Science, Conservation, and Indigenous Rights:
The Political Ecology of the George River Caribou Herd

by
Romea Dennis

supervised by
Gregory Thiemann

A Major Paper
submitted to the Faculty of Environmental Studies
in partial fulfillment of the requirements for the degree of Master in Environmental Studies
York University, Toronto, Ontario, Canada

2018/07/31

(International, n.d.)

Foreword

Climate change is altering the physical world and triggering biophysical impacts that modify our environments and our society. An example of this is caribou decline in northern Canada. The George River caribou herd decreased from upwards of 800,000 animals in the 1990s and approximately 8,900 animals in 2016. The herd's decline is a manifestation of industrial development, resource management, wildlife conservation, indigenous land use and government environmental policy interactions. My plan of study focused on climate change science, perspectives and policy as well as political ecology. Political ecology links human causes and environmental reactions. Researching the various human and environmental causes that led to the 99% decline of the George River caribou herd allowed me to research components of my plan of study in action. *Science, Conservation, and Indigenous Rights: The Political Ecology of the George River Caribou Herd* explores scientific, indigenous and government perspectives of what caused the drastic decline of the George River caribou herd. The case of the herd fits in the zeitgeist of 2018 Canadian environmental issues- the melting Arctic, governments scrambling to balance economic interests with environmental conservation and indigenous users being both marginalized and empowered in resource management issues.

Abstract

Caribou decline in Labrador is driven by habitat degradation, climate change and industrial development. The George River caribou herd has declined by 99% to fewer than 6,000 animals since the 1990s. The provincial government has enacted a hunting moratorium to stave off extinction, but thus far the policy has only been successful in enraging local indigenous groups. Political ecology finds the connections between the social and biophysical factors that led to the near extinction of what was once the largest migratory caribou herd on Earth.

Introduction

The George River caribou (*Rangifer tarandus caribou*) herd is a migratory woodland caribou herd occupying a massive range in Labrador and northern Québec and Nunatsiavut Inuit land claim area, a region known as Ungava (Bergerud et al, 2012). In the 1990s, the George River caribou herd was the largest migratory herd in the world, with numbers exceeding 700,000. A 2016 herd census showed that the herd had declined by 99% to fewer than 9,000 animals (Government of Newfoundland and Labrador, 2016a). Scientific studies attributed the decline to numerous factors, both natural and anthropogenic, including Arctic greening (Fauchald et al., 2017), industrial development, habitat decline, predation and over hunting (Festa-Bianchet et al., 2011). In response to the drastic decline of the George River herd, the Government of Newfoundland and Labrador instituted a hunting ban in 2012 which has continued to present day. The hunting moratorium was a policy implemented as part of the Province's 2004 "Labrador Caribou Initiative." This initiative monitors the herd's demography and investigates caribou death and predation within the herd. The plan also identifies calving grounds as well as habitat locations, and works to incorporate indigenous knowledge (Government of Newfoundland and Labrador, 2015). Indigenous groups that hunt the herd for cultural and subsistence purposes have stated that there is limited evidence that selective hunting could further destabilize the George River caribou herd (Skinner, 2016). In autumn of 2017, a roundtable council of seven indigenous governments was formed to provide a conservation strategy for the George River herd that incorporates indigenous culture and knowledge. Called, "Ungava Peninsula Caribou Aboriginal Round Table" (UPCART), the purpose of the round table strategy is to conserve the herd while continuing to harvest caribou for subsistence and cultural purposes. UPCART advances co-management of the herd between indigenous users and the government. Shortly after UPCART released their document outlining the indigenous

perspectives of caribou conservation, Innu members continued to hunt and Innu Nation formally left the round table agreement (White, 2018).

Political ecology examines the linkages between society and biophysical occurrences. In the case of the George River caribou herd, political ecology explores the connection between the human and environmental interactions that triggered the decline. It provides guidelines to understand the government and indigenous reactions to the decline, and the application of functional recovery measures to conserve the George River herd. Political ecologists Basset and Zueli observe, "One of the challenges of doing cultural and political ecology is demonstrating the linkages between a variety of social and biophysical processes driving environmental change" (Bassett & Zuéli, 2000). The decline of the George River caribou herd is an issue of resource management and access for local and indigenous users. Political ecology provides a framework to understand the conflict between Indigenous groups and the Government of Newfoundland and Labrador after the hunting moratorium was imposed. It also addresses the different scales of power, such as the infighting amongst the indigenous users and members of the roundtable, and the government's hunting moratorium after decades of inaction. To this point, Simon Batterbury wrote, "The argument is that access to environmental resources is always socially mediated or constrained, usually involving multiple processes acting at different scales" (Batterbury, 2015).

In an attempt to build a critical overview of the interacting factors that have contributed to the decline of the George River herd, this paper provides a review of biophysical and anthropogenic factors that have culminated in the herd's decline, a review of the governments' reaction to the herds' decline and policy implementation for the herds' recovery, based on information provided by the scientific community, government scientific committees and

indigenous groups. The indigenous groups' reliance on the herd, and reaction to the decline is described, as well as co-operation with the government to develop a co-management plan.

Research Question

- How have government, indigenous groups and scientific research interacted in response to the decline of the George River Caribou herd?
- What are the linkages between the human and environmental factors that have led to the 99% population decline of the George River Caribou herd?

Theoretical Framework

Below is an overview of political ecology that provides the theoretical framework for this paper. These interpretations of political ecology are important because they provide the baseline concept that considers equally the views of scientific research, government and indigenous groups. Political ecology breaks down the silos of government, indigenous groups and science – exploring the conversation between the three systems of knowledge as opposed to the consideration of a single ontology.

Political Ecology

Applied in the context of this paper, political ecology can be understood as a framework that examines the interactions of human systems of power in the context of environmental and resource issues (Robbins, 2012). Political ecology frames the analysis of government and multiple indigenous groups (systems of power) interacting with environmental events (climate change, arctic greening) that have resulted in the decline of the George River caribou herd. Political ecology describes the relations between social science and environmental issues. It considers different perspectives and research methods, including indigenous knowledge, to explain environmental events (Brookfield, 2005; Robbins, 2012; Vaccaro et al., 2013; Watts, 2000). A guiding question in political ecology and environmental degradation is to understand, "Our basic question is why these failures have occurred, and whether or not the problem has been perceived as such by those responsible at the place and time" (Blaikie & Brookfield, 1987). The question assists in understanding how and why governments react to resource management and wildlife conservation issues (such as the drastic decline of the George River herd) (Blaikie & Brookfield, 1987).

Blaikie and Brookfield describe political ecology in relation to land degradation, but the concept applies to caribou decline, an environmental resource that is degraded by a combination of natural and human causes. Blaikie and Brookfield understand human induced degradation as when environmental forces deteriorate an area to such an extent that no human management can recover the space, or when the human management of the area is poorly executed (Blaikie & Brookfield, 1987).

Blaikie and Brookfield see that land degradation is both a social and physical problem, and that degradation is based on perception and society. In their book, *Land Degradation and Society,* Blaikie and Brookfield write, "All aspects of the relationship between land degradation and society are both social and physical – a commonplace statement that is self-evidently true, but not trivial. It means that degradation is perceptual and socially defined" (Blaikie & Brookfield, 1987). The argument that environmental problems are equal parts a product of society's actions and perceptions in relation to environmental issues is the foundation of political ecology. Vaccaro states that political ecology connects ecological changes with social occurrences, writing, "Political ecology emphasized the connections between ecology and social context by matching ecological and social chronologies, contributing to the understanding of their interactions and the social production of landscapes" (Vaccaro et al., 2013).

In his work, *Critical Political Ecology: the Politics of Environmental Science,* Forsyth defines political ecology as social and political conditions that frame or intersect with environmental issues. Forsyth writes, "It is widely accepted that debates concerning "political ecology" refer to the social and political conditions surrounding the causes, experiences and management of environmental problems" (Forsyth, 2003).

Paul Robbins' definition of political ecology will be used to connect the ecological events leading to the extreme decline of the George River caribou herd. Political ecology seeks to link politics, power and economy that trigger or influence environmental change,

> [T]he frameworks with which we imagine non-human world are as important (and contested and puzzling) as the variability of that world as understood in ecological science. The mandate in much political ecology, therefore, is to map the politics of environmental ideas as carefully as the politics of material ecological change, working to link the two across space and time (Robbins, 2012).

Robbins describes political ecology as a system of knowledge to understand the connections between systems of power and environmental changes. Robbins writes;

> Political ecology… explores these social and environmental changes with an understanding that there are better, less coercive, less exploitative, and more sustainable ways of doing things. The research is directed at finding causes rather than symptoms of problems, including starvation, soil erosion, landlessness, biodiversity decline, human health crises, and the more general and pernicious conditions where some social actors exploit other people and environments for limited gain at collective cost. Finally, it is a field that stresses not only that ecological systems are political, but also that our very ideas about them are further delimited and directed through political and economic process (Robbins, 2012).

Political ecology incorporates various forms of knowledge and argues that diverse epistemologies and ontologies can be included in rigorous scientific and social scientific framework. Political ecology sees knowledge produced by scientists, historians, indigenous people and local resource users. Robbins asserts that a benefit of incorporating local resource users in frameworks of knowledge in environmental practice is that local knowledge tends to "produce extremely different categorical structures for interpreting the objective realities of the natural world…[T]hese knowledges can be adjudicated by incorporating local ways of knowing into a flexible but rigorous scientific framework" (Robbins, 2012). Robbins argues that science is socially situated and incorporating diverse forms of knowledge produces more robust, "emancipatory" knowledge. Essentially, different perspectives form a

more holistic framework for understanding and addressing environmental issues. Political ecology can be distilled into a simple concept, linking politics of ecological change with politics of environmental ideas (Robbins, 2012).

Background

A synopsis of caribou and the woodland caribou subspecies is provided as background context of the George River caribou herd. It provides baseline information as to the vulnerability of caribou to environmental and anthropogenic disturbances that have resulted in their decline across Canada, and with the George River herd specifically.

Caribou Overview

Caribou are a large terrestrial mammal inhabiting northern Canada, from Newfoundland to the Yukon. Caribou are a vital cultural and subsistence resource to indigenous and non-indigenous people in northern Canada (COSEWIC, 2017). Caribou exist throughout northern Canada, in large migratory and non-migratory herds. Most caribou populations in Canada have experienced a decline in the last two decades (COSEWIC, 2017). The decline of caribou populations in boreal regions in Canada is attributed to the direct and indirect effects of human activity altering caribou habitats (Vistnes & Nellemann, 2008).

Caribou and reindeer are one species, while woodland caribou are one of five caribou subspecies found in North America (Banfield, 1961). Woodland caribou are identified by skull measurements (Banfield, 1961).

Caribou are integral to maintaining vegetation structure and nitrogen cycling, as well as predator populations (Dale et al., 1994; Mowat and Heard 2006; Musiani et al., 2007; Festa-Bianchet et al., 2011). Caribou are a medium-sized deer that are adapted to Arctic and Subarctic conditions. Caribou are characterized by brown fur that turns almost white in winter, square faces and crescent shaped hooves. The hooves create a distinct click as they walk. Caribou's broad hooves are wider than tall to facilitate walking in snow (Banfield, 1961). Both male and female caribou have antlers, (with exceptions in certain herds, including the George River herd) and most woodland caribou herds are not migratory (Bergerud et al., 2012).

There are significant behavioral, genetic morphological differences amongst woodland caribou, which are generally influenced by location, habitat, food sources as well as "glacial advances, refugia, and re-colonization" (Banfield, 1961).

Climate-driven range fluctuations during the Pleistocene era altered caribou distribution after the most recent ice age (COSEWIC, 2017). Research determined that caribou migrated to North America from northern Europe during two major migration paths, one via the North American ice sheet and the other by Seringa-Eurasia ice sheet 14,000 to 22,000 years ago (COSEWIC, 2017). Caribou habitat range in Canada extends from Newfoundland, across Québec, Ontario, Manitoba, Saskatchewan, Alberta and midway through British Columbia. The Rockies in western Canada offer a natural boundary in more southern regions of Canada. Certain subspecies of caribou extending into southern Alaska and the Canadian territories (Bergerud et al., 2012). Woodland caribou's historical habitat and dispersal covered most of boreal North America and inhabit boreal forest areas and Arctic tundra in the winter.

Species Description

The following sections provide background information on woodland caribou, including their habitat, demography and recruitment.

Name and classification: Woodland Caribou

Class: Mammalia
Order: Artiodactyla
Family: Cervidae
Scientific name: Rangifer tarandus caribou (Linnaeus 1758)

Common Names: Caribou; Minunasawa atikw (Innu); Ahtik/Atik (Cree); Tuttu (Inuktitut) (COSEWIC, 2017).

Woodland caribou occur across Canada with the exception of Nunavut, the maritime provinces and Prince Edward Island and exist in 5/8 National Ecological Areas. Woodland caribou have been classified as a species at risk in Labrador since 2002 (Labrador Woodland Caribou Recovery Team, 2004).

General Decline in North America

Almost all woodland caribou herds in Canada and the American Arctic have experienced population decline (Species at Risk Act, 2017). Parks Canada reported that the primary cause in caribou population destabilization is habitat degradation caused by oil and gas and mining activities, recreational activity and linear fragmentation which supports the increase of deer, elk, and moose. Other ungulates may outcompete caribou for resources, while leading to an increase in their predators in caribou habitat, such as bear and wolves (Parks Canada, 2014). The expansion of agriculture in caribou range has also amplified alteration, loss and fragmentation to caribou habitat (Species at Risk Public Registry, 2017). The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) writes, "Woodland caribou herd decline is pervasive across Canada and is attributed to natural population cycles, changes in habitat and human-wildlife conflict" (COSEWIC, 2017).

George River Caribou Herd

Herd Overview

The George River caribou are woodland caribou and are one of four subpopulations of the Eastern Migratory herds of caribou in northern Canada. The herd's range extends through Labrador and Northern Québec (Labrador Woodland Caribou Recovery Team, 2004).

The George River herd undertakes a spring and winter migration, crossing approximately 1000 km of Labrador and Northern Québec with each migration (COSEWIC, 2017). The spring migration brings the George River herd to their calving grounds in the Arctic tundra (COSEWIC, 2017). The calving season concludes by June and the herd migration continues to their summer feeding grounds, subsisting on resources such as birch and willow shrubs. The George River herd begin their second migration in the fall to their wintering grounds, where the Arctic tundra and Boreal forest merge (COSEWIC, 2017).

Habitat and Distribution

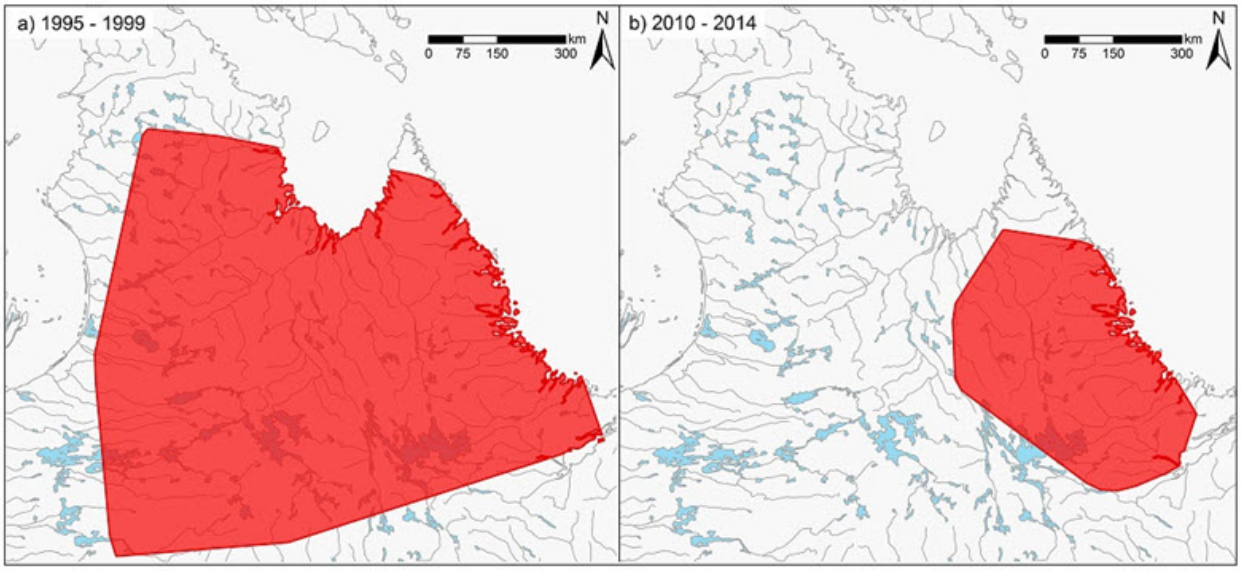

Figure 1 Range of the George River caribou herd in the late 1990s (left) compared to range 2010 - 2014 (right), indicating a range decrease of approximately 85% (COSEWIC, 2017).

