 2011). Many hunters harvest woodland caribou in the Sahtu Settlement Area with annual harvests varying among communities (Olsen *et al.* 2001). Based on the Sahtu 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 mountain woodland caribou, using percentages estimated by A. Veitch (pers. comm. 2011). Estimates by ENR staff in the Dehcho Region suggest that people in Trout Lake harvest an average of 15 boreal caribou per year; while from April 2005-April 2011 people from Wrigley, Jean Marie River, and Fort Simpson harvested a total of 73 caribou or an average of 12 per year (Larter pers. comm. 2011). 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). Estimates of the Aboriginal harvest for other regions are not available.

Together, these data suggest that the average number of boreal caribou harvested annually in the NWT could be as low as 80 (1% of the population estimate of 6500), but could be higher than 200 (>3%). Because mortality is additive, the current level of harvest in combination with those killed by predators may be sufficient to cause local declines, and may have contributed to boreal caribou declines in some portions of the southern NWT. Reliable population estimates and harvest numbers are required to determine sustainable harvest levels.

Threat 5 – Climate change and severe weather

Climate change is occurring more rapidly in the Mackenzie Basin than in most other areas of North America. The anticipated regional effects of climate change (described under *Habitat trends*, p.85) will likely change boreal caribou habitat, however many of these effects have not yet been observed or measured in the NWT.

The forested part of the NWT is experiencing warmer and more variable weather in all seasons (ENR 2011b). Biting insects are most active during periods of warm temperatures (Russell *et al.* 1993), thus longer warmer summers may lead to longer periods of insect harassment and, as a result, reduced body condition for boreal caribou. These conditions may occur with greater frequency in the future. 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, foraging, and predator avoidance more difficult for boreal caribou (Nagy *et al.* 2005; Larter pers. comm. 2012). However, winter

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snowfall appears to be declining overall in the forested part of the NWT (ENR 2011b). One of the anticipated effects of climate change is more forest fires, which could increase total habitat disturbance for boreal caribou. However, the number and area of forest fires in the NWT did not increase between 1990 and 2010 (ENR 2011b).

Threat 6 – 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 (Environment Canada 2012), nor is there evidence that they pose a major threat to boreal caribou in the NWT. 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 these were previously reported in boreal caribou, barren-ground caribou, or reindeer and did not appear to 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).

White-tailed deer expanded their range far into the NWT (Larter pers. comm. 2010; Kelly pers. comm. 2012) as a result of more moderate winters, leading to the possibility of the introduction of the meningeal worm (*Parelaphostrongylus tenuis*) and Chronic Wasting Diseases. 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).

Threat 7 – Noise and light disturbance

Noise and light disturb caribou leading to functional habitat loss (McDonald 2010; Environment Canada 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 oil and gas developments.

Status of Boreal Caribou in the NWT – Scientific Knowledge component

Threat 8 – Accidental mortality from vehicle collisions

Collisions with vehicles are not thought to be one of the major threats affecting boreal caribou at the national level (Environment Canada 2012), nor is there evidence that they pose a major threat to boreal caribou in the NWT. Very small numbers of mortalities caused by vehicle collisions have been reported to ENR (Gau pers. comm. 2012).

Threat 9 – Pollution

Currently there are no large scale developments that generate pollutants within boreal caribou range in the NWT. The primary pollutants within the boreal caribou range in the NWT include waterborne pollution generated in Alberta (e.g., pulp mill and tailings pond effluent) that flows downstream in the Mackenzie River, or airborne pollution that is deposited by global atmospheric air currents. Little is known about the effects of pollution on the recovery of boreal caribou (Environment Canada 2012).

Positive influences

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 done on the distribution, movements, primary mortality factors, productivity, recruitment, adult female survival, habitat selection, parasites, diseases, response to anthropogenic features (seismic lines, etc.), and identification of critical habitats of boreal caribou in the NWT.

The Government of the Northwest Territories (GNWT) and its co-management partners have taken steps to manage boreal caribou (ENR 2010b). 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 are being selected for the first comprehensive boreal caribou range management plan in the southern NWT. Additionally, upon approval and construction of the Mackenzie Valley Pipeline, the GNWT in cooperation with all co-management partners would likely identify additional areas for boreal caribou range

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management plans and identify additional boreal caribou studies or monitoring that will be needed in many areas of the NWT.

