Species at Risk Act
Recovery Strategy Series

Amended Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Atlantic-Gaspésie Population, in Canada

Woodland Caribou, Atlantic-Gaspésie Population

2022

Government of Canada
Gouvernement du Canada
Canada

Recommended citation:

Environment and Climate Change Canada. 2022. Amended Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Atlantic-Gaspésie Population, in Canada, *Species at Risk Act* Recovery Strategy Series, Environment and Climate Change, Ottawa, viii + 80 p.

Official version
The official version of the recovery documents is the one published in PDF. All hyperlinks were valid as of date of publication.

Non-official version
The non-official version of the recovery documents is published in HTML format and all hyperlinks were valid as of date of publication.

For copies of the recovery strategy, or for additional information on species at risk, including the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) status reports, residence descriptions, action plans, and other related recovery documents, please visit the Species at Risk Public Registry[1].

Cover illustration: Gaspésie Caribou – © Denis Desjardins, Parc national de la Gaspésie, Société des établissements de plein air du Québec.

Également disponible en français sous le titre
« Programme de rétablissement modifié du caribou des bois (*Rangifer tarandus caribou*), population de la Gaspésie-Atlantique, au Canada »

ISBN 978-0-660-41772-1
Catalogue No. En3-4/351-2022E-PDF

Note: The Woodland Caribou, Atlantic-Gaspésie population, is referred to as "Gaspésie caribou" in this document.

[1] www.canada.ca/en/environment-climate-change/services/species-risk-public-registry.html

Preface

The federal, provincial, and territorial government signatories under the Accord for the Protection of Species at Risk (1996)[2] agreed to establish complementary legislation and programs that provide for effective protection of species at risk throughout Canada. Under the *Species at Risk Act* (S.C. 2002, c. 29) (SARA), the federal competent ministers are responsible for the preparation of recovery strategies for listed Extirpated, Endangered, and Threatened species and are required to report on progress within five years after the publication of the final document on the Species at Risk Public Registry.

The Minister of Environment and Climate Change is the competent minister under SARA for the Woodland Caribou, Atlantic-Gaspésie population, and has prepared this recovery strategy in accordance with section 37 of SARA. To the extent possible, it has been prepared in cooperation with the Quebec government (Department of Forests, Wildlife and Parks [MFFP]) as per section 39(1) of SARA.

Success in the recovery of this species depends on the commitment and cooperation of many different constituencies that will be involved in implementing the directions set out in this strategy. Success cannot be achieved by Environment and Climate Change Canada or any other jurisdiction alone. All Canadians are invited to join in supporting and implementing this program for the benefit of the Woodland Caribou, Atlantic-Gaspésie population, and Canadian society as a whole.

This recovery strategy will be followed by one or more action plans that will provide information on recovery measures to be taken by Environment and Climate Change Canada and other jurisdictions and/or organizations involved in the conservation of the species. Implementation of this strategy is subject to the appropriations, priorities and budgetary constraints of the participating jurisdictions and organizations.

The recovery strategy sets the strategic direction to arrest or reverse the decline of the species, including identification of critical habitat to the extent possible. It provides all Canadians with information to help take action on species conservation. When critical habitat is identified, either in a recovery strategy or an action plan, SARA requires that critical habitat then be protected.

In the case of critical habitat identified for terrestrial species including migratory birds, SARA requires that critical habitat identified in a federally protected area[3] be described in the *Canada Gazette* within 90 days after the recovery strategy or action plan that

[2] www.canada.ca/en/environment-climate-change/services/species-risk-act-accord-funding.html#2

[3] These federally protected areas are: a national park of Canada named and described in Schedule 1 to the *Canada National Parks Act*, The Rouge National Park established by the *Rouge National Urban Park Act*, a marine protected area under the *Oceans Act*, a migratory bird sanctuary under the Migratory Birds Convention Act, 1994 or a national wildlife area under the *Canada Wildlife Act*. See subsection 58(2) of SARA.

identified the critical habitat is included in the public registry. A prohibition against destruction of critical habitat under subsection 58(1) will apply 90 days after the description of the critical habitat is published in the *Canada Gazette*.

For critical habitat located on other federal lands, the competent minister must either make a statement on existing legal protection or make an order so that the prohibition against destruction of critical habitat applies.

If the critical habitat for a migratory bird is not within a federal protected area and is not on federal land, within the exclusive economic zone or on the continental shelf of Canada, the prohibition against destruction can only apply to those portions of the critical habitat that are habitat to which the *Migratory Birds Convention Act*, *1994* applies as per SARA subsections 58(5.1) and 58(5.2).

For any part of critical habitat located on non-federal lands, if the competent minister forms the opinion that any portion of critical habitat is not protected by provisions in or measures under SARA or other Acts of Parliament, or the laws of the province or territory, SARA requires that the Minister recommend that the Governor in Council make an order to extend the prohibition against destruction of critical habitat to that portion. The discretion to protect critical habitat on non-federal lands that is not otherwise protected rests with the Governor in Council.

Acknowledgments

Special thanks are extended to the following persons for their valuable contributions to this document: Sylvain Giguère and Pierre-André Bernier (Environment and Climate Change Canada, Canadian Wildlife Service – Quebec Region), Mélinda Lalonde (formerly with the Quebec Department of Forests, Wildlife and Parks, Direction de la gestion de la faune de la Gaspésie–Îles-de-la-Madeleine), Mathieu Morin (Quebec Department of Forests, Wildlife and Parks, Direction de la gestion de la faune de la Gaspésie–Îles-de-la-Madeleine), Claude Isabel (Société des établissements de plein air du Québec, Parc national de la Gaspésie), Martin-Hugues St-Laurent and Frédéric Lesmerises (Université du Québec à Rimouski) and Marie-Andrée Carrière (Environment and Climate Change Canada, Canadian Wildlife Service – National Capital Region). Thanks are also due to the Gaspésie Woodland Caribou Recovery Team for its participation. We are also grateful to everyone else who provided advice and input to help inform the development of this recovery strategy, including various Indigenous individuals and organizations, landowners, citizens and various stakeholders.

Executive Summary

This recovery strategy is for the Woodland Caribou (*Rangifer tarandus caribou*), Atlantic-Gaspésie population, herein referred to as “Gaspésie caribou”. This is an amended recovery strategy, which is an update of the recovery strategy for the Gaspésie caribou, published by Environment Canada (2007) under the title “Gaspésie Woodland Caribou Recovery Plan (2002-2012) (*Rangifer tarandus caribou*).” That recovery plan was adopted in 2007 by the Minister of Environment as a recovery strategy pursuant to section 44 of SARA. The final published version of this amended recovery strategy replaces the Gaspésie Woodland Caribou Recovery Plan (2002-2012) (*Rangifer tarandus caribou*) (Environment Canada 2007).

In 2004, the Woodland Caribou, Atlantic-Gaspésie population, was listed as Endangered on Schedule 1 of the *Species at Risk Act* (S.C. c. 29). In Quebec, this population, identified as the “woodland caribou, mountain ecotype, Gaspésie population”, was listed as Threatened under the *Act Respecting Threatened or Vulnerable Species* (CQLR, c. E-12.01) (LEMV) in 2009.

Gaspésie caribou are found in only a small portion of Quebec’s Gaspésie and Bas-Saint-Laurent region. This is a relict subpopulation of the caribou populations that formerly occurred throughout the Gaspé Peninsula, in the Maritimes and in some New England states. From the start of monitoring in the 1950s and 1970s, a significant decline was noted in the Gaspésie caribou population, which continued into the 1980s. Although the population stabilized somewhat in the late 1990s and early 2000s, the decline subsequently continued, such that the population now consists of fewer than about 50 individuals.

The Gaspésie caribou population is highly sensitive to reduced adult (particularly female) and calf survival rates—two parameters that are mainly dependent on the predation rate. In general, these caribou require large areas of relatively undisturbed, interconnected habitat, which enables them to separate themselves from predators and other prey species, modify their use of habitat in response to various natural and human-caused habitat disturbances and human activities, and access their preferred food sources.

Given their specific life history characteristics, Gaspésie caribou face a number of threats, the main ones being logging, excessive predation by coyotes (*Canis latrans*) and black bears (*Ursus americanus*), road and transportation development, wind farm development, recreational activities, insect outbreaks and mining and mineral exploration. These threats are closely interrelated and act cumulatively to cause direct and indirect effects on Gaspésie caribou and their habitat.

There are unknowns regarding the feasibility of recovery of Gaspésie caribou. Nevertheless, in keeping with the precautionary principle, this recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is

determined to be feasible. It addresses the unknowns surrounding the feasibility of recovery of the Gaspésie caribou.

The long-term population and distribution objective for the Gaspésie caribou is to achieve and maintain a self-sustaining population within its current range. To work toward attaining the long-term objective, two short-term objectives have been established: (i) Maintain the species' current range, and restore habitat conditions that favour population persistence and (ii) Halt the population decline and increase the number of caribou in the population.

Broad strategies as well as research and management approaches for achieving the objectives are presented in the section “Strategic Direction for Recovery”.

Gaspésie caribou critical habitat is partially identified in this recovery strategy. Critical habitat for this population is identified at the landscape scale on the basis of two overlapping geographic areas: (1) the Gaspésie caribou range, with a view to achieving and maintaining 65% undisturbed habitat there; (2) those areas within the core range of the Gaspésie caribou having the biophysical features of the species’ preferred habitat. A schedule of studies outlines the activities required to complete the identification of critical habitat.

One or more action plans will be posted on the Species at Risk Public Registry within five years of the posting of the final version of the amended recovery strategy.

Summary of Recovery Feasibility

Based on the following four criteria that Environment and Climate Change Canada uses to establish recovery feasibility, there are unknowns regarding the feasibility of recovery of the Gaspésie caribou. In keeping with the precautionary principle, a recovery strategy has been prepared as per section 41(1) of SARA, as would be done when recovery is determined to be technically and biologically feasible. This recovery strategy addresses the unknowns surrounding the feasibility of recovery.

Although current evidence supports the conclusion that the recovery of the population is technically and biologically feasible, the small size of the population and its isolation mean that it is at risk of not becoming self-sustaining. It is therefore possible that the population may not be able to withstand threats such as habitat loss and increased predation associated with habitat alteration and predator–prey dynamics. The population does not benefit from immigration that would help to maintain its genetic diversity and it is therefore at risk of not persisting in the long term. Over time, the recovery of the population may prove to be not biologically or technically feasible. This may affect the likelihood of achieving the population and distribution objectives.

1. *Individuals of the wildlife species that are capable of reproduction are available now and in the foreseeable future to sustain the population or improve its abundance.*

Yes. The Gaspésie caribou population has so far sustained itself through the presence of wild breeding individuals. In 2019, the size of the population was estimated at between 38 and 42 caribou, but no individuals were observed in the Mount Logan area during the aerial survey (Morin and Lesmerises 2020). Camera traps installed on Mount Logan for a period of 30 days in the fall of 2019 detected six individuals. This is likely a minimum value for this area since the camera trap survey method requires a larger number of observations to produce an acceptable estimate of population size (Morin and Lesmerises 2020).

2. *Sufficient suitable habitat is available to support the species or could be made available through habitat management or restoration.*

Unknown. Suitable habitat is available both within and outside the boundaries of Parc national de la Gaspésie. However, there is an insufficient amount of suitable habitat at present, mainly because of the high level of cumulative habitat disturbance within the core range (68%) and within the range as a whole (81%; F. Lesmerises and M.-H. St-Laurent, unpubl. data; see section 3.2 for a definition of range). This level of disturbance would prevent the population from becoming self-sustaining according to the method developed for the Woodland Caribou, Boreal population (Environment Canada 2011a). On the one hand, it is conceivable that habitat management or restoration could increase the amount of suitable habitat and its quality and thereby enable the population to become self-sustaining. On the other hand, a recent population viability analysis showed that there is a high risk of

extinction of the McGerrigle Mountains group and, even more so, the Mount Albert and Mount Logan groups over a 50-year horizon (Frenette and St-Laurent 2016). It is uncertain whether sufficient habitat may be made available during this time period. Reversing ecological processes detrimental to caribou populations (e.g., habitat degradation and loss, increase in predator and alternate prey populations) and instituting changes to management frameworks and ongoing land use arrangements often entail timeframes in excess of 50 to 100 years.

3. *The primary threats to the species or its habitat (including threats outside Canada) can be avoided or mitigated.*

Yes. The main threats to the Gaspésie caribou population or its habitat can be reduced or mitigated through coordinated land and resource planning, and habitat restoration and management. Population conditions may warrant predator and alternate prey management. This recovery strategy provides strategies and approaches to achieve this.

4. *Recovery techniques exist to achieve the population and distribution objectives, or can be expected to be developed within a reasonable timeframe.*

Yes. Predator control measures were carried out in the 1990s and, as of this writing (2021), have been ongoing since 2001. Rigorous, ongoing black bear and coyote control actions reduce predation pressure on caribou. In addition, habitat management encompassing protected areas, and a forest management strategy that makes the forest matrix unfavourable to predators at the landscape scale could help reduce the factors contributing to the decline in the caribou population. At present, logging is prohibited in Parc national de la Gaspésie, and habitat restoration initiatives (e.g., logging road closures) are under way there. The forest management plan that is already being implemented in some forest areas on the periphery of the park could also be enhanced. There is uncertainty with regard to the effectiveness of some of these measures, as they have not yet undergone a sufficiently long trial period.

Table of Contents

1. COSEWIC* Species Assessment Information

Date of Assessment: November 2014

Common Name (population): Caribou – Atlantic-Gaspésie population

Scientific Name: *Rangifer tarandus*

COSEWIC Status: Endangered

Reasons for Designation:
This small isolated population has declined to fewer than 120 adults. Historically, these caribou were much more widely spread, occurring in New Brunswick, Nova Scotia, and Prince Edward Island. Today, they mainly use alpine habitats on mountain plateaus in the Gaspésie region, in Quebec. The habitat has been modified by resource development activities, including forest management that reduced forest age, and increased density of predators of caribou. Adult mortality and continued low calf recruitment due to Eastern Coyote[4] and Black Bear predation are contributing to an ongoing decline. Population models predict the population may become extinct by 2056.

Canadian Occurrence: Quebec

COSEWIC Status History: Atlantic-Gaspésie population designated Threatened in April 1984. Status re-examined and designated Endangered in May 2000. Status re-examined and confirmed in May 2002 and November 2014.

* COSEWIC (Committee on the Status of Endangered Wildlife in Canada)

In 2011, COSEWIC recognized 12 designatable units (DU) for caribou (*Rangifer tarandus*), including the Atlantic-Gaspésie population (DU11; COSEWIC 2011). In November 2014, the status of the Woodland Caribou, Atlantic-Gaspésie population was reassessed by COSEWIC (2014), which confirmed the conservation status assigned in the previous assessment, specifically Endangered.

2. Species Status Information

The entire Woodland Caribou, Atlantic-Gaspésie population (referred to as "Gaspésie caribou" in this recovery strategy) is found in Canada, in a small portion of Quebec's Gaspésie and Bas-Saint-Laurent regions (Environment Canada 2007; see section 3.2 of this document). This population corresponds to the COSEWIC designatable unit for caribou, Atlantic-Gaspésie population, and is the only caribou

[4] In this document, the terms "eastern coyote" (*Canis latrans* x *Canis* sp. cf. *lycaon)* and "coyote" (*Canis latrans*) are used synonymously to designate the wild canid that occurs in the Gaspésie region and is a predator of woodland caribou.

designatable unit made up of a single population (COSEWIC 2011; COSEWIC 2014). This population was listed as Endangered on Schedule 1 of the *Species at Risk Act* (S.C. 2002, c. 29) (SARA) in 2004 under the name of Woodland Caribou, Atlantic-Gaspésie population. In Quebec, the "woodland caribou, mountain ecotype, Gaspésie population" was designated as threatened under the Quebec *Act Respecting Threatened or Vulnerable Species* (CQRL, c. E-12.01) (LEMV) in 2009 (it was previously assessed as vulnerable in 2001).

The Gaspésie caribou has a global conservation status rank[5] of G5T1Q (NatureServe 2018), which indicates that the species itself is widespread and common, but that the Gaspésie population is critically imperilled. The Gaspésie caribou has a national rank of N1 (critically imperilled) and provincial ranks of S1 (critically imperilled) in Quebec and SX (presumed extirpated) in New Brunswick, Nova Scotia and Prince Edward Island (NatureServe 2018).

3. Species Information

3.1 Species Description

Caribou and reindeer are members of a single species, *Rangifer tarandus*. The term "caribou" is used to describe the various subspecies present in North America, whereas "reindeer" refers to the domesticated, semi-domesticated or wild subspecies found in Eurasia (Hummel and Ray 2008). Although there is considerable variation in phenotypic traits in this species (e.g., body size, pelage colour, morphology), caribou and reindeer are able to interbreed and produce fertile, viable offspring (Hummel and Ray 2008). It should be noted that reindeer occur in North America, particularly Newfoundland, as a result of human introductions.

Based on morphological criteria, four caribou subspecies are currently recognized in North America (Banfield 1961): Peary Caribou (*R. tarandus pearyi*), Barren-ground Caribou (*R. tarandus groenlandicus*), Grant's Caribou (*R. tarandus granti*) and Woodland Caribou (*R. tarandus caribou*). The latter subspecies is the only one found in Quebec, and three ecotypes[6] associated with it occur in the province: migratory caribou, forest-dwelling caribou and mountain caribou. The Gaspésie caribou herd is one of only two mountain ecotype populations in Quebec. The other inhabits the Torngat Mountains in the extreme northeastern part of the province (DU10; COSEWIC 2011).

[5] The conservation status of a species or population is designated by a character or group of characters (1: critically imperilled; 2: imperilled; 3: vulnerable; 4: apparently secure; 5: secure; H: extirpated; NR: unranked; X: presumed extirpated), preceded by one or more letters denoting the geographic scale of the assessment (G: Global; [T: subspecies or population]; N: National; and S: Subnational).

[6] An ecotype is "a population or group of populations adapted to a particular set of environmental conditions". There is no universally accepted list of caribou ecotypes or of criteria to distinguish them (COSEWIC 2011).

The Woodland Caribou is a medium-sized member of the deer family (*Cervidae*) (shoulder height of 1 to 1.2 m and weighing 110 to 210 kg; COSEWIC 2002). It can be distinguished from other cervids (e.g., moose [*Alces alces*], white-tailed deer [*Odocoileus virginianus*] and elk [*Cervus elaphus*]) by the fact that both male and female caribou have antlers, although some females may have a single antler or none at all (Schaefer and Mahoney 2007). The Woodland Caribou differs from the Barren-ground Caribou by the darker colour of its pelage (mainly brown in summer and grayer in winter) and the shape of its antlers, which are flattened, complex and compact (COSEWIC 2002). Gaspésie caribou have a similar appearance to individuals of other Woodland Caribou populations.

3.2 Population and Distribution

In Canada, caribou occur from north of Ellesmere Island to the Canada–U.S. border along a north-south axis and from British Columbia and Yukon to Newfoundland (Environment Canada 2011a; Figure 1).

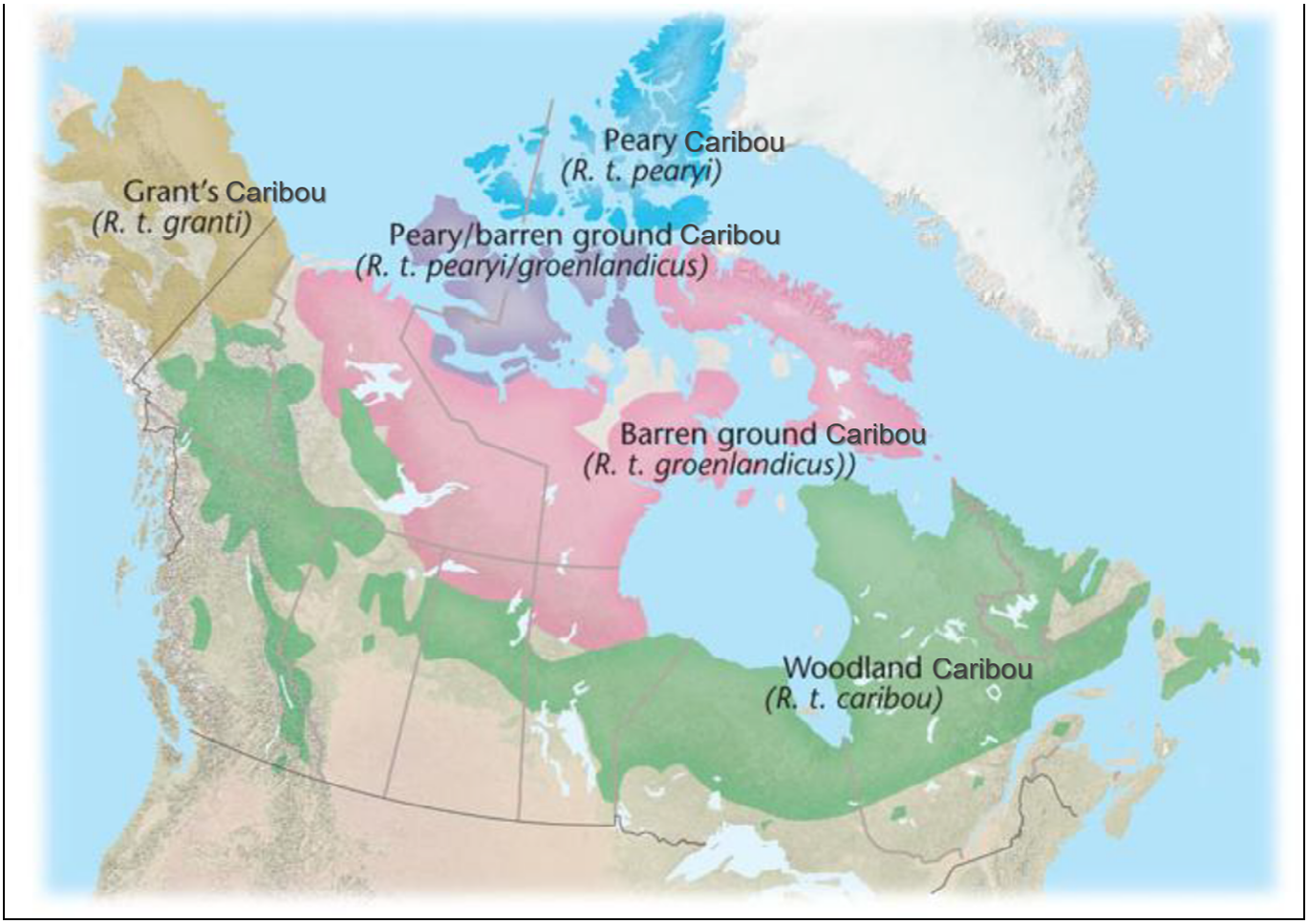


Figure 1. Distribution of caribou subspecies in Canada according to Banfield (1961), adapted from COSEWIC (2011).

The Gaspésie caribou population is geographically and genetically isolated from the other caribou populations of Quebec and Canada (Courtois et al. 2003; COSEWIC 2011; Festa-Bianchet et al. 2011; Yannic et al. 2016). It is a relict subpopulation[7] of the caribou populations that formerly occurred across the Gaspé Peninsula, in the Maritimes and in a few New England states (Moisan 1956). Following European settlement, Gaspésie caribou were concentrated in the mountains and central part of the Gaspé Peninsula (Moisan 1956). Today, this is the only remaining caribou population south of the St. Lawrence River, where it is confined mainly to the highest plateaus of the Chic-Chocs Mountains (including mounts Albert and Logan) and the McGerrigle Mountains (including mounts Jacques-Cartier and Vallières-de-Saint-Réal),

[7] The term "subpopulation" is used to refer to the subunits within the designatable unit corresponding to the Gaspésie caribou population. In other documents concerning the caribou, the term "herd" (group of wild animals living together) or "local population" is sometimes used. Delineating these subunits can be very challenging (Environment Canada 2011a; Nagy 2011).

which are part of the Appalachian Mountains (Fournier and Faubert 2001; Mosnier et al. 2002). It has been geographically isolated for more than 150 years (St-Laurent et al. 2009). The extent of occurrence[8] is estimated to be about 1,500 km^2 (COSEWIC 2014), including all of Parc national de la Gaspésie (802 km²) along with a portion of the area located on the periphery of the park. The area of occupancy[9] is estimated to be less than 1,000 km^2 (COSEWIC j2014). However, a telemetry study (GPS) carried out between 2013 and 2016 significantly improved knowledge about the species' presence. On the basis of the study data, the size of the range was estimated at between 1,515 km^2 and 5,376 km^2, depending on the delineation method and criteria used. The method that best explains differences in the recruitment, survival and growth rate of the population is the minimum convex polygon (MCP) method encompassing 99% of the data, to which an area of 10 km around its perimeter is added (5,376 km^2; Lesmerises and St-Laurent 2018; Figure 2). In the rest of this document, "range" refers to this delineation.

In the 1950s, Moisan (1956) suggested that the herds on Mount Logan, Mount Albert and the McGerrigle Mountains could be relatively independent entities, but sightings made in the Mount Albert area in 1959 indicated that exchanges of individuals occurred between the Mount Albert and Mount Logan herds and the Mount Albert and McGerrigle Mountain herds (Rivard 1978) at that time. Exchanges between the Mount Albert and McGerrigle Mountain herds (Georges et al. 1975) as well as between mounts Albert and Logan were confirmed (Rivard 1978). Since the late 1970s, however, the situation appears to have changed. Telemetry studies by both Ouellet et al. (1996; 1987–1992) and Mosnier et al. (2003; 1998–2001) found that no exchanges took place between the three areas and concluded that the herds concerned should be considered three relatively independent subpopulations that nonetheless form a metapopulation. More recently, out of 43 radio-collared individuals (i.e., about 45% of the population) monitored from 2013 to 2016, only two females moved from the McGerrigle Mountains area to Mount Albert (F. Lesmerises, pers. comm.). Recent genetic analyses suggest that low but significant genetic differentiation exists between the McGerrigle Mountain caribou and those that occur on mounts Albert and Logan (Pelletier et al. 2018), and it appears that this differentiation has increased over the past 20 years. Thus, given that genetic exchanges between the groups are possible but likely rare, it is important to consider the Gaspésie caribou population as a set of two subpopulations forming a metapopulation (*sensu* Wells and Richmond 1995; Mosnier et al. 2003). This is especially important in view of the very small size of the Mount Albert and Mount Logan subpopulations, which exposes them to a risk of extinction that is of greater concern than the risk of extinction of the McGerrigle Mountain subpopulation (Frenette 2017).