The herd occupies a tundra area of approximately 54,000 km^2 located on the Labrador Peninsula, east of the George River and south of Ungava Bay. The herd's range during peak population and current population is depicted in **Figure 1**. COSEWIC reported that from the 1980s until 2010, the herd's range decreased by 85% (COSEWIC, 2017).

The herd's range increases and decreases with population size (See **Figure 2**) (Bergerud et al., 2012; Messier et al., 1988). In the 1980s, when the George River herd was at its largest, the

herd's range extended throughout most of northern Labrador and Québec (See **Figure 2**). At peak population, the herd's habitat ranged from 55º-66º north, bordered by the Labrador Sea, Ungava Bay and Hudson's Bay (Messier et al., 1988). The herd's range in the early 1970s was approximately 160,000km^2, covering the southern Ungava area and the Labrador Peninsula. As the herd numbers strengthened, the area increased to 195,000km^2 from 1976 to 1980. As the herd's population reached its maximum in the 1980s, the George River caribou habitat extended to cover most of northern Québec and Labrador, measuring approximately 442,000km^2 and causing the animals to push their pasture areas into boreal tundra ecozones (Messier et al., 1988). When the herd's population was at 776,000 ± 104,000 in the mid-1990s, their habitat range extended across most of northern Labrador (see **Figure 1**) (Boudreau et al., 2003). Habitat rapidly degraded due to climate change and industrial development in the 2000s, and the herds' distribution dwindled (COSEWIC, 2017).

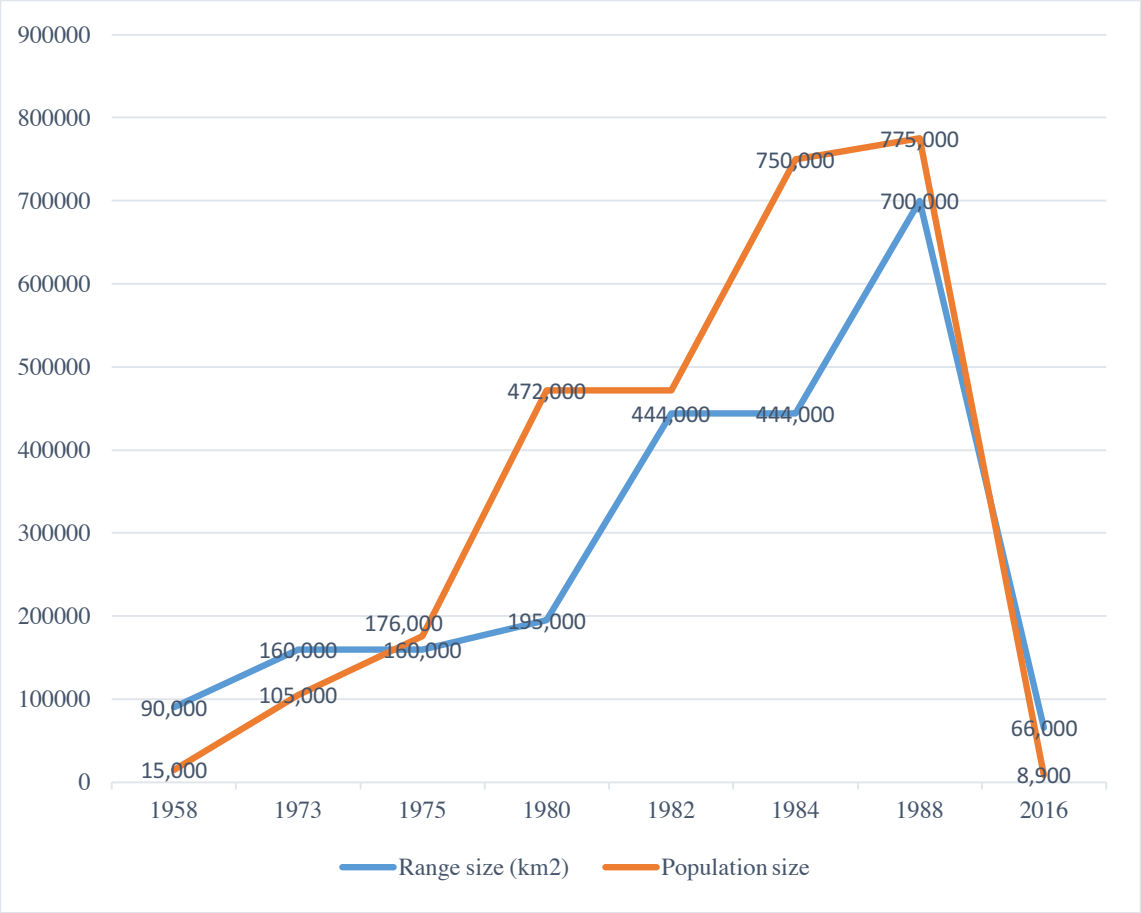

Figure 2 The population and range size of the George River caribou herd 1958-2016 (Bergerud et al., 2012; COSEWIC, 2017; Messier et al., 1988).

Population Dynamics

George River caribou herd population dynamics have been studied since the 1950s, showing both population instability and recovery (See **Figure 3** and **Figure 4**) (Bergerud et al., 2012).

In the 1950s, the herd's population numbered approximately 5000. By the mid 1990s, the herd had grown and stabilized to approximately 776,000 ± 104,000 (Biodiversity Canada, 2015). The herd's habitat began to degrade in the 2000s, leading to a population decline to 385,000 ± 108,00 in 2001, "[F]ollowed by a further decline to 74,100 ± 12,600, based on the 2010 post- calving photo-census" (Biodiversity Canada, 2015). In 2014, the census counted 14,000 caribou in the

herd, leading the Ministry of Environment of Newfoundland and Labrador to impose the hunting moratorium.

Herd population fluctuations are frequently related to grazing habitat. Long term and seasonal distribution changes of migratory caribou are associated with changes in the amount and condition of pasture/edible biomass (COSEWIC, 2017). High herd populations are often cyclically followed by periods of decline, which is correlated with pasture degradation then biomass recovery during the herd's population downturn. In 2016, the herd's population was less than 9000 (Government of Newfoundland and Labrador 2017). Caine concludes that despite intensive research, including indigenous knowledge, "We still do not know for certain why caribou herds are subject to large-scale periodic decline" (Caine, 2018).

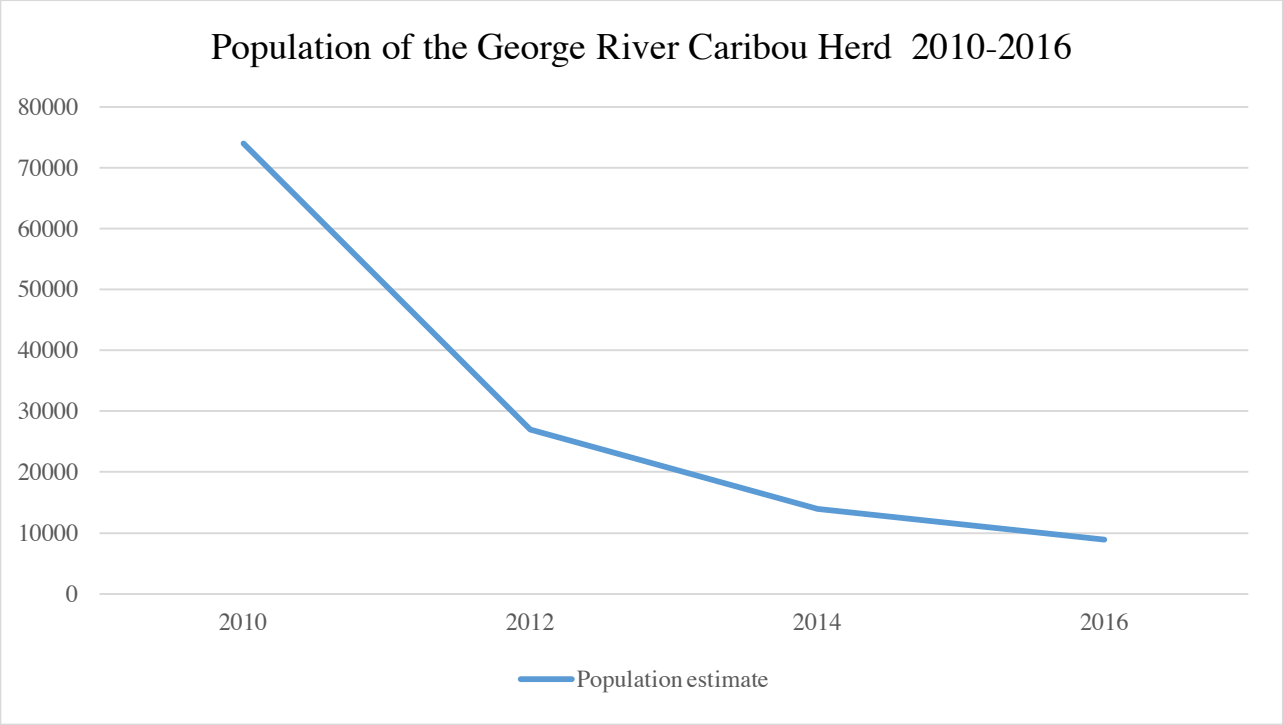

Figure 3 Population of the George River Caribou Herd 2010-2016 (Bergerud et al., 2012; Biodiversity Canada, 2015; COSEWIC, 2017; Government of Newfoundland and Labrador, 2017).

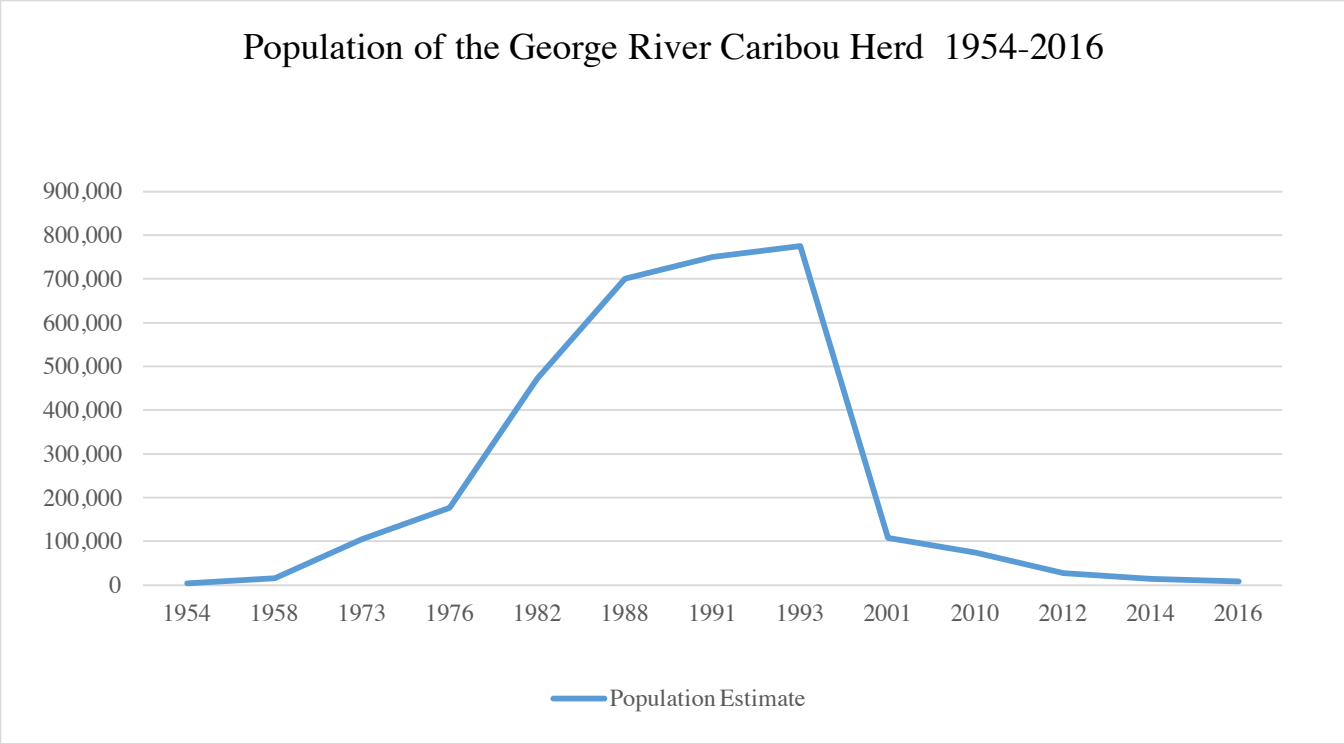

Figure 4 Population of the George River Caribou Herd 1954-2016 (Bergerud et al., 2012; Biodiversity Canada, 2015; COSEWIC, 2017; Government of Newfoundland and Labrador, 2017).

The George River caribou herd's range area is characterized by its hills, tundra, coastal plains and mountainous region by Torngat Mountain (northeastern Labrador) (Messier et al., 1988). The forest tundra (southern portion of the Ungava Peninsula) of this area is populated by Norwegian and white spruce, larches, balsam furs, birch and willows, and lichens. The Ungava Peninsula is composed of tundra and is populated by various species of mosses and graminoids and the swampy areas contain lowbush berry shrubs (cranberry, blueberry, crowberry etc.) (Messier et al., 1988). The George River herd frequents peatland complexes in summer and calving seasons (COSEWIC, 2017).

Conifer forests provide nutritious lichen, a primary and often only available winter food source for caribou. Caribou are known to dig for lichen under the snow. Older forests often have less dense snow, and provide more food sources (Mosnier et al., 2003; Ferguson and Elkie, 2004;

Mayor et al., 2009). The herd uses tundra and peatland regions in spring and summer months and for calving (COSEWIC, 2017). During the calving season period, forested areas, larch swamps, areas with dense willow, and large fens are avoided. Indigenous knowledge cites that female caribou occupy "hillsides, mountain plateaus, and islands" (COSEWIC, 2017) in calving periods. Migratory caribou's distribution expands south of the tree line as their numbers increase (Skoog, 1968).

Recruitment

According to the Ministry of Natural Resources, caribou population stability can be achieved if there is an adult female survival rate of 85%, coupled with a recruitment rate of approximately 29 calves per 100 adult female caribou (Ministry of Natural Resouces and Forestry, 2014). This rate of return is not currently being met with the George River caribou herd (Government of Newfoundland and Labrador 2017)[1].

Smaller calves and lower juvenile recruitment rates occur when caribou experience food insecurity, relating to harsh winters, or density dependent food competition with other ungulates. Climate change may affect the quality and abundance of caribou food, also resulting in smaller calves being born, with lesser chances of survival (Gaillard et al., 1998). Juvenile caribou death is mainly attributed to predation from wolves, coyotes, lynx, and black bears (Gaillard et al., 1998).

[1] While all mammals have a maximum annual population growth (r_m), r_m s do not occur of migratory caribou in habitats without predators. Caribou typically have a r_m of r=0.32 in areas with no predators, such as islands. Herds that are hunted or predated on at a moderate rate have a finite rate of increase (λ) of 1.03 to 1.14. populations do not tend to increase without periods of decline, which exist in caribou generally as $\lambda = 0.86$ and r=-0.15 (Bergerud et al., 2012).

Cycles of Decline

Bergerud et al. studied historic herd data (information relating to herd data prior to 1950) to understand historic declines of the George River caribou herd. Bergerud et al. assume historical herd sizes based on range size and archival data, based on contemporary herd sizes and range extent. They write, "We postulate that when eastern, central, and western hunters, each in turn, had access in the previous population cycle, caribou numbers were similar to the levels of abundance recorded when regular counts had commenced in the 1970s" (Bergerud et al., 2012). Another method to determine past herd sizes was to match periods of caribou decline with indigenous periods of starvation in the 19th century, as indigenous groups were reliant on the George River herd as an essential food source.

Bergerud et al.'s research indicated that the George River herd experienced high numbers in the late 19th century, but declined sharply in the 1920s and 30s (Bergerud et al., 2012; Messier et al., 1988). Bergerud et al. suggest this decline correlates with indigenous hunting and renewed access to firearms (Bergerud et al., 2012).