Boreal caribou were formally 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 (Environment Canada 2012). The strategy identifies critical habitat for boreal caribou in the NWT as at least 65% undisturbed habitat; under *SARA* critical habitat is protected from destruction. 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.

There is some current and proposed habitat protection in place for boreal caribou in the NWT through existing protected areas, proposed protected areas moving forward through the Protected Areas Strategy, an approved land use plan in the Gwich'in Settlement Area, and regional land use planning processes underway in the Sahtu Settlement Area, Dehcho region, and Tłı̨chǫ region (Figure 11, p.106). Land management regimes vary among these areas but many include restrictions on resource development, on either a permanent or interim basis. Areas that are likely significant in terms of protection of boreal caribou habitat include the Khaii luk, Nagwichoonjik/Dachan choo gehnjik (Travaillant Lake, Mackenzie/Tree River) Gwich'in Conservation Zone, Wood Buffalo National Park, and several proposed National Wildlife Areas: Ts'ude niline Tu'eyeta (Ramparts River and wetlands area), Edézhíe (Horn Plateau area), Kwets'ootl'aa (north arm of Great Slave Lake), Sambaa K'e (Trout Lake area), and Ka'a'gee Tu (Kakisa area). Pehdzeh Ki Ndeh (Wrigley area) would also be significant if established, however this area does not yet have a legislative protection mechanism identified.

If all these protected area initiatives and land use plans are implemented, the protection of habitat for boreal caribou has the potential to be a positive influence of large magnitude. However, because many of the protected areas and land use plans are not yet established or finalized, their ultimate long-term impact on boreal caribou is unknown.

Protected Areas in the Northwest Territories: Established, Interim and Proposed Protection