[8] The area included in a convex polygon encompassing the geographic distribution of all known populations of a species.
[9] The index calculates the area within the "extent of occurrence" that is potentially occupied by the species.

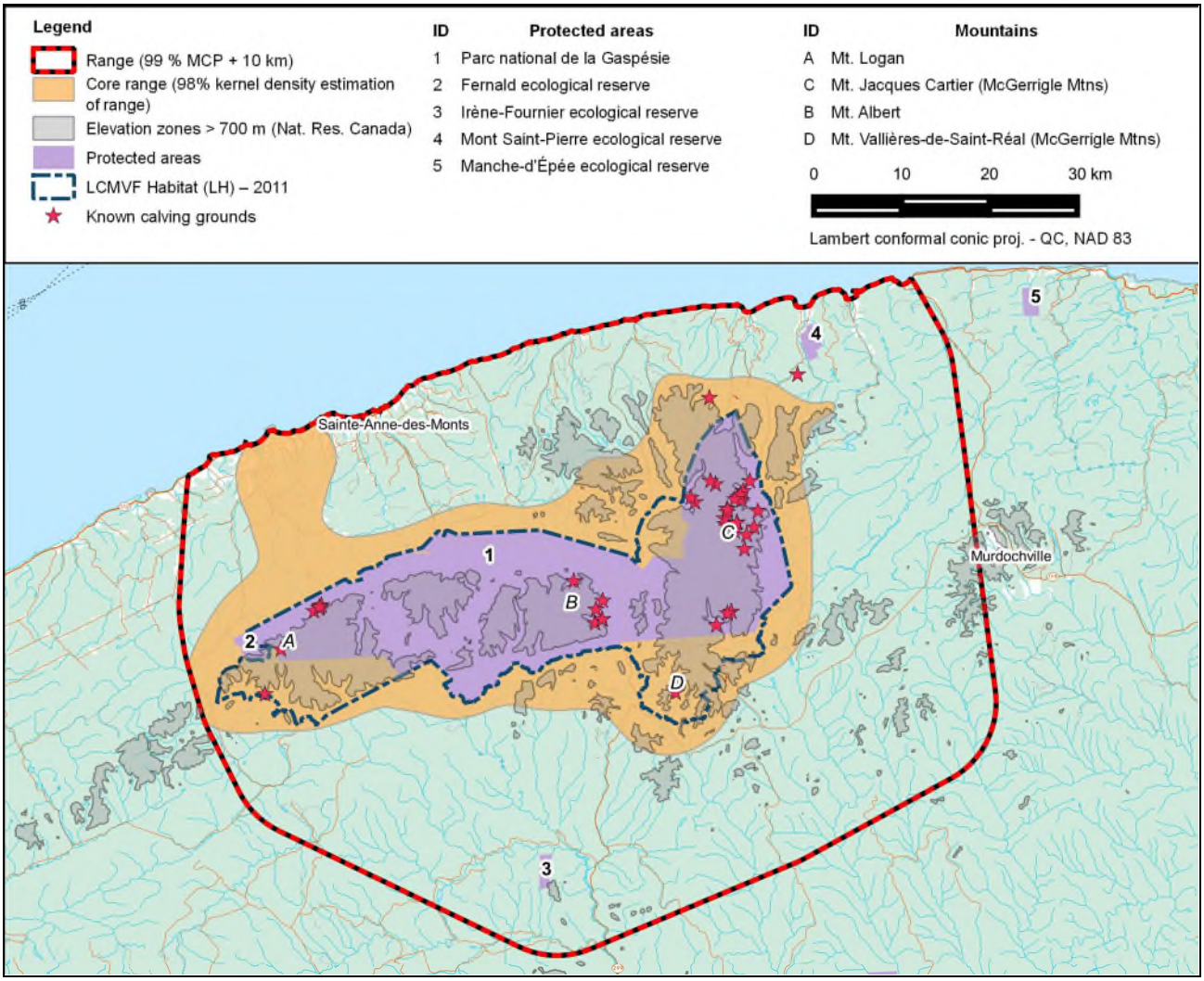


Figure 2. Range of the Gaspésie caribou
The delineation of the range and core range is based on telemetry caribou location data (VHF and GPS) collected between 1977 and 2016 (MFFP, unpubl. data; F. Lesmerises and M.-H. St-Laurent, unpubl. data). The range was delineated by means of a minimum complex polygon (MCP) encompassing 99% of the location data, to which a 10-km-wide area is added around the perimeter (this range is referred to as "99% MCP + 10 km"; Lesmerises and St-Laurent 2018). The core range was delineated using the kernel density estimation method and was performed by subsampling 1,000 locations per year, repeating the exercise 10 times and tallying the 10 estimates. An *ad hoc* smoothing factor based on the assumption of a bivariate normal distribution was used (Lesmerises and St-Laurent 2018). It should be noted that a small area resulting from this kernel density estimation that was located outside the range (west) was removed. The locations of calving sites were obtained from satellite (GPS) telemetry monitoring of 25 females (2, 5 and 18 in the areas of Mount Albert, Mount Logan and the McGerrigle Mountains, respectively), conducted between May 20 and June 20 from 2013 to 2016, for a total of 61 individuals-year. The locations (exact or estimated) of 41 calving sites were identified within the range (F. Lesmerises and M.-H. St-Laurent, unpubl. data). The information on the locations of calving sites is not exhaustive. Finally, the illustrated delineation of "LCMVF Habitat (LH) – 2011" corresponds to the habitat mapped by the Government of Quebec under the *Regulation respecting wildlife habitats* (c. C-61.1, r. 18) passed under the *Act Respecting the Conservation and Development of Wildlife* (CQLR, c. C-61.1) (LCMVF), last updated in 2011.

In the 1950s, the first quantitative evaluation of population size estimated caribou abundance at between 700 and 1,500 individuals, with the lower figure considered more likely (Moisan 1957). At that time, the caribou formed four main groups occupying the area including Mount Logan, Mount Albert, the McGerrigle Mountains and Mount Copper (Murdochville). It is not known when the Mount Copper caribou were extirpated. Between 1966 and 1973, several surveys were conducted on Mount Albert and Mount Jacques-Cartier, and to a lesser extent on Mount Logan (Brassard 1967; Vézina 1971; Potvin 1974). Although the size of the population was not estimated during this period, a decline was observed (Potvin 1974). In 1976 and 1977, the population was estimated at 150 and 144 individuals, respectively (Rivard 1978). Surveys conducted as part of the annual fall aerial survey program instituted in 1983 have documented the continuing decline of the population despite the recovery efforts begun more than 30 years ago (Morin 2017; Figure 3). In the second half of the 1980s, the proportion of calves in the population as sighted in the fall stood at less than 3% (Morin 2017; Figure 4), which is below the threshold (17%) for ensuring population maintenance (see section 3.3.2 for more details).

In light of these low values, a Gaspésie caribou predator control program was implemented from 1990 to 1996 and likely helped to increase the proportion of calves, which slightly exceeded the 17% threshold (see section 3.3.2) in the 1990s (Équipe de rétablissement du caribou de la Gaspésie 2010; Figure 4). However, by 1998, the proportion of calves in the population had once again fallen below 17% (Morin 2017; Figure 4), resulting in the reinstatement of predator control measures in 2001. In subsequent years, the number of individuals and percentage of calves in the population increased steadily, and in 2005 and 2006, the proportion of calves far exceeded the 17% threshold (Morin 2017; Figure 4). However, a decline in numbers was observed once again in 2008 and, in 2011, the aerial survey resulted in the lowest counts obtained over the previous 30 years of monitoring and a proportion of calves of well below 17% (Morin 2017). Between 2011 and 2019, the population remained small (generally < 100 individuals; Figure 3) and the proportion of calves in the population fluctuated considerably, remaining almost always below the 17% threshold (Figure 4). The predator control program initiated in 2001 is still in place today (2021; Équipe de rétablissement du caribou de la Gaspésie, unpubl. data), despite an increased trapping effort over the years, and the results obtained indicate that the predator control measures alone were insufficient to halt the population decline. The results of the aerial surveys carried out between 1983 and 2019 are shown in figures 3 and 4. The aerial surveys conducted between 2011 and 2016 as well as in 2019 did not detect any caribou in the Mount Logan area because of the denser, closed-canopy forest in that area. Assessments conducted by other methods in 2016 led to an abundance estimate for Mount Logan of at least 20 caribou (by telemetry; Morin 2016) or 5 to 34 caribou (by automated camera trap; Pettigrew and St-Laurent 2017). In 2019, the size of the population was estimated at between 38 and 42 individuals (95% CI), but no caribou were observed in the Mount Logan area during the aerial survey (Morin and Lesmerises 2020). Camera traps installed on Mount Logan for a period of 30 days in the fall of 2019 nonetheless detected six individuals. This is likely a minimum value for this area since

the camera trap survey method requires a larger number of observations to produce a reliable population size estimate (Morin and Lesmerises 2020).

Annual monitoring conducted since 1983 shows a marked decline in the Gaspésie caribou population, with a proportion of calves generally below the 17% threshold (Figure 4) considered desirable for population maintenance when the survival rate of females is high. Between 1988 and 2015, the average annual survival rate of adult females was estimated at 0.90 ± 0.08 (± standard deviation; Frenette 2017). This survival rate is similar to that of several other caribou populations in North America (see section 3.1.2), but it is heavily skewed upward by the survival rate calculated at Mount Logan (0.97 ± 0.04), compared with the lower rates at Mount Albert (0.87 ± 0.18) and McGerrigle Mountains (0.86 ± 0.15). This difference could be explained by the fact that the females at Mount Logan use a particular avoidance strategy (low density of females across the entire elevation gradient, rather than being concentrated at a higher density on the summits; Frenette 2017). However, according to this study, the annual female survival rates calculated for recent years (i.e., 2014–2015) are cause for concern, particularly at the scale of the McGerrigle Mountains area (0.65 ± 0.1) and Parc national de la Gaspésie (0.77 ± 0.05). The annual female survival rate during this period at Mount Albert cannot be calculated from the available data, but the most recent rates (1999 and 2001) are very low (average of 0.55; Frenette 2017). In 2014 and 2015, the annual male survival rates were also very low (average of 0.56; Frenette 2017). Lesmerises (2012) noted that in this context where the adult mortality rate is high, the target of 17% calves in the population to achieve a stable population is likely underestimated, and should be at least 21%. This level has not been reached in more than 10 years (Morin 2017; Figure 4).

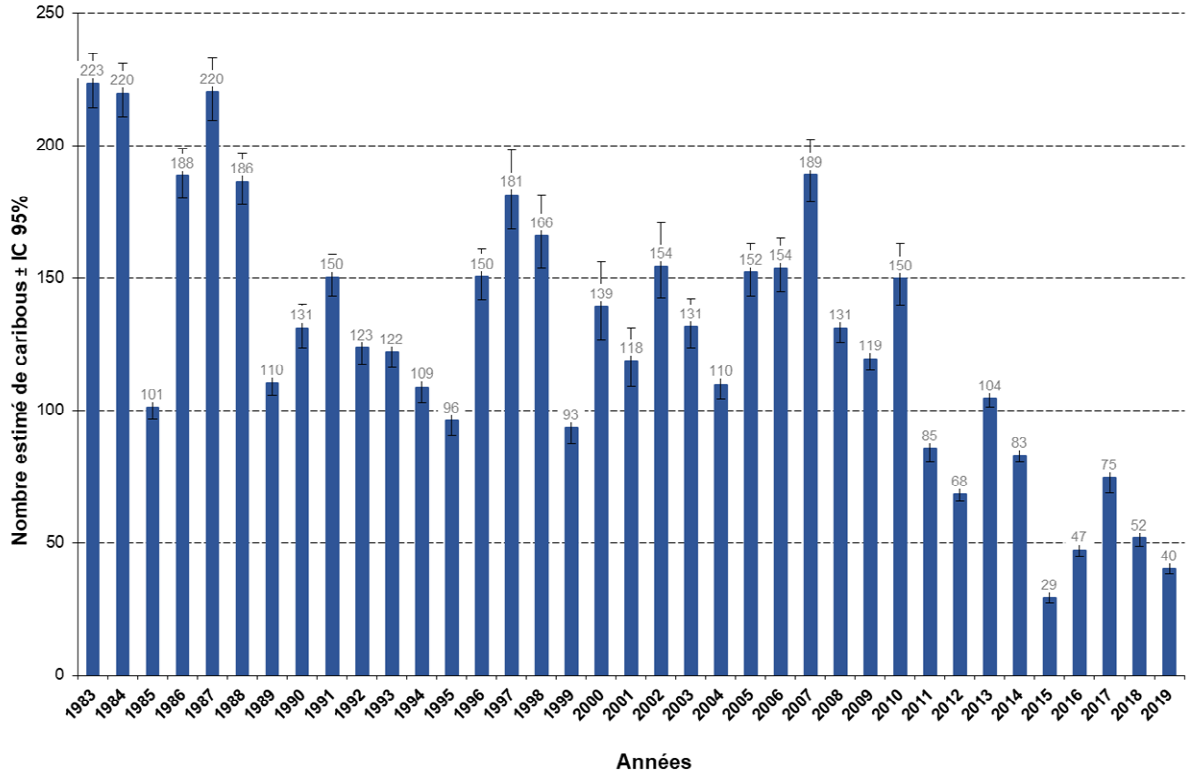


Figure 3. Annual estimate of the size of the Gaspésie caribou population based on the results of aerial surveys (corrected for the visibility rate, including Mount Albert [visibility rate of 80.4%], Mount Logan [visibility rate of 40.6%] and the McGerrigle Mountains [visibility rate of 88.5%], with a 95% CI; Morin and Lesmerises 2020). The annual total represents the sum of the estimates for the different areas.

See the translation below :
Nombre estimé de caribous ± IC 95% = Estimated caribou population ± CI 95%
Années = Years

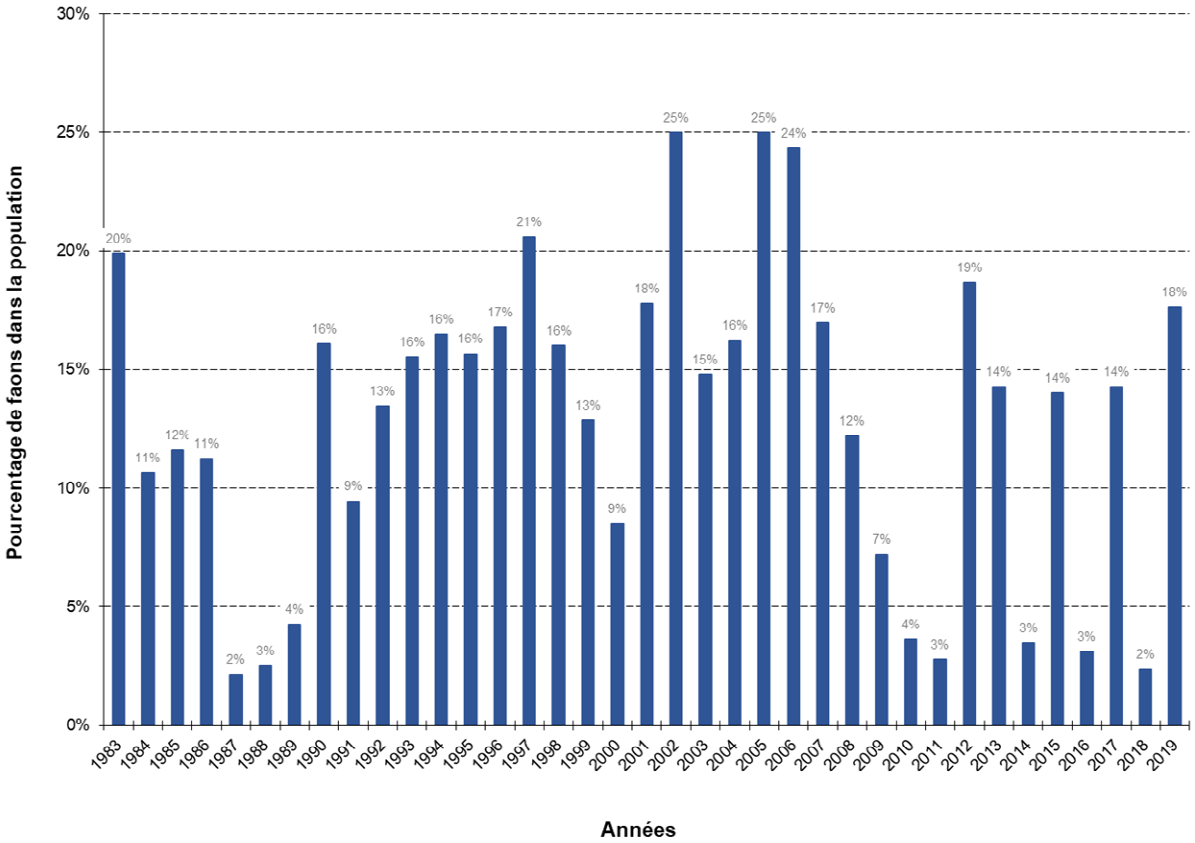


Figure 4. Annual estimate of the percentage of calves in the Gaspésie caribou population based on the results of aerial surveys, including Mount Albert, Mount Logan and the McGerrigle Mountains (Morin and Lesmerises 2020).

See the translation below :
Pourcentage de faons dans la population = Percentage of calves in the population
Années = Years

3.3 Needs of the Gaspésie Caribou

3.3.1 Biological and habitat needs

Habitat selection by caribou is a complex hierarchical process that incorporates nutritional needs and predator avoidance (e.g., Rettie and Messier 2000). Gaspésie caribou require large areas of relatively undisturbed, interconnected habitat where they can separate themselves from predators, modify their use of space in response to various natural and anthropogenic disturbances, and access their preferred food sources.

Gaspésie caribou mainly frequent montane and alpine zones at elevations above 700 m; at lower levels, they inhabit mature or overmature balsam fir stands (≥ 70 years) and, on the summits, they use alpine and subalpine tundra (Mosnier et al. 2003). Although in the past, the Mount Logan caribou used primarily mountain ridges, in recent years they have been using valleys, at elevations below 700 m (Morin 2016). This group of caribou also makes greater use of mature balsam fir stands than the other groups, most likely because of the smaller area of alpine tundra available to them (Mosnier et al. 2003). The close association of Gaspésie caribou with summits and overmature forests is typical of the mountain caribou populations of North America (Poole et al. 2000; Apps et al. 2001). The current knowledge is insufficient to determine the types of habitat that were used during the pre-industrial period, or whether montane and alpine zones were used to the same extent as they are today.

In early winter, caribou frequent the summits, where they feed on terrestrial lichens, mosses and certain types of shrubs by digging craters in the snow. When the snow depth is too great or the snow is dense and crusty, they feed on arboreal lichens, which are available mainly in mature or overmature balsam fir stands surrounding the summits at lower elevations (Mosnier et al. 2003). Optimal winter habitat should therefore have a topography that favours the presence of various types of plant cover, in order to provide sufficiently varied snow cover conditions to enable caribou to access all their winter food resources. Arboreal lichens make up an important part of their winter diet and are a critical food source when other food resources are difficult to access (Serveheen and Lyon 1989). These lichens may account for up to 53% of the caribou diet in winter compared with 27% in summer (St-Laurent et al. 2009). This energy-rich resource has a low protein content, however, and may sometimes be limiting in terms of completing gestation and surviving the harsh winter (Parker et al. 2005; Barboza and Parker 2008).

When weather conditions improve in early spring, the caribou become more mobile, moving back up to the summits where the snow has melted, exposing their preferred forage plants (Environment Canada 2007). Late spring is the calving period. Females in the Gaspésie population tracked by radio telemetry between 2013 and 2016 generally calved between May 20 and June 1, although one calf birth was reported on May 16 and another on June 12 (F. Lesmerises, pers. comm.). From late May until mid-June, the females disperse to a variety of habitats (Bergerud 1973; Rivard 1978; M. Lalonde

and R. Faubert, pers. comm.). The dispersal behaviour of females at calving appears to be dictated by the need to distance themselves from alternate prey and predators, a pattern also observed in other woodland caribou populations (e.g., Leclerc et al. 2012). Females monitored during the calving period on Mount Albert and the McGerrigle Mountains made heavy use of shrub barrens, rock barrens, areas with stunted trees, and open and other conifer stands, whereas other habitat categories[10] were visited less regularly (St-Laurent et al. 2015a). Inter-annual variations in snow melt are believed to influence the females' selection of calving sites (Environment Canada 2007). A model developed by St-Laurent et al. (2015a) nonetheless illustrates the existence of a relative degree of breeding site fidelity among Gaspésie caribou.

Fecal analyses showed that the summer diet of Gaspésie caribou was composed primarily of common juniper (*Juniperus communis*), balsam fir (*Abies balsamea*) and field horsetail (*Equisetum arvense*) and that competition for food with moose was limited during this season, given the differences in their diets (Christopherson et al., in prep.). Elevation does not appear to be a factor in the selection of forage plant species by caribou or moose. It is not known whether Gaspésie caribou select specific types of habitat in the summer. According to the study by Rivard (1978), caribou did not select any particular type of habitat during this season, possibly because food resources were widely available. However, the telemetry location data collected by Mosnier et al. (2003) show that, on average, caribou spend more time at higher elevations (primarily in barren areas) in the summer and fall than during the other seasons. This may be part of their anti-predator strategy.

Bergerud (1973) reported that mating occurs in about mid-October. Aerial surveys of the caribou population showed that rutting and mating takes place between late September and mid-October (Lalonde and Michaud 2013; Lalonde 2013). During the rutting and mating season, caribou gather in barren habitats in alpine areas on several plateaus within their range, including the summits of Mount Albert, Mount Logan and the McGerrigle Mountains (including mounts Jacques-Cartier and Vallières-de-Saint-Réal; Moisan 1957; Bergerud 1973; Rivard 1978; Fournier and Faubert 2001).

The home range size of adult caribou is fairly small for the species, with an area of 219 ± 339 km^2 (mean ± standard deviation) recorded for the 43 individuals monitored using GPS telemetry between 2013 and 2016 (males = 308 ± 471 km^2; females = 162 ± 197 km^2; 100% MCP estimator; F. Lesmerises and M.-H. St-Laurent, unpubl. data). These home range estimates are larger and more realistic than those obtained by Ouellet et al. (1996) between 1987 and 1992 using VHF telemetry (148 km^2 on average) or by Mosnier et al. (2003) between 1999 and 2000 (46 to 77 km^2 on average), because they are not limited to the locations identified in the habitat typically surveyed in previous VHF telemetry surveys. The home range sizes calculated for the period from 2013 to 2016 include extra-territorial movements, with some individuals travelling as far west as Saint-Ulric or as far east as Gaspé. Nonetheless, the caribous'

[10] The other habitat types include mixed forests, deciduous forests, wet barrens, areas affected by natural disturbances, and forest cutovers (St-Laurent et al. 2015a).

predator avoidance strategy causes them to concentrate on the barren summits (Mosnier et al. 2003; Lesmerises et al. 2017), which may in part explain the smaller size of their home range relative to that of the Woodland Caribou, Boreal population (average of 1,772 km^2; Bastille-Rousseau et al. 2011).

Mosnier et al. (2003) suggested that the existence of distinct groups of caribou (see section 3.2) should be taken into consideration in managing the caribou population and subpopulations. Indeed, they appear to be geographically distinct entities that use space and habitat differently, notably depending on habitat availability and distance between habitats. This study also showed that individuals in the different groups used habitats between the summits during dispersal movements. Mosnier et al. (2003) considered this connecting habitat to be very important because its disturbance would result in the complete isolation of the various groups. Habitat connectivity is essential for the maintenance of a caribou population (or, in this case, a metapopulation) since it permits seasonal movements among habitats offering the various resources required for life history processes and allows alternate areas to be used in response to disturbance or while disturbed habitat is in the process of recovery (Saher and Schmiegelow 2005).

Woodland caribou are sensitive to habitat disturbance, particularly because of the associated increase in predator abundance (COSEWIC 2014). Maintaining low predation risk is essential for the recovery of the Gaspésie caribou. Although these caribou primarily use high elevation ranges and/or habitat types where they are spatially separated from alternate prey and predators (Ouellet et al. 1996; Mosnier et al. 2003), the habitat–prey–predator dynamics at lower elevations and in areas adjacent to ranges influence predator–prey dynamics and caribou mortality within their annual ranges. This is because predators move beyond valley bottoms and may also use higher elevations, especially during summer and fall (Mosnier et al. 2008a; Boisjoly et al. 2010; St-Laurent et al. 2015b).

3.3.2 Limiting factors

Changes in the size of the Gaspésie caribou population are primarily dependent on two closely related factors, namely adult survival, particularly adult females (Gaillard et al. 1998), and annual calf recruitment and survival (Environment Canada 2007), which are primarily a function of predation rate.

Compared with other ungulates, caribou have a low gross reproduction rate[11] (COSEWIC 2014). Females typically do not produce young until three years of age and give birth to only one calf per year (Bergerud 2000). If calf survival is low, the number of calves may be insufficient to compensate for annual adult mortality. In the 1980s, although the female survival rate was fairly high, it was determined that in order to maintain at least minimal population growth, the proportion of calves in the Gaspésie caribou population should be at least 17%, or the equivalent of about 30 calves per

[11] The gross reproduction rate indicates how many female calves 100 female caribou would produce during their lifetime, in the absence of mortality.