From the 1950s to the 1980s, the herd experienced high population growth. Potential reasons that supported the growth include a lack of predators such as bears and wolves as a limiting factor (Messier et al., 1988). From 1954 to 1984, the herd increased tenfold. At a rate of population increase (r) at 0.14 from 1955 to 1984, and r equaling 0.11 from 1970 to 1984, the herd grew from 4700 to 472,200 (Messier et al., 1988). From 1954-1984, the George River herd experienced λ=1.14 (Messier et al., 1988). Bergerud et al. observed that this rate of increase was half of the potential finite rate of increase, because of increased indigenous hunting (Bergerud et al., 2012). In the 1980s, the herd experienced a much lower mortality rate of both adult males and females (5-10%). By 1993, when the herd was reaching peak population, the rate of adult

male mortality was 24/100, and adult cow mortality at 17/100, a decline in calf survival at 86/100, and a $\lambda = 0.93$, marking the herd's eventual decline (Bergerud et al., 2012).

Caribou population stability is often determined by juvenile survival rate, as calf survival rate varies from year to year. Gaillard et al's research determined that "the highly variable juvenile survival" was more significant than the constant adult survival in explaining changes in population size (Gaillard et al., 1998).

Scientific Assessment of Caribou Decline

The following section provides a review of various factors scientific research has identified as contributing to the decline of the George River caribou herd. Categorized under the broad term of "limiting factors," the factors are not an exhaustive list, rather an overview of physical and anthropogenic processes which have a significant effect on the George River herd's decline.

Limiting Factors

A limiting factor is a case of mortality that depresses a population or weakens rates of increase (Smith & Smith, 2000). The limiting factors describe the various processes that have caused the herd's decline, the anthropogenic limiting factors tie into the political ecology narrative of human systems of power further degrading the George River caribou herd's population and habitat.

Typically, once the limiting factor is identified, measures are put in place to manage the factor, usually in the form of some sort of protection or conservation (Bergerud et al., 2012). The most common limiting factors for all caribou subspecies in Canada include; predation by wolves or bears, accidental death, disease, starvation, and hunting (Bergerud et al., 2012; Théau & Duguay, 2004). Other limiting factors that are attributed to caribou population fluctuations include overuse of wintering grounds and changes in climate (Bergerud et al., 2012; Théau & Duguay, 2004). Limiting factors of the George River caribou are atypical, as they are one of the few migratory herds to exceed their summer habitat capacity and they are relatively insulated from wolf predation (Messier et al., 1988; Théau & Duguay, 2004). For most caribou herds in northern environments, forage is more abundant and the range is more extensive in summer months (Messier et al., 1988). Wolves predate the George River caribou herd; however, the

herd's extensive range is a deterrent. And, for many decades, the population of other ungulates was too small to support a wolf population (Messier et al., 1988).

Not every limiting factor has been studied in the context of the George River herd. Several limiting factors listed below are described in context of woodland caribou in general, other woodland caribou herds, with the assumption that these limiting factors apply to the George River herd as well.

Industrial Development

There is limited information available regarding the impacts of industrial activity on the George River herd in Labrador. There is data regarding other herds in Labrador, or the George River herd's range in Québec[2] (See **Figure 5**).

Caribou and other species that migrate long distances change their usual distribution and migratory routes, resulting in significant impact caused by industrial activities including mining, forestry and construction (Boulanger et al., 2012). Industrial activity also limits the amount of available habitat to the George River caribou herd, because of expanding road networks, and changes in surface hydrology (COSEWIC, 2017). Rudolph et al. studied the effects of habitat disturbance (forestry and roads) and caribou population and found a direct connection between habitat degradation resulting from industrial development and woodland caribou population decline (Rudolph et al., 2017). Rudolph et al.'s research supports the disturbance-demography relationship, wherein habitat degradation or fragmentation results in the significant decline of woodland caribou populations.

---

2 Information regarding industrial development and the George River herd in Québec is largely in French and was not incorporated into this section.

COSEWIC reported that the George River caribou herd experiences mid to high levels of disturbances from industrial development in herd's range in Québec and Labrador. Multiple hydroelectric projects, including dams that result in flooding extensive areas of the herd's winter habitat (COSEWIC, 2017). Large groups of caribou are more likely to avoid disturbed areas, compared to smaller groups (Weir, Mahoney, McLaren, & Ferguson, 2007). Polfus et al. found that caribou avoid roads by buffers of at least 2 km, human settlements by 9 km and mines by 2 km (Polfus et al, 2011).

Furthermore, the George River herd may experience further impacts of industrial development with the Government of Québec's proposed "Plan Nord." The plan seeks to invest $80 billion in constructing airports, roads and developing mining and forestry activity in northern and central Québec (COSEWIC, 2017).

Woodland caribou in Subarctic areas have experienced limited exposure to human industrial activity, and tend to react by avoiding areas with industrial development which impacts caribou migration areas, herd recruitment and population dynamics (Wolfe et al., 2000). Caribou migrations are sensitive to industrial activity, affecting timing and extent of caribou migrations within their typical ranges, it also enhances herd fragmentation and is linked to a decrease in reproduction (Weir et al., 2007).

Rudolph et al.'s results demonstrate that a minimum of 65% undisturbed habitat is required to sustain healthy woodland caribou populations and that adult caribou mortality is significantly higher in disturbed areas of caribou range (Rudolph et al., 2017).

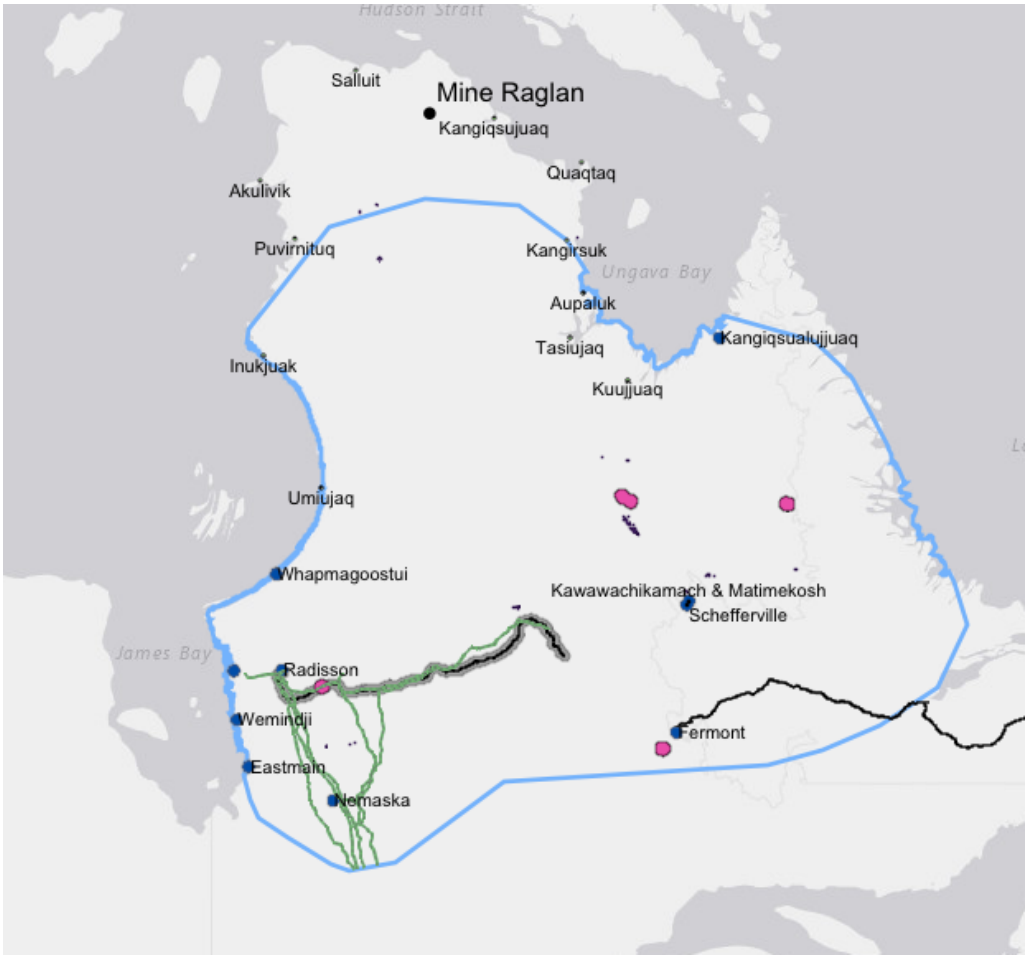

Figure 5 This map depicts industrial and other human activity occurring within the George River caribou herd's range of Québec (encircled in light blue). Pink circles denote mining activity, green lines denote power lines, blue circles denote human habitation sites and black lines indicates the Trans Labrador Road (Côté & Rodon, 2017).

Roads

One of the single largest human impacts that is linked to woodland caribou population decline is linear features such as roads, hydroelectric corridors and seismic lines (Weir et al., 2007). Roads and other corridors are linked to an increase in an increase caribou vulnerability to predation, both by humans and wildlife (Wolfe et al., 2000). COSEWIC reported that it is difficult to assess the impact of roads and other linear features on the George River caribou herd, because there are "no reliable projections of road density" related to increases of industrial development in Labrador and Northern Québec. It can be assumed that there will be an increase

in roads and other linear features because of the on-going intensification of mining and forestry activity in Québec and Labrador (COSEWIC, 2017). There are multiple winter roads proposed for mines in the George River herd's range. The Lac Brission mining project constructed a road which connects to Voissey's Bay. The road is built in a George River herd calving habitat and would also bisect a George River caribou herd migration corridor (COSEWIC, 2017). There is a winter road from Fort Severn in Labrador (near the Hudson Bay range) connecting to Shamattawa and Gillam, Manitoba that crosses the herd's range south of Hudson (COSEWIC, 2017).

Roads disturb caribou in numerous ways and tend to be avoided, especially during autumn and winter migration periods. Linear features facilitate access for hunters (indigenous and recreational), especially forestry roads and seismic lines used by off roads vehicles (COSEWIC, 2017).

Rudolph et al.'s study showed that the negative effects on caribou calf recruitment are related most strongly to linear disturbances in landscapes, including but not limited to seismic lines, hydroelectric corridors and roads (Rudolph et al., 2017). Wolfe et al. report, "Elevated roads that present a visual barrier, roads that create a break in habitat in forested areas, or roads with adjacent snow berms or habitat that obscured vision were most strongly avoided by caribou in fall and winter" (Wolfe et al., 2000). Woodland caribou avoid roads and railway tracks if they are actively used, which prevents crossing or enhances vulnerability to hunters and wildlife predation because of increased visibility. Limiting factors such as accidental death by collision increased as caribou are reported to cross railways and roads to avoid insects (Wolfe et al., 2000). Migration routes that are intersected by roads, or other linear clearings are typically

interrupted, avoided or in some way delayed by woodland caribou (Wolfe et al., 2000). Larger groups of caribou crossing roads enhance the danger of vehicle collision.

Researchers have noted that cows and calves appear more reactive to avoiding roads, and pipeline right of ways - regardless of traffic levels, compared adult males, especially during calving periods in the spring and summer (Bergerud et al., 2012; Wolfe et al., 2000). Wolfe et al., conducted a literature review on caribou reactions to linear features and found that on average, "[C]aribou density at calving was inversely related to road density, declining by 63% from baseline densities when there was >0.3km road/km^2 and declining by 86% from baseline densities when there was >0.9 km road/km^2" (Wolfe et al., 2000).

Rudolph et al argue that conservation strategies that see 65% undisturbed habitat as a maximum benchmark rather than a minimum requirement are unlikely to succeed (Rudolph et al., 2017).

Habitat Loss

Habitat loss is a main cause of caribou and other wildlife population decline worldwide, human industrial activity and other human impacts indirectly and directly causes caribou displacement and habitat fragmentation (Polfus et al., 2011). Polfus et al. reported that caribou avoidance of human disturbances is seasonal, more significant in winter, and dependent on the type of human activity. Polfus et al.'s study found that human activity reduces high density or quality caribou habitat between 2-8%. Côté et al. estimate that the George River herd loses upwards of 2% of its range in summer months due to human occupation, and approximately 20% of its winter areas to avoid human settlements and associated disturbances (Côté & Rodon, 2017).

Polfus recommend that conservation initiatives should focus on protecting high quality habitat near human activity, as the habitat is significantly degraded by human development (Polfus et al., 2011).

Logging

Logging has a double impact on the George River caribou herd. First, logging in Ontario and Québec is linked to moose populations migrating into caribou habitat, which is associated with an increase in competition for range and food sources between moose and caribou. Moose population increases are linearly connected with an increase in wolf populations. Attracting additional predators such as wolves into caribou range depresses caribou populations (Weir et al., 2007).

Second, forestry activity in Labrador impacts habitat as well as foraging resources. Logging in Labrador removed upwards of 30-55% of lichen coverage in forested areas, and "After clear-cutting, natural lichen regeneration only occurred within 350 m of mature forest with high lichen abundance" (Wolfe et al., 2000).

Mines

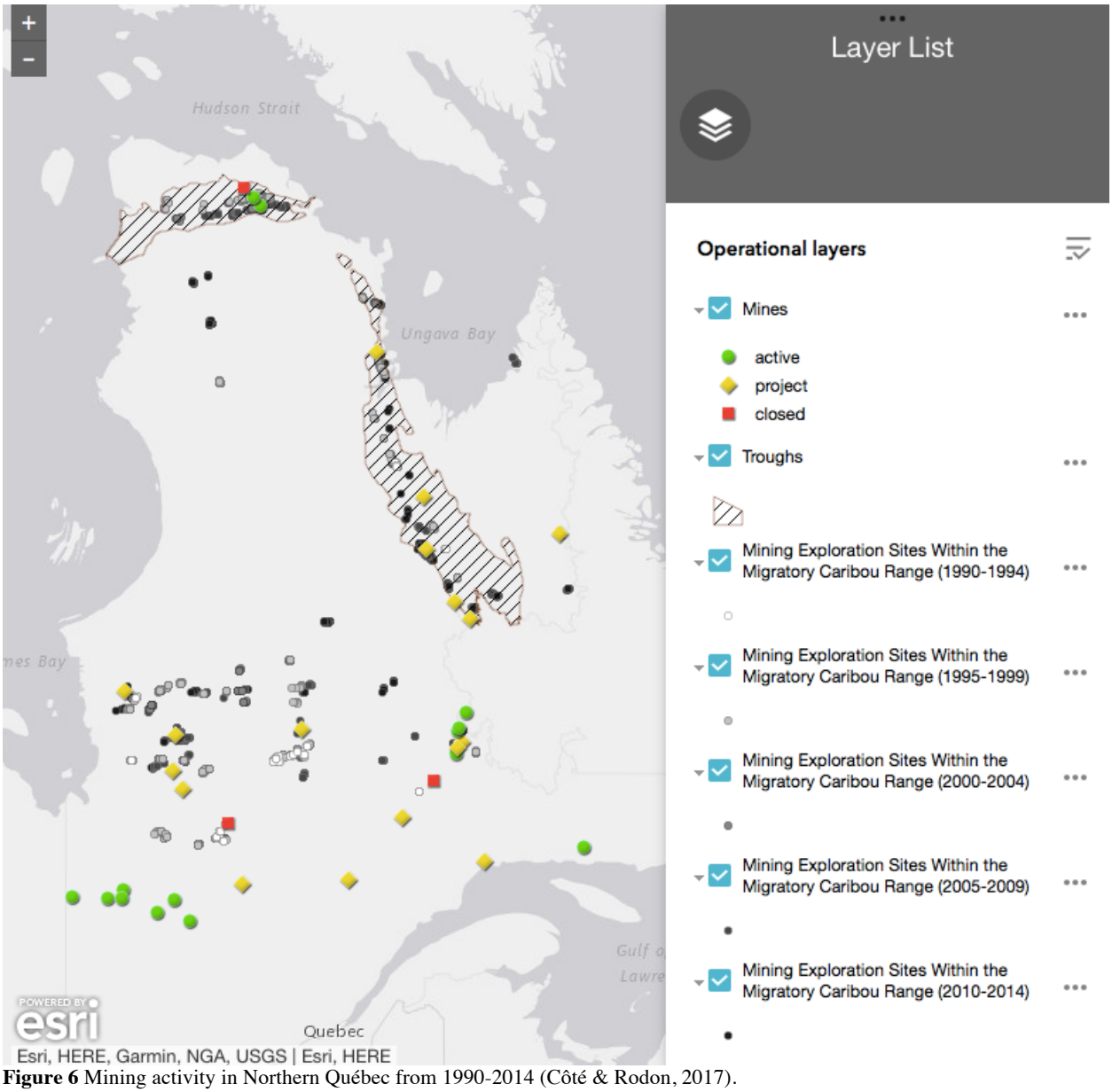

Figure 6 Mining activity in Northern Québec from 1990-2014 (Côté & Rodon, 2017).