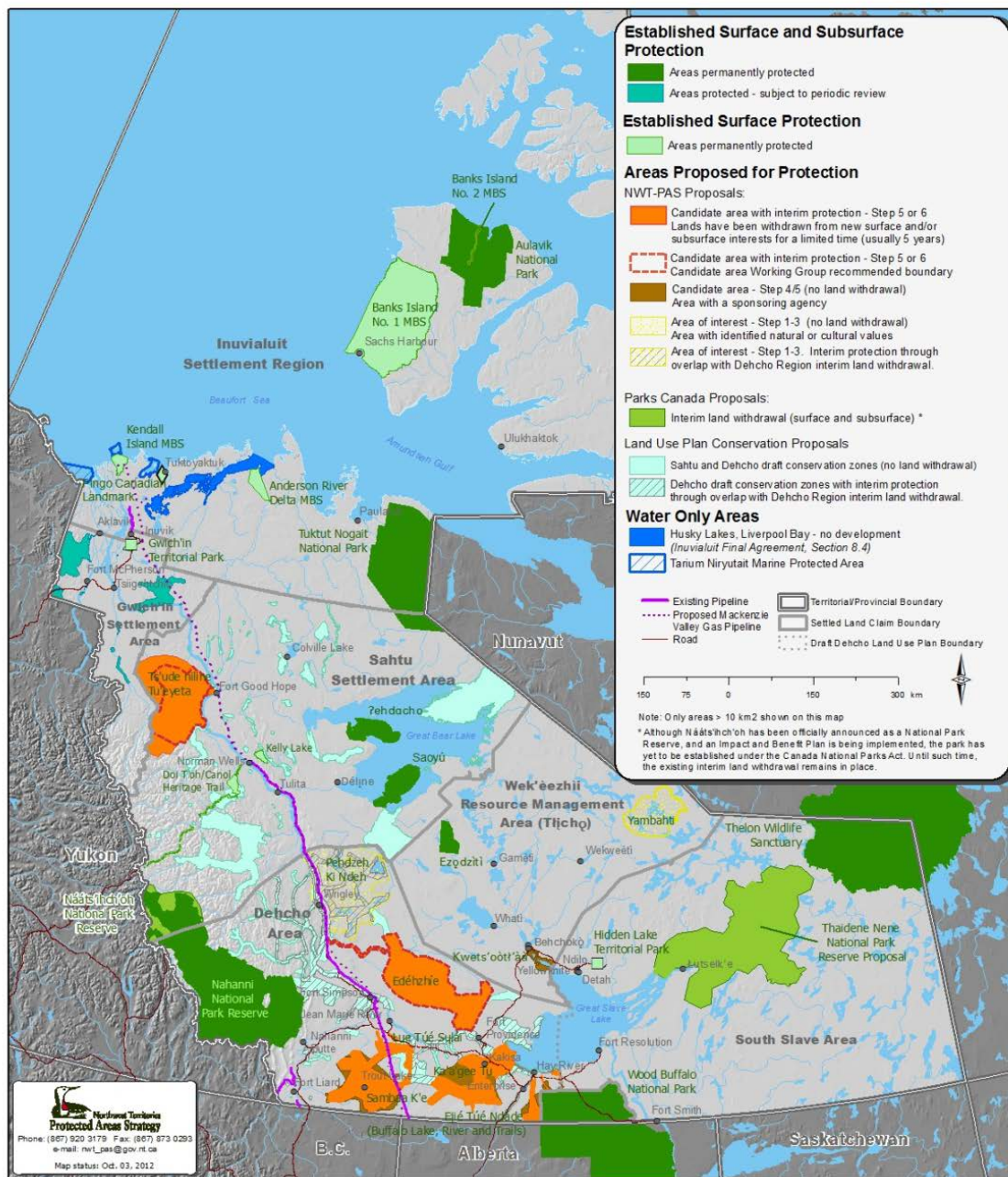


Figure 11. Established, interim and proposed land protection in the NWT, as of October 3, 2012. Map courtesy of NWT Protected Areas Strategy (www.nwtpas.ca). Existing protected areas are green; proposed protected areas are orange or brown; existing conservation zones are dark turquoise; and proposed conservation zones are pale turquoise.

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John completed a BSc in 1971 at the University of Lethbridge and a PhD under the direction of Andrew E. Derocher at the University of Alberta in 2011. His PhD was on the use of space by boreal, mountain woodland, Dolphin and Union island, and migratory and tundra-wintering barren-ground caribou. He analyzed satellite tracking data obtained for caribou during 1993 to 2009 in the NWT and Nunavut to quantify subpopulation structure, timing and synchrony of activity, area and site fidelity of caribou and the response of boreal caribou to seismic lines. After retirement in 2009, he continued to write reports and publications when not travelling and doing wildlife photography.

Status and ranks

Region	Coarse filter (Ranks) To prioritize	Fine filter (Status) To provide advice	Legal listings (Status) To protect under species at risk legislation
Global	G5TNR – Species secure, subspecies not yet assessed (NatureServe)		
Canada	NNR – Not yet assessed (NatureServe Canada 2002)	Threatened (COSEWIC – 2002)	Threatened (SARA 2003)
Northwest Territories	Sensitive (NWT General Status Ranking Program 2011)	Threatened (SARC – 2012)	To be determined
Adjacent Jurisdictions			
Alberta	S2 – Imperiled (NatureServe)		
British Columbia	S2 – Imperiled (NatureServe 2006)		
Labrador and Newfoundland	S2S3 – Vulnerable to Imperiled (NatureServe)		
Manitoba	SNR – Not yet assessed (NatureServe)	Threatened (Endangered Species Advisory Committee – 2002)	Threatened (Manitoba Endangered Species Act - 2006)
Ontario	S4 – Apparently secure (NatureServe)	Threatened (COSSARO - 2007)	Threatened (Ontario Endangered Species Act - 2007)
Quebec	S2S3 Vulnerable to Imperiled (NatureServe)		Vulnérable (Loi sur les espèces menacées ou vulnérables – 2005)**
Saskatchewan	SNR – Not yet assessed (NatureServe)		
Yukon	S1 – Critically imperiled (NatureServe)		

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People that contributed information to the various studies and meetings used for this report are acknowledged here by name where possible. In several cases, names cannot be included because of confidentiality clauses or missing information. In those cases, participants are represented by numbers participating only. Participant names were not provided for the following reports and summaries:

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- Zimmer *et al.* 2002. Colville Lake (9); Fort Good Hope (10); Tulita (11); Norman Wells (10)
- ENR 2007e-j: Paulatuk (10 attendees), Tuktoyaktuk (10), Inuvik (14), Fort McPherson (9), Aklavik (14), Tsiigehtchic (7)

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Walter Alexie, Fort McPherson

Willie Simon, Inuvik

Berger Community Hearings Transcripts (1976):

Ted Landry, Fort Providence

Cluff *et al.* 2006:

Behchokq̃ (7), Detah (8), Gamètì (16), Whatì (13). Including Francis Simpson, Peter Moosenose, Llyod Bishop, Pierre Beaverho, William Chocolate, Daniel Chocolate, John DeQuitte, Sammy Arrowmaker, Charlie Pride, Joe Zoe, Eddie Chocolate, Jimmy Wagary, Joe Black, Pierre Tlokka, Isadore Zoe and Georgina Chocolate, Michel Paper, Eddie Sikyea, Isadore Tsetta and Judy Charlo, among others.

ENR 2006a-c and 2007a-d:

- K'atł'odeeche First Nation Participants –Alec Sunrise, Victoria Martel St. Jean, Peter Sabourin, Amos Cardinal, Leslie Norn, Raymond Sonfrere; April Cayen (technician)Wrigley participants – Gabe Hardisty, Albert Moses, Tim Lennie

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- Trout Lake participants – Joe Punch, Edward Jumbo, Tommy Kotchea, Dennis Deneron
- Wrigley participants – Gabe Hardisty, Albert Moses, Tim Lennie, Mike Neyelle
- Nahanni Butte participants – Eric Betsaka
- Jean Marie participants – Isidor Simon, Stanley Sanguéz, William Sake, Jonas Sanguéz
- Fort Smith Métis Council – Betty Villebrun, Louise Fraser, Lucien Villebrun, Ken Hudson, Melissa Johns
- Hay River Métis Council – Gladys Bloomstrand, Connie Belanger, Faye Johns, Alex Lafferty
- Hay River Métis Council and NWT Métis Nation – Vern Jones
- Fort Resolution Métis Council – Kara King, Ronald McKay, Pete King, Lloyd Cardinal, Arthur Beck, Tammy Hunter, Frank Fabien
- NWT Métis Nation – Earl Jacobsen
- West Point First Nation – Nancy Michel, William Michel, Ken Thomas, Courtney Cayen (technician), Bobby Cayen (technician)
- Fort Providence Resource Management Board – Ted Landry and Louie Constant (Deh Gah Got'ie Dene Council), James Christie and Richard Lafferty (Métis Nation Fort Providence), Edwin Sabourin, Darren Campbell

Gunn *et al.* 2004:

Herb Norwegian (Fort Simpson), Ricky Tsetso (Fort Simpson), George Moses (Wrigley), Victor Jumbo (Trout Lake), D'Arcy Simba (Kakisa), Joe Lacorne (Fort Providence)

Gunn 2009:

K'atl'odeeche First Nation Participants: Daniel Sonfrere, Jim and Sarah Lamalice, Pat Buggins, Clara Lafferty, Solomon Smallgeese, Fred Tambour, Pat Martel, Ernest Martel, Robert Lamalice, (one unidentified participant)

Joint Review Panel 2010a:

Chief Dennis Deneron

McDonald 2010:

Frank Pierrot, Fort Good Hope

Clayton MacCauley, Tulita

Julie Lennie, Tulita

David Etchinelle, Tulita

Richard Kochon, Colville Lake

Edward Oudzi, Norman Wells

Olsen *et al.* 2001:

Tulita/Norman Wells – Fred Andrew, Maurice Mendo, Margaret MacDonald

Ross River – Dorothy Dick, Ted Charlie

Colville Lake – Fred Rabisca, Alexis Blancho, Sarah Kochon

Fort Good Hope – Evert Kakfwi, Karen Caesar, Michel Lafferty

Déline – Andrew Kenny, Dophus Baton, Raymond Taniton

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Appendix A: Additional information