100 females (Crête and Desrosiers 1995). Modelling performed since then has shown that when the female survival rate is lower, as is currently the case for the Gaspésie caribou, the ratio should be at least 37 calves per 100 females (i.e., the proportion of calves should be 21.0%; Lesmerises 2012), or 36 calves per 100 females (i.e., 20.4%) in the McGerrigle Mountains and 48 calves per 100 females (i.e., 27.2%) on mounts Albert and Logan (Frenette 2017). The primary proximate factor in the survival of Gaspésie caribou calves is likely predation by coyotes and black bears. Crête and Desrosiers (1995) documented calf mortality using radio telemetry tracking and found that coyotes (64%) and black bears (27%) were likely implicated in the majority of confirmed cases of predation. They also reported that mortality decreased considerably after the first few months of life, that is, low calf mortality was recorded during the first winter. According to the available information, other factors likely to influence calf survival in the Gaspésie population include poor nutritional status, abandonment by the cow, harsh weather conditions and accidents (Environment Canada 2012).

In North America, annual survival of females is generally on the order of 0.78 to 0.96 (Bergerud 1971; Fuller and Keith 1981; Stuart-Smith 1997; Rettie and Messier 1998; Wittmer et al. 2005, cited in Frenette 2017). Lesmerises (2012) showed that a reduction in annual adult mortality from 13% (i.e., the mean value calculated for the Gaspésie population for the period 1983–2011)[12] to 11% would cause a 40% decline (i.e., from 50% to 10%) in the probability of extinction on a 100-year horizon. Thus, to promote the persistence of the Gaspésie caribou population, annual adult mortality should be 11% or lower (Lesmerises 2012).

The small size of the Gaspésie caribou population is another limiting factor that makes it vulnerable to stochastic events, such as heavy snowfalls, ice layer formation, avalanches, forest fires, parasites and pathogens, or other environmental events of similar magnitude (COSEWIC 2014). The avalanche-associated death of the last southern mountain woodland caribou in Banff National Park is an example (Hebblewhite et al. 2010). Any event that causes the accidental or episodic mortality of a few adult caribou within a short time period can represent the loss of a significant proportion of the population and thus significantly impede its recovery.

The anti-predator strategy of caribou involves dispersing over large areas to separate itself from other cervid species (moose and white-tailed deer), thereby reducing encounters with predators (Ouellet et al. 1996; De Bellefeuille 2001; Mosnier et al. 2003; Vors et al. 2007; Mosnier et al. 2008a). This strategy may also be considered a limiting factor, since it entails the use of large areas of undisturbed habitat, which may become limiting due to the impact of certain threats (see section 4).

[12] Mean of 5-year running averages (T_{-2}, T_{-1}, T_0, T_{+1}, T_{+2}). The removal of outliers (e.g., negative mortality rates) gives adjusted mortality rates of 19.5 (McGerrigle Mountains) and 24.6 (mounts Albert and Logan) (Lesmerises 2012).

Lastly, geographic isolation compounds the effect of the small size of the caribou population, making it susceptible to genetic drift[13] and inbreeding depression[14] (COSEWIC 2002). Under such circumstances, individuals and populations become less able to acclimate or adapt to new environmental constraints (Bijlsma and Loeschcke 2012) and are therefore more likely to be severely affected by stochastic events (Wittmann et al. 2018).

4. Threats

4.1 Threat Assessment

The assessment of threats to the Gaspésie caribou population is based on the International Union for the Conservation of Nature/Conservation Measures Partnership (IUCN-CMP) unified threats classification system. Threats are defined as the proximate activities or processes that have caused, are causing, or may cause in the future the destruction, degradation, and/or impairment of the entity being assessed (population, species, community, or ecosystem) in the area of interest (global, national, or subnational). Limiting factors are not considered in this assessment process. During this threat assessment process, only present or future threats (within a 10-year timeframe) are considered. In addition, only the direct effects of the threats are considered. For example, in the case of forest harvesting, caribou dispersal to locations where the predation risk is higher (indirect effect) is not considered in the assessment of this threat, but it is considered in connection with the threat of excessive predation.

This threat assessment is based on that of COSEWIC (2014),[15] and was carried out by considering the current range. For more information on how the values are assigned in Table 1, see the table footnotes. The calculated overall threat impact, which takes into account the additive effect of the threats identified in Table 1, is “very high” (COSEWIC 2014). Many of the threats to Gaspésie caribou and their habitat are linked and can interact with one another, in which case they can have cumulative impacts, which can be less obvious when the threats are examined individually (Weclaw and Hudson 2004; Badiou et al. 2011). Historical threats, indirect or cumulative effects of the threats, or any other relevant information that would help understand the nature of the threats, are presented in section 4.2.

[13] “Any random change in gene frequency in a population (Delvin and Pham 1990).
[14] Decreased vigour in terms of growth, survival, or fertility following one or more generations of inbreeding (King 1985).
[15] However, threats 3.1 “Gas exploration and development” and 7.3 “Other ecosystem modifications” were added to the 2014 assessment, because new information became available.

Table 1. Threat classification for the Gaspésie caribou

Threat	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing	Comments
1	**Residential & commercial development**	High	Pervasive	Serious	High	
1.2	Commercial & industrial areas	Low	Small	Serious	Moderate	A project to establish a natural water pumping station adjacent to the population's range is being assessed.
1.3	Tourism & recreation areas	High	Pervasive	Serious	Moderate	Tourism infrastructure already exists in Parc national de la Gaspésie, and there is potential for further development in the population's range on a 10-year horizon.
3	**Energy production & mining**	High	Large	Serious	High	
3.1	Gas exploration and development	Unknown	Small	Unknown	High	Within the range, gas exploration and development activities are permitted outside of protected areas (e.g. Parc national de la Gaspésie). While no production rights have been granted, exploration activities are being carried out. The known gas zones of interest are located outside of Parc national de la Gaspésie, in some cases within the species' range, and it is estimated that less than 10% of the total population could be affected over the coming 10 years. The real impact on the population is unknown.
3.2	Mining & quarrying (mining and mineral exploration)	Medium	Large	Moderate	Moderate	There is potential for mining and mineral exploration within the range or nearby, on the periphery of Parc national de la Gaspésie. Moreover, several exploration claims are active there. The assessment of this threat is based on cases where caribou quickly abandoned areas adjacent to sites where mines were opened in the 1950s.
3.3	Renewable energy (wind farm development)	High	Large	Serious	High	There is potential for wind farm development within the range or nearby.

Threat	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing	Comments
4	**Transport & service corridors**	High	Large	Serious	High	
4.1	Roads & railroads (Development of road/transportation network)	High	Large	Serious	High	The cumulative disturbance rate is currently estimated at approximately 75% using the methods described in Environment Canada (2012). The road network interferes with habitat use by woodland caribou and facilitates movements of their predators. New roads might be built in connection with forestry operations, oil and gas or mineral exploration and development, wind farm construction or tourism infrastructure development, and the effects of existing roads within the caribou range (including the roads serving Parc national de la Gaspésie) are still felt today. On the other hand, it is planned to close roads and restore them to a more natural state over the coming decade.
4.2	Utility & service lines	Low	Small	Moderate	High	There are several utility rights-of-way in the Gaspésie caribou range (e.g., power lines and associated service roads, telecommunication towers and associated service roads), and new rights-of-way continue to be established.
5	**Biological resource use**	Very high	Pervasive	Extreme	High	
5.1	Hunting & collecting terrestrial animals (poaching)	Low	Medium	Slight	Moderate	Poaching of Gaspésie caribou may occur, as has been documented in the past. While it does not appear to be a widespread threat in the park or on its periphery, if poaching were to increase, it could have an impact on the caribou.
5.3	Logging & wood harvesting	Very high	Pervasive	Extreme	High	Forest harvesting is carried out within the population's range, outside the boundaries of Parc national de la Gaspésie. Since the park itself is not large enough to adequately protect the population, this threat is a concern. The harvesting activities that took place in the park and on its periphery until 1970 altered the habitat to such an extent that it is still not

Threat	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing	Comments
						suitable for caribou. The indirect threats associated with logging (e.g., development of transportation network resulting in habitat degradation and increased predation pressure from coyotes and black bears) were not considered in the assessment of this threat as they are addressed under a different heading.
6	**Human intrusions and disturbance**	Low	Pervasive	Slight	High	
6.1	Recreational activities (e.g., use of snowmobiles and all-terrain vehicles, hiking, snowshoeing, snow sports, hunting)	Low	Pervasive	Slight	High	Several recreational activities that take place within the park and on its periphery pose a threat, since they cause caribou to flee to habitats where the risk of predation is higher.
6.3	Work & other activities (population monitoring activities)	Low	Pervasive	Slight	High	Helicopters are used for annual population monitoring, but in only part of the range.
7	**Natural system modifications**	Medium	Large	Moderate	High	
7.1	Fire & fire suppression	Unknown	Unknown	Unknown	Unknown	Forest fires are a natural process that can restrict the habitat available for caribou.
7.3	Other ecosystem modifications	Medium	Large	Moderate	High	Outbreaks of insects such as the spruce budworm can limit the habitat available for caribou.
8	**Invasive and other problematic species and genes**	Very high	Pervasive	Extreme	High	
8.1	Invasive/non-native alien species (transmission of pathogens from domestic animals, livestock or invading wildlife)	Unknown	Unknown	Unknown	Unknown	Little information is available on the Gaspésie population with respect to pathogens. Recent studies appear to indicate that the intensity of infections is generally low, and that the parasites detected are fairly common but have little effect on the adult survival rate.

Threat	Threat Description	Impact[a]	Scope[b]	Severity[c]	Timing	Comments
8.2	Problematic native species (excessive predation by coyotes and black bears)	Very high	Pervasive	Extreme	High	Coyotes and black bears exert excessive predation pressure on caribou calves within the population's range. Predator populations and predator access to caribou are favoured by certain human activities, including logging, road construction and certain collateral effects of recreational activities (e.g., snow compaction and waste generation). The high moose density in the sector also supports a high predator density (apparent competition).
9	**Pollution**	Unknown	Unknown	Moderate – Slight	Moderate	
9.2	Industrial & military effluents	Unknown	Unknown	Moderate – Slight	Moderate	A project to build a natural water pumping station adjacent to the caribou range will generate pollutants; however, the information needed to assess this threat is not available at present.
10	**Geological events**	Low	Small	Serious – Moderate	Moderate	
10.3	Avalanches/landslides	Low	Small	Serious – Moderate	Moderate	Caribou mortality due to avalanche events occurs roughly every two years. A significant fraction of the population can be lost in a single avalanche. The scope of this threat is described as "small" because only some of the mountains used by caribou have conditions conducive to avalanche formation.
11	**Climate change & severe weather**	Unknown	Large	Unknown	Moderate	
11.1	Habitat shifting & alteration	Not calculated (outside the assessment period)	Pervasive	Unknown	Low	A change in the tree line, vegetation structure and habitats in general is expected, but not over the next 10 years.
11.3	Extreme temperatures	Unknown	Large	Unknown	Moderate	An increase in the frequency of freezing rain or rain events followed by freezing is expected; this can make it difficult for caribou to access food resources on the ground in winter.

[a] **Impact –** The degree to which a species is observed, inferred, or suspected to be directly or indirectly threatened in the area of interest. The impact of each threat is based on Severity and Scope rating and considers only present and future threats. Threat impact reflects a reduction of a species population or decline/degradation of the area of an ecosystem. The median rate of population reduction or area decline for each combination of scope and severity corresponds to the following classes of threat impact: Very High (75% declines), High (40%), Medium (15%), and Low (3%). Unknown: used when impact cannot be determined (e.g., if values for either scope or severity are unknown); Not Calculated: impact not calculated as threat is outside the assessment timeframe (e.g., timing is insignificant/negligible or low as threat is only considered to be in the past); Negligible: when scope or severity is negligible; Not a Threat: when severity is scored as neutral or potential benefit.

[b] **Scope** – Proportion of the species that can reasonably be expected to be affected by the threat within 10 years. Usually measured as a proportion of the species' population in the area of interest. (Pervasive = 71–100%; Large = 31–70%; Restricted = 11–30%; Small = 1–10%; Negligible = ≤ 1%).

[c] **Severity –** Within the scope, the level of damage to the species from the threat that can reasonably be expected to be affected by the threat within a 10-year or 3-generation timeframe. Usually measured as the degree of reduction of the species' population. (Extreme = 71–100%; Serious = 31–70%; Moderate = 11–30%; Slight = 1–10%; Negligible = ≤ 1%; Neutral or Potential Benefit = ≥ 0%).

[d] **Timing –** High = continuing; Moderate = only in the future (could happen in the short term [< 10 years or 3 generations]) or now suspended (could come back in the short term); Low = only in the future (could happen in the long term) or now suspended (could come back in the long term); Insignificant/Negligible = only in the past and unlikely to return, or no direct effect but limiting.

4.2 Description of Threats

The main threats are described below in decreasing order of impact level. Section 4.2.8 includes all low-impact threats and section 4.2.9 includes potential threats and threats whose impact is unknown because of the current lack of information about them.

4.2.1 Logging

(IUCN threat 5.3: Logging & wood harvesting)

In North America, logging is the main factor responsible for the northward retraction of the woodland caribou's range (e.g., Schaefer 2003; Vors and Boyce 2009; Festa-Bianchet et al. 2011). It is probably the most significant cause of decline at the regional scale. Logging is recognized as having major impacts on the Gaspésie caribou because it causes habitat loss and degradation, is a source of disturbance and favours predator populations (Stone et al. 2008; St-Laurent et al. 2009). Furthermore, logging results in the development of road networks, which are detrimental to caribou (see section 4.2.3).

VHF telemetry tracking from 1998 to 2001 showed that radio-collared caribou spent nearly 20% of the year outside the boundaries of Parc national de la Gaspésie (Mosnier et al. 2003), a situation confirmed by telemetry tracking from 2013 to 2016 (F. Lesmerises, unpubl. data). The forests surrounding Parc national de la Gaspésie are still being logged and are therefore highly disturbed. Under the terms of the 2013–2018 forest management plan for the Gaspésie caribou range (Chouinard et al. 2013), which includes habitat mapped under the *Act Respecting the Conservation and Development of Wildlife* (shortened to "LH" hereinafter; map in Appendix A), logging is prohibited in certain "conservation zones" and the silvicultural treatments permitted at elevations above 700 m are aimed at maintaining the balsam fir stands commonly used by caribou. However, this means that the caribou are restricted to montane, subalpine and alpine habitats, which may interfere with their dispersal movements. Logging also increases the risk of windthrow in residual stands (e.g., Ruel et al. 2003; Larouche et al. 2007). In areas of the park adjacent to harvested zones, this is a cause for concern because older fir stands there are susceptible to windthrow (Environment Canada 2007).

Forestry operations are also a source of disturbance for the Gaspésie caribou population. There is general agreement in the scientific literature that woodland caribou tend to avoid recently harvested areas (Hins et al. 2009; Vors and Boyce 2009; Festa-Bianchet et al. 2011; Leclerc et al. 2012; Dussault et al. 2012). Studies on the Woodland Caribou in Newfoundland and Labrador (Schaefer and Mahoney 2007; Newfoundland population), Ontario (Vors et al. 2007; Boreal population) and Quebec (Fortin et al. 2013; Boreal population) show that caribou avoid recent cutovers, maintaining a distance of several kilometres from them. The effects of disturbance are further detailed in sections 4.2.3 and 4.2.5. Forest harvesting is accompanied by an extensive network of logging roads, which contribute to a functional loss of caribou habitat (see section 4.2.3).

It takes many years (~90 years) for a harvested forest stand to regenerate to the point where it offers sufficient arboreal lichen biomass for caribou (Stone et al. 2008). Therefore, although the habitats within Parc national de la Gaspésie have been protected from forest harvesting activities since 1977, some of them have not yet reached the stage at which they provide favourable conditions for caribou. Past and present forestry operations could also have longer term effects or create the need for specific interventions to restore conifer-dominated stands at the landscape level. Pinna et al. (2009) prepared a portrait of the pre-industrial forests in the Gaspésie which showed that the forest matrix, previously dominated by mature conifers, is now dominated by young stands with a more significant deciduous component. After harvesting, fir-dominated stands appear to be replaced by deciduous or mixed stands instead of reverting to their previous composition (Boucher et al. 2009; Desrosiers et al. 2012). The decline in the relative quality of habitat for caribou between 1998 and 2009 reflects a functional loss of habitat in the LH and on its periphery during the snow-free period[16] and during the winter,[17] probably due to the intensification of logging near the perimeter of the LH (St-Laurent et al. 2015b; Appendix B). This reduction in habitat quality is primarily linked to a decrease in the proportion of mature balsam fir stands in the LH and on its periphery, as well as to an increase in the proportional area of clear-cuts and partial cuts (0–20 years) and in the density of gravel roads (primarily on the periphery of the LH; St-Laurent et al. 2015b; Appendix B).

Not all forest management activities affect Gaspésie caribou habitat in the same way. Forest management practices that maintain some cover (e.g., partial cutting) retain more of the forest attributes that are representative of mature forests with suitable habitat for caribou (e.g., residual abundance of arboreal lichens) and create habitat that is less suitable for caribou predators, in contrast with clearcutting (e.g., seed tree system, cutting with protection of regeneration and soils), which provides favourable conditions for caribou predators and alternate prey and which removes almost all arboreal lichens (Stone et al. 2008; St-Laurent et al. 2015b; Nadeau Fortin et al. 2016; Boudreau 2017; see section 4.2.2). In addition to causing the loss and degradation of habitat that is important for maintaining the caribou population, logging in woodland caribou habitat and, on a larger scale, across the Gaspé Peninsula has led to an increase in predation pressure (see section 4.2.2). In this regard, logging that results in a shift from mature forest to an overly high proportion of young stands is considered the ultimate cause of the population decline (St-Laurent et al. 2009).

4.2.2 Excessive predation by coyotes and black bears

(IUCN threat 8.2: Problematic native species)

The logging that was carried out within the boundaries of Parc national de la Gaspésie until 1977 and is still taking place on the periphery of the park and across the Gaspé

[16] Decrease of 31% in relative habitat quality for caribou in the LH and decrease of 47% in an area corresponding to the LH and 30 km around it.
[17] Decrease of 4% of relative habitat quality for caribou in the LH and decrease of 19% in an area corresponding to the LH and 30 km around it.

Peninsula has resulted in an overrepresentation of young deciduous forests. This trend has benefited two generalist predators: the black bear and the coyote.[18] The dense vegetation, including fruit-bearing trees and shrubs (e.g., raspberry [*Rubus* sp.], mountain ash [*Sorbus americana*] and wild sarsaparilla [*Aralia nudicaulis*] [; Mosnier et al. 2008b), along with the presence of prey species (moose, white-tailed deer, snowshoe hare [*Lepus americanus*], and small mammals) on these regenerating sites, represent important food resources for these predators (Boileau 1993; Mosnier et al. 2008a; St-Laurent et al. 2009; Boisjoly et al. 2010). The presence of other cervid species tends to lead to increased predator abundance (Schwartz and Franzmann 1989; Bergerud *et al. 1*985) and, therefore, to increased predation pressure on caribou (Bergerud and Ballard 1988; Seip 1992). This phenomenon is called "apparent competition" (Holt 1977; 1984). For example, a large portion of the caribou range is located in areas known to have high moose densities. In 2010 and 2012, respectively, densities of 11 moose per 10 km^2 in the Chic-Chocs wildlife reserve (Dorais and Lavergne 2010) and 33 moose per 10 km^2 in the Matane wildlife reserve (Lamoureux et al. 2012) were observed, compared with an average density in 2007 of 7.9 ± 0.9 moose per 10 km^2 in all of hunting zone 1, which encompasses the Gaspésie and part of the Bas-Saint-Laurent region (Landry and Lavergne 2007). These moose densities can support high predator densities (Mosnier et al. 2008a; Boisjoly et al. 2010), thus leading to an unsustainable level of predation on caribou calves (Mosnier et al. 2008a; Vors et al. 2007). The calf mortality rate is currently very high (see section 3.2), and field observations suggest that a large proportion of this mortality is attributable to predation (M.-H. St-Laurent, unpubl. data). Accordingly, excessive predation by coyotes and black bears is considered the main proximate cause of the recent decline in the Gaspésie caribou population (Crête and Desrosiers 1995; St-Laurent et al. 2009).

Between 1998 and 2009, the mean relative probability of occurrence of black bears and coyotes decreased overall in the LH. It also decreased on the periphery of the LH at certain times of the year (St-Laurent et al. 2015b). However, given the intensification of forest harvesting (see section 4.2.1), the quality of habitat for black bears and coyotes has increased on the periphery of the LH[19] (St-Laurent et al. 2015b). Mosnier et al.

[18] Since the turn of the 20th century, predator–prey dynamics south of the St. Lawrence River have been profoundly altered. Over time, the expansion of agriculture and intensive hunting gradually led to the extermination of the grey wolf (*Canis lupus*). At the same time, intensive forest management has caused a significant decline in mature forest cover and a corresponding increase in open habitats. With these profound changes in landscape structure and composition, coyotes have been successful in colonizing the Bas-Saint-Laurent and Gaspésie regions. The first records of their presence in the Gaspésie date back to 1973 (Larivière and Crête 1992). Coyotes subsequently became well established in the area of occupancy of the Gaspésie caribou. The coyote is now recognized as the main predator of caribou calves (Crête and Desrosiers 1995; Fournier and Faubert 2001; Boisjoly et al. 2010) and has also been implicated in cases of adult mortality.

[19] For example, the relative quality of black bear habitat increased by 49% in the spring (in an area corresponding to the LH and 25 km around it) and by 75% in the fall (in an area corresponding to the LH and 10 km around it). The relative quality of coyote habitat increased by 2,634% (in an area corresponding to the LH and 25 km around it) and by 3,839% (in the Bas-Saint-Laurent and Gaspésie regions) during the calving period (March 16 to April 30), and by 54% (in an area corresponding to the LH

(2008a) showed that despite considerable spatial and altitudinal separation between caribou and their predators, predators' high dispersal capabilities allow them to travel—often from habitats very distant from Parc national de la Gaspésie—to areas used by female caribou at a time when calves are vulnerable. Furthermore, the forestry road network facilitates predator movement (Renaud et al. 2010; St-Laurent et al. 2012; Gaudry 2013).

Through VHF telemetry tracking of 28 adult females, Ouellet et al. (1996) noted an overuse of alpine habitats relative to their availability, contrary to what was observed in an earlier study (Rivard 1978), before coyotes became abundant in the region. This increased use of alpine tundra is consistent with the hypothesis that caribou avoid coyote predation (Mosnier et al. 2003). However, the black bear, a known predator of young caribou (Boileau 1993; Bastille-Rousseau et al. 2011), forages in alpine tundra, particularly during the first few weeks after caribou calves are born—the period when calves are the most vulnerable to predators (Mosnier et al. 2005; Pinard et al. 2012; Leclerc et al. 2014). In a study characterizing the habitat selection patterns of bears in relation to the seasonal availability of certain forage plants, including several types of fruit consumed mainly during the summer, Mosnier et al. (2008b) identified movements along an altitudinal gradient that enabled bears to access valuable food resources in subalpine zones where the snow cover disappears faster. Given the proximity of these zones to caribou calving grounds, black bears opportunistically prey on calves as they move between vegetation-rich areas. This has also been documented in the Charlevoix woodland caribou herd (Bastille-Rousseau et al. 2011).

Various conservation strategies can be adopted for species like the Gaspésie caribou that are affected by apparent competition (see Frenette and St-Laurent 2016). One such strategy is predator population control. A preliminary analysis of the data collected since the predator population control program was reinstated in 2001 suggests, however, that while this approach helps to control black bear numbers, it has still not proven as effective as anticipated for controlling the coyote population, which has continued to grow (Lesmerises 2012; Michaud 2013). However, if coyote control efforts were halted, the caribou calf mortality rate would reach close to 100% (Lesmerises 2012). Other conservation strategies include prey population control, which can have positive results when implemented gradually (Serrouya et al. 2015), and caribou habitat management and restoration (e.g., Vors and Boyce 2009; Festa-Bianchet et al. 2011; Environment Canada 2011a; 2012; Hervieux et al. 2013).

4.2.3 Development of road/transportation network

(IUCN threat 4.1: Roads & railroads)

Road networks affect wildlife in various ways and can have a major impact on animal populations (Trombulak and Frissell 2000; Fahrig and Rytwinski 2009). The actual impact of a road network can vary with the type of infrastructure, frequency of use, and

---

and 25 km around it) to 89% (in the Bas-Saint-Laurent and Gaspésie regions) during the period of caribou calf vulnerability (May 1 to July 31).

types of vehicle used, as well as the type of habitat fragmented (e.g., Fahrig et al. 1995; Forman and Alexander 1998). The impact of the road network on wildlife populations also depends on the life history characteristics of the species concerned (Fahrig and Rytwinski 2009; Renaud et al. 2010). The adverse effects of road networks are complex and act at various levels. Traffic can cause direct mortality (i.e., collisions). Road construction and maintenance and vehicle traffic also have several indirect effects, including behavioural changes (disturbance), habitat loss and fragmentation, pollution-related habitat degradation, a barrier effect leading to a reduction in genetic exchanges, and alteration of the plant communities bordering the road infrastructure (Renaud et al. 2010).