The number of mines operating in the George River caribou herd migration range doubled between 1990 and 2016 (Côté & Rodon, 2017). In the herd's Québec range, there are four active mines and numerous proposed mines and related mining activity (COSEWIC, 2017).

Researchers conducted studies regarding indigenous caribou hunting and mining activity in northern Québec and found that the presence of mines in caribou range degraded caribou

habitat, altered caribou migration patterns and led to an increase in wolf predation, and accidental death via vehicle collision (Herrmann et al., 2014). The study also revealed that caribou avoid mining activity by an average distance of 7 km. Herrmann et al. argue that cumulative effects of mining, with the additional pressures of roads, vehicle use in caribou habitat and climate change are what negatively drives caribou population decline in migratory caribou herds in north eastern Canada (Herrmann et al., 2014).

Boulanger et al. developed a statistical assessment to measure areas of reduced caribou occupancy, known as Zone of Influence (ZOI). Their research observed that on average, caribou avoid open pit mines on average by 14 km (Boulanger et al., 2012). The implications of their research extended beyond the conclusion that caribou are displaced by mining and other activity, it demonstrated that environmental assessment valued components such as sound and noise are insufficient in measuring environmental impacts of mining on migratory caribou herds. Dust fall on forage resulting from mining activity was suggested to be a significant factor in caribou avoiding mining areas. While dust coverage decreases exponentially with distance from mining activity, the study found that caribou avoided areas with even small amounts of dust. The researchers noted that dust coverage is assessed for vegetation in environmental assessments for mines, but dust impacting animal species is largely unsearched (Boulanger et al., 2012).

Côté et al. produced an interactive story map that depicts the interactions of indigenous communities, caribou and mining activity in northern Québec and Labrador and developed a series of maps to depict how much industrial activity has increased in the George River herd's (and other migratory herds) range (See **Figure 6**)(Côté & Rodon, 2017).

Researchers Weir et al. documented mining activity impacts on Newfoundland caribou populations and their results indicated mining has significant effects on caribou displacement and

habitat disruption. Weir et al.'s results indicated that caribou numbers increased farther away from mining activity. Weir et al. write, "Between 51 and 92% of the variation in caribou distribution was accounted for by distance from the mine centre. There was an overall reduction in the number of caribou, within the 100-km^2 study area, as the mine activity progressed" (Weir et al., 2007). Furthermore, their results indicate that towards the end of winter and periods before and during calving, caribou density within the zone of influence of mines declined substantially from pre-operation population density in the area (Weir et al., 2007). Furthermore, their study showed that fewer than 27% of caribou remained in the zone of influence of the mine during operation, compared to herd density in the area measured during pre-disturbance in the region (Weir et al., 2007).

Weir et al. suggest that mining activity in caribou range resulted in a loss of habitat of upwards of 50km^2, which may not appear significant. However, any amount of geographic decline of caribou habitat can result in alteration of migration pattern, population fragmentation and, especially if the loss of habit occurs in important migration route areas. Furthermore, the pressures of mining displacement only enhance other limiting factors woodland caribou, in relation to logging, hunting, predation and habitat over use (Weir et al, 2007).

Climate Change

Climate change in northern Québec and Labrador has numerous impacts on the George River herd, impacting habitat and thermoregulation (COSEWIC, 2017). Changes in Arctic sea ice has led to Arctic greening, impacting the timing, quantity, availability, distribution, while delaying access to important vegetation resources (Fauchald et al., 2017; COSEWIC, 2017). Fauchauld et al. write, "[T]he annual sea ice concentration provided a strong signal for climate-induced changes on the adjacent caribou summer ranges, outperforming other climate indices in

explaining summer [normalized difference vegetation index] and consequently the caribou population dynamics" (Fauchald et al., 2017).

Other complications include increased snow coverage in areas, which affects how the herd can access important calving grounds. Calving can also be disrupted by climate change because earlier springs can alter peak vegetation periods and available food, "calf production and survival are reduced when the asynchrony between the birth pulse and vegetation green-up increases, a phenomenon termed 'trophic mismatch'" (COSEWIC, 2017). Earlier springs may affect the amount of vegetation This affects the recruitment of the herd, or it may delay access to the calving grounds as the herd may select alternate routes with less snow coverage (Mameamskum, 2015). An increase in forest fires tied to climate changes may contribute to limiting factors such as food insecurity, as it takes 30-40 years for lichen crops to recolonize after forest fires (Théau & Duguay, 2004).

While not studied specifically within the George River herd, researchers studying woodland caribou herds in Ontario project extensive habitat loss due to changes in climate. Based on 126 climate change forecast scenarios, researchers predict that climate change will lead to a 55% loss of range for woodland caribou in Ontario by 2050. These climate forecasting models do not include increases of industrial development as a factor of habitat decline and species extinction (Masood et al., 2017). Masood et al. provided the example that under conservation estimations of temperature increase (0.9-5.3 degrees c), it would lead to a 57%-98% loss of caribou habitat range in northern Ontario. Increased temperatures result in less snow cover, and an increase in open watercourses such as rivers and lakes. Lack of ice and frozen waterways interrupts migration patterns significantly (Masood et al., 2017). Change in ice also leads to an increase in accidental death such as drowning and an increase in energy spent in

swimming in open waters. Indigenous knowledge has also provided evidence of climate changes in the George River caribou herd range. Observations include thinning ice in lake and rivers, which obstructs crossings, as well as an increase in unpredictable weather (Mameamskum, 2015).

Arctic Greening

Arctic greening occurs when Arctic sea ice melts, causing warmer temperatures in adjacent land masses. The warming climate thaws permafrost and increases vegetation growth because of lengthened growth periods (Fauchald et al., 2017). Fauchald et al. found that declining sea ice leads to arctic greening in Labrador, changing the biomass quantity and type because of extended growing seasons and changes in permafrost (Fauchald et al., 2017). The study connected declining sea ice to degradation of woodland caribou habitat in Labrador. Fauchald et al. showed that Arctic greening caused an increase of tall shrubbery and other tundra biomass in the Labradorian tundra. The researchers originally hypothesized that oscillating caribou population sizes would counteract the expansion of tundra shrubbery, while the expanding biomass would support population growth of caribou herds in Labrador. Contrary to their original hypothesis, the study showed that warming over Labrador increased the growth of alder and birch and outcompeted edible willow (Fauchald et al., 2017). The increase of green biomass caused by Arctic greening in the George River caribou herd grazing areas effectively degraded the quality of pasture, with alder and birch replacing moss, grass and other edible shrubs (Fauchald et al., 2017). This indicates that caribou grazing had almost no negative effects on summer tundra biomass, leading them to conclude that while shrubbery had increased, the quality of the caribou pasture and grazing quality had diminished (Fauchald et al., 2017)

Bergerud et al. stated that a "shortage of green biomass," is a substantive regulating factor on the George River caribou herd. (Bergerud et al., 2012). Bergerud et al. found that the reduced availability of caribou food sources created a reduction in caribou fertility, generally smaller mature caribou that are more susceptible to hunting and predation. Fauchald et al. reported that, "[T]he sea ice cover in the Arctic Ocean has provided a strong signal for climate-induced changes on the adjacent caribou summer ranges, outperforming other climate indices in explaining the caribou-plant dynamics" (Fauchald et al., 2017). The decrease of edible pasture in conjunction with hunting and wolf predation was sufficient to limit and regulate the George River Caribou herd (Bergerud et al., 2012).

Forage Decline

A substantive limiting factor for the George River caribou herd is forage decline, resulting from overuse and Arctic greening altering the herd's edible biomass (Bergerud et al., 2012; Fauchald et al., 2017; Messier et al., 1988).

Numerous caribou ecologists theorize that access to forage is a central mortality factor in caribou population sizes, because the carrying capacity of the range is exceeded which leads to low calf recruitment (Parlee et al., 2018). The George River caribou herd subsists primarily on terricolous lichens, which grow "at a rate of 3.5mm year" (Messier et al., 1988). Because the slow growth of the plant, the caribou-lichen feedback system does not permit for stable caribou population growth. COSEWIC writes, "Increased Caribou density is followed by local decline, which then may allow vegetation to recover" (COSEWIC, 2017). Messier et al. put forth that lichen crops are a result of multiple decades of growth, and caribou population growth is not sustained by annual lichen growth (Messier et al., 1988). Caribou population fluctuations are related to access to food because, "[H]abitat limitations would become effective when the overall

demand for lichens substantially exceeds the annual production of the habitat. Caribou-lichen interactions have the strong delayed density-dependent attributes that can promote population fluctuations" (Messier et al., 1988).

Unlike many caribou herds across Canada, access to summer forage is a limiting factor for the George River herd (Messier et al., 1988; Théau & Duguay, 2004). The herd's preferred summer grazing habitat/calving areas (see **Figure 7**) is along the coastal tundra plateaus of the Labrador Sea, because wind protects the caribou from insects and the high elevation of the plateaus deters predation (Théau & Duguay, 2004). This region accounts for 15%+/- of the herd's total grazing area. The heavy usage during the summer months likely puts unsustainable pressure on pasture coupled with the slow growth rate of lichen making habitat recovery slow. Théau & Duguay reported, "[H]igh latitude distribution of caribou makes their habitat very sensitive to perturbations because of slow vegetation growth (Théau & Duguay, 2004). Researchers noted that the herd migrated away from the preferred grazing areas earlier and earlier, which suggest the resource was no longer sustaining the herd. Théau et al. observe that this type of habitat, protected from summer insects cannot be replaced with in the herd's range, while supporting an expanding population (Messier, et al. 1988; Théau & Duguay, 2004).

As range expands, this may delay the caribou-lichen feedback loop. Lack of sufficient forage becomes apparent when the herd's territory can no longer expand (Messier et al., 1988). Furthermore, it seems that the preferred calving ground is not replicable, as no other areas are as protected from wind and insects that can support a strengthening George River herd population (Messier et al., 1988).

Researchers Théau and Duguay measured lichen coverage in the George River Herd summer range and calving grounds from 1976-1998. Lichen changes correlated with the herd's

population dynamics and range extent observed in other studies (Théau & Duguay, 2004). Their study showed degraded lichen coverage that matched with herd expansion. The results also measured an increase of lichen in areas near the George River, which connects with Messier et al.'s research connecting the herd's population dynamics relying on summer grazing ground resource security (Théau & Duguay, 2004). The George River herd selects calving location on the eastern tip of the Ungava Peninsula, an extreme location to avoid risk of predation (Bergerud et al., 2012). Wolf presence may limit George River herd migration and movements, adding additional pressure on available habitat for calving and summer forage.

Théau and Duguay reported a decline of lichen in the herd's summer habitat from 1985-1986 (Théau & Duguay, 2004). A similar decrease in lichen was measured in 1993. Theau et al.'s study indicated that the herd abandoned these areas typically inhabited for calving grounds and moved northward. This change in range correlates with Bergerund et al.'s data showing a significant decline in pregnancy rates and calf survival of the George River herd at this time. The rate of pregnancy in the George River herd in the late 1980s was approximately in the low 60s, while there were 34-39 calves/100 females, compared to 56 calves/100 female in 1973 (Bergerud et al., 2012).

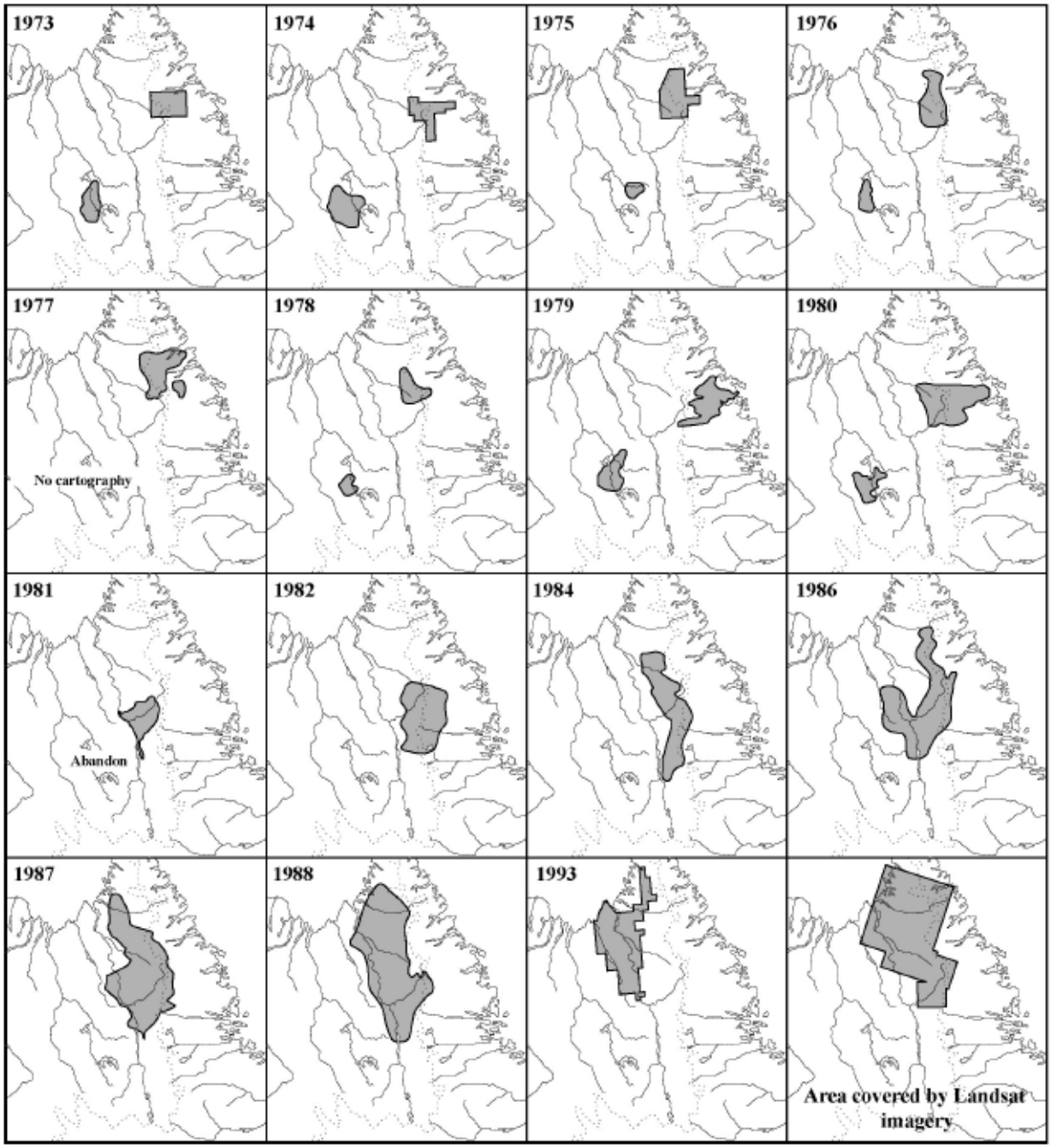

Figure 7 George River Caribou herd calving areas (grey) from 1973-1993 in Labrador (Théau & Duguay, 2004).

Predation

Wolves

Wolves preying on caribou is generally considered to be a major limiting factor to woodland caribou (Bergerud et al., 2012). According to researcher Bergerud et al., the most significant

mortality factor that prevented population growth in the George River caribou herd was hunting and wolf predation (Bergerud et al., 2012). Wolf populations are generally low in Ungava (Northern Labrador), likely because there are not other ungulate populations (deer, moose) that could support a strong wolf population (Bergerud et al., 2012). Caribou's extensive migration can be a predator deterrent, wolf pups are known to starve in Arctic conditions (Bergerud et al., 2012).

Despite low density of wolf populations, Bergerud et al. reported that wolves were the primary cause of death of in radio collared females in the George River herd from the 1970s-90s (Bergerud et al., 2012).