Names and classification

- (1) For the Tłı̄chǫ region, caribou that migrate between the barrens and the boreal forest are referred as hoziṛekwò, as opposed to tqdzi which refers to them living only within forest (Wek'èezhii Renewable Resources Board 2010; Chocolate 2011). In South Slavey, the language spoken by people from K'átł'odeeche, there are distinct words for each type of caribou. Elders sometimes use a South Slavey phrase that translates as “from Dogrib country” to refer to barren-ground caribou and distinguish between those and woodland caribou. The South Slavey phrase used to refer to woodland caribou translates as “the caribou from our traditional area.” Caribou are also distinguished by area of origin. Several mentions of a third type of caribou referred to as “large caribou” (seen near Birch River, Slave Lake and the Horn Plateau west of Great Slave Lake) could be elk or reindeer that were transplanted into the area (Schramm 2005 in Gunn 2009: 149). 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).
- (2) Four different types of caribou are recognized by hunters in the SSA: barren-ground, boreal woodland, northern mountain, and small caribou. One Sahtu interviewee mentioned a type of caribou called “tozi”, that is almost as big as a moose (Johnson and Ruttan 1993). Additionally, each SSA community has a descriptive name for boreal caribou. Slight differences in dialects are reflected in the pronunciation and inflections used to describe the animal (McDonald 2010).
- (3) In the Dene Zhatie/Yati – the language of the Dehcho region, mbedzih refers to woodland caribou, both the boreal and mountain types. This is distinct from the nódi, or the barren-ground caribou (Dehcho First Nations 2011).
- (4) Northwest Territories residents commonly use a variety of names to refer to boreal caribou. In the Gwich'in area, both boreal caribou and woodland caribou are used although ‘woodland caribou’ is used more often. In the Dehcho Region, it appears that

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boreal caribou is more frequently used. Common English names for the boreal population of *Rangifer tarandus* subspecies *caribou* include:

- Woodland caribou
- Woodland caribou (boreal type)
- Boreal caribou
- Boreal caribou

Threats and limiting factors

Regional assessment of threats

Table A1. Impact of various factors on boreal caribou in the Sahtu 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), Déljine RRC (3), Colville Lake RRC (2), Tulita 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

- (5) 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

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as wires or toxic chemicals left by developers or other land users are a threat to the caribou (Benson 2011).

- (6) According to elders and hunters in Samba K'e, the proposed Mackenzie Gas Project would disturb 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

- (7) 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]).
- (8) In Gamètì, one workshop participant stated that mining and hydro-electric dams are examples of activities in the Tẖcho̱ 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

- (9) People from the West Point and K'átł'odeeche First Nations have heard rumours that cougars have been seen in their area. They also report more wolves in the boreal caribou

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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'átl'odeeche First Nation]).

- (10) Samba 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).
- (11) Dehcho participants reported that boreal caribou seem to choose wet areas as a means of predator avoidance during calving: three K'átl'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. Participants did not mention predation by bear, wolverine or lynx (Gunn 2009).

Climate change

- (12) 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]).
- (13) In one Inuvialuit traditional 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).
- (14) The impacts of climate change on caribou were recorded during recent traditional 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).

- (15) 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]).
- (16) Participants in a recent traditional 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).
- (17) 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]).

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- (18) In a Sahtu 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).
- (19) 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]).
- (20) 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]).
- (21) 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

- (22) 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

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mentioned a need for careful firearm use and harvesting only what is needed to feed the community (Zimmer *et al.* 2002).

(23) 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]).

(24) 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

Traditional stewardship practices

(25) Many of the communities within the range of boreal caribou in the Northwest Territories are guided by traditional 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).

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- (26) 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]).

Suggestions from traditional and community knowledge sources for protection, research and monitoring

- (27) 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 Tẖcho̱ region before the population starts to decline, and Whatì wants to work closely with the government to find solutions (Environment Canada 2010b [Whatì]).
- (28) Forest fire control could have a big impact on boreal caribou and their habitat. Forest fires 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]).
- (29) There were some meeting participants that questioned whether 'acts of God,' such as forest fires or climate change, should be 'managed', however overall, community members were in support of responding to forest fires more quickly (ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]).
- (30) Gwich'in elders felt that an aggressive approach to fighting forest fires was appropriate. Although forest fires can have a rejuvenating effect on the land, they still need to be controlled (ENR 2007j [Tsiigehtchic]; Benson 2011).
- (31) Several people at a Whatì meeting emphasized that habitat protection is crucial to maintaining caribou populations. They felt that forest fires were the main cause of decline for caribou in the region, and stressed the need to protect caribou habitat from forest fires. 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]).