In recent years, development of road networks has been identified as one of the most significant threats to several woodland caribou populations, both in Quebec and elsewhere in North America, and generalized avoidance of roads by caribou has been confirmed by an increasing number of studies (e.g., Dau and Cameron 1986; St-Laurent et al. 2012; Gaudry 2013; Leblond 2013). Rudolph (2011) found that the movements of woodland caribou (boreal population) near roads (<5 km) showed high tortuosity, compared with the much more linear movements of individuals at distances of over 30 km from the road network. These observations are consistent with the results of a study by Dyer et al. (2001), who found that road networks acted as a semi-permeable barrier to caribou movements. Other studies have shown that the probability of caribou occurrence in a region is correlated with lower road density at the landscape scale (Wolfe et al. 2000; Apps and McLellan 2006). Caribou avoidance translates to a functional loss of habitat, which can even include the complete desertion of certain areas and disruption of calving site fidelity in females (Vors et al. 2007; Faille et al. 2010). Leblond et al. (2011) found that boreal caribou (Woodland Caribou, Boreal population) exhibit avoidance of habitat within a 750 m radius of roads. Such avoidance is equivalent to functional loss of habitat or habitat degradation for individuals that use the disturbed area, a situation recently confirmed by another study on this behaviour in the Gaspésie caribou (Gaudry 2013).

The use of suboptimal habitats, the maintenance of a prolonged state of vigilance and the segregation of a population into partly isolated subgroups can have significant demographic effects. However, to date, these effects have not been quantified to an appreciable extent in woodland caribou. The complex forest access network (logging roads, trails, etc.) also facilitates the movement of potential predators (James and Stuart-Smith 2000; Houle et al. 2010; Lesmerises et al. 2013; Gaudry 2013) and may increase predator–prey encounters (Whittington et al. 2011; see section 4.2.2.)

Logging is the main factor driving development of the road network in relatively isolated forest landscapes. Since 1977, when logging was prohibited in provincial parks, harvesting activities have been restricted to the area around Parc national de la Gaspésie, resulting in a very high density of logging roads outside the park boundaries. These access roads were recently identified as a source of disturbance that elicits

strong avoidance in Gaspésie caribou and has caused functional habitat loss[20] ranging from 33% to 77%, depending on the type of habitat involved (Gaudry 2013). This situation could explain why several previous studies found that a high proportion of caribou sightings (Moisan 1957) or telemetry locations (between 75% and 91%; see Ouellet et al. 1996, Mosnier et al. 2003) were located within the park boundaries, where the road network is less developed.

The presence of major linear infrastructure between the McGerrigle Mountains and Mount Albert (e.g., Route 299) helps limit the potential for genetic exchange between these two populations (St-Laurent et al. 2015a). The connectivity between the subpopulations of Mount Logan and Mount Albert is also limited by a network of secondary roads (Bauduin 2016).

Restoration of migration routes in suitable habitat has proven to be successful in promoting wild reindeer recovery in Norway (Nellemann et al. 2010). Bauduin (2016) also reported that the restoration of secondary roads in protected areas is a conservation approach that can help compensate for the decline in caribou movement associated with climate change. However, the negative effects of the road access network both within and outside the park are likely to persist, given the multiple purposes for which roads are now used (e.g., timber harvesting and transport, recreational activities, fishing and hunting).

4.2.4 Wind farm development

(IUCN threat 3.3: Renewable energy)

Development of wind farms in the Gaspésie caribou range would entail the use of large structures, which must be located at high elevations due to the required wind conditions. This type of development also requires the construction and maintenance of permanent roads that are wide enough to allow the passage of specialized vehicles (see section 4.2.3).

Wind farms often result in wildlife habitat alteration (Kuvlesky et al. 2007). Habitat loss associated with the construction of wind turbines is the main impact on terrestrial wildlife (Kuvlesky et al. 2007). The effects of wind farms on caribou are not yet well understood. However, since the level of disturbance in Parc national de la Gaspésie and the surrounding area is already fairly high, any wind energy development within the Gaspésie caribou range would likely be detrimental. Several wind farms already exist within the population's range, and the construction of new wind farms is planned (COSEWIC 2014).

[20] Functional habitat loss occurs when an animal stops using a habitat in order to avoid a disturbance or an impediment (in this case a linear infrastructure) which restricts access (Polfus et al. 2011).

4.2.5 Recreational activities

(IUCN threats[o]1.3: Tourism & recreation areas, 6.1 Recreational activities and 10.3 Avalanches/landslides)

Recreational activities can lead to habitat loss and degradation, for example when roads or buildings are constructed in suitable caribou habitat and vegetation clearing is carried out in such areas (Gaudry 2013). Caribou avoidance of such infrastructure, similar to avoidance of snowmobile trails, results in functional habitat loss (Polfus et al. 2011), that is, an indirect loss of access to suitable habitat located near a disturbance that elicits avoidance behaviour. The quality of Gaspésie caribou habitat has been adversely affected by various types of infrastructure associated with recreational activities, including paved roads, forest roads and hiking trails (Gaudry 2013). In addition, the many recreational activities that are carried out within the population's range (e.g., snowmobile, snow-tracked vehicle and all-terrain vehicle use, snow sports [e.g., alpine ski touring, telemark, snowboarding, heli-skiing], hiking, snowshoeing, sport hunting and fishing, trapping, boating activities [canoeing, kayaking], camping and cottage/resort use) can have a negative impact on caribou by causing disturbances, injuries or direct mortality, along with habitat loss and degradation.

Woodland caribou are sensitive to human disturbance (Duchesne et al. 2000). Johnson and St-Laurent (2011) developed a hierarchical conceptual framework for the impacts of human developments at different biological scales. According to these authors, disturbance first generates a physiological response that elicits anti-predator strategies including vigilance, avoidance and flight. Renaud (2012) documented increased levels of cortisol, an indicator of chronic stress, in individuals frequently exposed to disturbance. When the physiological effects of stress are excessive, a more marked change may occur in the animal's behaviour, particularly in habitat selection and use, which may cause it to avoid higher quality sites (see Dumont 1993). These changes can lead to energy budget alterations associated with increased dispersal movements and reduced calorie intake, which can affect the individual's physical fitness, reproductive success and survival. If generalized, this decrease in caribou fitness can have serious consequences for population dynamics (St-Laurent et al. 2012).

Motorized activities generally have a greater potential impact than non-motorized activities, given their scope (high noise level and ready access) and their severity (increased risk of disturbance and collision). During the winter, snowmobile use can have a detrimental effect, given the ready access that snowmobiles have to high quality caribou habitats (Paquet 1997; Simpson and Terry 2000). In British Columbia, Seip et al. (2007) linked a caribou herd's abandonment of a mountain range to intensive snowmobile use in the area. A study conducted by Nellemann et al. (2000) around a resort complex in Norway revealed that almost all of the wild reindeer in the area avoided the immediate periphery (0–5 km) of the resorts. Backcountry skiing can also elicit an avoidance response in Gaspésie caribou; the presence of skiers prompts caribou to move to lower elevations, where the risk of predation may be higher (Lesmerises et al. 2018). Additional studies are needed to determine the impact of this type of activity, considering the existence of seemingly contradictory information. For

example, it is reported that a group of at least 10 caribou spent winter 2018 near the summit of the skiable slopes in the Champ de mars sector, one of the most popular backcountry skiing areas in the Réserve faunique des Chic-Chocs (Accès Chic-Chocs 2020).

Disturbance during the calving and rearing period, a critical period in the annual life cycle[21] which is very important for population dynamics (Cameron et al. 1992; St-Laurent et al. 2012), is especially worrisome. Lesmerises et al. (2017) reported that the presence of hikers triggered behavioural responses in all females observed, but these responses differed according to whether a calf was present (positive correlation with trails) or not (avoidance of trails).

Recreational activities can also result in injuries or mortality, for example when a collision occurs or caribou flee. Winter recreational activities can be an indirect cause of injuries or death. For example, backcountry recreational activities cause an increase in avalanche frequency, because the great majority of accidental avalanches are triggered by human activity (e.g., skiers, hikers and snowmobilers; Avalanche Québec 2017). Parts of the Gaspésie caribou range are avalanche risk areas. A few cases of caribou mortality in Parc national de la Gaspésie have been attributed to avalanches (Environment Canada 2007). Not enough information is available at present to adequately evaluate this threat component (Environment Canada 2007).

Finally, a sizeable portion of the Gaspésie caribou range is located in areas that have high moose densities and are subject to intensive wildlife harvesting (e.g., Matane wildlife reserve, Chic-Choc wildlife reserve). Forest management activities carried out to maintain high moose densities appear to be incompatible with the needs of caribou; they can lead to increased predator populations and therefore to a higher risk of predation for caribou (see section 4.2.2). Other types of wildlife enhancements can favour predators as well. For example, feeding of white-tailed deer in the winter maintains this prey species' numbers at an artificially high level, a situation that can maintain or increase coyote numbers (see section 4.2.2), while also encouraging the fidelity of deer and their predators to certain areas near those used by Gaspésie caribou.

4.2.6 Insect outbreaks

(IUCN threat 7.3: Other ecosystem modifications)

The spruce budworm is an insect that eats the foliage of several conifer species, including spruces (*Picea* spp.) and balsam fir, causing defoliation and often tree mortality, particularly in older stands (MFFP 2016a). The spruce budworm has been present in the Gaspésie and Bas-Saint-Laurent since 2012 (MFFP 2016b), and the outbreak places the central Gaspé Peninsula, including Gaspésie caribou habitat, at high risk of severe defoliation. Severe defoliation of overmature coniferous forests used

[21] In Parc national de la Gaspésie, the areas where woodland caribou concentrate during this critical period are located a significant distance from recreational activities.

by Gaspésie caribou could result in significant habitat loss for this population and could increase the area of favourable habitat for predators of caribou and alternate prey and their access to these habitats (see sections 4.2.2 and 4.2.3). Removal of dead trees by the forestry industry following a spruce budworm outbreak can also intensify the effect of this threat on Gaspésie caribou (see sections 4.2.1 and 4.2.3).

4.2.7 Mining and mineral exploration

(IUCN threat 3.2: Mining and quarrying)

Although mineral exploration is prohibited within the boundaries of Parc national de la Gaspésie, mining companies still hold mining rights in the portion of the caribou's range that lies on the periphery of the park (Gaspésie Woodland Caribou Recovery Team 2010). Any prospecting or mining activity in caribou habitat is, at a minimum, likely to cause disturbance of the species as well as destruction or degradation (e.g., pollution or contamination) of parts of its habitat, which is already largely disturbed within the species' range (St-Laurent et al. 2015a).

Given the current state of scientific knowledge, it is not possible to assess the impacts of mining and mineral exploration on the ecology of Gaspésie caribou (M.-H. St-Laurent, pers. comm.). However, the Woodland Caribou, Boreal population, generally avoids areas within 4 km of a mine centre during most of its life cycle, and effects have also been observed as far as 6 km from the centre of a mine during the period from late winter to the calving season (Weir et al. 2007). The proximity of mines was also used as a parameter in the habitat quality model for the Woodland Caribou, Boreal population (Leblond et al. 2014). In addition, mining is supported by a road network which is used to haul ore and transport workers. The road network reduces caribou functional habitat (see section 4.2.3).

4.2.8 Low-impact threats

Rights-of-way (IUCN threat 4.2: Utility and service lines): Various rights-of-way (e.g., power line corridors, telecommunication towers) and the service roads used to reach them are located within the population's range, and new rights-of-way continue to be added. This situation contributes to functional loss of habitat and favours the populations of predators of caribou (discussed previously in the section on the threat of excessive predation). However, given the limited total area of these rights-of-way and the low proportion of the population affected by them, the scope of this threat is considered small.

Commercial and industrial development (IUCN threats 4.2: Utility and service lines; and 9.2: Industrial and military effluents): The forestry, mining and wind industries, commercial activities associated with recreational activities, and the related roads and service roads were discussed individually in earlier sections. However, there are also other types of commercial and industrial development that threaten the Gaspésie caribou population. For example, a proposal to construct a natural water pumping station adjacent to the population's range is currently under review. Like forestry, mining

and wind-power operations, commercial and industrial development is a source of disturbance for caribou populations and causes habitat loss. In addition, many types of commercial and industrial development generate polluting effluent, and its probable effects on the Gaspésie caribou population must be taken into account.

Poaching (IUCN threat 5.1: Hunting and collecting terrestrial animals): The Quebec *Act Respecting Threatened or Vulnerable Species* prohibits hunting of Gaspésie caribou. However, it is possible that individual caribou are occasionally poached. Photos from hunting cameras outside Parc national de la Gaspésie have shown caribou using salt licks intended for moose hunting. Poaching is therefore possible, but while difficult to quantify, does not appear to be widespread. One case of Gaspésie caribou poaching was reported by the Quebec Department of Forests, Wildlife and Parks (MFFP) in the fall of 2018 (Radio-Canada 2018). Prior to that, illegal hunting of caribou had been reported by the public, but the Wildlife Protection Branch of MFFP had never received any official complaints, testimony or sufficient evidence that would enable charges to be laid (M. Lalonde, pers. comm.).

Monitoring, capture and tagging of caribou (IUCN threat 6.3: Work and other activities): To document population trends and calf survival in the Gaspésie caribou population, the Quebec Department of Forests, Wildlife and Parks (MFFP) conducts an annual helicopter survey (see section 6.1) that may disturb the caribou (the effects of this disturbance are described in the section on the threat posed by recreational activities). However, since the survey is localized, is overseen by a recognized and certified animal protection committee, and is carried out just once a year, the impact of this threat on the population is considered low (COSEWIC 2014). In addition, many studies of Woodland Caribou, particularly those focusing on habitat selection and use, survival, physical condition, reproduction, parasitism, and demography, require capture and tagging of individuals. The pursuit and capture of caribou involve direct handling of animals, which could expose them to the risk of minor or sometimes severe injuries and, in extremely rare cases, could lead to euthanasia. Research institutions and governments must follow protocols and methods to reduce these risks as much as possible. To that end, these organizations have their capture and handling protocols reviewed and approved for compliance with the rules of the Canadian Council on Animal Care by recognized, certified animal care committees. A high level of precaution must be maintained to obtain this certification.

4.2.9 Potential threats and threats whose impact is unknown

Transmission of pathogens (IUCN threats 8.1: Invasive non-native/alien species; and 8.2: Problematic native species): Woodland Caribou are affected by a wide range of parasites and diseases.[22] Turgeon et al. (2018) recently identified seven species of

[22] In particular, they may be infested with parasites including the reindeer warblefly (*Oedemagena tarandi*), the giant liver fluke (*Fascioloïdes magna*) and intestinal worms (*Taenia* spp.*, Echinococcus* spp.) and may be susceptible to diseases of wild ungulates (Fréchette 1986).

parasites in the Gaspésie caribou population.[23] Infections by nematodes (*Trichuris* spp. and *Capillaria* spp.) and cestodes (*Moniezia benedeni*) are generally uncommon in North American caribou (Korsholm and Olesen 1993; Kutz et al. 2012), but are highly prevalent in the Gaspésie population (Turgeon et al. 2018). On the other hand, although the meningeal worm (*Parelaphostrongylus tenuis*)[24] is present in white-tailed deer in the Gaspésie (Claveau and Fillion 1984), the risk of transmission to caribou appears to be very low due to the small number of caribou and the fact that there is little overlap between the habitats used (M.-H. St-Laurent, pers. comm.). No cases have been reported in either caribou or moose in Parc national de la Gaspésie (Crête and Desrosiers 1993; Crête et al. 1994). Nevertheless, signs of infection should be monitored to prevent an outbreak in white-tailed deer that could spread to the Gaspésie caribou. As for chronic wasting disease (CWD), there is a risk of transmission from cervids[25] to Gaspésie caribou because the disease can spread geographically through movements of infected live cervids (natural movements of wild cervids or human movement of farmed cervids) and through the transportation of carcasses or parts of carcasses of wild infected cervids, for example by hunters. In Quebec, a first case of CWD was detected in September 2018 at a red deer farm in the Laurentides region (MFFP 2018). The presence of visitors from areas where CWD has been detected in cervids could also pose a risk of transmission, particularly if they were transporting material that had come in contact with contaminated fluid (Pritzkow et al. 2018). Lastly, studies are under way on *Neospora caninum*, a protozoan parasite generally found in domestic dogs and cattle, but also wild ungulates, that can cause abortions in infected animals (Ghalmi et al. 2007), and on *Toxoplasma gondii*, an intracellular parasite that causes toxoplasmosis. The results of the study by Turgeon et al. (2018) suggest that parasitic infections are not a threat to Gaspésie caribou in the short term. The intensity of infections is generally low for this population, and the parasites detected are relatively common and did not affect the adult survival rate (Turgeon et al. 2018).

Fire and fire suppression (IUCN threat 7.1: Fire and fire suppression): Forest fires are a natural disturbance of forest ecosystems used by Woodland Caribou and significantly alter the quantity of lichens available for food. In response to this disturbance, it has been demonstrated that woodland caribou can alter their spatial distribution and habitat use within their home range (Joly et al. 2003; Dalerum et al. 2007). However, given the reduction in the area of occupancy of the Gaspésie caribou population over the decades, individuals likely have fewer alternative habitats into which they can move after a forest fire, when they temporarily avoid certain burned areas. Forest fires therefore pose a potential threat to the species, especially since it takes many years for burned areas to return to suitable caribou habitat. They must first undergo a regeneration phase that may be avoided by caribou (Dalerum et al. 2007). In addition,

[23] These are four nematodes belonging to the genera *Protostrongylidea*, *Nematodirinea*, *Trichuris*, and *Capillaria* and another from an unidentified genus that is part of the Srongylida family; one cestode (*Monezia benededi*) and one protozoan belonging to the genus *Eimeria.*

[24] This worm is a parasite of the nervous system of the white-tailed deer. It has little effect on that host, but it is lethal for moose and caribou (Claveau and Fillion 1984).

[25] CWD is a fatal disease of the central nervous system of cervids; it belongs to the family of transmissible spongiform encephalopathies.

these regenerating environments are more suitable for moose and white-tailed deer, a situation that could increase the predation pressure on caribou (see section 4.2.2).

Gas exploration and development (IUCN threat no. 3.1: Oil and gas drilling): The Gaspésie is one of the five most favourable regions in Quebec for the discovery of hydrocarbon deposits (Ministere de l'Energie et des Ressources naturelles [MERN] 2018a). To date, hydrocarbon development in the Gaspésie region has been concentrated mainly in the Côte-de-Gaspé administrative region, in the eastern part of the Gaspé Peninsula, which appears to attract more interest from oil and gas companies than the rest of the region (Pieridae Energy 2018). No production leases have been granted in or near the Gaspésie caribou range (MERN 2018b). Nonetheless, most of the land in the Gaspésie region, excluding protected areas such as provincial and national parks, is covered by exploration licences for oil, gas and underground reservoirs (MERN 2018b). Although these licences require the holders to carry out exploration activities (geological, geophysical or drilling operations) every year, it appears at present that these activities are being kept to a minimum (Pieridae Energy 2018). Nonetheless, from the work carried out to date, it has been determined that the region located on the periphery (particularly on the south side) of Parc national de la Gaspésie has considerable hydrocarbon potential. Exploration activities are likely to intensify in the future (Pieridae Energy 2018) and the steps required to proceed with the development of natural gas deposits could be taken if the potential is deemed to be great enough. Exploration and development can cause disturbance to caribou and destruction or degradation of its habitat, which is already largely disturbed within the species' range (St-Laurent et al. 2015a). Such activities can lead to functional habitat loss or a reduction in connectivity (Environment Canada 2011a).

Climate change (IUCN threats 11.1: Habitat shifting and alteration; and 11.2: Temperature extremes): Climate change is expected to impact the Gaspésie caribou population, but the exact nature and timing of the impacts are as yet unknown. It is highly likely that the frequency of extreme weather conditions and events, including winter rain and freezing rain, and an increased frequency of freeze–thaw cycles (which makes it more difficult for the caribou to forage for food on the ground in winter) will increase (Vors and Boyce 2009; Aanes et al. 2002). An increase in the frequency of avalanches can also be expected in the coming decades (Desaulniers 2015). Changes to the treeline, vegetation structure and habitats in general are also anticipated (Logan 2012, in Bauduin 2016; Dumais et al. 2014; Périé et al. 2014), but likely over a time horizon of more than 10 years. Despite the uncertainties related to the impact of climate change, it is considered a lesser threat in the short term than the other threats described above. According to Yannic et al. (2014), the Gaspé Peninsula is in an area where climatic conditions suitable for caribou are unstable. According to the models applied by these authors and a scenario projecting significant climate change between 2020 and 2080, many caribou populations would be restricted to high elevations, while populations in more southern areas, like the Gaspésie caribou, are likely to become extirpated.

5. Population and Distribution Objectives

5.1 Long-term Population and Distribution Objective

The long-term population and distribution objective for Gaspésie caribou is to achieve and maintain a self-sustaining[26] population in its current range.[27]

This objective reflects the best achievable scenario that is biologically and technically feasible based on the information available, and it is informed by the scientific principles of conservation. The recovery objective applies to the entire Gaspésie caribou population rather than specific subpopulations, given that the population is sensitive to fragmentation and that connectivity between subpopulations is required to ensure a self-sustaining population.

Since the feasibility of recovery for Gaspésie caribou involves uncertainties associated with the possibility of making sufficient suitable habitat available to the population, the achievement of the population and distribution objectives may not be possible. Gaspésie caribou occur in mature forest ecosystems that have evolved over centuries and take decades to recover from disturbance. Reversing ecological processes detrimental to caribou (e.g., habitat degradation and loss, increases in predator and alternate prey populations) and instituting changes to management frameworks and ongoing land use arrangements will often require timeframes in excess of 50 years. Given this situation, it may take decades for the population to become self-sustaining again. Immediate action must be taken to avoid extirpation so that recovery can be achieved over time.

5.2 Short-term Population and Distribution Objectives

To work toward achieving the long-term objective, the following short-term objectives have been established that are to be met within a period of about 10 years following the publication of the recovery strategy:

1. Maintain the species' current range, and restore habitat conditions that favour population persistence
2. Halt the population decline and increase the number of caribou in the population

[26] "Self-sustaining population" means a Woodland Caribou population that, on average, demonstrates stable or positive population growth (over a period of time equal or shorter than20 years) and is large enough to withstand stochastic events and persist over the long term (≥ 50 years) without the need for ongoing active management intervention (e.g., predator management or transplants from other populations; Environment Canada 2011a). A number of publications cited in Environment Canada (2011a) indicate that over 300 boreal caribou are needed for a population to be considered self-sustaining.

[27] As shown in Figure 2.

The recovery of Gaspésie caribou will be achieved by applying a combination of coordinated habitat conservation and restoration and population management measures to return, over the long term, to a self-sustaining population.

Gaspésie caribou are largely found in alpine and subalpine habitats in and around Parc national de la Gaspésie. Because the species is highly mobile, it is also able to use other habitats located within and on the margin of its range. However, natural and human disturbance of these habitats makes them less suitable for caribou. A study by St-Laurent et al. (2015b; see Appendix B) shows that between 1998 and 2009, the proportion of mature fir stands decreased not only at the scale of the habitat mapped under the Quebec *Act Respecting the Conservation and Development of Wildlife* (LCMVF) (abbreviated here as LH), but also on its periphery or at the regional scale (Bas-Saint-Laurent and Gaspésie). At the same time, the area of clear-cuts and partial cuts less than 20 years old increased at all scales, as did the average density of gravel roads, especially on the periphery of the LH. Caribou are known to avoid these habitats (Ouellet et al. 1996; Mosnier et al. 2003; Gaudry 2013). In addition, greater fragmentation of mature balsam fir stands in and on the periphery of the caribou habitat increases the probability of co-occurrence of caribou and their predators, which benefit from young forests and linear structures such as roads (Mosnier et al. 2008a; Boisjoly et al. 2010; Gaudry 2013). The study by St-Laurent et al. (2015b) shows that the relative quality of caribou habitat deteriorated significantly between 1998 and 2009, especially during the period without snow cover. Snow cover decreased by 31% within the LH, and by 47% when the first 30 km on its periphery are included. Meanwhile, the quality of black bear and coyote habitat increased at certain times of the year (see section 4.2.2). Therefore, to ensure the habitat is more conducive to the persistence of the caribou population, the proportion of available suitable habitat in the range, particularly mature and overmature coniferous forests, must be increased significantly. Because it is unclear whether the existing range is sufficient to enable the population to achieve and maintain self-sustainability, it is possible that habitat conditions suitable to the population's long-term persistence will also need to be restored on the periphery of its range.

Using the recruitment rate observed in the population from 2007 to 2012, Frenette and St-Laurent (2016) predicted a high probability of extirpation for the McGerrigle Mountains group (p=0.82) and for the groups on Mount Albert and Mount Logan (p=0.96) within a 50-year horizon (Appendix C). As mentioned previously, the change in the size of the Gaspésie caribou population over time is closely related to a number of demographic parameters, particularly the annual calf survival rate. An increase in the survival rate, which is highly dependent on the predation rate, which is in turn associated with the forest matrix and the density of other cervids, is a prerequisite for maintaining the Gaspésie caribou population and for achieving the above-mentioned population objective. Current knowledge indicates that the population cannot recover unless the proportion of calves in the population is higher than the adult mortality rate and reaches 17% (about 30 calves per 100 adult females; Environment Canada 2007) by 2035. Between now and 2025, this proportion should reach at least 20.4% (about 36 calves per 100 adult females) in the McGerrigle Mountains and at least 27.2% (about

48 calves per 100 adult females) on Mount Albert and Mount Logan, compensating for the high adult mortality rate and thereby lowering the probability of extirpation within the next 50 years (Frenette 2017). In addition, the annual adult survival rate has been low in recent years, especially in the Mount Albert and McGerrigle Mountains subpopulations (see section 3.2). To lower the probability of population extirpation over the next 50 years, the annual adult mortality rate will have to be less than 11% by 2025 (Lesmerises 2012).