Bergerud et al.'s research indicates that wolf predation regulates caribou populations, they hypothesized that at a caribou density of 0.4 km^2, caribou are not food stressed, there is enough caribou to support a wolf population, and at that density, enough wolves would exist in the area to stop caribou herd population growth (Messier et al., 1988). Bergerud et al.'s research was at odds with other researchers studying the George River herd's demography. Messier et al. argue that there is a low density of wolves in northern Québec and Labrador, not a sufficient population to limit the growth of the George River herd. The studies found that the George River herd doubled its 0.4km^2 density in the 1980s, meaning that wolves were not effective in limiting the herd's population growth as Bergerud had reported. Furthermore, calf recruitment remained steady and began to decline only when faced with food resource limitations (Messier et al., 1988). Messier et al. argue that caribou in Labrador are not attractive prey to wolves because of their significant migration, which limits wolf predation during summer months, because wolves are somewhat tethered to their dens because of wolf pups (Messier et al., 1988).

Prior to the decline, Messier et al. predicted that if the George River herd declines, wolves would become a significant threat to the herd, writing, "[W]olf predation rate should be expected to increase during a decline of a caribou population" (Messier et al., 1988). Bergerud et al. disagreed with Messier et al.'s hypothesis that wolves were not a significant predator of the George River herd. Bergerud et al.'s data indicated that in the 1990s, wolf predation was the primary killer of calves and radio collared females (Bergerud et al., 2012), and Messier's study coincided with a rabies outbreak in wolves in the Ungava region that may have accounted for the low number of wolves in the 1980s.

Migratory caribou have distinct distribution patterns to evade wolf predation, which could lean in favour of the argument that wolf predation is not a significant limiting factor to the George River herd as some researchers argue. Female caribou space away from treed areas and male caribou, to increase search time from wolves and other predators (Bergerud et al., 2012), or frequent calving areas in the tundra, areas with minimal predators. Other calving areas to evade wolf predation are near waterways, such as lakes or islands, as the caribou cows are able to escape wolves via the watercourse (Bergerud et al., 2012). Bergerud writes, "Caribou have evolved…major antipredator spacing strategies to reduce predation for their newborn calves" (Bergerud et al., 2012), seeking out still frozen lakes north of the tree line (Bergerud et al., 2012).

Because of increased logging in other provinces, Moose have advanced into Labrador's migratory caribou habitat from Ontario, due to logging (Bergerud et al., 2012) or because of milder winters resulting from warming climates (COSEWIC, 2017).

Not only to caribou compete with moose for forage, moose populations are relational to wolf populations. Caribou populations have been shown to be relative to moose population density,

which in turn attracts wolves as predators, moose numbers are known to increase wolf predation rates on caribou (COSEWIC, 2017). Bergerud et al. wrote, "Thomas proposed that when moose are common, wolf densities of more than 5-8/1,000km^2 will hold caribou populations at low levels for long periods" (Bergerud et al., 2012).

Bears

Indigenous knowledge reports that climate change in Ungava has led to an increase of black bears (COSEWIC, 2017). Black bear predation on George River caribou herd calves may be substantial. Black bears preying on the George River herd may now be a limiting factor, as the herd's population is vulnerable and calf survival is important for herd population recovery (COSEWIC, 2017).

Hunting

COSEWIC states, "Hunting is presently known to be the major source of mortality on the George River subpopulation" (COSEWIC, 2017). Caribou are easily disturbed by the presence of hunters and other recreational users in their habitat. The George River herd is typically accessed by humans via snowmobile or small engine planes (Department of Environment and Conservation, Natural Heritage Branch, 2010). Caribou avoid areas where hunters may target them (Wolfe et al., 2000). Bergerud et al. observed that hunting, "[I]s additive and not compensatory to other mortality factors" but hunting could become significant if the population or habitat was degraded (Bergerud et al., 2012).

In the case of the George River herd, hunting access was determined by the range and extent of the herd's migrations. In the 1950s, the herd was smaller and occupied areas on the northern Labrador coast, and was predominantly harvested by residents of the small coastal settlements. "As the herd grew and shifted farther west, the Inuit…were the recipients, and it

became more difficult to measure the harvest" (Bergerud et al., 2012). In the 1970s, the herd moved south, giving access to the Cree and other indigenous groups in Ungava. This compounded with the rise of recreational hunting as an industry in Québec and Labrador (Bergerud et al., 2012). Caribou hunting in Newfoundland and Labrador is controlled by the Ministry of Fisheries and Land Resources. Each year, a limited amount of caribou hunting licenses are released by the Government of Newfoundland and Labrador for recreational hunting. The Newfoundland and Labrador Wildlife Division reported that Between 2007-2009, 3,200 caribou from the George River herd were hunted by resident hunters, commercial harvesters hunted approximately 430 animals and non-resident hunters and guide outfitters hunted 350 +/- George River herd caribou (Government of Newfoundland and Labrador, 2010).

In 2018, the provincial recreational hunting quota for caribou was 618 and the hunting moratorium on the George River caribou herd was maintained (Government of Newfoundland and Labrador, 2018a).

Indigenous hunting for subsistence and cultural purposes is not currently sustainable with the herd's demographically weak status. Caribou herds' populations generally remain stable if hunting takes <5% of the herd (Bergerud et al., 2012). COSEWIC stated, "The impact of harvest will increase as the Caribou populations decline" (COSEWIC, 2017). The Newfoundland and Labrador Wildlife Division reported that Between 2007-2009, Inuit in Labrador hunted approximately 1,300 caribou from the herd and reported that there is not an accurate number of caribou hunted by other indigenous groups (Government of Newfoundland and Labrador, 2010).

Limiting Factors Conclusion

Arctic greening, forage decline and industrial development and their cumulative impacts are the limiting factors that most likely triggered the decline of the George River caribou herd (Bergerud et al., 2012; COSEWIC, 2017; Côté & Rodon, 2017; Fauchald et al., 2017; Messier et al., 1988). When the herd's decline reached critically low levels in the 2000s, hunting and wolf predation became limiting factors that prevented the herd's population from recovering (Bergerud et al., 2012; COSEWIC, 2017). It also appears that recreational hunting (until the hunting moratorium in 2013) accounted for the significantly higher numbers of caribou mortality compared to caribou hunted by indigenous users (Government of Newfoundland and Labrador, 2010).

COSEWIC Assessment

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) is an independent advisory panel to inform the Ministry of Environment and Climate Change. Species at Risk Act (SARA) formed COSEWIC to provide a "single, official, scientifically sound, national listing of wildlife species at risk" and incorporates biological, local and indigenous knowledge in its assessments (COSEWIC, 2017). COSEWIC developed a threats classification and assessment calculator in 2012, the measurements are included in all COSEWIC reports since this date (COSEWIC, 2017). COSEWIC recommendations only protect or recover species listed the Species at Risk Act (SARA), SARA "provides for separate scientific assessment and legal listing. COSEWIC assesses the conservation status of wildlife species based solely on biological information" (Festa-Bianchet et al., 2011). It is government responsibility to protect, manage or conserve wildlife identified by SARA and COSEWIC, COSEWIC assesses the conservation

status of wildlife species based solely on biological information, but only species that are listed under SARA receive legislative protection. The federal government may use social or economic arguments to refuse to list a species assessed by COSEWIC at some level of endangerment" (Festa-Bianchet et al., 2011).

In April 2017, COSEWIC assessed the Eastern Migratory population of caribou (which includes the George River herd) as endangered. When a species is listed as endangered it means, "A wildlife species facing imminent extirpation or extinction" (Government of Canada, 2016). The endangered status was designated because the Eastern Migratory population had experienced an 80% decline over three generations (18-21 years) and a total decline of 99%. COSEWIC reported a "high to very high" threat score classification in the Threats Summary. The COSEWIC assessment describes numerous threats and limitations to the George River Caribou herd that prevent population recovery. COSEWIC acknowledges that caribou decline is often influenced by resource availability, but other limiting factors include indigenous and recreational hunting of the herd. The report stated that the main limiting factor is reduced forage because of climate change (COSEWIC, 2017) and noted the concern that while caribou herd populations do fluctuate greatly, that cumulative threats combined with the herd's lowest ever recorded population numbers, population recovery is limited (COSEWIC, 2017).

COSEWIC states that caribou are sensitive to human, industrial and environmental disturbances. The assessment stated that mining activity, roads, hunting, decreased habitat because of fires and a climate change related resource and habitat degradation are all concerns in the threat assessment calculator. Alterations in habitat and pasture quality because of shrub increase resulting from climate change, as well as parasites are also limiting factors in herd stability (COSEWIC, 2017).

Government Management of Caribou

Caribou conservation requires provincial legislation, in addition to federal regulations, COSEWIC recommendations and SARA listings (Festa-Bianchet et al., 2011). Most woodland caribou habitat occurs on Crown or public lands, making it the primary responsibility of provincial levels of government to manage lands, resources and wildlife (COSEWIC, 2017). The federal government's 2012 recovery strategy required that provincial and territorial governments develop range management plans to protect wildlife habitat. Alberta, Ontario and Québec have provided plans to date and the Government of Newfoundland and Labrador has prioritized woodland caribou management as an issue (Species at Risk Act, 2017).

Government of Newfoundland and Labrador Conservation

The George River caribou herd occupies range in Labrador, Québec and Nunatsiavut (Inuit Land Claim Area), there no legislation in place in Labrador protecting George River caribou herd calving grounds (COSEWIC, 2017). A joint habitat protection policy is being considered by the Government of Québec and the Government of Newfoundland and Labrador (COSEWIC, 2017), which could potentially overcome inter-jurisdictional challenges of managing the George River caribou herd (COSEWIC, 2017).

The Government of Newfoundland and Labrador's Endangered Species Act (the Act) fulfills the government's commitments to the National Accord for the Protection of Species at risk and provides protective measures to endeared or at risk wildlife species. COSEWIC informs the Act's decisions to designates species for protection (Government of Newfoundland and Labrador, 2018b).

In response to caribou decline in Newfoundland and Labrador, the "Labrador Caribou Initiative" was created in 2010, and allocated $1.9 million from Department of Environment and Conservation for 2011-2014. This allowed the government to "Implement research and monitoring programs designed to inform management of the herd including the implementation of a five year ban on all hunting (Government of Newfoundland and Labrador, 2015). The government committed to funding an additional $975,000 in 2014 for five years to, "Fund enhanced monitoring and research programs for the George River caribou herd" (Government of Newfoundland and Labrador, 2015).

The "Labrador Caribou Initiative" includes monitoring the demographics of the herd, investigating deaths of caribou, finding the relation between predators and caribou mortality. The plan identifies important habitat areas and calving locations. The initiative plans to incorporate indigenous knowledge and to work collaboratively with local indigenous communities (Government of Newfoundland and Labrador, 2015, 2016b). The objectives outlined in the Labrador Caribou Initiative are listed below:

- "To monitor how many caribou are in the herd and how this changes over time.
- To determine the proportion of males, females, yearlings and calves and their survival rates each year.
- To investigate deaths of collared caribou and to determine the cause of death.
- To collect information on the health and condition of caribou in the herd.
- To study the relationship between the herd and its predators, mainly wolves and black bears.
- To identify and map important areas such as calving grounds or migration corridors.
- To work collaboratively with others in the development of a Caribou Management and Conservation Plan that incorporates science based information and traditional knowledge" (Government of Newfoundland and Labrador, 2015)

The goal of the Labrador Caribou Initiative is to gain information on the factors leading to the sharp decline of the herd and to gather scientific information to inform conservation

management decisions made by the Government of Newfoundland and Labrador (Government of Newfoundland and Labrador, 2015, 2016b).

Labrador Caribou Initiative

Reporting on Phase 1 of the Labrador Caribou Initiative (2011-2014) was published in 2015. Key findings of the "George River Caribou Information Update" include that the herd is experiencing "critically low numbers" and continues to decline, and the survival rate of all age/sex classes in the herd is significantly lower than needed to stabilize the herd population. The report stated that 34 calves/100 cows are needed to stabilize the herd, and the herd is experiencing a recruitment is11.3 calves/100 females. Males in the herd are also in decline, which may be associated with non-compliance of the hunting moratorium (Government of Newfoundland and Labrador 2015). An update released shortly after reported that her herd experienced a recruitment of 80 calves/100 females, and male caribou numbers were increasing. (Government of Newfoundland and Labrador 2015).

George River Caribou Herd Hunting Moratorium

In January of 2013, the Government of Newfoundland and Labrador imposed a hunting ban on the George River caribou herd. In a news conference, the Honourable Tom Hedderson, Minister of Environment and Conservation stated,

> The George River herd continues to experience a very serious decline and strong action is required by our government to address the immediate and long-term protection of this important resource…Our first priority is conservation of these animals, and that is why we are imposing a total ban on this herd. George River caribou have shown a continued steep decline in the latest survey results, and a continued harvest is simply not sustainable at this point in time. The goal of today's decision is central to all people of Labrador to help ensure that the George River caribou will be here for future generations. Given the biological information that we have, we must do our part and work together to ensure the herd's existence. (Environment and Conservation Executive Council, 2013).

The goal of the hunting moratorium is to stabilize the population of the George River caribou herd (Government of Newfoundland and Labrador, 2017). The hunting moratorium was extended in 2016 and is currently in place. The province's Ministry of Environment and Climate Change stated in an online news release, "At the current rate of decline and without immediate cessation of illegal hunting, biologists predict this herd could become functionally extirpated in less than five years, meaning that the herd will become so small it will essentially lose its capacity to recover" (Government of Newfoundland and Labrador, 2016b).

Since the moratorium, herd census reports that the herd has further declined from 14,200 animals in 2014, to 8,938 in the summer of 2016 (Government of Newfoundland and Labrador 2017)

The government acknowledges that the population decline observed in the 1990s was not triggered by hunting, but stated that the herd was too demographically week to support hunting. The Government of Newfoundland and Labrador sated,

> Therefore, under current conditions, any hunting at this time is driving the herd to decline at a faster rate and to lower levels that may jeopardize recovery efforts…any hunting at this time results in mortality that is in addition to the proportion of the population annually dying from natural causes… if hunting continues, the population becomes smaller and the longer it will take for the herd to recover to a point where any sustainable harvest can be resumed (Government of Newfoundland and Labrador 2015).

The minister of Fisheries and Land Resources said that the government is open to creating a co-managed conservation plan that would allow for indigenous groups to hunt. The minister said, "If there is to be a hunt for social and ceremonial purposes, which I am still open to consulting about. It must be within the original context which the Indigenous nations themselves concluded back in October 2015" (CBC News, 2018b).

Indigenous Perspectives

The George River caribou herd's Labrador range occurs on Labrador Inuit Settlement Area land claim (land owned by or exclusively used by Inuit). Areas of the herd's range in central and southern Labrador range are involved in ongoing land claim negotiations between the Inuit and federal government (COSEWIC, 2017). The herd's eastern range occurs on public or "Inuit, Cree, and Naskapi land categories 1 to 3 of the James Bay and Northern Québec Agreement in northern Québec" (COSEWIC, 2017).

In autumn of 2017, an Innu-Cree-Inuit roundtable council, UPCART, was formed to establish an indigenous conservation strategy for the caribou of Labrador in an effort to recover the population of the George River herd. Members of UPCART at the time of formation in 2017 included; Nunatsiavut Government, Innu Nation, Nation Innue, NunatuKavut, Naskapi Nation of Kawawachikamach, Inuit of Nunavik (Makivik) and Cree Nation Government.

UPCART - Indigenous Round Table

Formulation

The foundations of UPCART are based on management strategies including, prioritization of user groups, harvest exploitation rates, research needs and communication. UPCART was created in response to decades of frustration with the governments' response to the herd's decline, and provincial legislation that seemed to ignore the needs and rights of indigenous users who rely on the herd. The goal of UPCART is to collaborate with members in the roundtable, as well as with government, to enact a functional and equitable conservation plan. UPCART writes, "For the first time in human history the Peoples of Ungava have the capacity to coordinate decision-making on a scale that can affect the distribution and abundance of caribou" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

The UPCART strategy includes six main priorities to developing conservation policy that will recover the George River herd. Priority 1 is to develop an indigenous sharing agreement, so that a limited amount of caribou from the George River herd can be harvested annually by members of UPCART. Other priorities of UPCART include goals to develop a research and monitoring plan, followed up establishing a habitat management and environmental impact plan. Priority 5 is to create a stewardship, engagement, and communication plan, which would provide guidelines for how UPCART works internally, so to present UPCART as cohesive conservation plan, representing all seven members of UPCART equally. Priority 6 is an economic plan that includes guidelines for sport hunting that would benefit indigenous communities (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

UPCART outlines a conservation plan to recover the George River Caribou herd, but also provides an overview of how indigenous groups in the roundtable incorporate the George River herd into their culture, identity, worldview and survival. Beyond its cultural significance, harvesting caribou (and other country foods) is essential to the health of these remote indigenous communities. Parlee et al. reported that northern indigenous groups rely on country foods such as caribou, where healthy food from supermarkets is unaffordable and expensive (Parlee, 2005).