- (32) 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'átl'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).
- (33) 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).
- (34) 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]).

- (35) 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).
- (36) 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).
- (37) 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]).
- (38) 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'átl'odeeche First Nation]; ENR 2007h [Fort McPherson]; Environment Canada 2010c [Behchokq]; McDonald 2010; Benson 2011; Dehcho First Nations 2011).
- (39) 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]).

- (40) 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 forest fires 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'átl'odeeche First Nation]).
- (41) General suggestions for mitigation of threats include protection of water sources (Environment Canada 2010c [Behchokq]); protection of large enough portions of land left open or undeveloped as a buffer for disturbances such as forest fire, 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]).
- (42) 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).
- (43) 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).

(44) Some important areas are described in the *Habitat* section (p.17). 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 [Whati]);
- Boreal caribou habitat is all along Nq̄dii plateau on the west side of Whati (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'átl'odeeche First Nation]).

(45) 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]);
- Look into doing seasonal collaring – a good time to track would be during calving (ENR 2007c [West Point First Nation and K'átl'odeeche First Nation]);

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- 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]).

Appendix B: Confidential Appendix

Maps and information included in Appendix B are not to be distributed because they contain sensitive information. The confidential Appendix B includes:

Figure 12. Boreal caribou sightings, tracks, and hunting areas (reported by 20 Gwich'in elders and hunters in 2010). From Benson (2011).

Figure 13. Boreal caribou sightings and hunting locations reported by 11 hunters and elders in a Gwich'in Renewable Resources Board 2001 study. From Benson (2011).

Figure 14. Map of Gwich'in boreal caribou harvest locations as reported by 11 hunters and elders in a Gwich'in Renewable Resources Board 2001 study. From Gwich'in Renewable Resources Board (2001).

Figure 15. Map of boreal caribou sightings as reported by 11 hunters and elders in a Gwich'in Renewable Resources Board 2001 study. From Gwich'in Renewable Resources Board (2001).

Figure 16. Boreal caribou harvest sites and habitat areas in the Sahtu Settlement Area. From McDonald (2010).

Figure 17. Map showing traditional ecological knowledge of boreal caribou in southern NWT and northern Alberta, compiled from a series of interviews with 19 hunters and elders from the Katlodeeche First Nation, the Little Red River Cree Nation, and the Mikisew Cree First Nation. This map includes caribou sightings, tracks, calving areas and seasonal movements documented by study participants. From Gunn (2009:90).

Figure 18. Map showing traditional ecological knowledge of boreal caribou in the Buffalo Lake area, using information compiled from a series of interviews with 19 hunters and elders from the Katlodeeche First Nation, the Little Red River Cree Nation, and the Mikisew Cree First Nation. From Gunn (2009:94).

Figure 19. Map of boreal caribou calving areas in southern NWT and northern Alberta, documented during a series of interviews with 19 hunters and elders from the Katlodeeche First Nation, the Little Red River Cree Nation, and the Mikisew Cree First Nation. From Gunn (2009:103).

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Figure 20. Map of boreal caribou movements between the NWT and Alberta, compiled from interviews with 19 hunters and elders from the Katlodeeche First Nation, the Little Red River Cree Nation, and the Mikisew Cree First Nation. From Gunn (2009:135).

Figure 21. Distribution of calving sites of radio-collared female boreal caribou in the Northwest Territories, northwestern Alberta, northeastern British Columbia, and northeastern Yukon Territory (n=324 calving sites) (Nagy *et al.* 2005; Environment and Natural Resources 2006a, b, 2007; Larter and Allaire 2010; Kelly and Cox 2011; Environment and Natural Resources 2011c).

Figure 22. Distribution of incidental sightings of male boreal caribou in the Gwich'in Settlement Area, 2002-2006 (based on data from Nagy *et al.* 2005).