The Gaspésie caribou population trend is in decline and the population is estimated at fewer than 50 individuals (section 3.2). However, the range's carrying capacity is likely greater than the population's current abundance would suggest. This recovery strategy sets a demographic target based on the recent carrying capacity of the range (see Figure 3), namely at least 100 individuals in the short term, in order to mitigate the risk of quasi-extinction,[28] and 200 individuals in the medium term, which is the number that a comparable range supported in the early 1980s. These demographic targets could be adjusted upwards in the future on the basis of new knowledge.

Of the various management scenarios analyzed by Frenette and St-Laurent (2016), that which offers the lowest relative probability of population extinction consists of a decrease in the proportion of 6- to 20-year-old clearcuts to 9% of the study area, combined with a further 25% decrease in the relative regional coyote abundance index. Section 6 details the broad strategies and general approaches for achieving the identified objectives.

6. Broad Strategies and General Approaches to Meet Objectives

6.1 Recovery Actions Completed or Under Way

The Government of Canada, the Government of Quebec, non-governmental organizations and some stakeholder industries have implemented various measures aimed at the recovery of the Gaspésie caribou population and its habitat. The recovery actions completed or under way include the following.

Recovery planning
A recovery plan for the caribou in Parc national de la Gaspésie was published in 1990 (Crête et al. 1990), and a national recovery plan for Gaspésie caribou was produced in 1994 (Crête et al. 1994). A recovery team was formed in 2001, and it prepared a recovery plan for Gaspésie caribou for the period 2002–2012 (Gaspésie Woodland Caribou Recovery Team 2004). In 2007, that recovery plan was adopted by Canada's Minister of the Environment as a recovery strategy under section 44 of SARA

[28] For more information about the risk of quasi-extinction, see Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada. 2011 update (Environment Canada 2011a).

(Environment Canada 2007). A number of the actions mentioned in this section correspond to those implemented as part of that recovery strategy. An update to the recovery plan by the Gaspésie Woodland Caribou Recovery Team was published for the period 2020-2030 (Gaspésie Woodland Caribou Recovery Team 2018), and this recovery strategy is based in large part on that update.

Specific acts, regulations and administrative measures

For descriptions of the species' status rankings at the federal and provincial levels, see section 2.

Since 1993, the Gaspésie caribou's habitat has been partially protected at the provincial level through the LCMVF and the *Regulation respecting wildlife habitats* (CQRL, c. C-61.1, r. 18). The population's habitat is defined by the *Regulation respecting threatened or vulnerable wildlife species and their habitats* (CQRL, c. E-12.01, r 2; see Appendix A). This regulation provides guidance for forest management activities and mining and oil and gas exploration and development in the habitat. It also sets out conditions that must be met in order to carry out certain activities at specific times, in specific areas and using specific techniques. A forest management plan for the Gaspésie caribou's range was prepared for the period 1999–2004 (extended until 2006; Champagne et al. 1999) and for the periods 2007–2013 (Turcotte et al. 2007) and 2013–2018 (Chouinard et al. 2013).

In addition, MFFP has been working on a boreal and mountain caribou strategy titled *Stratégie pour les caribous forestiers et montagnards* in collaboration with key partners since 2019. The final version of the strategy, which is aimed at meeting the needs of boreal and mountain caribou to ensure their long-term survival, without impacting the forestry industry and its workers, is expected to be published by 2022. In the meantime, interim measures for the management of Gaspésie mountain caribou habitat (2019-2023) are in effect. These measures apply to forest management activities and focus on maintaining the most favourable caribou habitats that could play a key role in implementing future management practices.

The critical habitat for the Woodland Caribou, Atlantic-Gaspésie population, was identified in 2007 (Environment Canada 2007).

Parc national de la Gaspésie and other protected areas

Parc national de la Gaspésie was created in 1937, and caribou hunting has been prohibited in the park since 1949. Under the *Parks Act* (CQLR, c. P-9) adopted in 1977, forestry and mining operations are also prohibited in the park. Since 1978, Mount Logan has been included within the park boundaries. Since the 1990s, recreational activities in the park have been managed so as to reduce disturbance of caribou (e.g., trails have been marked and a schedule has been established limiting visitors' access to the mountains used most frequently by caribou). In addition to Parc national de la Gaspésie, there are currently three other protected areas within the range of the Gaspésie caribou, namely the Fernald, Irène-Fournier and Mont-Saint-Pierre ecological reserves (Figure 2).

Population monitoring

Every fall since 1983, an aerial survey of Gaspésie caribou has been conducted to determine the size of the population and the proportion of calves that have survived their first summer. However, monitoring of the population in the Mount Logan sector is considered incomplete because of the denser, closed forest cover, which reduces the rate at which individuals are detected. The development of additional survey methods has been underway in this sector since 2016. Through population monitoring, it is possible to track changes in the entire caribou population and to assess the effectiveness of the population recovery measures implemented. It also offers a quicker way to review the conservation measures to be put in place when the recruitment rate in the population is very low (Gaspésie Woodland Caribou Recovery Team 2011).

Research

Gaspésie caribou have been well studied, with research covering caribou predators, their habitats and their relationships with caribou (Boisjoly 2007; Mosnier 2008; Mosnier et al. 2008a; 2008b; Boisjoly et al. 2010; Pierre and St-Laurent 2012), the viability of the population (Huard 2012 ; Lesmerises 2012; Frenette 2017), the impact of forestry (Stone 2004; Stone et al. 2008; Nadeau Fortin 2015; Nadeau Fortin et al. 2016; Boudreau 2017), the impact of linear infrastructure (Gaudry 2013), disturbance by hikers (Lesmerises et al. 2017) and off-trail skiers (Lesmerises et al. 2018), and parasites and infections of caribou (Turgeon et al. 2018). Considerable research has also been done on caribou movements (Bauduin et al. 2016), their habitat, including functional connectivity (Bauduin 2016), habitat suitability (Leblond et al. 2014), and habitat selection and use (Rivard 1978; Ouellet et al. 1996; Mosnier et al. 2003). A study is currently under way to evaluate the diet of Gaspésie caribou and its predators using isotopic markers, the overlap of the isotopic niches of cervids frequenting Parc national de la Gaspésie, and the physiological condition of the caribou and their level of nutritional stress (M.-H. St-Laurent, pers. comm.).

Predator management

Predator control programs were implemented by the Government of Quebec from 1990 to 1996 and from 2001 to the present (2021, ongoing). They are designed to control black bear and coyote populations (e.g., trapping campaigns, bounty programs to encourage trapping or hunting of coyotes and black bears on the periphery of Parc national de la Gaspésie).

Communication

Since 2002, a number of organizations, including the Fédération des trappeurs gestionnaires du Québec, Conservation Caribou Gaspésie, Centre d’Avalanche de la Haute-Gaspésie, SÉPAQ, and the Gaspésie Woodland Caribou Recovery Team, have raised awareness of the content of the Gaspésie caribou recovery plans among various target audiences. A variety of communication tools have been used, including informational materials and e-newsletters, educational signage, informal evening talks, exhibitions, and public meetings.

6.2 Strategic Direction for Recovery

Table 2. Recovery planning

Threat or limiting factor[a]	Priority[b]	Broad strategy for recovery	General description of the research and management approaches
1, 2, 3, 4, 5, 6, 7, 8, 9	Urgent	Undertake landscape-level planning that considers current and future Gaspésie caribou habitat requirements.	• Develop an action plan focused on population and habitat management activities with measurable targets, taking a collaborative approach to managing the cumulative impacts within the range, in order to achieve the population and distribution objectives. • Undertake coordinated land use and resource planning to ensure that activities are planned and implemented at appropriate spatial and temporal scales (e.g., consider sensitive periods/areas in which the population is the most vulnerable). • Develop a plan for increasing or maintaining suitable habitat within the Gaspésie caribou's range and, where required, for recovering or maintaining habitat connectivity between sub-populations. • Ensure good communication and collaboration among governments, local communities, Micmac communities, non-governmental organizations, industry and other organizations involved in land and resource management and/or conservation within the range of the Gaspésie caribou.
1, 2, 3, 4, 5, 6, 7, 8, 9	Urgent	Increase and maintain the quantity and quality of suitable habitat.	• Within the Gaspésie caribou's range, work to create protected areas that meet the ecological needs of the caribou (e.g., Quebec provincial parks, ecological reserves, habitat of a threatened or vulnerable wildlife species). • Set out boundaries and barriers to forestry activities within the Gaspésie caribou's range through a forest management plan that meets the species' ecological requirements, then conduct compliance monitoring. • Using the appropriate means (e.g., acts and regulations; interim measures; guidelines; best management practices), establish boundaries and barriers to commercial and industrial activities that could destroy or reduce the quality of the habitat, in order to respect the habitat requirements of the caribou. • Reduce the impact of roads and rights-of-way on caribou habitat (e.g., restrict development of new roads and rights-of-way to a minimum; dismantle or restore unused or little-used infrastructure). • Implement appropriate measures to reduce the availability of habitats favourable to predators (black bears, coyotes) and alternate prey (e.g.,

Threat or limiting factor[a]	Priority[b]	Broad strategy for recovery	General description of the research and management approaches
			moose, white-tailed deer) in and on the periphery of the caribou's range. • Monitor outbreaks of insects, particularly spruce budworm, and when necessary implement control programs to reduce losses or degradation of habitat suitable for caribou.
1, 2, 3, 5, 7, 8, 9, 10, 11	Urgent	Increase and stabilize adult survival and calf survival	• Continue to develop and implement measures to reduce and stabilize predator and alternate prey populations (moose, white-tailed deer) in order to reduce the predation pressure on adult caribou and calves (e.g., predator control program, promotion of hunting and trapping, management of alternate prey species). • Study the feasibility of, develop and implement methods of last restort to support and increase the population (e.g., maternal penning). • Continue to monitor compliance with the acts and regulations that apply to Gaspésie caribou (e.g., monitoring by wildlife protection officers).
1, 3, 4, 5, 7, 8, 9, 11	Necessary	Reduce disturbance from human activity	• Continue to impose limits on and monitor recreational activities in Parc national de la Gaspésie. • Impose limits on and monitor recreational activities in the portion of the species' range that lies outside Parc national de la Gaspésie (e.g., apply the recommendations in the report on the impacts of recreational activities in caribou habitat [Gaspésie Woodland Caribou Recovery Team 2014]). • To the extent possible, avoid creating new recreational or resort developments within the caribou's range (e.g., first make maximum use of existing facilities). • Develop, enhance and apply good management practices in order to reduce the disturbance caused by commercial and industrial activities conducted within the range.
Knowledge gaps	Necessary	Monitor the population and its habitat	• Regularly assess the population parameters of Gaspésie caribou (e.g., population size and trends, proportion of calves in the population). • Develop and apply a system for monitoring the cumulative habitat disturbance rate in the species' range. • Periodically assess the viability of the population.

Threat or limiting factor[a]	Priority[b]	Broad strategy for recovery	General description of the research and management approaches
Knowledge gaps, all threats	Necessary	Conduct research	• Identify the factors interfering with recruitment and population growth (in particular, by building knowledge about factors affecting the population, limiting factors and existing or potential threats). • Determine the area of habitat that is unfavourable to predators and the predator density level that needs to be attained to ensure that predation rates on Gaspésie caribou are not excessive. • Specify the proportion and characteristics of disturbed habitat within the distribution range. • Document or develop techniques for reducing and/or mitigating threats and supporting the population, and set priorities based on their probability of success.
All threats	Necessary	Engage in partnerships, communication, outreach and education	• Implement the communication plan created for Gaspésie caribou (Gaspésie Woodland Caribou Recovery Team, unpubl. document) and revise it as needed. • Conduct outreach and education with various target publics regarding the situation of the caribou population and the issues involved in its recovery, and encourage action. • Promote compliance with acts and regulations, policies, and beneficial management practices for ensuring the conservation of Gaspésie caribou and its habitat.

[a] Threats or limiting factors: 1) Logging and wood harvesting; 2) Excessive predation by coyotes and black bears; 3) Wind farm development; 4) Recreational activities; 5) Development of road/transportation network; 6) Insect outbreaks; 7) Mining and mineral exploration; 8) Rights-of-way; 9) Commercial and industrial development; 10) Poaching; 11) Population monitoring and capture and tagging of caribou.

[b] *"Priority" reflects the degree to which the broad strategy contributes directly to the recovery of the species or is an essential precursor to an approach that contributes to the recovery of the species.*

6.3 Narrative to Support the Recovery Planning Table

Recovery of Gaspésie caribou will require commitment, collaboration and cooperation among federal, provincial and territorial jurisdictions, Micmac communities, local communities, industry and other interested parties. It will be important to monitor Gaspésie caribou habitat conditions and population distribution, sizes and trends so that the effectiveness of the overall strategies and management approaches in the range can be evaluated and adjusted as necessary. It will take time for the impact of human developments, natural disturbances and/or population and habitat restoration activities on Gaspésie caribou to become evident. Therefore, the management of the population and its habitat will have to take this time lag into account and will have to provide for short-term management actions to prevent further declines.

Landscape-level planning
The range is the most relevant scale at which to plan for the conservation of Gaspésie caribou and is the scale at which the population and distribution objectives are defined (section 5). Therefore, current and future land and natural resource planning should be undertaken (type, amount and location) at the landscape scale, taking into account natural disturbances within the species' range. That will enable effective management of the cumulative effects of habitat disturbance on the Gaspésie caribou population and management of disturbances over time, in order to ensure that sufficient habitat is available for the population. Range-level planning should also identify management activities that are tailored to the conditions of the population and its range. Lastly, planning for and management of Gaspésie caribou and its range should be coordinated among the various organizations involved in managing the land and/or natural resources or in conservation.

Increasing and maintaining the quantity and quality of suitable habitat
The long-term population and distribution objective cannot be achieved solely by maintaining the current habitat management regime, since it appears that the habitat management practices of the past few decades have created an ecological trap (Battin 2004) for Gaspésie caribou (St-Laurent et al. 2009) and that maintaining the status quo would quickly lead to extirpation of the population (Frenette and St-Laurent 2016; Appendix C). Rather, the Gaspésie caribou's range must be managed so as to ensure the long-term persistence of a self-sustaining population. It is imperative to manage the number, type and distribution of human activities that impact Gaspésie caribou habitat, in order to increase the amount and improve the quality of suitable habitat, while reducing the amount of habitat favourable to predators of caribou and alternate prey. Human and natural disturbance must also be monitored and measured. Disturbance caused by human activity (e.g., forestry operations, roads and rights-of way, wind farms) must be managed so as to take into account the current and future habitat requirements of the Gaspésie caribou. The impact of some threats must be reduced (e.g., by reducing developed areas) or mitigated (e.g., by using different silvicultural treatments; Nadeau Fortin 2015; St-Laurent et al. 2015b). Disturbed areas must be restored (e.g., by closing secondary roads; Nadeau Fortin 2015; Bauduin 2016) in order to achieve the population and distribution objectives. It will be particularly important to

restore functional connectivity between the areas used by the subpopulations, so that the caribou can reach high-quality habitats currently inaccessible to them (Bauduin et al. 2016). It may also be necessary to plan and design additional protected areas with biophysical attributes suitable for Gaspésie caribou (Bauduin 2016).

Increasing and stabilizing adult survival and calf survival

Human-induced habitat alterations have upset the natural balance between Gaspésie caribou and their predators by increasing the availability of habitats favourable to predators and their alternate prey. This has resulted in unnaturally high predation rates within the range (see section 4.2.2), thereby reducing adult and calf survival rates. A management approach that includes control of predators and alternate prey must be adopted in order to halt the decline in the caribou population and to stabilize it. Measures to control predators and, in some cases, alternate prey, may need to be implemented temporarily until habitat can be improved in the Gaspésie caribou's habitat (Frenette and St-Laurent 2016). However, other management tools will also have to be used at the same time to ensure recovery of the Gaspésie caribou, including habitat restoration and management measures. Modelling of the predator–prey–habitat system for the Gaspésie caribou population demonstrated that investing significantly greater effort in harvesting of predators (mainly coyotes), together with habitat restoration, was the most promising scenario for ensuring the long-term persistence of the population (Frenette and St-Laurent 2016; Appendix C). Control of alternate prey (e.g., moose) could be considered, even if that alone will not reverse the trend toward extirpation of the Gaspésie caribou population over a 50-year time horizon (Frenette and St-Laurent 2016). If necessary, simultaneous management of predators and alternate prey should be considered, since in the absence of concurrent predator management, the vulnerability of caribou to predation could increase temporarily due to a reduction in the abundance of alternate prey (Serrouya et al. 2015). Such alternate prey management measures could therefore compromise Gaspésie caribou conservation. Since the size of the caribou population has fallen to a critical level, it is essential to evaluate the feasibility of, develop and implement methods of last resort (e.g., maternal penning and captive rearing) to reduce the risk of extirpation of the population and to achieve the recovery objectives. Lastly, monitoring for compliance with the acts and regulations prohibiting the taking of Gaspésie caribou should be maintained in the field, in order to ensure that poaching does not reduce the likelihood of survival of individual caribou.

Reducing disturbance from human activity

Recreational use of backcountry areas may compromise efforts to conserve the Gaspésie caribou. Such recreational activities (see section 4.2.5) increase opportunities for predators to gain access to caribou habitat and could also displace caribou from some areas of the range. Currently, recreational activities in Parc national de la Gaspésie are subject to oversight, and similar oversight (e.g., type, period) would need to be implemented for activities in the rest of the species' range. In addition, maximum use should be made of existing infrastructure or sites, rather than creating new ones. Beneficial management practices should also be put in place to reduce disturbance caused by other types of human activity, including commercial and industrial operations.

Population and habitat monitoring

It will be important to monitor habitat condition (e.g., cumulative effects of human and natural disturbance) and population size, trends and viability, as well as certain demographic parameters (e.g., proportion of calves in the population). Such monitoring will make it possible to evaluate the effectiveness of the management approaches and adjust them if necessary. It will also provide a way to measure progress toward achieving the population and distribution objectives (see section 8).

Research

Additional knowledge will be required to assess the impact of certain potential threats (e.g., transmission of pathogens, climate change) or to reduce or mitigate existing threats to the Gaspésie caribou. That knowledge will enable a rapid response when needed in order to reduce the risk of extirpation of the population. Specifically with regard to predation, some studies conducted within the Gaspésie caribou range have shown that predation pressure is excessive. This suggests that predator density is too high and that the amount and quality of habitat unfavourable to predators (e.g., black bears and coyotes) and their alternate prey (e.g., moose and white-tailed deer) is insufficient, both within and outside the range. In addition, it is required to specify the proportion and characteristics of disturbed habitat in the distribution range. The proportion of habitat disturbed was estimated by St-Laurent et al. (2015a), but it must be updated according to the methodology developed by Environment Canada (2011a). Furthermore, it would be necessary to characterize disturbances according to whether they are of natural or anthropogenic origin, or whether they are linear or polygonal in nature.

Partnership, communication, outreach and education

To promote the recovery of the Gaspésie caribou, the organizations involved in managing the population and the land and/or resources within its range must work together toward common objectives, contributing in various ways (e.g., knowledge, implementation of beneficial practices, technical or financial assistance). In addition, broad public awareness and targeted outreach regarding the status of the Gaspésie caribou population and issues related to recovery of the population must be undertaken so that recovery of the species becomes a public concern and the groundwork is laid for concrete action. Educating various target audiences (e.g., industry, participants in recreational activities) will generate awareness, interest and motivation, thereby encouraging them to take action to contribute to recovery of the population. Accordingly, it will be necessary to make useful information available to key stakeholders to support the implementation of their activities. Lastly, promoting compliance with the acts, regulations, policies and beneficial management practices will facilitate enforcement.

7. Critical Habitat

7.1 Identification of Critical Habitat for Gaspésie Caribou

Under subsection 2(1) of SARA, the habitat of a terrestrial wildlife species is defined as "the area or type of site where an individual or wildlife species naturally occurs or depends on directly or indirectly in order to carry out its life processes or formerly occurred and has the potential to be reintroduced." Critical habitat is defined as "the habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species."

Critical habitat identification for Gaspésie caribou describes the habitat that is required for the population to become stable and self-sustaining in its current range. To achieve the population and distribution objectives, the quantity and quality of suitable habitat will have to be improved in many areas of the species' range. In this recovery strategy, critical habitat is partially identified, to the extent possible, on the basis of the best information available. More specific boundaries may be mapped and additional critical habitat may be identified in the future as new information becomes available.

Gaspésie caribou critical habitat is identified at the landscape scale, within the species' range, which is located in the Gaspésie–Îles-de-la-Madeleine and Bas-Saint-Laurent administrative regions of Quebec. The key to critical habitat identification—which is crucial to the recovery of Gaspésie caribou—is achieving and maintaining a dynamic suitable habitat supply system[29] within the species' range, including the maintenance and restoration of the biophysical attributes of the species' preferred habitat, which it requires to carry out life processes (e.g., calving grounds, feeding areas), and certain ecological behaviours (e.g., predator avoidance).

Using these criteria and the best information available, Gaspésie caribou critical habitat is identified as follows, based on two overlapping geographical areas (Figure 5):

1. Within the range (i.e., 99% MCP + 10 km):
    - A minimum of 65% undisturbed habitat[30] is achieved and maintained in order to provide overall ecological conditions that will allow for an ongoing

[29] The "dynamic" nature of habitat availability refers to the fact that the habitat used by the Gaspésie caribou is not necessarily spatially static over time. Therefore, individuals need to have access to large areas of relatively undisturbed habitat so that they can modify their use of space in response to various factors, including environmental conditions, predation risk, resources and natural and anthropogenic habitat disturbances.

[30] In the context of critical habitat, "undisturbed habitat" means the area of habitat that is not affected by natural or anthropogenic disturbance defined as follows: any anthropogenic disturbance that can be visually identified from Landsat imagery at a scale of 1:50,000 (e.g., forest cutblocks, roads) including a 500 m buffer around the disturbance (to account for avoidance by caribou and effects on caribou demography; see Environment Canada 2011a), and/or the area of habitat affected by forest fires (≤ 40 years), according to data provided by the Quebec government. Habitat disturbance in the range of

cycle of recruitment, retirement and recolonization of useable habitat and will help reduce the predation risk;

and

2. Within the core range (i.e., 98% kernel density estimation of range):
   - All areas corresponding to the biophysical attributes of the preferred habitat of Gaspésie caribou.

Sections 7.1.1 (Geographic location) and 7.1.2 (Habitat suitability) below describe the identification of critical habitat in greater detail.

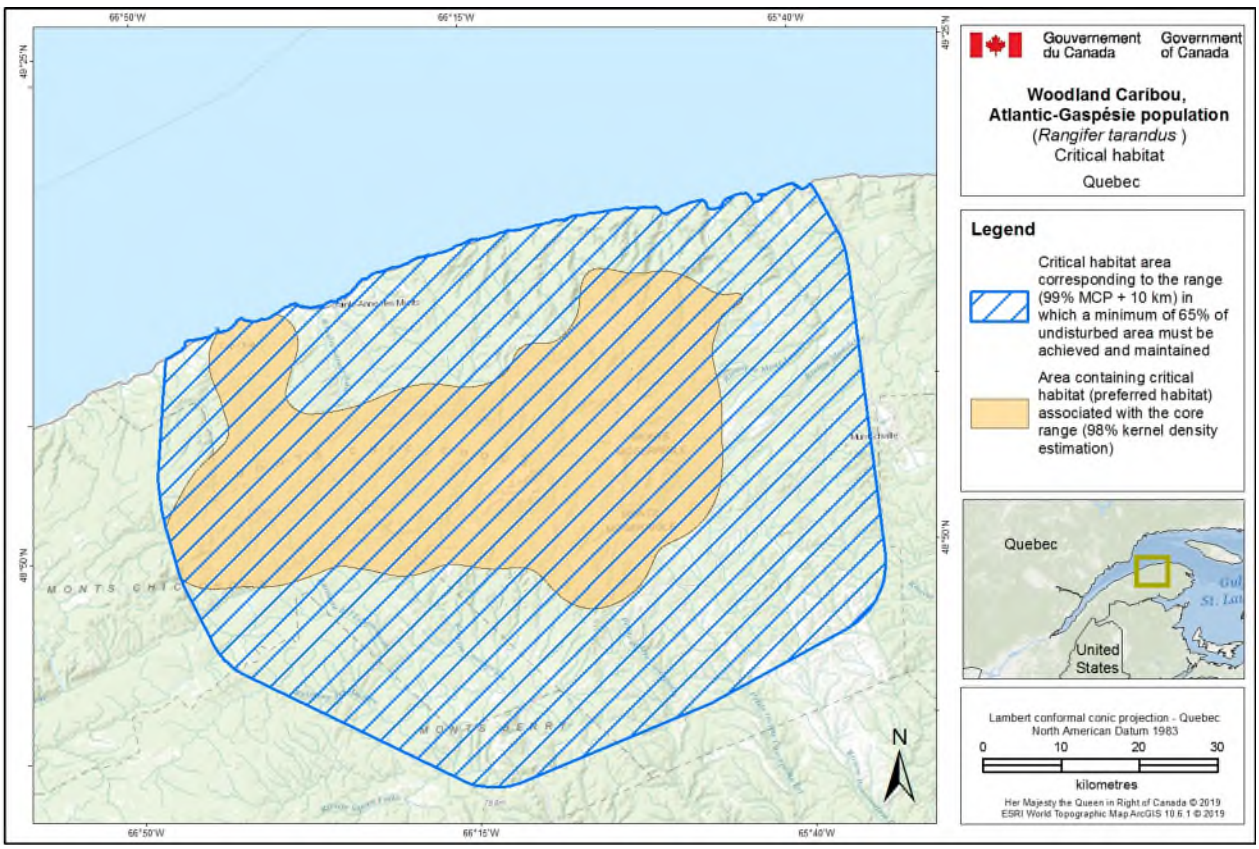


Figure 5. Location of the geographic areas within which critical habitat for Gaspésie caribou is found.

