SPECIES STATUS REPORT

Peary Caribou

(Rangifer tarandus pearyi)

Tuktu
Tuktuinak
Tuktuaraaluit
Tuttunguluurat
Caribou de Peary

in the Northwest Territories

NORTHWEST TERRITORIES
SPECIES AT RISK
COMMITTEE

Threatened

December 2012

Status of Peary Caribou in the NWT

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

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The drafts of this report were prepared by Roger McMillan (traditional and community knowledge component) and Kim Poole and Anne Gunn (scientific knowledge component), prepared under contract with the Government of the Northwest Territories, and edited by Joanna Wilson and Michelle Henderson.
For additional copies contact:

Species at Risk Secretariat
c/o SC6, Department of Environment and Natural Resources
P.O. Box 1320
Yellowknife, NT X1A 2L9
Tel.: (855) 783-4301 (toll free)
Fax.: (867) 873-0293
E-mail: sara@gov.nt.ca
www.nwtspeciesatrisk.ca

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

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

Northwest Territories Environment and Natural Resources

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

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NORTHWEST TERRITORIES SPECIES AT RISK COMMITTEE

Assessment of Peary Caribou

The Northwest Territories Species at Risk Committee met in Behchokǫ̀, Northwest Territories on December 4, 2012 and assessed the biological status of Peary Caribou in the Northwest Territories. The assessment process and objective biological criteria used by the Species at Risk Committee are available at www.nwtspeciesatrisk.ca.

Status: Threatened in the Northwest Territories

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

Reasons for the assessment: **Peary Caribou fits criteria (a) and (c) for Threatened**

(a) – There is evidence that the population is declining in such a way that it could disappear from the Northwest Territories in our children's lifetime

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

- All three Peary caribou subpopulations in the Northwest Territories display similar trends. High abundance was recorded in either the 1970s or 80s (Banks and northwest Victoria Islands) or the early 1960s (western Queen Elizabeth Islands), followed by steep declines (averaging >90%), with little evidence for recovery to historic higher numbers over a 20 year period.
- The only evidence of some recovery has been seen in the Queen Elizabeth Islands.
- The sustained low numbers (estimated 7,250 individuals) and high population variability between survey years suggest high vulnerability to further declines.
- A key influence that likely halted the decline of Peary caribou in the 1990s was the restriction of hunting, especially of female caribou.
- There does not seem to be an imminent threat (i.e. they are not facing imminent extinction), but they are very vulnerable to random catastrophic events.

- Peary caribou only exist in the Northwest Territories and Nunavut. Northwest Territories and Nunavut cannot count on a rescue effect from each other, because Peary caribou numbers are low across their entire range.

Threats to Peary Caribou and its habitat are:

- Aspects of climate change alter availability of forage and ability to move between islands;
- Increasing frequency of severe weather events due to climate change;
- Potential disturbance from industrial exploration and development and human activity;
- Potential competition for food and space with muskoxen;
- Potential for overharvesting; and
- Predation on Peary caribou by wolves is a threat due to small population size of Peary caribou.

Positive influences on Peary Caribou and its habitat are:

- Peary caribou are listed as Endangered under the federal *Species at Risk Act* and a recovery strategy must be developed by 2014;
- Harvest quotas and voluntary restrictions on harvest;
- Strong co-management and community leadership has resulted in the harvest quotas being reduced substantially and carefully monitored;
- Habitat management is well-defined through Community Conservation Plans and the Inuvialuit Land Administration's practice of seeking approval from local Hunters and Trappers Committees before approving development-related proposals;
- Some incidental habitat protection through Aulavik National Park and Migratory Bird Sanctuary No.1; and
- Some aspects of climate change could be beneficial to Peary caribou. These include warmer winters and more available high quality forage in summer.

Recommended measures to conserve Peary Caribou and its habitat are:

- Reproduce historical studies on forage quantity, quality and snow conditions on Banks Island to better determine the effects of climate change on Peary caribou ecology;
- Conduct frequent population surveys on Peary caribou;
- Cooperate with other jurisdictions to ensure effective management of this trans-boundary species;
- Commit funding to continue the collection and documentation of traditional knowledge on Peary caribou;
- Monitor the effects of permafrost change on Peary caribou ecology; and
- Substantially improve weather monitoring in the Arctic.