Indigenous Perspectives on Government Conservation

UPCART voices strong frustration towards the Government of Newfoundland and Labrador and the Government of Québec. The caribou conservation legislation provided by both governments offers no priority of access to indigenous groups who have relied on the herds for millennia, for cultural and subsistence purposes. Members of UPCART characterize their experience with government conservation methods as ineffective. UPCART writes, “Our

experience of caribou management in Ungava since around 1960 has been one of specific failings and disappointments, framed against a background of general successes" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). UPCART reports that recommendations from indigenous groups were given over the decades to inform caribou conservation relating to the herds of northern Québec and Labrador, and were repeatedly ignored. UPCART lists numerous attempts to propose co-management of the herd with the Government of Newfoundland and Labrador and the Government of Québec. UPCART writes,

> Co-management was recommended by the Nunatsiavut Government (then the Labrador Inuit Association) in 1981, the Hunting, Fishing and Trapping Coordinating Committee in 1985, 1997, 2004, 2008, 2011, and 2012, the Porcupine Caribou Co-Management Board in 1991, the Voisey's Bay Environmental Review Panel in 1999, the Lower Churchill Environmental Review Panel in 2010, and the Torngat Wildlife and Plants Co-Management Board in 2010, 2011, and 2012 (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

UPCART argues that poor government conservation policy led to decades of open access to hunting the herds, regardless of the population dynamics and general health of the herds(Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Indigenous members of UPCART have been vocal to news outlets in their frustration with the government's caribou recovery strategies. The UPCART document writes in response to the government's lack of activity in conserving the herd, only to enact a hunting ban,

> The result was decades of extremely liberal access for all user groups irrespective of caribou population trends, followed by a moratorium (in Labrador) for all users when the population reached extremely low levels. Management actions that could have, and should have, been spread throughout the period of decline, were instead condensed into just three years, between 2010 and 2013" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Outside of the UPCART document, indigenous members have repeatedly informed

media outlets that their cultural and survival needs are not being met or respected by the government and its conservation practices, and that banning indigenous users from hunting implies a certain level of blame for the herd's decline. Innu Nation Grand Chief Anastasia Qupee said, "There's an implication from government that indigenous people are to blame for declining caribou numbers, "and that's not right" (Skinner, 2016). In regards to the current hunting ban, Innu members have stated, "That's the way that we've been treated in the past and … it's really hard to move forward when you're being treated as a criminal [for] practicing your own culture" (Skinner, 2016).

UPCART writes in their round table document that indigenous lifestyles have changed in the last century, "The core ways of life continue to mirror key aspects of the seasonal and year-to-year rhythms and cycles of their physical and spiritual worlds" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Conflict

When the hunting moratorium was announced, Innu Nation stated it would continue to hunt the herd, that the decline of the herd was not the Innu's blame and that Innu elders teach and culturally transmit wildlife conservation (The Canadian Press, 2016). Since the Government of Newfoundland Labrador instituted the hunting moratorium on the herd in 2013, there has been conflict with indigenous groups illegally hunting caribou from the George River herd. In 2015, 10 Innu members were charged with slaughtering dozens of caribou from the herd. Innu chief and council defended the hunt, "Former grand chief Prote Poker said it was an infringement on the Innu traditional way of life, and they would continue to take 300 animals a year" (Squibb, 2016). The former chief acknowledged that Innu members had killed upwards of 150 caribou

from the George River herd in 2013. The CBC reported, “Chief Prote Poker said 149 caribou have already been shot and killed by Innu from Natuashish, and about 30 caribou have been hunted by Innu in Sheshatshiu” (CBC News, 2013). Indigenous hunting of the herd is explored in further depth in following sections. In response to Innu Nation’s continued hunt of the George River caribou herd, the Minister of Environment in Newfoundland and Labrador, Perry Trimper stated, “This is tragic, not only for the ecosystem, but for the Aboriginal people of Labrador and Québec who have utilized this herd as a resource” (The Canadian Press, 2016).

Since winter 2018, conflict has arisen within UPCART because of indigenous members hunting the George River herd. The ensuing dispute resulted in the Innu faction of the UPCART roundtable walking away from the agreement. Innu members have continued to hunt from the George River Caribou herd since the inception of the UPCART agreement. The Nunatsiavut Government stated that Innu Nation hunted the George River herd before a sharing agreement had been reached. The Nunatsiavut Government’s president told CBC, “This shows a blatant betrayal and a lack of respect to other Indigenous peoples who have traditionally relied on the George River caribou for sustenance and it sends a strong message that the Innu could care less whether or not the herd survives" (Barker, 2018). Innu Nation responded that they had developed their own caribou management plan in 2013 that allowed for 100-300 caribou from the George River herd to be harvested, and hunters were informed to avoid harvesting pregnant females (Barker, 2018).

Indigenous Use of the George River Caribou Herd

Indigenous members expressed that there is a lack of representation or understanding of their knowledge in regards to the George River caribou herd recovery plan. Their reliance on the

herd and the cultural significance of the George River herd is described in UPCART as a response to the government's conservation plan, as well as information provided by scientific research (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Sandlos et al. observed that to many indigenous groups, western scientific forms of conservation are "too narrow or too limited in their approach" and do not fully grasp the complexity of caribou population cycles (Sandlos, 2018). The following sections provide an overview of indigenous knowledge, use and perspectives of conserving the George River caribou herd.

Nunatsiavut Government

Nunatsiavut Government is a land claim organization that represents five Nunatsiavut Inuit communities in Labrador (Indigenous and Northern Affairs Canada, 2016). Nunatsiavut members have lived on Ungava Peninsula thousands of years prior to Euro-Canadian contact. The Nunatsiavut Government writes, "The cultural, social and physical survival of Labrador Inuit depended on their ability to hunt and gather caribou. An intricate knowledge of caribou and the land is held in the oral and written history of Labrador Inuit" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Inuit of the region followed seasonal rounds, harvesting resources throughout the community's territory in northern Labrador. Presently, community members of Nunatsiavut live in permanent settlements, camping and hunting Ungava caribou seasonally in their traditional territories" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Historically, caribou were hunted in August to prepare for winter. The herds were harvested for food, clothing, bedding, tools and other cultural and/or subsistence purposes" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). With the acquirement of modern firearms, Inuit hunting cycles changed to include winter and

spring hunting. The government writes, “The winter-spring hunt gradually became more important than the traditional summer-autumn hunt. Despite this shift in seasonal emphasis, the caribou herds continued as an integral and necessary feature of Labrador Inuit life” (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Nunatsiavut members recall cyclical declines of the George River caribou herd in the past and attribute the herd’s population fluctuation to natural cycles (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Nunatsiavut members state that caribou hunting and the survival of the George River caribou herd is essential to their identity, and connection to the land. They write, “[The emphasis on Inuit culture and identity] recognizes that the use of the land has been key to Inuit life and if crucial links with the land are broken, the Labrador Inuit way of life is threatened” (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Innu Nation

Innu Nation is the governing body of two Innu communities in Labrador, Mushuau Innu First Nation and Sheshatshiu Innu First Nation (INAC, 2010; Innu Nation, n.d.).

Innus of Labrador’s relationship to the land, relationship with other indigenous groups and with non-indigenous people is defined by caribou as a crucial resource. Innus of Labrador cite examples of defending their right to hunt and use their traditional lands in Canadian courts. Caribou are essential to interactions that build relationships on the land with other hunters outside of their indigenous communities.

Innu Nation asserts that their perspective of conservation differs from western scientific knowledge and is born from thousands of years of experience with caribou in their traditional lands. Innu Nation writes, "Conservation has meant taking only what we need, sharing any surplus, using all parts of the caribou, showing respect for the animal before, during, and after a hunt, and diversifying harvesting strategies and target species to distribute pressure" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Innu Nation acknowledges that there is merit to government and scientific conservation methods, and that caribou hunting practices by indigenous peoples has increased in intensity since firearms and motorized vehicles were introduced (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Innu Nation states, "We do, however, assert the primacy of Innu wildlife management paradigms, and the society and culture that has grown up alongside them over the course of thousands of years" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Nation Innue

Nation Innue is a governing collective of nine Innue communities in Québec (Nation Innue, 2014). Innue members have occupied areas of southern Labrador for thousands of years, relying on caribou from the George River herd for survival. Hunting caribou is essential to the Nation's relationship with their traditional and contemporary lands, named Nitassinan. Nation Innue has a spiritual connection and obligation to caribou and the George River herd, stating, "Our occupation of the territory is dictated by rules and practices inherited from previous generations. It is upon this cultural heritage that our relationship with Atik is based. Atik belongs to the Master of the caribou (*Papakasiu*)" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Nation Innue firmly rejects any act that capitalizes from the killing of

caribou in their territory, as it is a resource for subsistence and cultural purposes only. Nation Innue provides guiding principles to conserve the George River herd, including respecting other indigenous groups' relationship with the herd, Innue cultural transmission from elder to younger generations of Innue people and sharing and respecting the George River herd with a collective mentality (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

NunatuKavut

NunatuKavut is a governing body representing approximately 6,000 Inuit in central and southern Labrador (NunatuKavut Community Council, 2013). Since antiquity, Inuit of NunatuKavut followed seasonal rounds, harvesting caribou. The 1960s introduction of snowmobiles allowed for Inuit of southern Labrador to travel up to 1,400 km in hunting groups to hunt caribou in northern Labrador. The traditions of hunting caribou are maintained to this day, with Inuit using thousand-year-old caribou hunting trails that were used by their ancestor. NunatuKavut writes, "Taking part in the hunt and sharing the harvest was not about food, it was an essential part of their identity, linked directly to their culture and well-being" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Since the construction of the Trans Labrador Highway, access to the George River caribou herd has been facilitated for non-indigenous users, leading to harassment, over harvesting and misuse of caribou from the George River herd, "[C]aribou were harassed all winter, hunting became an "industry" for some settlers who sold great quantities of caribou meat illegally, and the Province of Newfoundland and Labrador failed to enforce the rules" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). NunatuKavut members observed unsafe hunting practices and waste, causing many to cease hunting caribou altogether. For decades, NunatuKavut has been active in attempting to conserve the George River caribou

herd, the organization has implemented numerous stewardship and population recovery programs that incorporate indigenous knowledge and increase community awareness. NunatuKavut writes, "In the fall of 2003, the NCC (then Labrador Metis Nation) developed its first Caribou Harvesting Plan and Interim Conservation and Safety Guidelines for Metis Hunters" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). NunatuKavut has voiced deep concern for the current status of the George River Caribou herd, and a frustration with the Government of Newfoundland and Labrador's lack of effective conservation. NunatuKavut community elder stated,

> We need to start the conversation to save the herd. The government's agenda is to get rid of the herd so development can occur, not the biologists, but others in government. Doing nothing is worse than finding a way. Let us look after the animals. Education and responsibility is the answer not control (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Naskapi Nation of Kawawachikamach

Naskapi Nation of Kawawachikamach is First Nation community located in Québec (INAC, 2018). Subsistence hunting, trapping and fishing are essential to Naskapi survival and identity, as is for most northern communities. Caribou is an important social, subsistence and cultural resource for Naskapi, who have relied on hunting caribou for thousands of years. Mameamskum writes, "Since time immemorial, the caribou is strongly linked to the cultural identity of the Naskapi, and contribute to the social and economic wellbeing, and this relationship continues to the present day" (Mameamskum, 2015). Caribou contributes to food, tools, clothing, and spirituality of the Nation, and the seasonal migrations have shaped the social structure, knowledge, behaviour and landuse of Naskapi people (Mameamskum, 2015).

Mameskum documented how the George River caribou decline and subsequent hunting moratorium impacted the way of life of Naskapi. Naskapi members provided knowledge regarding the changes in population, recruitment and distribution of the herd in living memory and knowledge passed down from generations (Mameamskum, 2015).

Hunters from the community reported observations that mining in caribou habitat, compounded recreational hunting, wildlife predation, changes in climate result in significant changes in caribou habitat, leading to herd population decline (Herrmann et al., 2014).

Inuit of Nunavik (Makivik)

Inuit of Nunavik comprises of numerous Inuit communities living in Northern Québec in the area called Nunavik (CBC News, 2007). Inuit of Nunavick have occupied areas along the shoreline of Labrador for millennia, relying on marine wildlife and caribou for subsistence and other purposes. They write, “The caribou herds of the Ungava Peninsula have always played a critical role in their livelihoods. Beyond the evident dietary contribution of caribou meat, the animals were essential (and remain important) for clothing, tools and artwork” (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). This reliant relationship on caribou has given Inuit of Nunavik substantive knowledge on caribou, which is essential to cultural transmissions between generations, while being verified and updated through use and experience. Inuit of Nunavik observe that caribou populations are cyclical, but are forward thinking towards future generations who can also rely on the George River caribou herd. Inuit of Nunavik state that conservation is essential, and should be achieved by ecosystem protection, harvest management and traditional values (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Cree Nation Government (Cree of Eeyou Istchee)

Cree Nation Government is the administrative body of the Grand Council of the Crees, the governing political organization representing Cree communities in Northern Québec (Eeyou Istchee) (Grand Council of the Crees, 2012). Cree of Eeyou Istchee have an ancient and strong relationship with caribou and the land. Cree of Eeyou Istchee's survival depended on caribou, and write that "Caribou is strongly connected with our culture, our identity and our physical and spiritual well-being" (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Members of Cree of Eeyou Istchee describe how the George River herd was hunted commercially in the 1980s, reporting an increase of waste and danger from the influx of recreational hunters. The lack of safety negatively influenced the nation's ability to access their traditional caribou hunting grounds. Cree Nation Government writes, "Every year when they returned to their hunting grounds after the winter sport hunt, and when the snow started to melt, the disgrace would be exposed all over the land; whole carcasses, legs, heads and entrails left abandoned along roads, beside camps, near water sources, etc." (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). This deepened a frustration, as the government did not accommodate the indigenous group's views on security, control and waste in regards to the George River herd (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Cree of Eeyou Istchee believe that the relationship between the land, the caribou and other wildlife need to be maintained and protected, through respect and good practice (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017).

Analysis

As separate yet interacting entities, scientific research, members of UPCART and the government have provided narratives explaining the decline of the George River caribou herd. The knowledge provided by each actor has yielded recommendations, action plans and a small amount of action.

Some members of UPCART stated that the current decline is part of the herd's natural cycle, and that decades of mismanagement from government has brought the herd to its present state of near extinction (Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). Scientific research and COSEWIC have provided information on numerous factors that explain what has caused the herd decline, many of which interact. Climate change related to human industrial activity has altered the biomass in the Labrador tundra and the George River herd, which now exceeds the carrying capacity of their summer foraging grounds because the shrubbery has become inedible to ungulates (Bergerudet et al., 2012; COSEWIC, 2017; Fauchald et al., 2017; Messier et al.,1988). Logging in other provinces has driven moose into the George River caribou herd's habitat, bringing with them wolves who now aggressively predate the George River herd. Scientific research acknowledged forage decline as the leading mortality factor (Fauchald et al. 2017), identified the George River herd's most critical calving habitat (Théau & Duguay, 2004) and recommended that 65% of habitat must remain undisturbed for woodland caribou herds to recover their population (Rudolph et al., 2017). Mining zones of influence were researched (Herrmann et al., 2014), and their impact on migratory caribou herds measured, while mining activity was identified in the George River caribou herd's range (Côté & Rodon, 2017). Political ecology explains these obvious links between human and biophysical events interacting to cause environmental change. Many drivers of the George River caribou

herd are the result of human-environmental interactions. The scientific research reviewed shows a clear link to human activity triggering biophysical changes.

Where it becomes interesting is how the human groups have reacted to a) the decline of the herd, b) the outcomes of scientific research and c) with each other. Robbins writes that political ecology seeks to find causes, rather than symptoms. He describes political ecology as a way to "address the conditions and change of social/environmental systems, with explicit consideration of relations of power" (Robbins, 2012). The indigenous members of UPCART use their position of power, which is cultural connection to caribou and thousands of years of building their society around hunting the George River caribou herd for their survival, to assert their continued right to hunt from the herd, despite the herd's population suffering critically low numbers (Bergerud et al., 2012; CBC, 2010; CBC News, 2013; Skinner, 2016).