---

the Gaspésie caribou, including that caused by logging, has resulted in an overrepresentation of young hardwood stands (see section 4.2), which has led to an increase in moose populations, which prefer this type of habitat. Higher numbers of moose are causing an increase in predator abundance (see section 3.3.2). This phenomenon is more pronounced in valleys, where habitat is more productive. In addition, disturbance from linear infrastructure (e.g., roads, paths, recreational vehicle trails) can increase the effectiveness of predators in search of food and can facilitate their access to habitats used by caribou.

7.1.1 Geographic location

The geographic location is the area in which critical habitat is found. For Gaspésie caribou, the relevant spatial scale for the identification of critical habitat is the population range. This approach is supported by the best information currently available, namely the conclusions of the Scientific Review for the Identification of Critical Habitat for the Woodland Caribou, Boreal Population (Environment 2008), namely that the range of a local population is the most relevant spatial scale for the identification of critical habitat. In general, the range is the geographic area in which a species can be found. For the Gaspésie caribou, the range includes the elevational and horizontal movements undertaken by individuals between the different areas used during their annual life cycle in response to various factors, including predation risk, food availability and environmental conditions (e.g., snow depth and other snow cover characteristics). A variety of methodologies can be used to define the geographic area. Using the best information currently available (St-Laurent et al. 2015a;b; Lesmerises and St-Laurent 2018), two complementary delineation methods were employed to identify critical habitat for the Gaspésie caribou (see Figure 5):

1. A minimum convex polygon (MCP) encompassing 99% of the location data for individuals (with outliers removed), plus a 10-km-wide buffer area around the perimeter to include habitats that have an important influence on population demographics. The geographic area delineated by this method corresponds to the definition of Gaspésie caribou range that is used in this document (see section 3.2). This delineation method, which defines an area[31] of 5,376 km^2, is the one that best explains differences in recruitment, survival and population growth rate (Lesmerises and St-Laurent 2018). This range includes areas that are currently not occupied by Gaspésie caribou. It is nonetheless consistent with Woodland Caribou ecology and with the long-term population and distribution objective. According to Mosnier et al. (2003), areas that have been used by Gaspésie caribou in the recent past or that have a high potential for use are just as important as areas currently being used because they could be used in the future. For example, in the 1980s caribou temporarily withdrew from the Mount Logan area, which is located mainly outside of Parc national de la Gaspésie, but beginning in 1997 that area was recolonized, probably by caribou from the Mount Albert area (Fournier and Faubert 2001; Mosnier et al. 2003).

2. The kernel density estimate, encompassing 98% of the location data of individuals. This method, which defines an area[32] of 1,996 km^2, corresponds to the core range of the Gaspésie caribou as it identifies the habitats most heavily used by individuals during their life cycle for the period considered (1977–2016). The kernel density estimation method provides a finer scale representation of the area that is actually used by individuals than MCPs (Worton et al. 1987; Börger

[31] The area was calculated using zone 6 of the modified Universal Transverse Mercator (UTM 6) projection, in the North American Datum of 1983 (NAD 83).
[32] Idem.

et al. 2006). Since this delineation is influenced largely by data from the telemetry study conducted between 2013 and 2016 (Lesmerises and St-Laurent 2018), the resulting area is considered the area currently used by the species. In this sense, this geographic area supports the short-term population and distribution objectives. However, the area delineated by this method is likely to change over time as a function of the dynamics of habitat use and abandonment by the caribou in relation to habitat availability.

7.1.2 Habitat suitability

Habitat suitability refers to areas possessing a specific set of biophysical attributes that support individuals of the species in carrying out essential life cycle activities and dispersal. Habitat suitability for the Gaspésie caribou is described here in relation to habitat disturbance rates within the range and in relation to the biophysical attributes of the species' preferred habitat within the core range.

Range (99% MCP + 10 km)
In this area (see Figure 5), habitat suitability is defined on the basis of the Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada – 2011 Update (Environment Canada 2011a). The assessment found that the variation in recruitment to local populations, and ultimately their likelihood of self-sustainability, is largely explained (nearly 70%) by habitat disturbance, particularly anthropogenic disturbance. Based on these findings, the recovery strategy for the Woodland Caribou, Boreal population (Environment Canada 2012) identifies a minimum of 65% undisturbed habitat in a range as the disturbance management threshold, which provides a measurable probability (60%) for a local population to be self-sustaining. This threshold is considered a minimum threshold, because at 65% undisturbed habitat there remains a significant risk (40%) that local populations will not be self-sustaining, owing to the uncertainty associated with stochastic events and their effects. Not enough information is currently available to adequately identify a relationship of this type that is specific to the Gaspésie caribou population (Lesmerises and St-Laurent 2018). Given the common characteristics shared by boreal caribou and Gaspésie caribou (similar needs, same apparent competition context), until the information needed to establish this relationship can be obtained (see section 7.3), this recovery strategy will use the threshold established for the Woodland Caribou, Boreal population (Environment Canada 2012).

The precise location of the 65% undisturbed habitat will vary over time and should exist in an appropriate spatial configuration including large areas of contiguous undisturbed habitat such that the caribou can move throughout their range and access the habitat they need. According to the best information available (F. Lesmerises and M.-H. St-Laurent, unpublished analyses, based on a method comparable to that used by Environment Canada [2011a]), the proportion of undisturbed habitat is currently about 19% (at the range scale) or 32% (at the core range scale). The precise proportions of undisturbed habitat, along with the respective contribution of natural and anthropogenic disturbances, will have to be assessed (see section 7.3).

Since the proportion of undisturbed habitat is currently below the 65% threshold, the critical habitat corresponds initially to the existing habitat which, over time, will contribute to the attainment of the established threshold of 65%. It should be noted that, although certain landscape elements are considered disturbed and do not currently constitute suitable habitat (e.g., young coniferous forests), maintaining these elements is important because, as the stands mature, it will enable the attainment of a larger area of undisturbed habitat. Maintaining undisturbed habitats at higher elevations (≥ 700 m) is also of vital importance, because these habitats are the primary refuges used by Gaspésie caribou throughout their life cycle to avoid predators (a central element of its predator avoidance strategy). Habitat disturbance in these high elevation areas should be limited to the maximum extent possible because any increase in the predation rate in these refuges could compromise the achievement of the recovery objectives.

Core range (98% kernel density estimation)

In the core range (see Figure 5), habitat suitability refers to the biophysical attributes of preferred habitat for the Gaspésie caribou. These attributes were summarized on the basis of data from habitat selection analyses and available scientific reports and articles. All the preferred habitat in the core range is identified as critical habitat. Table 3 describes the biophysical attributes of the preferred habitat of Gaspésie caribou. As described in section 3.3.1, Gaspésie caribou use mature coniferous forests (≥ 70 years), including fir and spruce stands, and alpine tundra to meet their life history requirements and enable movement between the groups that make up the population. The precise location of the biophysical attributes described will vary over time due to the dynamic nature of the ecosystems. In addition, areas with certain biophysical attributes do not need to be immediately adjacent to one another, as long as the habitats remain connected in such a way that individuals can move between them to carry out their life processes and respond to disturbances.

Table 3. Biophysical attributes of preferred habitat of Gaspésie caribou

Type of habitat	Biophysical attributes	Vital functions (details)[33]
Alpine tundra	Alpine tundra occupies the zone extending beyond the treeline in alpine regions. It is dominated by grasses and ericaceous plants, lichens and mosses, as well as rocks and other bare substrates. The habitat also includes dense patches of stunted balsam fir and white spruce (*Picea glauca*) in shrub form (*krummholz*), which become more and more disconnected as elevation increases.	• Safety (very low risk of predation) • Access to food (vegetation; minerals to lick) • Shelter from insects (windy and/or snowy areas) • Calving (bare rock or shrub barrens; stunted trees) • Rut • Movement
Mature fir stand (≥ 60* years)	Mature forest (≥ 60* years) dominated by balsam fir. The main companion species are yellow birch (*Betula alleghaniensis*) or paper birch (*Betula papyrifera*) and white spruce. Several secondary species may be found there, including eastern white cedar (*Thuja occidentalis*) and balsam poplar (*Populus balsamifera*).	• Safety (low risk of predation) • Access to food (abundant arboreal lichens, arboreal lichens growing on fallen trees, lichens that have fallen to the ground, shrubs and non-grass herbaceous plants) • Calving (at higher elevations, in alpine and subalpine zones) • Movement
Mature spruce stand (≥ 60* years)	Mature forest (≥ 60* years) dominated by white spruce or black spruce (*Picea mariana*). In both cases, balsam fir is the main companion species, and the forest floor is dominated by various sedges (*Carex* spp.), ferns, mosses and sphagnum.	• Safety (low risk of predation) • Access to food (abundant arboreal lichens, arboreal lichens growing on fallen trees, lichens that have fallen to the ground, shrubs and non-grass herbaceous plants) • Calving (at higher elevations, in alpine and subalpine zones) • Movement

* Fir and spruce stands are considered mature at the age of ≥ 70 years. However, in the description of biophysical attributes, an age of > 60 years is used in order to ensure consistency with the Norme de stratification écoforestière (MFFP 2015), in which the 70-year age class includes 61–80-year-old stands.

[33] See section 3.3 for more details on the vital functions identified.

7.2 Schedule of Studies Required for the Identification of Critical Habitat

This critical habitat identification is considered partial because of the limited understanding of:

- the contribution of some areas outside the range that could be required to attain the long-term population objective;
- the habitat disturbance threshold specific to Gaspésie caribou that must not be exceeded in the range if a self-sustaining population is to be achieved.

A schedule of studies is required under SARA where the available information is inadequate to identify all critical habitat. Table 4 outlines the studies required to complete the identification of critical habitat to meet the population and distribution objectives for the Gaspésie caribou.

Table 4. Schedule of studies required to complete the identification of critical habitat for Gaspésie caribou

Description of activity	Rationale	Timeline
Determine the extent to which areas outside the currently defined range (Figures 2 and 5) may contribute to achieving the long-term population objective.	It is important to determine whether the area of the range defined in this recovery strategy is sufficient to achieve and maintain a self-sustaining population. Some areas located outside of the current range (e.g., the ≥ 700 m elevation zone west of the range, in the Matane wildlife reserve) have strong potential for use by the Gaspésie caribou, even though no caribou location data have been reported from there recently (Bauduin et al. 2016). Such areas must be assessed to determine whether they can help support a self-sustaining Gaspésie caribou population.	2027
Determine the disturbance threshold that must not be exceeded in the range to ensure a self-sustaining population is achieved.	Natural disturbances have always occurred in landscapes occupied by caribou without compromising the persistence of the populations. Woodland Caribou populations can therefore tolerate a certain level of disturbance in their habitat. However, elsewhere in Canada it has been shown that the decline and the extirpation of some local populations is linked to an increase in human disturbance. Based on the current size of the Gaspésie caribou population and associated trends, we do not know the level of habitat disturbance that can be tolerated in the range without compromising the achievement of the long-term population objective. For the time being, the target established for boreal caribou (i.e., maximum disturbance of 35%; Environment Canada 2012) has been adopted for the Gaspésie caribou; however, a disturbance management threshold will have to be developed specifically for this population based on local conditions. The timeframe for this study is very long, because the available disturbance data date back only to 1986, when the disturbance rate was already more than 60% and the population was already declining (Lesmerises and St-Laurent 2018). To calculate a disturbance threshold that would make it possible to ensure a self-sustaining population, it will be necessary to wait until the disturbance rate in the range of the Gaspésie caribou has decreased significantly, in order to obtain a robust relationship between population demographics and habitat disturbance.	2072

7.3 Activities Likely to Result in Destruction of Critical Habitat

An understanding of what constitutes destruction of critical habitat is necessary for the protection and management of critical habitat. SARA requires that a recovery strategy identify examples of activities likely to destroy critical habitat. Destruction of critical habitat is determined on a case-by-case basis and would result if part of the critical habitat was degraded, either permanently or temporarily, to the point that it would not serve its function when needed by Gaspésie caribou. Destruction may result from a single activity at one point in time or from the cumulative effects of one or more activities over time (Government of Canada 2009). Table 5 gives examples of activities likely to cause destruction of critical habitat for the species; however, destructive activities are not necessarily limited to those listed.

The likelihood that critical habitat will be destroyed by an activity or combination of activities may vary according to several parameters, and can be decreased through the implementation of appropriate techniques to reduce or mitigate adverse effects (see Appendix D). In general, the likelihood that critical habitat will be destroyed is increased when an activity, or a combination of activities, were to occur in such a manner, place and time that any one of the following situations were to occur:

1. the ability of a range to be restored to 65% undisturbed habitat is compromised;
2. connectivity within the range is reduced;
3. predator and/or alternate prey access to undisturbed areas, in particular preferred habitat areas, is increased; or
4. biophysical attributes necessary for Gaspésie caribou are removed or altered.

A single project or activity may or may not result in the destruction of critical habitat; however, when considered in the context of all current and future development activities within the population's range, the cumulative effects[34] may result in the destruction of critical habitat. Mitigation of adverse effects from individual projects and activities will require a coordinated approach and management of cumulative effects within the population. A cumulative effects assessment is essential to position the proposed project or activity in the context of all current and future development activities. The cumulative effects assessment will:

1. assess the impact of all disturbances (anthropogenic and natural) at the population level;

[34] The additive and cumulative effects of activities likely to cause destruction of critical habitat refer to the synergistic, interactive or unpredictable outcomes of multiple anthropogenic land-use or development practices that aggregate over time and space and that have significant impacts on wildlife (Krausman 2011). These cumulative effects can therefore be defined as the aggregate stresses from past, present or future human activities on a key component of the ecosystem (Gunn et al. 2011). In the current context, where population numbers are low, even activities that, on their own, have only limited impact may, when combined, have a more significant impact (Johnson 2011) and could thereby compromise recovery.

2. monitor habitat conditions, including the amount of current disturbed and undisturbed habitat, and the amount of habitat being restored;
3. account for planned disturbances; and
4. assess the distribution of disturbance to determine the risk of reduction in habitat quantity, or of a loss of connectivity in certain parts of the range.

Table 5. Examples of activities likely to result in destruction of critical habitat

Description of activity	Description of effect	Details of effect
Forestry operations	Forestry operations are likely to result in direct loss, functional loss, or degradation of preferred habitat, namely destruction of critical habitat in the core range. This activity may also cause destruction of critical habitat and lead to an increase in the proportion of disturbed habitat within the range, for as long as the target of a minimum of 65% undisturbed habitat will not be achieved and maintained.	Related to threat 5.3 in the IUCN unified threat classification system (see section 4 of this document). Within the core range of the Gaspésie caribou, forestry activity may destroy critical habitat for a period of at least 70 years if carried out within preferred habitat (e.g., cuts in mature fir or spruce stands). If carried out near preferred habitat, it may also lead to degradation of habitat (e.g., windthrow caused by logging close to mature fir or spruce stands), or to functional loss of habitat if it causes the caribou to avoid the preferred habitat (e.g., if mature fir or spruce stands or alpine tundra are surrounded by logged areas, the caribou may stop using that habitat to avoid the cutovers). Within the Gaspésie caribou's range, forestry activity may also lead to the destruction of critical habitat for a minimum period of about 50 years (Environment Canada 2011a) if it increases the proportion of disturbed habitat, unless a minimum of 65% undisturbed habitat is achieved and maintained. Forestry activities may also lead to higher densities of predators of Gaspésie caribou (e.g., by creating more favourable conditions for other ungulates). Forestry activities carried out in close proximity to the periphery of the range (within 500 m) could also contribute to the destruction of critical habitat, since Gaspésie caribou will avoid disturbed areas and that avoidance will lead to functional loss of habitat. (See the definition of "undisturbed habitat" in section 7 of this document.). A single occurrence, at any time of the year, could result in destruction of critical habitat.

Description of activity	Description of effect	Details of effect
Development (e.g., commercial or industrial; mining; wind farms; tourism)	Development activities are likely to result in direct loss, functional loss, or degradation of preferred habitat, namely destruction of critical habitat in the core range. These activities may also cause destruction of critical habitat and lead to an increase in the proportion of disturbed habitat within the range, for as long as the target of a minimum of 65% undisturbed habitat will not be achieved and maintained.	Related to threats 1.2, 1.3, 3.2 and 3.3 in the IUCN unified threat classification system (see section 4 of this document). In the Gaspésie caribou's core range, development activities may cause permanent or temporary destruction of critical habitat if they occur in preferred habitat (e.g., direct loss of mature fir or spruce stands or alpine tundra). If these activities are carried out near preferred habitat, they may also lead to degradation of habitat (e.g., windthrow caused by forest clearing prior to development close to mature fir or spruce stands), or to functional loss of habitat if they cause the caribou to avoid areas of preferred habitat (e.g., development activities causing caribou avoidance of mature fir or spruce stands or alpine tundra). Within the Gaspésie caribou's range, development activities may also lead to permanent or temporary destruction of critical habitat if they increase the proportion of disturbed habitat, unless a minimum of 65% undisturbed habitat is achieved and maintained. Development activities carried out in close proximity to the periphery of the range (within 500 m) could also contribute to destruction of critical habitat, since Gaspésie caribou will avoid disturbed habitat. This avoidance will lead to functional loss of the habitat. (See the definition of "undisturbed habitat" in section 7 of this document.) A single occurrence, at any time of the year, could cause destruction of critical habitat.

Description of activity	Description of effect	Details of effect
Construction of linear infrastructure (e.g., highways, roads [including forest roads], recreational vehicle trails, utility lines)	Construction of linear infrastructure is likely to result in direct loss, functional loss, or degradation of preferred habitat, namely destruction of critical habitat in the core range. This activity may also cause destruction of critical habitat and lead to an increase in the proportion of disturbed habitat within the range, for as long as the target of a minimum of 65% undisturbed habitat will not be achieved and maintained. Linear infrastructure is also likely to increase habitat fragmentation and thereby cause loss of connectivity for the population. .	Related to threats 4.1 and 4.2 in the IUCN unified threat classification system, but also to other threats associated with the construction of linear infrastructure (e.g., IUCN threats 1.2 and 1.3; see section 4 of this document). Within the Gaspésie caribou's core range, construction of linear infrastructure may lead to permanent or temporary destruction of critical habitat if it occurs within preferred habitat (e.g., removal of mature fir or spruce stands). If this activity is carried out in close proximity to the preferred habitat, it may also lead to degradation (e.g., windthrow caused by removal of vegetation near mature fir or spruce stands; changes in roadside forest composition from coniferous to deciduous species, or functional loss of habitat, if it causes the caribou to avoid areas of preferred habitat (e.g., areas fragmented by logging roads). Within the Gaspésie caribou's range, construction of linear infrastructure may also lead to permanent or temporary destruction of critical habitat if it increases the proportion of disturbed habitat, unless a minimum of 65% undisturbed habitat is achieved and maintained. Construction of linear infrastructure in close proximity to the periphery of the range (within 500 m) could also contribute to destruction of critical habitat, since Gaspésie caribou will avoid disturbed habitat. This avoidance will lead to functional loss of habitat. (See the definition of "undisturbed habitat" in section 7 of this document.) A single occurrence, at any time of the year, could cause destruction of critical habitat.

8. Measuring Progress

The performance indicators presented below provide a way to define and measure progress toward achieving the population and distribution objectives.

The long-term performance indicators for Gaspésie caribou recovery are as follows:

1. The current size of the range is maintained or increased if deemed necessary.
2. A self-sustaining population of caribou occupies this range.

Habitat and population monitoring will play a key role in assessing the effectiveness of recovery actions and making any necessary adjustments over the next 50 years.

The short and medium terms performance indicators are as follows:

- Halt the population decline and increase the number of caribou in the population.
- The number of caribou is high enough that stochastic events will not compromise the population's long-term persistence (e.g., ≥ 50 years or more than three generations), or progress is being made toward reaching that number. In the medium term, the population size is greater than 200 individuals. Until more is known about the population size required, the threshold to be used is 100 individuals in the short term, as for other Woodland Caribou populations in Canada (e.g., boreal caribou, southern mountain caribou).
- Within the range (i.e., 99% MCP + 10 km; see Figure 5), the proportion of undisturbed habitat is stable or increasing.
- In the core range (i.e., 98% kernel density estimation; see Figure 5), the amount of preferred habitat is stable or increasing (particularly mature fir and spruce stands).

9. Statement on Action Plans

One or more action plans detailing the measures to be taken to implement the recovery strategy for Gaspésie caribou will be posted on the Species at Risk Public Registry within five years after the final posting of this amended recovery strategy.

10. References

Aanes, R., B.-E. Saether, F.M. Smith, E.J. Cooper, P.A. Wookey and N.A. Oritsland. 2002. The Arctic Oscillation predicts effects of climate change in two trophic levels in a high-arctic ecosystem. Ecology Letters 5:445-453.

Accès Chic-Chocs – Coopérative de Solidarité de Développement Récréo-touristique. 2020. Commentaires sur la proposition de programme de rétablissement modifié du caribou de la Gaspésie soumis lors de la consultation publique. Murdochville, Québec, 6 pp.

Apps, C.D. and B.N. McLellan. 2006. Factors influencing the dispersion and fragmentation of endangered mountain caribou populations. Biological Conservation 130:84-97.

Apps, C.D., B.N. McLellan, T.A. Kinley and J.P. Flaa. 2001. Scale-dependent habitat selection by mountain caribou, Columbia Mountains, British Columbia. Journal of Wildlife Management 65(1):65-77.

Avalanche Québec. 2017. Informations sur les avalanches. Web site: http:// https://avalanchequebec.ca/ [accessed August 2017].

Badiou, P., S. Boutin, M. Carlson, M. Darveau, P. Drapeau, J. Jacobs, C. Johnson, J. Kerr, M. Manseau, P. McLoughlin et al. 2011. Keeping woodland caribou in the boreal forest: Big challenge, immense opportunity. International Boreal Conservation Science Panel. 12 pp.

Banfield, A.W.F. 1961. A revision of the reindeer and caribou, genus Rangifer. Bulletin of the National Museum of Canada. Biology Service No. 66.

Barboza, P.S. and K.L. Parker. 2008. Allocating protein to reproduction in Arctic reindeer and caribou. Physiological and Biochemical Zoology 81:835-855.

Bastille-Rousseau, G., D. Fortin, C. Dussault, R. Courtois and J.-P. Ouellet. 2011. Foraging strategies by omnivores: are black bears actively searching for ungulate neonates or are they simply opportunistic predators? Ecography 34:588-596.

Battin, J. 2004. When good animals love bad habitats: ecological traps and the conservation of animal populations. Conservation Biology 18:1482-1491.

Bauduin, S. 2016. Integrating functional connectivity and climate change in the design of protected area networks. PhD thesis, Université Laval, Québec, Quebec, Canada. 123 pp.

Bauduin, S., E. McIntire, M.-H. St-Laurent and S. Cumming. 2016. Overcoming challenges of sparse telemetry data to estimate caribou movement. Ecological Modelling 335:24-34.

Bergerud, A.T. 1971. The population dynamics of Newfoundland caribou. Wildlife Monographs 25:3-55.

Bergerud, A.T. 1973. Movement and rutting behavior of caribou (*Rangifer tarandus*) at Mount Albert, Quebec. Canadian Field-Naturalist 87:357-369.

Bergerud, A.T. 2000. Caribou. *In* S. Demarais and P.R. Krausman (eds.). Ecology and Management of Large Mammals in North America. Prentice Hall, Upper Saddle River, New Jersey. p. 658-693.

Bergerud, A.T. and W.B. Ballard. 1988. Wolf predation on caribou: the Nelchina herd case history, a different interpretation. Journal of Wildlife Management 52:344-357.

Bergerud, A.T., H.E. Butler and D.R. Miller. 1985. Antipredator tactics of calving caribou: dispersion in mountains. Canadian Journal of Zoology 63:1324-1329.

Bijlsma, R. and V. Loeschcke. 2012. Genetic erosion impedes adaptive responses to stressful environments. Evolutionary Applications 5(2):117-129.

Boileau, F. 1993. Utilisation de l'habitat par l'ours noir *(Ursus americanus)* dans le parc de conservation de la Gaspésie. Master's thesis, Université Laval, Québec, Quebec, Canada. 55 pp.

Boisjoly, D. 2007. Sélection de l'habitat par le coyote, *Canis latrans*, dans le contexte de la conservation du caribou de la Gaspésie. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 60 pp.

Boisjoly, D., Ouellet, J.-P. and R. Courtois. 2010. Coyote habitat selection and management implications for the Gaspésie caribou. Journal of Wildlife Management 74:3-11.

Börger, L., N. Franconi, G. De Michele, A. Gantz, F. Meschi, A. Manica, S. Lovari and T. Coulson. 2006. Effects of sampling regime on the mean and variance of home range size estimates. Journal of Animal Ecology 75:1493-1405.

Boucher, Y., D. Arseneault, L. Sirois and L. Blais. 2009. Logging pattern and landscape change over the last century at the boreal and deciduous forest transition in Eastern Canada. Landscape Ecology 24(2):171-184.

Boudreau, M. 2017. Impacts de 25 ans d'aménagement forestier intensif sur l'habitat du caribou de la Gaspésie et de ses prédateurs. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 96 pp.

Brassard, J.-M. 1967. Inventaire de l'habitat hivernal et dénombrement des caribous des massifs du mont Albert et du mont Jacques-Cartier de la Gaspésie (févr. 1966-1967). Ministère du Tourisme, de la Chasse et de la Pêche, Québec, Quebec. 17 pp.

Cameron, R.D., D.J. Reed, J.R. Dau and W.T. Smith. 1992. Redistribution of calving caribou in response to oil-field development on the Arctic slope of Alaska. Arctic 45:338-342.

Champagne, S., H. Falardeau, J.-M. Hardy, N. Fournier, J. Lamoureux and G. Landry. 1999. Plan d'aménagement de l'aire du caribou de la Gaspésie. Ministère des Ressources naturelles et Société de la faune et des parcs du Québec, région de la Gaspésie–Îles-de-la-Madeleine, Quebec. 20 pp.