Executive Summary

Traditional and Community Knowledge	Scientific Knowledge
Description	
Tuktuk (singular: Tuktu, Peary caribou, or *Rangifer tarandus pearyi*) are recognized by Inuvialuit based on their smaller size, lighter colour, and different taste and texture of the meat compared to other groups of caribou. Inuvialuit have historically used them as a primary source of food and clothing while living and traveling on Banks Island and Northwest Victoria Island. They remain a preferred source of food for residents of Sachs Harbour and Ulukhaktok.	Peary caribou (*Rangifer tarandus pearyi*) are small in stature and have noticeably short legs and face. The winter coat is distinctive in being white with a pale brown back in early winter. In summer, the coat is slate grey on the back and does not have the pronounced flank stripe typical of barren-ground caribou. The pale gray antler velvet is a striking distinguishing characteristic compared to the brown velvet of barren-ground or woodland caribou.
Distribution	
Peary caribou live on the islands of the Canadian Arctic archipelago. Within the Arctic islands of the NWT, records of community and traditional knowledge pertain almost exclusively to Banks Island and Northwest Victoria Island; little has been documented for the Western Queen Elizabeth Islands. There have been observed movements of caribou between Banks and Northwest Victoria Island. On Northwest Victoria Island, Peary caribou are found north of Ulukhaktok, predominantly north and northeast of Minto	Peary caribou are restricted to the High Arctic (Queen Elizabeth Islands) and the mid-Arctic islands of Canada, as well as the very northern extension of the mainland (Boothia Peninsula). In the Northwest Territories (NWT), Peary caribou live on Banks Island, northwest Victoria Island and the western Queen Elizabeth Islands. The current distribution in the NWT covers approximately 144,000 km^2 and is naturally discontinuous (fragmented) by island geography and caribou behaviour into three geographical subpopulations (sometimes called

Traditional and Community Knowledge	Scientific Knowledge
Inlet and west of the Shaler Mountains. On Banks Island, Peary caribou range across most of the island. Peary caribou are also known to live on Melville Island and other islands in the Western Queen Elizabeth group. Observations of Peary caribou are made mainly in the context of hunting them for food, and this practice has declined over time in both Sachs Harbour and Ulukhaktok. Fewer harvesters go for Peary caribou than in the past; as well, hunts are conducted less often inland and more along the island coastlines, mostly in the autumn. On Northwest Victoria Island, no Peary caribou harvest has been reported since 1997-98. On Banks Island, a small harvest of Peary caribou continues.	herds). Surveys and observations have indicated a halt to in migration between eastern coastal Banks and northwest Victoria islands, and abandonments of three of the smaller western Queen Elizabeth Islands.
Habitat	
Peary caribou are known to rely on various lichens, especially in the autumn and winter. In June caribou show a preference for moss campion which grows in sandy locations. After snow is gone in mid-July, feeding is more focussed on areas rich in sedges, grass, willows, and mountain sorrel. Flowering legumes (such as pea plants), blueberry plants, and heather may also provide seasonal food sources.	Peary caribou use a relatively wide variety of terrain and vegetation types; available habitat is mostly composed of prostrate dwarf-shrubs and cryptogams. Peary caribou seasonally migrated between habitats such as calving and winter ranges during the 1970s when numbers were higher. The relationship between caribou abundance and extent of migration is a significant gap in current understanding of Peary caribou ecology.

Traditional and Community Knowledge	Scientific Knowledge
Peary caribou inhabit different areas during different times of the year. On Banks Island they are recorded as wintering in valleys, ravines, and side-hills, and summering on hills and slopes along the coast. Peary caribou habitat is affected by climate change and populations of muskoxen which have increased greatly since the 1960s. On Banks Island, especially, these factors are noted as important in Peary caribou declines. Muskoxen may compete with caribou for forage at times, and trample vegetation. The effects of climate change may include more forage for Peary caribou overall, but also possible alterations to the timing of green-up which may be problematic for calves. Increased variability in climate may also lead to more frequent freezing rains, which are noted as limiting factors to the availability of forage for Peary caribou. Peary caribou sometimes cope with freezing rains by moving out onto sea-ice and between islands. However, less stable sea-ice conditions may inhibit such movements.	Because of snow cover, a key habitat requirement is terrain and vegetation features that offer choices as caribou adjust their foraging to snow conditions. Little is known about the habitat requirements for calving areas other than the generalities that calving areas are mainly associated with major drainages and coastal sites with varied terrain, providing snow-free or shallow snow-covered sites. Habitat fragmentation (caused by human activities) has not been documented within Peary caribou range in the NWT.