Members of UPCART have stated that the George River herd declined for reasons separate from indigenous harvesting and they see the current government recovery strategy as punitive (Skinner, 2016). Bixler, who researched the political ecology of local users and caribou decline in British Columbia observed a similar occurrence between local users and scientific research. Bixler wrote, "The science and ecology of the mountain caribou provides a cohesive narrative, yet local stakeholders construct alternatives to explain the decline, and they position these narratives within contested political and ecological contexts" (Bixler, 2013). Members of UPCART, to a certain extent, have constructed a narrative to justify hunting the George River herd, despite empirical data stating that the herd will face imminent extinction if it continues to lose numbers to hunting (COSEWIC, 2017).

What is perhaps most interesting is attempting to understand the governments' lack of activity in conserving the George River caribou herd. From a functional standpoint, the

government's Labrador Caribou Initiative and hunting moratorium are ineffective. The hunting moratorium was established in 2013, there were 14,200 animals in 2014. The herd had continued to decline rapidly and in the summer of 2016, 8,938 caribou were counted in the herd (Government of Newfoundland and Labrador, 2016b). Hayes et al. argue that "It is not possible to stave off caribou declines without sustained and intensive management actions" (Festa-Bianchet et al., 2011; Hayes et al., 2000). The government is equally guilty in constructing a narrative to justify inactivity in applying recovery measures, while the government's only active policy measure (the moratorium) has numerous negative effects on members of UPCART, who make up most of the few humans who rely on the George River herd for subsistence reasons. Bixler found this reconstruction of narratives tends to occur when attempting to justify economic activity to the detriment of the environment, such as why the government does not have any policy measures that address industrial development in the George River caribou range. Or why critical calving habitat is not protected, despite recommendations from environmental organizations and members of UPCART (COSEWIC, 2017; Makivik Corperation, 2013). Bixler writes, "Narratives are crafted by social ideologies and used to legitimatize particular economic activities, to distort scientific-empirical understanding" (Bixler, 2015). This further exemplifies Robbins' concept that "science is socially situated." Powerful political bodies often control environmental changes (Robbins, 2012), with winners and losers (in this case, losers are the caribou and members of UPCART).

There is a rich discourse behind local users being marginalized by governmental bodies. Caine observes,

> The conservationists constantly depicted local subsistence users as merely following their own parochial interests; only the rational hand of state managers and scientists could see the bigger picture and harness natural resources to maximize productivity and serve the material needs of the larger society (Caine, 2018).

There is evidence of this relationship between subsistent users and government in the case of the George River caribou herd decline. Industrial activity, climate change and government resource mismanagement caused the George River caribou herd decline, not subsistence hunting. Yet, indigenous users primarily bear the consequences of the hunting moratorium (Government of Newfoundland and Labrador, 2016a; Skinner, 2016; Ungava Peninsula Caribou Conservation Aboriginal Round Table, 2017). The Government of Newfoundland and Labrador acknowledges that hunting did not cause population decreases in the herd, but is slow to enact any policy limiting industrial development or protect habitat in the George River caribou herd range. Indigenous members who continue to hunt the herd are publically criticized by the government (Government of Newfoundland and Labrador, 2017) and by other indigenous groups (Barker, 2018).

Conclusion

Co-management and the Political Ecology of the George River Caribou Herd

Changing climates and habitat degradation amplify the decline in cycles of caribou population, making the future unclear if the George River herd will ever recover. In 2016, the government stated, "At the current rate of decline and without immediate cessation of illegal hunting, biologists predict this herd could become functionally extirpated in less than five years, meaning that the herd will become so small it will essentially lose its capacity to recover" (Government of Newfoundland and Labrador, 2016a). Sandlos writes about caribou decline in Canada,

> Many observers of the current crisis have implicitly invoked Cronin's arguments about the unreliability of history as a guide to the future, suggesting that industrial development and climate change are unprecedented influences on the caribou that may lead to their permanent diminishment or demise (Sandlos, 2018).

However, there may be a silver lining in the case of the political ecology of the George River caribou herd's drastic decline (not for the caribou, only for the human actors), co-operation between the indigenous groups forming UPCART, and UPCART working with the government to co-manage the recovery of the George River caribou herd. It is documented that disagreements between local users and government policy delays effective recovery measures, co-operation can only improve the current status of recovering the George River herd (Festa-Bianchet et al., 2011).

Resource management in Canada, in wake of changing paradigms, has evolved to include more community and local participation. It includes alternate forms of information, not only western scientific knowledge. These changes include acknowledging human-environmental interactions in flexible and ever changing socio-ecological systems, the importance of various levels of participation and creation in the flexible, resilient resource management systems (Carlsson & Berkes, 2005). Seven (now six) differing indigenous groups co-operating under UPCART and the government's willingness to work with UPCART could, by some interpretations, be a form of co-management of the George River caribou herd. Co-management occurs when multiple stakeholders control a resource or area, with the idea that the resource can be improved through regulating use and co-operation between different actors (Carlsson & Berkes, 2005; Ostrom and Schlager, 1996). Co-management can simply be defined as a formal management strategy that allows both local communities and governing bodies control of a resource.

Examples of co-management between UPCART and the government include when Nunatsiavut Government urged the government to reject COSEWIC's recommendation to classify the George River herd as endangered, rationalizing that listing the George River herd as endangered adds additional levels of bureaucracy. The Nunatsiavut government argued that the COSEWIC assessment was based on outdated information and that the George River herd is recovering, based on calf recruitment numbers. The Nunatsiavut government stated, "The latest information we have from the [Government of Newfoundland and Labrador] is that calf recruitment is showing positive signs and adult recovery is showing positive signs. With the herd itself it looks like it's beginning to stabilize a bit more" (CBC News, 2018a). On January 30, 2018, the government announced that it will ignore the COSEWIC recommendation to list the George River caribou herd as endangered. The minister of Fisheries and Land resources stated, "It was the unanimous viewpoint, particularly from Indigenous communities directly connected to the herds, not to list at this point in time, as an endangered species" (CBC News, 2018b). The government issued the following statement to news media outlets,

> The Department of Fisheries and Land Resources, in collaboration with our Labrador and Indigenous Affairs Secretariat, initiated consultations in early December with Indigenous communities and governments. Officials continue to meet and discuss the [COSEWIC] recommendations and potential listings (CBC News, 2018a).

In theory, there are numerous benefits of co-management, including reducing conflict between governments and communities through participatory democracy, which also impacts decision making if it is no longer top down (Carlsson & Berkes, 2005), socially and economically benefiting and strengthening the local communities that rely on the resource (Carlsson & Berkes, 2005). The government stated that they are open to working with UPCART to develop an effective recovery program for the George River herd that is in line with the

growing trend in academia and in practice to incorporate knowledge and perspectives beyond western scientific knowledge.

Co-management is a more conceptual solution to the decline of the George River caribou herd. It improves indigenous-government relations and incorporates more equitable and diverse forms of knowledge into environmental management. It is also the most discernable outcome of interactions between science, government and indigenous groups. It is not a conservation policy that will somehow mitigate the forage limitations that have regulated the George River caribou herd population into near extinction. Amongst his other observations, Sandlos has also seen that wildlife recovery programs have been ineffective, which has ushered in a multidisciplinary approach to conservation that incorporates indigenous perspectives and other forms of ecological knowledge. He writes, "As a result of the failures of conventional wildlife science, many scholars see a new paradigm emerging in wildlife management, which recognizes that biological sciences continue to be relevant but are "not a sufficient stand-alone basis for the practice of wildlife management" (Sandlos, 2018). To answer the original research question simply – scientific research, government and indigenous groups have interacted to form the foundations of what may lead to a co-management recovery plan for the George River caribou herd. Unless the government announces plans for a captive breeding program, or technology to reverse the Arctic greening of George River caribou calving grounds – co-management is as good a solution as we can hope for.

Bibliography

Banfield, A. W. F. (1961). A revision of the reindeer and caribou, genus Rangifer. *Bulletin of the National Museum of Canada*, *177*, 1–137.

Barker, J. (2018). Harsh words — and different strategies — divide Innu Nation, Nunatsiavut government on caribou plan. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/newfoundland-labrador/innu-nation-george-river-hunt-continues-1.4499686

Bassett, T. J., & Crummey, D. (2004). African Savannas: global narratives and local knowledge of environmental change. *African Affairs*, *45*(3), 515–516. Retrieved from http://search.proquest.com/docview/232175455?accountid=14771

Bassett, T. J., & Zuéli, K. B. (2000). Environmental discourses and the Ivorian savanna. *Annals of the Association of American Geographers*, *90*(1), 67–95. https://doi.org/10.1111/0004-5608.00184

Batterbury, S. (2015). Doing political ecology inside and outside the academy. In R. Bryant (Ed.), *International Handbook of Political Ecology* (pp. 27–43). London: Edward Elgar Publishing Ltd.

Bergerud, A. T., Luttich, S. N., & Camps, L. (2012). *The return of caribou to Ungava*. *The Return of Caribou to Ungava*. https://doi.org/doi:10.2193/2008-380

Berkes, F. (2009). Evolution of co-management: Role of knowledge generation, bridging organizations and social learning. *Journal of Environmental Management*. https://doi.org/10.1016/j.jenvman.2008.12.001

Berkes, F. (2012). Sacred Ecology. *Sacred Ecology*, 239-. https://doi.org/10.2307/144393

Berkes, F., Berkes, M. K., & Fast, H. (2007). Collaborative integrated management in Canada's North: The role of local and traditional knowledge and community-based monitoring. *Coastal Management*, *35*(1), 143–162. https://doi.org/10.1080/08920750600970487

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of Traditional Ecological Knowledge as adaptive management. *Ecological Applications*. https://doi.org/10.1890/1051-0761(2000)010[1251:ROTEKA]2.0.CO;2

Biodiversity Canada. (2015). *Technical Thematic Report No. 10. - Northern caribou population trends in Canada*.

Bixler, R. P. (2013). The political ecology of local environmental narratives : power, knowledge, and mountain caribou conservation. *Journal of Political Ecology*, *20*, 273–285. Retrieved from http://ln.collaborativeconservation.org/sites/default/files/bixler_jpe.pdf

Bixler, R. P., Dell' Angelo, J., Mfune, O., & Hassan Roba, H. (2015). The political ecology of participatory conservation: institutions and discourse. *Journal of Political Ecology*, *22*, 164–182.

Blaikie, P., & Brookfield, H. (1987). Common property resources and degradation worldwide. In *Land degradation and society* (pp. 186–195).

Boudreau, S., Payette, S., Morneau, C., & Couturier, S. (2003). Recent Decline of the George River Caribou Herd as Revealed by Tree-Ring Analysis. *Arctic, Antarctic, and Alpine Research*, *35*(2), 187–195. https://doi.org/10.1657/1523-0430(2003)035[0187:RDOTGR]2.0.CO;2

Boulanger, J., Poole, K. G., Gunn, A., & Wierzchowski, J. (2012). Estimating the zone of influence of industrial developments on wildlife: a migratory caribou *Rangifer tarandus groenlandicus* and diamond mine case study. *Wildlife Biology*, *18*(2), 164–179. https://doi.org/10.2981/11-045

Brook, R. K., Kutz, S. J., Veitch, A. M., Popko, R. A., Elkin, B. T., & Guthrie, G. (2009). Fostering community-based wildlife health monitoring and research in the Canadian North. *EcoHealth*, *6*(2), 266–278. https://doi.org/10.1007/s10393-009-0256-7

Brook, R. K., & McLachlan, S. M. (2008). Trends and prospects for local knowledge in ecological and conservation research and monitoring. *Biodiversity and Conservation*, *17*(14), 3501–3512. https://doi.org/10.1007/s10531-008-9445-x

Brookfield, H. (2005). Political Ecology: A critical Introduction by Paul Robbins. *American Geographical Society Geographical*, *95*(2), 317–338. https://doi.org/10.1038/126199a0

Brosius, J. P. (2004). Indigenous peoples and protected at the world parks congress. In *Conservation Biology* (Vol. 18, pp. 609–612). https://doi.org/10.1111/j.1523-1739.2004.01834.x

Caine, B. P. K. (Ed.). (2018). *When the Caribou Do Not Come: Indigenous Knowledge and Adaptive Management in the Western Arctic*. Vancouver: UBC Press.

Carlsson, L., & Berkes, F. (2005). Co-management: Concepts and methodological implications. *Journal of Environmental Management*, *75*(1), 65–76. https://doi.org/10.1016/j.jenvman.2004.11.008

CBC. (2010, March). Québec Innu communities defend Caribou hunt. *CBC*. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/Québec-innu-communities-defend-caribou-hunt-1.885567

CBC News. (2018). Labrador caribou herds won't be listed as endangered, government says. *CBC*.

CBC News. (2018, January). Don't rush to brand 2 caribou herds endangered, warns Nunatsiavut government. *CBC*. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/george-river-caribou-torngat-mountains-endangered-darryl-shiwak-1.4495019

CBC News. (2018, January). Labrador caribou herds won't be listed as endangered, government says. *CBC*.

CBC News. (2013, March). Innu hunting caribou despite ban, says chief. *CBC*. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/innu-hunting-caribou-despite-ban-says-chief-1.1380683

CBC News. (2007). Inuit poised to gain control of large territory in Québec. Retrieved July 26, 2018, from http://www.cbc.ca/canada/ottawa/story/2007/08/13/inuit-territory.html

Chilisa, B. (2011). Indigenous Research Methodologies. *Indigenous Research Methodologies*, (September), ch. 2, 3, 6, 9, conclusion.

Colchester, M. (2004). Conservation policy and indigenous peoples. *Environmental Science and Policy*. https://doi.org/10.1016/j.envsci.2004.02.004

COSEWIC. (2017). *COSEWIC assessment and status report on the Caribou (Rangifer tarandus) Eastern Migratory population, Torngat Mountains population in Canada, 2017*. Ottawa. Retrieved from https://www.registrelep-sararegistry.gc.ca/default.asp?lang=En&n=CAA68B17-1

Côté, S., & Rodon, T. (2017). *Mining Development, Migratory Caribou, and Land Use in Northern Québec*. Québec City. Retrieved from http://ulaval.maps.arcgis.com/apps/MapJournal/index.html?appid=93ca02e5154f40c4a6c7e586582e9caa

Crête, M., Couturier, S., Hearn, B. J., & Chubbs, T. E. (1996). Relative contribution of decreased productivity and survival to recent changes in the demographic trend of the Rivière George Caribou Herd. *Rangifer*, 27–36. https://doi.org/10.7557/2.16.4.1217

Department of Environment and Conservation, Natural Heritage Branch, N. and L. (2010). *Our WIldlife - News From the Wildlife Division*. Retrieved from http://www.flr.gov.nl.ca/publications/wildlife/our_wildlife_spring2010.pdf

Dietz, T., Ostrom, E., & Stern, P. C. (2008). The struggle to govern the commons. In *Urban Ecology: An International Perspective on the Interaction Between Humans and Nature* (pp. 611–622). https://doi.org/10.1007/978-0-387-73412-5_40

Donovan, V. M., Brown, G. S., & Mallory, F. F. (2017). The impacts of forest management strategies for woodland caribou vary across biogeographic gradients. *PLoS ONE*, *12*(2). https://doi.org/10.1371/journal.pone.0170759

Environment and Conservation Executive Council. (2013). *Hunting Ban Announced on George River Caribou Herd*. Government of Newfoundland and Labrador.