Chouinard, D., M. Lalonde, J. Lamoureux, F. Leblanc, L. Gagné and E. Mauri. 2013. Plan d'aménagement forestier de l'aire de fréquentation du caribou de la Gaspésie, 3e édition. Ministère des Ressources naturelles, Direction générale de la Gaspésie–Îles-de-la-Madeleine, Direction générale du Bas-Saint-Laurent et Consortium en foresterie Gaspésie–Les-Îles. 25 pp. + appendices.

Christopherson, V., J.-P. Tremblay, J. Bégin and M.-H. St-Laurent. Meeting caribou in the alpine: do moose compete with caribou for food? [in prep].

Claveau, R. and J.-P. Fillion. 1984. Fréquence et distribution du ver des méninges (*Parelaphostrongylus tenuis*) chez le cerf de Virginie de l'Est du Québec. Le Naturaliste canadien 111:203-206.

Comité de rétablissement du caribou de la Gaspésie. 2004. Plan de rétablissement du caribou de la Gaspésie (2002-2012) (*Rangifer tarandus caribou*). Société de la faune et des parcs du Québec. 71 pp.

COSEWIC. 2002. COSEWIC Assessment and Update Status Report on the Woodland Caribou (*Rangifer tarandus caribou*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xi + 98 pp.

COSEWIC. 2006. COSEWIC Assessment and Status Report on the Green-scaled Willow (*Salix chlorolepsis*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 22 pp.

COSEWIC. 2011. Designatable Units for Caribou (*Rangifer tarandus*) in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. 88 pp.

COSEWIC. 2014. COSEWIC Assessment and Status Report on the Caribou *Rangifer tarandus*, Newfoundland population, Atlantic-Gaspésie population and Boreal population, in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. xxiii + 128 pp.

Courtois, R., L. Bernatchez, J.-P. Ouellet and L. Breton. 2003. Significance of caribou (*Rangifer tarandus*) ecotypes from a molecular genetics viewpoint. Conservation Genetics 4:393-404.

Crête, M. and A. Desrosiers. 1993. L'invasion du coyote (*Canis latrans*) menace la survie de la population relique de caribous (*Rangifer tarandus*) du parc de conservation de la Gaspésie. Ministère du Loisir, de la Chasse et de la Pêche, Direction de la faune et des habitats. 33 pp.

Crête, M. and A. Desrosiers. 1995. Range expansion of coyotes, *Canis latrans*, threatens a remnant herd of caribou, *Rangifer tarandus*, in southeastern Quebec. Canadian-Field Naturalist 109(2):227-235.

Crête, M., C. Banville, F. Duchesneau, J. Ferron, J. Lévesque and H. Ross. 1990. Plan de rétablissement de la population de caribous du parc de conservation de la Gaspésie. Ministère du Loisir, de la Chasse et de la Pêche. 20 pp.

Crête, M., C. Barette, F. Boulanger, J. Ferron, N. Fournier, M. Huot, J. Lamoureux, J. Lévesque and H. Ross. 1994. National Recovery Plan for the Gaspésie Caribou. Report No. 9. Ottawa: Recovery of Nationally Endangered Wildlife Committee. 18 pp.

Dalerum, F., S. Boutin and J.S. Dunford. 2007. Wildfire effects on home range size and fidelity of boreal caribou in Alberta, Canada. Canadian Journal of Zoology 85:26-32.

Dau, J.R. and R.D. Cameron. 1986. Effects of a road system on caribou distribution during calving. Rangifer (Special Issue) 1:95-101.

De Bellefeuille, S. 2001. Le caribou forestier et la sylviculture: revue de littérature et synthèse de la recherche et de l'aménagement en cours au Québec. Ministère des Ressources naturelles du Québec. Quebec. 86 pp.

Delvin, E. and G. Pham. 1990. Vocabulary of genetic engineering. Medical Research Council of Canada and Secretary of State of Canada. Ottawa, Canada. 328 pp.

Desaulniers, F. 2015. Les régimes avalancheux des Chic-Chocs, Québec, Gaspésie, dans un contexte de changements climatiques. Master’s Essay, Université de Sherbrooke, Sherbrooke, Quebec, Canada. 67 pp.

Desrosiers, M., H. Varady-Szabo and A. Malenfant. 2012. Caractérisation de la structure d’âge des forêts actuelles (2008) et détermination des écarts avec la forêt préindustrielle de la Gaspésie – analyse par région écologique et par unité homogène de végétation. Consortium en foresterie Gaspésie-Les-Îles, Gaspé. 38 pp.

Dorais, M. and D. Lavergne. 2010. Inventaire aérien de l'orignal dans la réserve faunique des Chic-Chocs à l'hiver 2010. Ministère des Ressources naturelles et de la Faune, Direction de l'expertise (Énergie, Faune, Forêts, Mines, Territoire) de la Gaspésie–Îles-de-la-Madeleine. Caplan. 12 pp.

Duchesne, M., S.D. Côté and C. Barette. 2000. Responses of woodland caribou to winter ecotourism in the Charlevoix Biosphere Reserve, Canada. Biological Conservation 96:311-317.

Dumais, C., P. Ropars, M.-P. Denis, G. Dufour-Tremblay and S. Boudreau. 2014. Are low altitude alpine tundra ecosystems under threat? A case study from the Parc National de la Gaspésie, Québec. Environmental Research Letters 9:1-10.

Dumont, A. 1993. Impact des randonneurs sur les caribous, *Rangifer tarandus caribou*, du parc de conservation de la Gaspésie. Master's thesis, Université Laval, Québec, Quebec, Canada. 80 pp.

Dussault, C., V. Pinard, J.-P. Ouellet, R. Courtois and D. Fortin. 2012. Avoidance of roads and selection for recent cutovers by threatened caribou: fitness-rewarding or maladaptive behaviour? Proceedings of the Royal Society B 279:4481–4488.

Dyer, S.J., J.P. O'Neill, S.M. Wasel and S. Boutin. 2001. Avoidance of industrial development by woodland caribou. Journal of Wildlife Management 65:531-542.

Environment Canada. 2007. Gaspésie Woodland Caribou Recovery Plan (2002-2012), (*Rangifer tarandus caribou*) [Final]. Environment Canada, Ottawa. xi + 67 pp.

Environment Canada. 2008. Scientific Review for the Identification of Critical Habitat for Woodland Caribou, Boreal Population (*Rangifer tarandus caribou*) in Canada. Environment Canada, Ottawa. 72 pp. + appendices.

Environment Canada. 2011a. Scientific Assessment to Inform the Identification of Critical Habitat for Woodland Caribou (*Rangifer tarandus caribou*), Boreal Population, in Canada: 2011 update. 102 pp. + appendices.

Environment Canada. 2011b. Recovery Strategy for the Green-scales Willow (*Salix chlorolepis*) in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. v + 15 pp.

Environment Canada. 2012. Recovery Strategy for the Woodland Caribou (*Rangifer tarandus caribou*), Boreal population, in Canada. *Species at Risk Act* Recovery Strategy Series. Environment Canada, Ottawa. xi + 138 pp.

Équipe de rétablissement du caribou de la Gaspésie. 2010. Bilan du Plan de rétablissement du caribou de la Gaspésie (2002-2012) (*Rangifer tarandus caribou*) pour la période de 2002 à 2009. Ministère des Ressources naturelles et de la Faune. 36 pp.

Équipe de rétablissement du caribou de la Gaspésie. 2011. Bilan du rétablissement du caribou de la Gaspésie (*Rangifer tarandus caribou*) pour la période 1990-2009. Ministère des Ressources naturelles et de la Faune, Secteur des Opérations régionales, Direction de l'expertise Énergie-Faune-Forêts-Mines-Territoire de la Gaspésie–Îles-de-la-Madeleine et Faune Québec, Direction de l'expertise sur la faune et ses habitats. 25 pp.

Équipe de rétablissement du caribou de la Gaspésie. 2014. Impact des activités récréatives et de leurs infrastructures sur le caribou : Recommandations pour l'habitat légal du caribou de la Gaspésie. 18 pp.

Équipe de rétablissement du caribou de la Gaspésie. 2018. Plan de rétablissement de la population de caribous (*Rangifer tarandus caribou*) de la Gaspésie – 2019-2029. Produit pour le compte du ministère des Forêts, de la Faune et des Parcs. Direction générale de la gestion de la faune et des habitats. 59 pp.

Fahrig, L. and T. Rytwinski. 2009. Effects of roads on animal abundance: an empirical review and synthesis. Ecology and Society 14(1):21.

Fahrig, L., J.H. Pedlar, S.E. Pope, P.D. Taylor and J.F. Wegner. 1995. Effect of road traffic on amphibian density. Biological Conservation 73:177-182.

Faille, G., C. Dussault, J.-P. Ouellet, D. Fortin, R. Courtois, M.-H. St-Laurent and D. Dussault. 2010. Range fidelity: the missing link between caribou decline and habitat alteration? Biological Conservation 143:2840-2850.

Festa-Bianchet, M., J.C. Ray, S. Boutin, S.D. Côté and A. Gunn. 2011. Conservation of caribou (*Rangifer tarandus*) in Canada: an uncertain future. Canadian Journal Zoology 89:419-434.

Forman, R.T.T. and L.E. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207-232.

Fortin, D., P.-L. Buono, A. Fortin, N. Courbin, C.T. Gingras, P.R. Moorcroft, R. Courtois and C. Dussault. 2013. Movement Responses of Caribou to Human-Induced Habitat Edges Lead to Their Aggregation near Anthropogenic Features. The American Naturalist 181(6):827-836.

Fournier, N. and R. Faubert. 2001. Évaluation du troupeau de caribous de la Gaspésie. Société de la faune et des parcs du Québec, Direction de l'aménagement de la faune de la Gaspésie–Îles-de-la-Madeleine. 23 pp.

Fréchette, J.-L. 1986. Guide pratique des principaux parasites et maladies de la faune terrestre et ailée du Québec. Distribution Pisciconsult inc. Saint-Hyacinthe, Quebec. 280 pp.

Frenette, J. 2017. Démographie et viabilité de la population de caribous de la Gaspésie-Atlantique. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 101 pp.

Frenette, J. and M.-H St-Laurent. 2016. Acquisition de connaissances nécessaires à la désignation de l'habitat essentiel du caribou des bois, population de la Gaspésie-Atlantique – Rapport intérimaire 2016. Scientific report presented to Environment Canada – Canadian Wildlife Service. Rimouski, Quebec. iii + 47 pp.

Fuller, T.K. and L.B. Keith. 1981. Woodland caribou population dynamics in northeastern Alberta. Journal of Wildlife Management 45:197-213.

Gaillard, J.-M., M. Festa-Bianchet and N.G. Yoccoz. 1998. Population dynamics of large herbivores: variable recruitment with constant adult survival. Trends in Ecology and Evolution 13:58-63.

Gaudry, W. 2013. Impacts des structures linéaires sur la sélection d'habitat du caribou de la Gaspésie, le coyote et l'ours noir et sur le potentiel de cooccurrence entre une proie et ses prédateurs. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 60 pp.

George, S., J. Picard and G. Lemay. 1975. Localisation des aires d'hivernement des ongulés sauvages. Région du mont Albert et mont Logan. Ministère du Tourisme, de la Chasse et de la Pêche, Service de l'aménagement de la faune. Québec. 10 pp.

Ghalmi, F., B. China and B. Losson. 2007. Diagnostic et surveillance épidémiologique de *Neospora caninum*. Annales de Médecine Vétérinaire 151:123-149.

Government of Canada. 2009. *Species at Risk Act* Policies, Overarching Policy Framework [Draft]. *Species at Risk Act*, Policies and Guidelines Series. Environment Canada, Ottawa. 38 pp.

Gunn, A., C.J. Johnson, J.S. Nishi, C.J. Daiel, D.E. Russell, M. Carlson and J.Z. Adamczewski. 2011. Understanding the Cumulative Effects of Human Activities on Barren-Ground Caribou. Chapter 8 *in* P.R. Krausman and L.K. Harris (eds.). Cumulative Effects in Wildlife Management: Impact Mitigation. CRC Press Taylor and Francis Group, Boca Raton, Florida. p. 113-133.

Hebblewhite, M., C. White and M. Musiani. 2010. Revisiting extinction in national parks: mountain caribou in Banff. Conservation Biology 24:341-344.

Hervieux, D., M. Hebblewhite, N. DeCesare, M. Russell, K. Smith, S. Robertson and S. Boutin. 2013. Widespread declines in woodland caribou (*Rangifer tarandus caribou*) continue in Alberta. Canadian Journal of Zoology 91:872-882.

Hins, C., J.-P. Ouellet, C. Dussault and M.-H. St-Laurent. 2009. Habitat selection by forest-dwelling caribou in managed boreal forest of eastern Canada: evidence of a landscape configuration effect. Forest Ecology and Management 257:636-643.

Holt, R.D. 1977. Predation, apparent competition, and the structure of prey communities. Theoretical Population Biology 12:197-229.

Holt, R.D. 1984. Spatial heterogeneity, indirect interactions, and the coexistence of prey species. American Naturalist 124:377-406.

Houle, M., D. Fortin, C. Dussault, R. Courtois and J.-P. Ouellet. 2010. Cumulative effects of forestry on habitat use by gray wolf (*Canis lupus*) in the boreal forest. Landscape Ecology 25:419-433.

Huard, M. 2012. Analyses de viabilité de la population de caribou des bois (*Rangifer tarandus caribou*) de la Gaspésie. Mémoire de diplôme d'études supérieures spécialisées (DESS) en gestion de la faune, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 29 pp.

Hummel, M. and J.C. Ray. 2008. Caribou and the North: a shared future. Dundurn. 288 pp.

James, A.R.C. and A.K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. Journal of Wildlife Management 64:154-159.

Johnson, C.J. 2011. Regulating and planning for cumulative effects: The Canadian experience. Chapter 3 *in* P.R. Krausman and L.K. Harris (eds.). Cumulative Effects in Wildlife Management: Impact Mitigation. CRC Press, Boca Raton, Florida. p. 29-46.

Johnson, C.J. and M.-H. St-Laurent. 2011. Unifying framework for understanding impacts of human developments on wildlife. Chapter 3 *in* D.E. Naugle (ed.). Energy Development and Wildlife Conservation in Western North America. Island Press, Washington. p. 23-54.

Joly, K., B.W. Dale, W.B. Collins and L.G. Adams. Winter habitat use by female caribou in relation to wildland fires in interior Alaska. Canadian Journal of Zoology 81:1192-1201.

King, R. 1985. A dictionary of genetics. Oxford University Press, New York, New York. 480 pp.

Korsholm, H. and C.R. Olesen. 1993. Preliminary investigations on the parasite burden and distribution of endoparasite species of muskox (*Ovibos moschatus*) and caribou (*Rangifer tarandus groenlandicus*) in West Greenland. Rangifer 13:185-189.

Krausman, P.R. 2011. Quantifying Cumulative Effects. Chapter 4 *in* P.R. Krausman and L.K. Harrris (eds.). Cumulative Effects in Wildlife Management: Impact Mitigation. CRC Press Taylor and Francis Group, Boca Raton, Florida. p. 47-64.

Kutz, S.J., J. Ducrocq, G.G. Verocai, B.M. Hoar, D.D. Colwell, K.B. Beckmen, L. Polley, B.T. Elkin and E.P. Hoberg. 2012. Parasites in ungulates of Arctic North America and Greenland: a view of contemporary diversity, ecology, and impact in a world under change. Advances in Parasitology 79:99–252.

Kuvlesky, W.P., L.A. Brennan, M.L. Morrison, K.K. Boydston, B.M. Ballard and F.C. Bryant. 2007. Wind energy development and wildlife conservation: challenges and opportunities. Journal of Wildlife Management 71(8):2487-2498.

Lalonde, M. 2013. Inventaire aérien de la population de caribou de la Gaspésie (*Rangifer tarandus caribou*) – Automne 2013. Ministère du Développement durable, de l'Environnement, de la Faune et des Parcs. 20 pp.

Lalonde, M. and J. Michaud. 2013. Inventaire aérien de la population de caribou de la Gaspésie (*Rangifer tarandus caribou*) – Automne 2012. Ministère des Ressources naturelles du Québec, Direction de l'expertise de la Gaspésie–Îles-de-la-Madeleine. 19 pp.

Lamoureux, J., M. Bélanger and C. Laroque. 2012. Inventaire aérien de l'orignal dans les réserves fauniques de Matane et de Dunière à l'hiver 2012. Ministère des Ressources naturelles et de la Faune, Direction de l'expertise Faune-Forêts-Territoire du Bas-Saint-Laurent. Rimouski. 40 pp.

Landry, G. and D. Lavergne. 2007. Inventaire aérien de l'orignal dans la zone de chasse 1 à l'hiver 2007. Ministère des Ressources naturelles et de la Faune, Direction de l'aménagement de la faune de la Gaspésie–Îles-de-la-Madeleine, New Richmond, 16 pp.

Larivière, S. and M. Crête. 1992. Causes et conséquences de la colonisation du Québec par le coyote (*Canis latrans*). Ministère du loisir, de la chasse et de la pêche. Québec. 38 pp.

Larouche, C., J.-C. Ruel and L. Bélanger. 2007. L'effet du patron de répartition des coupes sur les pertes par chablis : Étude de cas dans la sapinière à bouleau blanc de l'Est. Forestry Chronicle 83:84-91.

Leblond, M. 2013. Impacts des routes sur le comportement et la survie du caribou forestier. PhD thesis, Université du Québec à Montréal, Montreal, Quebec, Canada. 192 pp.

Leblond, M., C. Dussault and M.-H. St-Laurent. 2014. Développement et validation d'un modèle de qualité d'habitat pour le caribou forestier (*Rangifer tarandus caribou*) au Québec. Pour le compte du ministère des Forêts, de la Faune et des Parcs. Université du Québec à Rimouski, Rimouski, Quebec, Canada. 87 pp. + appendices.

Leblond, M., J. Frair, D. Fortin, C. Dussault, J.-P. Ouellet and R. Courtois. 2011. Assessing the influence of resource covariates at multiple spatial scales: an application to forest-dwelling caribou faced with intensive human activity. Landscape Ecology 26:1433-1446.

Leclerc, M., C. Dussault and M.-H. St-Laurent. 2012. Multiscale assessment of the impacts of roads and cutovers on calving site selection in woodland caribou. Forest Ecology and Management 286:59-65.

Leclerc, M., C. Dussault and M.-H. St-Laurent. 2014. Behavioural strategies towards human disturbances explain individual performance in woodland caribou. Oecologia 176:297-306.

Lesmerises, F. 2012. Analyses de viabilité de la population de caribou des bois (*Rangifer tarandus caribou*) de la Gaspésie. Rapport de recherche présenté au Ministère des Ressources naturelles et de la Faune du Québec, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 36 pp.

Lesmerises, F. and M.-H St-Laurent. 2018. Influence du taux de perturbation de l'habitat, de l'abondance régionale du coyote et du contrôle des prédateurs sur les paramètres démographiques de la population de caribous de la Gaspésie-Atlantique. Scientific report submitted to Environment and Climate Change Canada – Canadian Wildlife Service, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 22 pp. + appendices.

Lesmerises, F., C. Dussault and M.-H. St-Laurent. 2013. Major roadwork impacts the space use behaviour of a large carnivore. Landscape and Urban Planning 112:18-25.

Lesmerises, F., C.J. Johnson and M.-H. St-Laurent. 2017. Refuge or predation risk? Alternate ways to perceive hiker disturbance based on maternal state of female caribou. Ecology and Evolution 7(3):845-854.

Lesmerises, F., F. Déry, C.J. Johnson and M.-H. St-Laurent. 2018. Spatiotemporal response of mountain caribou to the intensity of backcountry skiing. Biological Conservation 217:149-156.

Logan, T. 2012. Scénarios climatiques pour les régions naturelles de la péninsule de la Gaspésie et la Dépression de La Tuque. Québec, Quebec.

Michaud, J. 2013. Résultats des opérations de régulation des prédateurs du caribou de la Gaspésie 2011-2012. Ministère des Ressources naturelles, Direction de l'expertise de la Gaspésie-Îles-de-la-Madeleine. 35 pp.

Ministère de l'Énergie et des Ressources naturelles. 2018a. Questions fréquentes. Web site: https://mern.gouv.qc.ca/energie/hydrocarbures/savoir-davantage/questions-frequentes [accessed July 2018].

Ministère de l'Énergie et des Ressources naturelles. 2018b. Carte hydrocarbures. Web site: http://sigpeg.mrn.gouv.qc.ca/gpg/hydrocarbures/hydrocarbures.htm [accessed July 2018].

Ministère des Forêts, de la Faune et des Parcs. 2015. Norme de stratification écoforestière. Quatrième inventaire écoforestier du Québec méridional. Secteur des Forêts, Direction des inventaires forestiers. 80 pp. + appendices.

Ministère des Forêts, de la Faune et des Parcs. 2016a. La tordeuse des bourgeons de l'épinette. Ministère des Forêts, de la Faune et des Parcs. Web site: https://mffp.gouv.qc.ca/forets/fimaq/insectes/fimaq-insectes-insectes-tordeuse.jsp [accessed September 2017].

Ministère des Forêts, de la Faune et des Parcs. 2016b. Épidémie de la tordeuse des bourgeons de l'épinette – Gaspésie–Îles-de-la-Madeleine. Page mise à jour en 2016. Ministère des Forêts, de la Faune et des Parcs. Web site: https://mffp.gouv.qc.ca/forets/protection/documents/Feuillet-TBE-Gaspesie-Iles.pdf [accessed September 2017].

Ministère des Forêts, de la Faune et des Parcs. 2018. Maladie débilitante chronique du cervidé – Détection d'un premier cas au Québec. Web site: https://mffp.gouv.qc.ca/maladie-debilitante-chronique-du-cervide-detection-premier-cas-au-quebec-2018-09-14/ [accessed November 2018].

Moisan, G. 1956. Le caribou de Gaspé I. Histoire et distribution. Le Naturaliste canadien. 83:225-234.

Moisan, G. 1957. Le caribou de Gaspé III. Analyse de la population et plan d'aménagement. Le Naturaliste canadien. 84(1):5-27.

Morin, M. 2016. Inventaire aérien de la population de caribous de la Gaspésie (*Rangifer tarandus caribou*) – Automne 2016. Ministère des Forêts, de la Faune et des Parcs, Direction de la gestion de la faune de la Gaspésie–Îles-de-la-Madeleine. 9 pp.

Morin, M. 2017. Inventaire aérien de la population de caribous de la Gaspésie (*Rangifer tarandus caribou*) – Automne 2017. Ministère des Forêts, de la Faune et des Parcs, Direction de la gestion de la faune de la Gaspésie–Îles-de-la-Madeleine. 8 pp.

Morin, M. and F. Lesmerises. 2020. Inventaire de la population de caribous montagnards (*Rangifer tarandus caribou*) de la Gaspésie à l'automne 2019 et à l'hiver 2020. Ministère des Forêts, de la Faune et des Parcs, Direction de la gestion de la faune de la Gaspésie–Îles-de-la-Madeleine, Québec. 13 pp.

Mosnier, A. 2008. Utilisation du milieu boréal par l'ours noir et implications pour la conservation du caribou de la Gaspésie. PhD thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 139 pp.

Mosnier, A., D. Boisjoly, R. Courtois and J.-P. Ouellet. 2005. Les patrons de déplacement des prédateurs du caribou de la Gaspésie peuvent limiter l'effet d'un programme ponctuel de contrôle des prédateurs. Ministère des Ressources naturelles et de la Faune, Secteur Faune Québec. Direction de la recherche sur la faune. 40 pp.

Mosnier, A., D. Boisjoly, R. Courtois and J.-P. Ouellet. 2008a. Extensive predator space use can limit the efficacy of a control program. Journal of Wildlife Management 72:483-491.

Mosnier, A., J.-P. Ouellet and R. Courtois. 2008b. Black bear adaptation to low productivity in the boreal forest. Ecoscience 15:485-497.

Mosnier, A., J.-P. Ouellet, L. Sirois and N. Fournier. 2002. Utilisation de l'espace et de l'habitat par la métapopulation de caribou de la Gaspésie. Université du Québec à Rimouski, Rimouski, Quebec, Canada. 31 pp.

Mosnier, A., J.-P. Ouellet, L. Sirois and N. Fournier. 2003. Habitat selection and home-range dynamics of the Gaspé caribou: a hierarchical analysis. Canadian Journal of Zoology 81:1174-1184.

Nadeau Fortin, M.-A. 2015. Impacts de l'aménagement forestier sur l'habitat du caribou de la Gaspésie-Atlantique. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 90 pp.

Nadeau Fortin, M.-A., L. Sirois and M.-H. St-Laurent. 2016. Extensive forest management contributes to maintain suitable habitat characteristics for the endangered Atlantic-Gaspésie caribou. Canadian Journal of Forest Research 46:933-942.

Nagy, J.A.S. 2011. Use of space by caribou in northern Canada. PhD thesis, University of Alberta, Edmonton, Alberta. 164 pp.

NatureServe. 2018. NatureServe Explorer: An online encyclopedia of life. Web application, Version 7.1. NatureServe, Arlington, Virginia. Web site: http://www.natureserve.org/explorer [accessed February 2017].

Nellemann, C., I. Vistness, P. Jordhøy, O.-G. Støen, B.P. Kaltendon, F. Hanssen and R. Helgesen. 2010. Effects of recreational cabins, trails and their removal for restoration of reindeer winter ranges. Restoration Ecology 18:873-881.

Nellemann, C., P. Jordhøy, O.G. Støen and O. Strand. 2000. Cumulative impacts of tourist resorts on wild reindeer (*Rangifer tarandus tarandus*) during winter. Arctic 53:9-17.

Ouellet, J.-P., J. Ferron and L. Sirois. 1996. Space habitat use by threatened Gaspé caribou, southeastern Québec. Canadian Journal of Zoology 74:1922-1933.