Traditional and Community Knowledge	Scientific Knowledge
Biology	
Peary caribou are usually seen in small groups of five to ten, but sometimes singly. On rare occasions, larger groups have been seen. Peary caribou are often assessed by hunters in terms of their fat, which accumulates in particular areas such as above the back muscles, in bone marrow, and around the kidneys. Accumulating fat provides the energy required for females to produce calves, and for relocation between foraging areas. Fat reserves may vary depending on age, gender, and season. Wolves prey on Peary caribou. Wolf populations were reportedly increasing on Northwest Victoria Island in the 1990s and numbers were 'healthy' on Banks Island in 1998. Interactions with muskoxen are often described as having negative implications for caribou. Muskoxen compete with caribou for forage and have a strong smell that Peary caribou avoid. Muskoxen are noted as being detrimental to Peary caribou more frequently on Banks Island than on Northwest Victoria Island.	Peary caribou are adapted to extreme cold. Annual variability in winter conditions is characteristic of Peary caribou habitat. Peary caribou are adapted to this variability through their foraging strategies which include local or long-distance movements when winter snow and ice conditions are exceptionally restrictive. The debate about whether muskoxen and Peary caribou compete for food or space dates back to the 1970s and is largely unresolved. However, the two species do show overlap in dietary components. Wolves prey on Peary caribou.

Traditional and Community Knowledge	Scientific Knowledge
Population	
A female caribou in good condition (i.e. sufficiently fat) may calve every year after reaching sexual maturity between 2 and 4 years of age. They may not calve every year if they are in poor condition. Hunters reported in 2001 that Peary caribou on Banks Island were not as fat as they used to be (likely in the 1970s), although they were still in fairly good condition. Inter-island movements of caribou may be decreasing. On Northwest Victoria Island, Peary caribou range was reported to have moved south in the 1950s, when the animals were more common around Holman than they had been previously. By 1998, however, their range had shifted northwards away from the community again. On Banks Island, Peary caribou may have shifted their range in the last 50 years. In the 1960s, they were reported to undertake a seasonal migration from the north and east in the summer to the south and west in the winter. In contrast, in 2008 they were reported to move from the northwest to the southeast. On Victoria Island, hunters believe Peary caribou have been declining gradually since	Peary caribou usually calve at 3 years of age, although under high forage availability and a corresponding high rate of body growth, cows can calve at 2 years of age. Under high forage availability cows can calve every year but this is rare. Peary caribou cows cope with occasional years of restricted forage access either by not becoming pregnant, or by weaning a calf prematurely. Variability in age classes (cohorts) for Peary caribou is evident from high annual variations in productivity. Changes in a population's age structure are a factor in declines and recoveries. The most current information indicates that there are about 7,250 Peary caribou (excluding calves) in the NWT (1,100 caribou on Banks Island and 150 caribou on northwest Victoria Island estimated in 2010, and 6,000 caribou on western Queen Elizabeth Islands estimated in 2012). The NWT holds about 30-60% of the global population, the rest are in Nunavut. All three subpopulations in the NWT display similar trends: high abundance was recorded in

Traditional and Community Knowledge	Scientific Knowledge
the 1970s. Co-management documents follow wildlife biology population estimates that show a large decline in the herds on Northwest Victoria Island, and interviews with Holman hunters in 1993 record their deep concern about the status of Peary caribou. In terms of the availability of caribou to residents of Sachs Harbour, they were reportedly rare in the 1950s, became abundant around the community by the 1970s, and scarce again by the l990s. This latter scarcity appears to have continued until the present time. Peary caribou are described as highly mobile, and their populations are often reported to be cyclic. Previous experiences with scarcity and abundance of Peary caribou leads some hunters in both Sachs Harbour and Ulukhaktok to believe that the caribou will 'come back'. This may refer to a change in either population or their whereabouts. Physiological changes in Peary caribou were reported on Banks Island in 2001. These included smaller antlers on bulls- signifying fewer large bulls in the population- and less fat (likely compared to the 1970s).	either the 1970s-80s (Banks and northwest Victoria Islands) or the early 1960s (western Queen Elizabeth Islands) followed by steep declines (averaging >90%) to lower numbers with no clear evidence for recovery to the higher numbers over the past 20 years. The overall estimated decline for all three subpopulations in NWT only is from about 36,000 Peary caribou (in 1961, 1972 and 1980) to about 7,250 (in 2010 and 2012, combining totals from different years). This represents an overall decline of approximately 80% for the past 50 years (7 generations) for the NWT population. Peary caribou numbers have remained relatively stable during the last 20 years at these severely reduced levels with no evidence of recovery in the NWT, except in the northern-most islands. The predominant factors involved in the declines are hunting, predation, reduced forage availability caused by severe icing events, and competition with increased numbers of muskoxen. These factors act differently depending on whether the number of caribou is high or low.