Fauchald, P., Park, T., Tømmervik, H., Myneni, R., & Hausner, V. H. (2017). Arctic greening from warming promotes declines in caribou populations. *Science Advances*, *3*(4), e1601365. https://doi.org/10.1126/sciadv.1601365

Ferguson, M. A. D., Williamson, R. G., & Messier, F. (1998). Inuit knowledge of long-term changes in a population of arctic tundra caribou. *Arctic*, *51*(3), 201–219. https://doi.org/10.2307/40512132

Festa-Bianchet, M., Ray, J. C., Boutin, S., Côté, S. D., & Gunn, A. (2011). Conservation of caribou (Rangifer tarandus) in Canada: an uncertain future. *Canadian Journal of Zoology*, *89*(5), 419–434. https://doi.org/10.1139/z11-025

Folke, C., Hahn, T., Olsson, P., & Norberg, J. (2005). Adaptive Governance of Social-Ecological Systems. *Annual Review of Environment and Resources*, *30*, 441–473. https://doi.org/10.1146/annurev.energy.30.050504.144511

Forsyth, T. (2003). Critical political ecology: the politics of environmental science. *Books.Google.Com*. Retrieved from http://books.google.com/books?hl=en&lr=&id=XX2I4kq8VmQC&oi=fnd&pg=PR11&dq=political+ecology&ots=BYaao4L-2O&sig=FeboyXjABwFHIVObc3Ft0KYh5R4%5Cnpapers://33432778-ef7b-4391-ae67-220f9c46620d/Paper/p2619

Gaillard, J. M., Festa-Bianchet, M., & Yoccoz, N. G. (1998). Population dynamics of large herbivores: Variable recruitment with constant adult survival. *Trends in Ecology and Evolution*. https://doi.org/10.1016/S0169-5347(97)01237-8

Godlewska, A., Schaefli, L., Massey, J., Freake, S., & Rose, J. (2017). Awareness of Aboriginal peoples in Newfoundland and Labrador: Memorial's first-year students (2013) speak. *Canadian Geographer*. https://doi.org/10.1111/cag.12427

Government of Canada. (2016). COSEWIC wildlife species status categories and definitions. Retrieved from https://www.canada.ca/en/environment-climate-change/services/committee-status-endangered-wildlife/wildlife-species-status-categories-definition.html

Government of Newfoundland and Labrador. (2017). Minister Trimper Advises that the George River Caribou Herd is Critically Vulnerable During Winter Months. *Environment and Climate Change*. Retrieved from http://www.releases.gov.nl.ca/releases/2017/env/0202n03.aspx

Government of Newfoundland and Labrador. (2016). Summer Census Shows George River Caribou Herd at Critically Low Level. Retrieved from http://www.releases.gov.nl.ca/releases/2016/ecc/0829n02.aspx

Government of Newfoundland and Labrador. (2016). *The Department of Environment and Conservation 2015-16 Annual Report*.

Government of Newfoundland and Labrador. (2018). Provincial Government Announces Moose and Caribou Quotas.

Government of Newfoundland and Labrador. (2018). Species at Risk.

Government of Newfoundland and Labrador. (2015). George River Caribou Information Update May 2015.

Government of Newfoundland and Labrador. (2010). *Management and Research of the George River Caribou Herd by the Newfoundland and Labrador Widlife Division*. Montreal.

Government of Northwest Territories. (2017). *NWT Environmental Research Bulletin*. Yellowkniife.

Grand Council of the Crees. (2012). About the Cree Nation Government.

Hayes, R. D., Baer, AM., Wotschikowsky, U., & Harestad, a S. (2000). Kill rate by wolves on moose in the Yukon. *Canadian Journal of Zoology*, *78*, 49–59. https://doi.org/10.1139/z99-187

Herrmann, T. M., Sandström, P., Granqvist, K., D'Astous, N., Vannar, J., Asselin, H., … Cuciurean, R. (2014). Effects of mining on reindeer/caribou populations and indigenous livelihoods: Community-based monitoring by Sami reindeer herders in Sweden and First Nations in Canada. *Polar Journal*, *4*(1), 28–51. https://doi.org/10.1080/2154896X.2014.913917

INAC. (2018). Naskapi Nation of Kawawachikamach. Retrieved May 17, 2018, from http://fnp-ppn.aandc-aadnc.gc.ca/fnp/Main/Search/FNMain.aspx?BAND_NUMBER=81&lang=eng

Indigenous and Northern Affairs Canada. (2016). Inuit Nunangat Map Information.

Indigenous and Northern Affairs Canada. (2010). Fast Facts on the Labrador Innu. Retrieved from http://www.aadnc-aandc.gc.ca/eng/1100100018914/1100100018915

Indigenous and Northern Affairs Canada. (2017). First Nation Detail Naskapi Nation of Kawawachikamach. Retrieved from http://fnp-ppn.aandc-aadnc.gc.ca/fnp/Main/Search/FNMain.aspx?BAND_NUMBER=81&lang=eng

Innu Nation. (n.d.). Innu Nation. Retrieved July 26, 2018, from http://www.innu.ca

International, S. (n.d.). Wie leben sie? Retrieved from https://www.survivalinternational.de/indigene/innu

Joly, K., Klein, D. R., Verbyla, D. L., Rupp, T. S., & Chapin, F. S. (2011). Linkages between large-scale climate patterns and the dynamics of Arctic caribou populations. *Ecography*, *34*(2), 345–352. https://doi.org/10.1111/j.1600-0587.2010.06377.x

Keil, Roger; Bell, David; Penz, Peter; Fawcett, L. (Ed.). (1998). *Political Ecology: Global and Local*. London: Psychology Press,. Retrieved from http://books1.scholarsportal.info/viewdoc.html?id=/ebooks/ebooks2/taylorandfrancis/2013-03-15/1/9780203982860#tabview=tab0

Kendrick, A. (2003). The flux of trust: Caribou co-management in Northern Canada. *Environments*, *31*(1), 43–60.

Kendrick, A., & Manseau, M. (2008). Representing traditional knowledge: Resource management and inuit knowledge of barren-ground Caribou. *Society and Natural Resources*, *21*(5), 404–418. https://doi.org/10.1080/08941920801898341

Klütsch, C. F. C., Manseau, M., & Wilson, P. J. (2012). Phylogeographical Analysis of mtDNA Data Indicates Postglacial Expansion from Multiple Glacial Refugia in Woodland Caribou (Rangifer tarandus caribou). *PLoS ONE*, *7*(12). https://doi.org/10.1371/journal.pone.0052661

Labrador Woodland Caribou Recovery Team. (2004). *Recovery Strategy for Three Woodland Caribou Herds (Rangifer tarandus caribou; Boreal population) in Labrador*.

Larter, N. C., Jung, T. S., & Allaire, D. G. (2017). Snow depth does not affect recruitment in a low-density population of boreal woodland caribou (Rangifer tarandus caribou). *European Journal of Wildlife Research*, *63*(1). https://doi.org/10.1007/s10344-017-1085-6

Leblond, M., St-Laurent, M. H., & Côté, S. D. (2015). Caribou, water, and ice - fine-scale movements of a migratory arctic ungulate in the context of climate change. *Movement Ecology*, *4*(1). https://doi.org/10.1186/s40462-016-0079-4

Makivik Corperation. (2013). Aboriginal Leaders Come Together to Protect the George RIver and Leaf River Caribou Herds. Retrieved July 30, 2018, from https://web.archive.org/web/20131219071527/http://www.makivik.org/aboriginal-leaders-come-together-to-protect-the-george-river-and-leaf-river-caribou-herds/

Mallory, C. D., & Boyce, M. S. (2017). Observed and predicted effects of climate change on Arctic caribou and reindeer. *Environmental Reviews*, 1–13. https://doi.org/10.1139/er-2017-0032

Mameamskum, J. (2015). *Assessment of climate change impacts on the caribou, the land, and the Naskapi Nation, and identification of priority adaptation strategies*. Ottawa: Canadian Electronic Library. Retrieved from http://books2.scholarsportal.info/viewdoc.html?id=/ebooks/ebooks0/gibson_cppc/2015-02-25/1/10993154#tabview=tab0

Masood, S., Van Zuiden, T. M., Rodgers, A. R., & Sharma, S. (2017). An uncertain future for woodland caribou (Rangifer tarandus caribou): The impact of climate change on winter distribution in Ontario. *Rangifer*, *37*(1), 11. https://doi.org/10.7557/2.37.1.4103

MatildeTomasellia; Susan Kutzab; Craig, G. S. C. (2018). Local knowledge to enhance wildlife population health surveillance: Conserving muskoxen and caribou in the Canadian Arctic. *Biological Conservation*, *217*, 337–348.

Messier, F., Huot, J., Le Henaff, D., & Luttich, S. (1988). Demography of the George River caribou herd: evidence of population regulation by forage exploitation and range expansion. *Arctic*. Retrieved from https://arctic.journalhosting.ucalgary.ca/arctic/index.php/arctic/article/view/1733

Ministry of Natural Resouces and Forestry. (2014). *State of the Woodland Caribou Resource Report: Part 2*.

Murray, G., & Dennis L. (2018). Climate change can alter predator–prey dynamics and population viability of prey. *Oecologia*, *186*(1), 141–150. Retrieved from https://link.springer.com/article/10.1007/s00442-017-4017-y

Nation Innue. (2014). Formation de la Nation Innue. Retrieved from http://nationinnue.com/formation-de-la-nation-innue/

Newton, E. J., Pond, B. A., Brown, G. S., Abraham, K. F., & Schaefer, J. A. (2014). Remote sensing reveals long-term effects of caribou on tundra vegetation. *Polar Biology*, *37*(5), 715–725. https://doi.org/10.1007/s00300-014-1472-3

NunatuKavut Community Council. (2013). Our Governance. Retrieved July 30, 2018, from http://www.nunatukavut.ca/home/our_governance.htm

Oakerson, R. J. (1990). Analyzing the Commons: a Framework. *Making the Commons Work: Theory, Practice and Policy*, 41–59.

Olsson, P., Folke, C., & Berkes, F. (2004). Adaptive Comanagement for Building Resilience in Sociall Ecological Systems. *Environmental Management*, *34*(1). https://doi.org/10.1007/s00267-003-0101-7

Parks Canada. (2014). *Species at Risk Woodland Caribou – Southern Mountain population Rangifer tarandus caribou*. Retrieved from http://www.pc.gc.ca/eng/nature/eep-sar/itm3/eep-sar3caribou.aspx

Parlee, B., Manseau, M., & Lutsel K'E Dene First Nation. (2005). Using traditional knowledge to adapt to ecological change: Denesoline monitoring of caribou movements. *Arctic*, *58*(1), 26–37. https://doi.org/10.2307/40512664

Parlee, B. L., Sandlos, J., & Natcher, D. C. (2018). Undermining subsistence: Barren-ground caribou in a "tragedy of open access." *Science Advances*, *4*(2). https://doi.org/10.1126/sciadv.1701611

Pettorelli, N., Weladji, R. B., Holand, Ø., Mysterud, A., Breie, H., & Stenseth, N. C. (2005). The relative role of winter and spring conditions: linking climate and landscape-scale plant phenology to alpine reindeer body mass. *Biology Letters*, *1*(1), 24–26. https://doi.org/10.1098/rsbl.2004.0262

Plante, S., Dussault, C., & Côté, S. D. (2017). Landscape attributes explain migratory caribou vulnerability to sport hunting. *Journal of Wildlife Management*, *81*(2), 238–247. https://doi.org/10.1002/jwmg.21203

Polfus, J. L., Hebblewhite, M., & Heinemeyer, K. (2011). Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. *Biological Conservation*, *144*(11), 2637–2646. https://doi.org/10.1016/j.biocon.2011.07.023

Robbins, P. (2012). *Political Ecology: A Critical Introduction*. Hoboken: John Wiley & Sons,.

Rudolph, T. D., Drapeau, P., Imbeau, L., Brodeur, V., Légaré, S., & St-Laurent, M. H. (2017). Demographic responses of boreal caribou to cumulative disturbances highlight elasticity of range-specific tolerance thresholds. *Biodiversity and Conservation*, *26*(5), 1179–1198. https://doi.org/10.1007/s10531-017-1292-1

Sandlos, J. (2018). The Past Facing Forward, History and Caribou Management in Northern Canada. In K. Parlee, Brenda L.; Caine (Ed.), *When the Caribou Do Not Come* (1st ed.). Vancouver: UBC Press.

Schaefer, J. A. (2003). Long-Term Range Recession and the Persistence of Caribou in the Taiga. *Conservation Biology*, *17*(5), 1435–1439. https://doi.org/10.1046/j.1523-1739.2003.02288.x

Serreze, M. C., & Barry, R. G. (2011). Processes and impacts of Arctic amplification: A research synthesis. *Global and Planetary Change*, *77*(1–2), 85–96. https://doi.org/10.1016/j.gloplacha.2011.03.004

Simon, D. (2008). Political ecology and development: Intersections, explorations and challenges arising from the work of Piers Blaikie. *Geoforum*, *39*(2), 698–707. https://doi.org/10.1016/j.geoforum.2007.01.011

Skinner, J. (2016). Innu treated "like criminals" for hunting George River caribou, says grand chief. *CBC*. Retrieved from http://www.cbc.ca/news/canada/newfoundland-labrador/innu-nation-george-river-caribou-1.3742552

Skoog, R. O. (1968). *Ecology of the caribou (Rangifer tarandus granti) in Alaska. Doctoral Thesis*. https://doi.org/10.16953/deusbed.74839

Smith, T. M., & Smith, R. L. (2000). *Elements of Ecology, 7. Conservation Biology* (Vol. 2011). https://doi.org/10.2307/1978795

Spaeder, J. J. (2005). Co-management in a landscape of resistance: The political ecology of wildlife management in Western Alaska. *Anthropologica*, *47*(2), 165–178. https://doi.org/10.2307/25606234

Spak, S. (2005). The position of indigenous knowledge in Canadian Co-management organizations. *Anthropologica*, *47*(2), 233–246.

Species at Risk Act. (2017). *Report on the Progress of Recovery Strategy Implementation for the Woodland Caribou (Rangifer tarandus caribou), Boreal population in Canada for the Period 2012 to 2017*. Retrieved from http://registrelep-sararegistry.gc.ca/default.asp?lang=En&n=7037FCE4-1

Species at Risk Public Registry. (2017). *Canada-British Columbia Southern Mountain Caribou (Central Group) Protection Study - February 2017*.

Squibb, M. (2016, July 8). Photos, video of dozens of dead caribou evidence at Innu hunting trial. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/newfoundland-labrador/innu-caribou-hunters-labrador-trial-george-river-1.3666982

Taillon, J., Festa-Bianchet, M., & Côté, S. D. (2012). Shifting targets in the tundra: Protection of migratory caribou calving grounds must account for spatial changes over time. *Biological Conservation*. https://doi.org/10.1016/j.biocon.2011.12.027

The Canadian Press. (2016). Caribou herd in Labrador on verge of collapse, biologists say The once-thriving caribou herd could be wiped out in less than five years, according to a recent census. *Toronto Star*.

Théau, J., & Duguay, C. R. (2004). Mapping lichen changes in the summer range of the George River Caribou Herd (Québec-Labrador, Canada) using Landsat imagery (1976-1998). *Rangifer*, *24*(1), 31. https://doi.org/10.7557/2.24.1.299

Ungava Peninsula Caribou Conservation Aboriginal Round Table. (2017). *A Long Time in the Future, Caribou and the People of Ungava*.

Vaccaro, I., Beltran, O., & Paquet, P. A. (2013). Political ecology and conservation policies : some theoretical genealogies. *Jornal of Political Ecology*, *20*, 255–272.

Vistnes, I., & Nellemann, C. (2008). The matter of spatial and temporal scales: A review of reindeer and caribou response to human activity. *Polar Biology*. https://doi.org/10.1007/s00300-007-0377-9

Vors, L. S., & Boyce, M. S. (2009). Global declines of caribou and reindeer. *Global Change Biology*, *15*(11), 2626–2633. https://doi.org/10.1111/j.1365-2486.2009.01974.x

Watts, M. (2000). Political Ecology. In *A Companion To Economic Geography* (pp. 257–275).

Weir, J. N., Mahoney, S. P., McLaren, B., & Ferguson, S. H. (2007). Effects of mine development on woodland caribou Rangifer tarandus distribution. *Wildlife Biology*, *13*(1), 66–74. https://doi.org/10.2981/0909-6396(2007)13

White, B. (2018, January). "We're not going to sit idle": Caribou preservation group forges ahead without Innu Nation. *CBC News*. Retrieved from https://www.cbc.ca/news/canada/newfoundland-labrador/labrador-caribou-upcart-innu-nation-1.4501815

Wilson, S. (2008). Research is ceremony. *Indigenous Research Methods*. *Nova Scotia, Canada:* …, 56. https://doi.org/10.1787/9789264243507-1-en

Wolfe, S. A., Griffith, B., & Wolfe, C. A. G. (2000). Response of reindeer and caribou to human activities. *Polar Research*, *19*(1), 63–73. https://doi.org/10.1111/j.1751-8369.2000.tb00329.x

Wunderlich, G., & Ostrom, E. (1992). Governing the Commons: The Evolution of Institutions for Collective Action. *American Journal of Agricultural Economics*, *74*(1), 240. https://doi.org/10.2307/1243016