Paquet, M. 1997. Toward a mountain caribou management strategy for British Columbia. Background Report. Ministry of Environment, Lands and Parks, Wildlife Branch, Victoria, British Columbia. vii + 72 pp.

Parker, K.L., P.S. Barboza and T.R. Stephenson. 2005. Protein conservation in female caribou (*Rangifer tarandus*): effects of decreasing diet quality during winter. Journal of Mammalogy 86:610-622.

Pelletier, F., G. Turgeon, A. Bourret, D. Garant and M.-H. St-Laurent. 2018. Genetic structure and effective size of an endangered population of woodland caribou. Conservation Genetics doi: 10.1007/s10592-018-1124-1.

Périé, C., S. de Blois, M.-C. Lambert and N. Casajus. 2014. Effets anticipés des changements climatiques sur l'habitat des espèces arborescentes au Québec. Ministère des Ressources naturelles, Direction de la Recherche forestière, Mémoire de recherche forestière 173. Québec, Quebec. 46 pp.

Pettigrew, P. and M.-H. St-Laurent. 2017. Inventaire automnal 2016 du caribou de la Gaspésie dans le secteur du mont Logan à l'aide de pièges photographiques automatisés. Université du Québec à Rimouski, Rimouski, Quebec, Canada. 32 pp.

Pieridae Energy. 2018. Technical review of P&NG holdings of Pieridae Energy Ltd. in Quebec and New Brunswick (As of December 31, 2017). Pieridae Energy Limited, Calgary (Alberta). 61 pp.

Pierre, A. and M.-H. St-Laurent. 2012. Détermination des impacts du contrôle des prédateurs du caribou de la Gaspésie sur la démographie des populations de coyotes et d'ours noirs. Mémoire de diplôme d'études supérieures spécialisées (DESS) en gestion de la faune, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 37 pp.

Pinard, V., C. Dussault, J.-P. Ouellet, D. Fortin, R. Courtois. 2012. Calving rate, calf survival rate, and habitat selection of forest-dwelling caribou in a highly managed landscape. Journal of Wildlife Management 76:189-199.

Pinna, S., A. Malendant, B. Hébert and M. Côté. 2009. Portrait forestier historique de la Gaspésie, Consortium en foresterie Gaspésie–Les-Îles, Gaspé. 204 pp.

Polfus, J.L., M. Hebblewhite and K. Heinemeyer. 2011. Identifying indirect habitat loss and avoidance of human infrastructure by northern mountain woodland caribou. Biological Conservation 144:2637-2646.

Poole, K.G., D.C. Heard and G. Mowat. 2000. Habitat use by woodland caribou near Takla Lake in central British Columbia. Canadian Journal of Zoology. 78:1552-1561.

Potvin, F. 1974. Où en est le caribou de la Gaspésie en 1973. Ministère du Tourisme, de la Chasse et de la Pêche, Québec, Quebec. 19 pp.

Pritzkow, S., R. Morales, A. Lyon, L. Concha-Marambio, A. Urayama and C. Soto. 2018. Efficient prion disease transmission through common environmental materials. Journal of Biological Chemistry 293:3363-3373.

Radio-Canada. 2018. Braconnage d'un caribou de la Gaspésie. Web site: https://ici.radio-canada.ca/nouvelle/1134447/braconnage-caribou-chasse-gaspesie [accessed May 2019].

Renaud, L.-A. 2012. Impacts de l'aménagement forestier et des infrastructures humaines sur les niveaux de stress du caribou forestier. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 97 pp.

Renaud, L.-A., M. Leblond, D. Beauchesne and M.-H. St-Laurent. 2010. Synthèse des connaissances relatives aux impacts du réseau routier sur l'écologie du caribou forestier. Université du Québec à Rimouski, Rimouski, Quebec, Canada. 21 pp.

Rettie, J. W. and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. Canadian Journal of Zoology 76:251-259.

Rettie, J.W. and F. Messier. 2000. Hierarchical habitat selection by woodland caribou: its relationship to limiting factors. Ecography 23:466-478.

Rivard, G. 1978. Étude du caribou de la Gaspésie en considérant l'habitat. Ministère du Tourisme, de la Chasse et de la Pêche, Direction de la recherche faunique. Report RRF-22. 65 pp.

Rudolph, T. 2011. Mouvements et sélection d'habitat lors des déplacements printaniers du caribou forestier (*Rangifer tarandus caribou*) dans le Nord du Québec. Master's thesis, Université du Québec à Montréal, Montreal, Quebec, Canada. 166 pp.

Ruel, J.-C., P. Raymond and M. Pineau. 2003. Windthrow after shelterwood cutting in balsam fir stands. Northern Journal of Applied Forestry 20(1):5-13.

Saher, D.J. and F.K.A. Schmiegelow. 2005. Movement pathways and habitat selection by woodland caribou during spring migration. Rangifer (Special Issue) 6:143-154.

Schaefer, J.A. 2003. Long-Term Range Recession and the Persistence of Caribou in the Taiga. Conservation Biology 17:1435-1439.

Schaefer, J.A. and S.P. Mahoney. 2007. Effects of progressive clearcut logging on Newfoundland Caribou. Journal of Wildlife Management 71:1753-1757.

Schwartz, C.C. and A.W. Franzmann. 1989. Bears, wolves, moose, and forest succession: some management considerations on the Kenai Peninsula, *in* J.W. Rettie and F. Messier. 1998. Dynamics of woodland caribou populations at the southern limit of their range in Saskatchewan. Canadian Journal of Zoology 76:251-259.

Seip, D.R. 1992. Factors limiting woodland caribou populations and their interrelationships with wolves and moose in southeastern British Columbia. Canadian Journal of Zoology 70:1494-1503.

Seip, D.R., C.J. Johnson and S. Watts. 2007. Displacement of mountain caribou from winter habitat by snowmobiles. Journal of Wildlife Management. 71:1539-1554.

Serrouya, R., M.J. Wittmann, B.N. McLellan, H.U. Wittmer and S. Boutin. 2015. Using predator-prey theory to predict outcomes of broadscale experiments to reduce apparent competition. American Naturalist 185:665-679.

Servheen, G. and L.J. Lyon. 1989. Habitat use by woodland caribou in the Selkirk Mountains. Journal of Wildlife Management. 53(1):230-237.

Simpson, K. and E. Terry. 2000. Impacts of backcountry recreation activities on mountain caribou – Management concerns, interim management guidelines and research needs. Ministry of Environment, Lands and Parks. Wildlife Branch, Victoria (British Columbia). Wildlife Working Report WR-99. 11 pp.

St-Laurent, M.-H., F. Lesmerises, M.-A. Nadeau Fortin and S. Bauduin. 2015a. Acquisition de connaissances nécessaires à la désignation de l'habitat essentiel du caribou des bois, population de la Gaspésie-Atlantique – Rapport final 2015. Scientific report presented to Environment Canada – Canadian Wildlife Service, Rimouski, Quebec. 36 pp.

St-Laurent, M.-H., J.-P. Ouellet, A. Mosnier, D. Boisjoli and R. Courtois. 2009. Le parc national de la Gaspésie est-il un outil de conservation efficace pour maintenir une population menacée de caribou ? Le Naturaliste Canadien 133(3):6-14.

St-Laurent, M.-H., L.-A. Renaud, M. Leblond and D. Beauchesne. 2012. Synthèse des connaissances relatives aux impacts des routes sur l'écologie du caribou. Le Naturaliste Canadien 136(2):42-47.

St-Laurent, M.-H., M.-A. Nadeau Fortin and M. Boudreau. 2015b. Influence de l'aménagement forestier sur les relations prédateurs – proies et implications dans la désignation de l'habitat essentiel de la population de la Gaspésie-Atlantique du caribou des bois. Scientific report submitted to Environment Canada – Canadian Wildlife Service, Rimouski, Quebec. 50 pp.

Stone, I. 2004. Impact de la coupe forestière sur les lichens arboricoles dans les vieilles sapinières de la Gaspésie. Master's thesis, Université du Québec à Rimouski, Rimouski, Quebec, Canada. 85 pp.

Stone, I., J.-P. Ouellet, L. Sirois, M.-J. Arseneau and M.-H. St-Laurent. 2008. Impacts of silvicultural treatments on arboreal lichen biomass in balsam fir stands in Québec's Gaspé Peninsula: Implications for a relic caribou herd. Forest Ecology and Management 255:2733-2742.

Stuart-Smith, A.K., C.J.A. Bradshaw, S. Boutin, D.M. Hebert and A.B. Rippin. 1997. Woodland caribou relative to landscape patterns in northeastern Alberta. Journal of Wildlife Management. 61(3):622-633.

Tardif, B., G. Lavoie and Y. Lachance. 2005. Atlas de la biodiversité du Québec. Les espèces menacées ou vulnérables. Ministère du Développement durable, de l'Environnement et des Parcs, Direction du développement durable, du patrimoine écologique et des parcs. Québec (Canada). 60 pp.

Trombulak, S.C. and C.A. Frissell. 2000. Review of ecological effects of roads on terrestrial and aquatic communities. Conservation Biology 14:18-30.

Turcotte, C., S. Champagne, D. Chouinard, J. Lamoureux and G. Landry. 2007. Plan d'aménagement de l'aire du caribou de la Gaspésie (*Rangifer tarandus caribou*), deuxième édition. Ministère des Ressources naturelles et de la Faune du Québec, Directions de l'aménagement de la faune de la Gaspésie–Îles-de- la-Madeleine et du Bas-Saint-Laurent et Unités de gestion de la Gaspésie et du Bas-Saint-Laurent. 85 pp.

Turgeon, G., S.J. Kutz, M. Lejeune, M.-H. St-Laurent and F. Pelletier. 2018. Parasite prevalence, infection intensity and richness in an endangered population, the Atlantic-Gaspésie caribou. International Journal for Parasitology: Parasites and Wildlife 7(1):90-94.

Vézina, R. 1971. Inventaire aérien du caribou dans le Parc de la Gaspésie, Québec. Ministère du Tourisme, de la Chasse et de la Pêche, Service de l'aménagement et de l'exploitation de la faune, région du Bas-Saint-Laurent–Gaspésie–Îles-de-la-Madeleine. 5 pp.

Vors, L.S. and M.S. Boyce. 2009. Global declines of caribou and reindeer. Global Change Biology 15:2626-2633.

Vors, L.S., J.A. Schaefer, B.A. Pond, A.R. Rodgers and B.R. Patterson. 2007. Woodland caribou extirpation and anthropogenic landscape disturbance in Ontario. Journal of Wildlife Management 71:1249-1256.

Weclaw, P. and R.J. Hudson. 2004. Simulation of conservation and management of woodland caribou. Ecological Modelling 177:75-94.

Weir, J.N., S.P. Mahoney, B. McLaren and S.H. Ferguson. 2007. Effects of mine development on woodland caribou *Rangifer tarandus* distribution. Wildlife Biology 13:66-74.

Wells, J.V. and M.E. Richmond. 1995. Populations, metapopulations and species populations: what are they and who should care? Wildlife Society Bulletin 23:458.462.

Whittington, J., M. Hebblewhite, N.J. Decesare, L. Neufeld, M. Bradley, J. Wilmshurst and M. Musiani. 2011. Caribou encounters with wolves increase near roads and trails: a time-to-event approach. Journal of Applied Ecology 48(6):1535-1542.

Wild Species. 2015. Wild Species 2015 report and database of the report. Web site: https://www.wildspecies.ca/reports [accessed August 2017].

Wittmann, M. J., H. Stuis and D. Metzler. 2018. Genetic Allee effects and their interaction with ecological Allee effects. Journal of Animal Ecology 87(1):11-23.

Wittmer, H.U., A.R. Sinclair and B.N. McLellan. 2005. The role of predation in the decline and extirpation of woodland caribou. Oecologia 144:257-267.

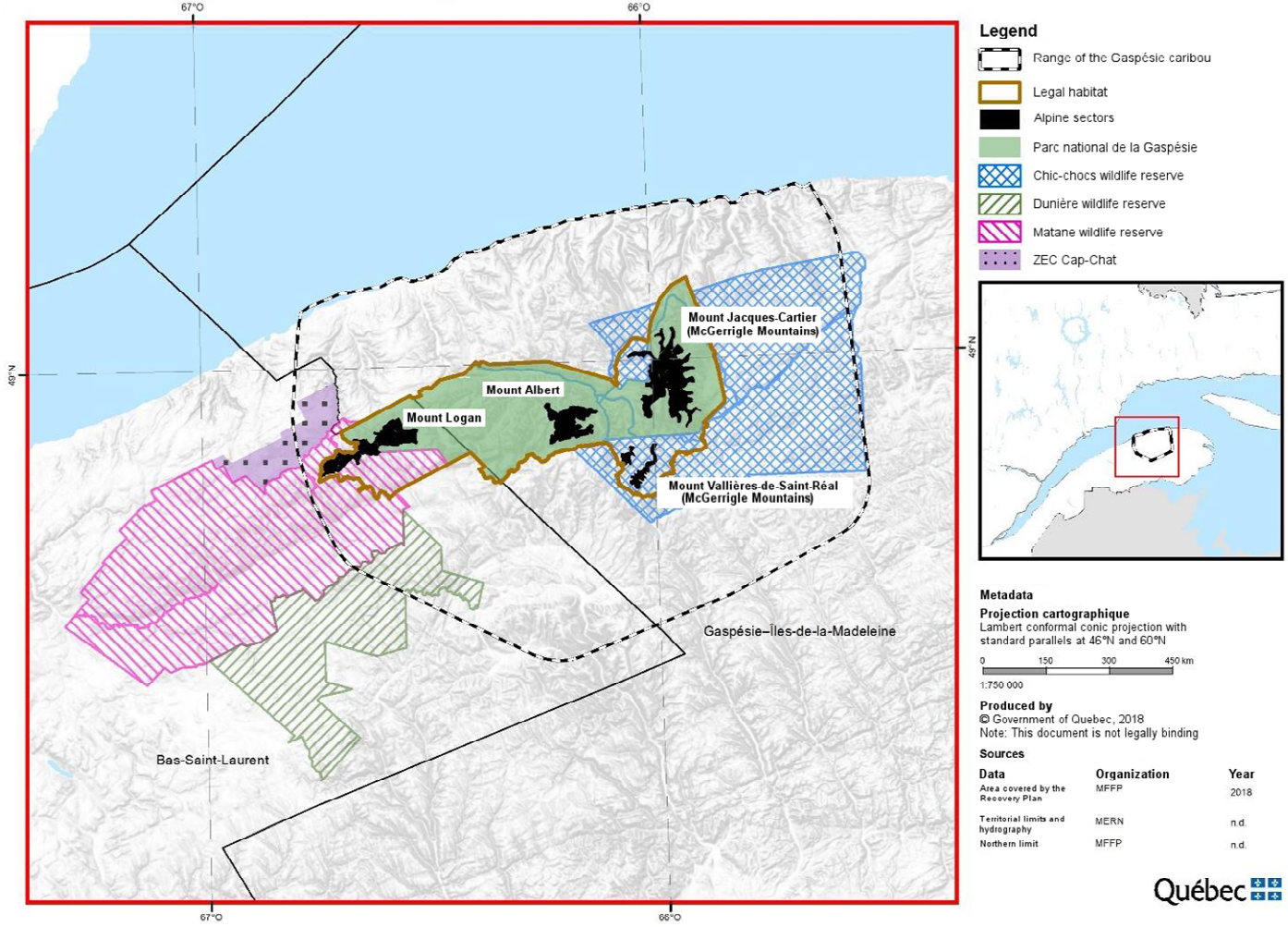
Wolfe, S.A., B. Griffith and C.A.G. Wolfe. 2000. Response of reindeer and caribou to human activities. Polar Research 19:63-73.

Worton, B.J. 1987. A review of models of home range for animal movement. Ecological Modelling 38:277-298.

Yannic, G., L. Pellisier, J. Ortego, N. Lecomte, S. Couturier, C. Cuyler, C. Dussault, K.J. Hundertmark, R.J. Irvine, D.A. Jenkins et al. 2014. Genetic diversity in caribou linked to past and future climate change. Nature Climate Change 4:132-137.

Yannic, G., M.-H. St-Laurent, J. Ortego, J. Taillon, A. Beauchemin, L. Bernatchez, C. Dussault and S.D. Côté. 2016. Integrating ecological and genetic structure to define management units for caribou in Eastern Canada. Conservation Genetics 17:437-453.

Appendix A: Boundaries of Gaspésie Caribou Habitat, as Mapped by the Government of Quebec under the *Act Respecting the Conservation and Development of Wildlife*



In the legend, “Legal habitat” is “LCMVF Habitat (LH) – 2011”.
Source: Équipe de rétablissement du caribou de la Gaspésie, 2018

Note: Figure translated and adapted by ECCC from a French map produced by the Government of Quebec

Appendix B: Changes in Forest Composition and Structure in Gaspésie Caribou Habitat (1998–2009)

From St-Laurent et al. (2015b). For more detailed information, please refer to the article.

Changes over time in area covered with mature fir stands, mean density of gravel roads, and area of clearcuts and partial cuts less than 20 years old between the 3rd and 4th ecoforestry inventories

Spatial scale	Ecoforestry inventory	Area of mature fir stands (%)	Mean density of gravel roads (km/km^2)	Area of clearcuts (%), 0–20 years	Area of partial cuts (%), 0–20 years
LH*	3rd inventory (1998)	58.08	5.57	3.74	0.59
	4th inventory (2009)	56.38	6.93	2.09	1.06
LH + 5 km	3rd inventory (1998)	56.57	8.16	5.33	1.92
	4th inventory (2009)	53.88	12.49	5.46	3.95
LH + 10 km	3rd inventory (1998)	58.83	9.75	6.88	1.86
	4th inventory (2009)	51.41	16.18	8.51	6.09
LH + 15 km	3rd inventory (1998)	59.86	11.13	7.25	1.99
	4th inventory (2009)	49.03	18.65	10.29	6.84
LH + 20 km	3rd inventory (1998)	59.77	12.39	7.49	2.26
	4th inventory (2009)	46.94	20.48	11.20	7.01
LH + 25 km	3rd inventory (1998)	59.21	12.49	7.55	2.71
	4th inventory (2009)	45.41	20.84	11.97	7.27
LH + 30 km	3rd inventory (1998)	58.27	12.62	7.59	2.64
	4th inventory (2009)	44.54	20.97	11.90	7.55
Bas-Saint-Laurent and Gaspésie	3rd inventory (1998)	46.16	17.50	8.36	1.56
	4th inventory (2009)	35.72	23.72	8.84	7.16

* LH = “LCMVF Habitat (LH) – 2011”; the width of the buffer zone around the periphery of the LH is also shown.

Appendix C: Probability of Extirpation of Gaspésie Caribou, Based on Different Scenarios

From Frenette and St-Laurent (2016). For more detailed information, please see the article.

Probability of extirpation of the Gaspésie caribou population in the McGerrigle Mountains area and the Mount Albert and Mount Logan area within a time horizon of 50 years, based on six different scenarios

Scenario		Intensity	Relative probability of extirpation			
			McGerrigle Mountains	Difference in relation to scenario 2*	Mounts Albert/Logan	Difference in relation to scenario 2*
1	Observed current recruitment	Current	0.82	-0.53	0.96	-0.24
2	Estimated current recruitment	Current	0.29	0	0.72	0
3	Reduction of regional coyote population	-15%	0.02	0.27	0.44	0.28
		-25%	0.03	0.26	0.26	0.46
		-35%	0.00	0.29	0.15	0.57
4	Reduction of regional moose population	-10%	0.13	0.16	0.56	0.16
		-25%	0.08	0.21	0.57	0.15
		-50%	0.24	0.05	0.69	0.03
5	Habitat restoration (in % of 6- to 20-year-old cuts)	Target of 9%	0.18	0.11	0.57	0.15
		Target of 7%	0.21	0.08	0.73	-0.01
		Target of 5%	0.37	-0.08	0.75	-0.03
6	Habitat restoration and reduction of coyote population	Target of 9% of 6–20 year-old cutblocks and -25% coyotes	0.01	0.28	0.18	0.54

* The difference between the probability of extirpation for each scenario and the probability for the scenario using the estimated recruitment figures while conserving the current conditions of the system (scenario 2) is presented as a performance indicator under each scenario.

Appendix D: Mitigation Techniques to Avoid Destruction of Critical Habitat

Adapted from Environment Canada (2012).

Mitigation of the adverse effects that may result from a proposed project on Gaspésie caribou could include various techniques, including avoiding destruction of undisturbed habitat or biophysical attributes necessary for the species to carry out life processes, reducing noise and pollution, or minimizing disturbance by adapting its shape or adjusting the timing of the disturbance. The following table presents examples of considerations and possible mitigation techniques to use when planning development within the range of Gaspésie caribou.

Examples of considerations when planning development within the range of Gaspésie caribou and possible mitigation techniques

Factors to consider during development planning	Examples of possible mitigation techniques
Threshold of disturbance in the short and long terms	Minimize the footprint of development by considering the use of locations where habitat is already disturbed. Restore habitat to provide continual availability of undisturbed habitat over time.
Ecological factors	Avoid destruction of biophysical attributes.
Spatial configuration	Minimize disturbance by adapting its shape (small polygon vs. linear).
Sensory disturbances	Mitigate noise, light, odours and vibrations to prevent harassment of boreal caribou.
Pollution	Mitigate pollution by using scrubbers or other techniques.
Timing of disturbances	Time certain types of disturbance to occur only in seasons when Gaspésie caribou are not using the area or do not respond negatively to the activity.
Induced effects	New access roads in previously undisturbed areas may induce further disturbance by opening territory to more development, recreational users, etc. This could be prevented by means of an access management plan that includes limiting access, decommissioning roads, etc.
Corridors that support predator movement	Reduce impact by using techniques that prevent use of corridors by predators (no compaction of snow, immediate replanting of trees, etc.).
Increases in predator and/or alternate prey populations	Consider mortality management techniques where the killing of predators would be a final, necessary option implemented temporarily, together with habitat restoration.

Appendix E: Effects on the Environment and other Species

A Strategic Environmental Assessment (SEA) is conducted on all SARA recovery planning documents, in accordance with the *Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals*[35]. The purpose of a SEA is to incorporate environmental considerations into the development of public policies, plans, and program proposals to support environmentally sound decisions-making and to evaluate whether the outcomes of a recovery planning document could affect any component of the environment or any of the Federal Sustainable Development Strategy's[36] (FSDS) goals and targets.

Recovery planning is intended to benefit species at risk and biodiversity in general. However, it is recognized that strategies may also inadvertently lead to environmental effects beyond the intended benefits. The planning process based on national guidelines directly incorporates consideration of all environmental effects, with a particular focus on possible impacts on non-target species or habitats. The results of the SEA are incorporated directly into the strategy itself, but are also summarized below in this statement.

The possibility that this recovery strategy will inadvertently have adverse effects on the environment and on other species has been considered. For example, the recovery activities include predator control measures for coyotes and black bears. However, given the numbers of these predators in the Gaspésie and Bas-Saint-Laurent region and the fact that control measures are currently being implemented in only part of the species' range, the impact of these measures on the two species is not considered significant at the scale of these two administrative regions. Trapping of predators is carried out by professionals (e.g., Department of Forests, Wildlife and Parks [MFFP]; Société des établissements de plein air du Québec [SÉPAQ]) in accordance with rigorous standards. Those standards include the use of traps that make the capture of caribou impossible and that reduce incidental captures of other species.

The broad recovery strategies set out in this document should have an overall positive effect on all plant and wildlife species present in the habitats of the target species, which is associated with both alpine tundra and forest areas. It should be noted that the Gaspésie caribou's range is recognized as one of Quebec's biodiversity hotspots (Tardif et al. 2005). A number of at-risk plant species occur there, including green-scaled willow (*Salix chlorolepis*) and mountain holly fern (*Polystichum scopulinum*), both of which are listed as threatened in Schedule 1 of SARA. These two species, along with Indian's dream (*Aspidotis densa*), serpentine stitchwort (*Minuartia marcescens*) and dwarf arctic groundsel (*Solidago simplex* subsp. *simplex* var. *chlorolepis*) are identified as

[35] www.canada.ca/en/environmental-assessment-agency/programs/strategic-environmental-assessment/cabinet-directive-environmental-assessment-policy-plan-program-proposals.html
[36] www.fsds-sfdd.ca/index.html#/en/goals/

threatened species in Quebec under the *Act Respecting Threatened or Vulnerable Species*. A number of plant species likely to be designated threatened or vulnerable in Quebec, such as Aleutian maidenhair fern (*Adiantum aleuticum*), swamp thistle, mountain variety (*Cirsium muticum* var. *monticolum*), and rough fescue (*Festuca altaica*), also occur in the Gaspésie caribou's range. In addition, its range is used by a number of bird species at risk, including the following SARA Schedule 1 species: Bicknell's thrush (*Catharus bicknelli*) – threatened; harlequin duck (*Histrionicus histrionicus*), Eastern population – species of concern; and Barrow's goldeneye (*Bucephala islandica*), Eastern population – species of concern. These species are also identified as vulnerable under the *Act Respecting Threatened or Vulnerable Species*, as are the golden eagle (*Aquila chrysaetos*) and the bald eagle (*Haliaeetus leucocephalus*).

There is currently no reason to believe that the recovery of Gaspésie caribou could pose a significant threat to these species. However, Gaspésie caribou frequent areas where green-scaled willow grows. This species is vulnerable to trampling and browsing by caribou (Environment Canada 2011b). At this time, it is impossible to predict the impact of trampling by caribou. As for browsing, although Woodland Caribou are known to eat willow leaves and twigs, it is not known how much green-scaled willow they consume. These two potential threats appear to be relatively limited, as they are not identified in the COSEWIC (2006) report on the green-scaled willow in Canada.

In conclusion, the information that is currently available tends to confirm that this recovery strategy will not result in significant adverse effects on the environment or other species.