Traditional and Community Knowledge	Scientific Knowledge
Threats and limiting factors	
Sources note several contributing factors to Peary caribou declines on Banks and Northwest Victoria Island. Past overharvesting is most frequently mentioned as the primary cause on Northwest Victoria Island; this threat appears to have been removed as no harvesting of Peary caribou has been reported there since 1997-98. Competition with muskoxen and severe weather events are most frequently mentioned as causes of declines on Banks Island; these effects appear to be ongoing. Some effects of climate change could have negative implications for Peary caribou. For example, a warming climate and changing winds, and less stable sea-ice conditions could impede their ability to travel between islands, which is one way they cope with severe weather conditions. Wolves are noted by many on Banks Island as a threat to caribou; wolf numbers increased in the 1980s and 1990s. A past wolf control (poisoning) program in the late 1950s has also been linked by some to growth of the muskox population on Banks Island. Wolf predation seems to be a less important threat on	Availability of forage as mediated by weather, hunting, and wolf predation are main threats and limiting factors for Peary caribou. There is uncertainty about which threats are responsible for the absence of recovery in the three NWT geographic subpopulations because although productivity varies annually, it is not consistently low and trends are not apparent. There are no measures of adult survival. Disturbance from human activity and contaminants at current levels do not appear to be threats. The prevalence, intensity, and effect of parasite infections or diseases in Peary caribou are scarcely known. While temperatures and precipitation can be variable, it is not understood how this variability influences forage growth and productivity relative to winter forage availability, or parasite or disease prevalence. Wolf numbers and muskox numbers appear to have increased in most Peary caribou subpopulation ranges since the 1980s. Increased muskox abundance has likely supported increased wolf numbers; in other words, muskoxen could be subsidizing predation rates on Peary caribou.

Traditional and Community Knowledge	Scientific Knowledge
Northwest Victoria Island. There are concerns about the negative effects of resource development on Peary caribou. Specific concerns pertain to low-flying helicopters, increasing interest in coal exploration, a proposed Melville Island gas pipeline, offshore oil and gas exploration, and potentially increased offshore marine traffic.	
Positive Influences	
Current wildlife management regimes are a positive influence on Peary caribou. Harvest quotas for Peary caribou have greatly reduced hunting pressure on both Banks and Northwest Victoria Islands; this has been especially important on Northwest Victoria Island. There is also some harvesting of muskoxen and wolves taking place. In Canada, Peary caribou were listed as Endangered under the federal *Species at Risk Act* in 2011. This means that a Recovery Strategy must be developed by 2014. Habitat management is well-defined through Community Conservation Plans and the Inuvialuit Land Administration's practice of seeking approval from local Hunters and Trappers Committees before approving	A key positive influence that likely halted the decline of Peary caribou in the 1990s was the voluntary restriction of hunting of Peary caribou by Sachs Harbour and Ulukhaktok hunters. Management planning, community conservation plans, and recovery planning has occurred but with unknown direct impact on subpopulations. Benefits from habitat protection through land use planning are unmeasured but may become increasingly important in the future.

Traditional and Community Knowledge	Scientific Knowledge
development-related proposals. Some implications of a warming climate and changing winds are reported as being beneficial to Peary caribou. These include fewer mosquitoes in the summer, more available forage, and warmer winters.	

Technical Summary

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
Population trends		
Generation time (*average age of parents in the population***) (indicate years, months, days, etc.)**	Peary caribou can produce offspring beginning when they are 2-4 years of age, and can live up to 15 years in the wild.	7 years. However, calculation of generation time depends on age structure and average age of the population, which for Peary caribou can change over time
Number of mature individuals in the NWT (or give a range of estimates)	Exact number not available from traditional and community knowledge sources; however Peary caribou numbers are considered very low compared to the 1970s.	About 7,250 adults (1+ year olds), based on 2010 surveys of Banks and Victoria islands, and 2012 surveys of NWT western Queen Elizabeth Islands. The number of mature individuals (capable of reproducing) is unknown. Peary caribou can reproduce at 2 to 4 years of age.
Amount of change in numbers in the recent past; *Percent change in total number of mature individuals over the last 10 years or 3 generations, whichever is longer*	Most sources indicate that Peary caribou have become scarcer on Banks and NW Victoria Island since the 1970s. Significant concerns often accompany descriptions of the recent scarcity of Peary caribou, suggesting that the amount of change has been relatively dramatic.	Numbers have generally stabilized at reduced numbers over the last three generations (21 years). Because of information gaps in calculating generation time and the extreme climatic variability characteristic of the region, it is appropriate to also assess trends in distribution over 40-50 years. Current numbers in the NWT are about 80% less than historic numbers seen 50 years ago.

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
Amount of change in numbers predicted in the near future; *Percent change in total number of mature individuals over the next 10 years or 3 generations, whichever is longer*	Few reports make claims as to future numbers of caribou, but those that do note cyclical population trends. Caribou are predicted to 'come back' (although no indications are offered as to when). This may refer to a change in either numbers or their whereabouts.	SARC (2010) defines "continuing decline" as "a recent, current or projected future decline, which may be smooth, irregular or sporadic, that is liable to continue unless remedial measures are taken". Peary caribou in the NWT remain at low numbers, it is difficult to detect whether this "stability" is a slow decline, or a slow recovery, or no trend. However, the sustained low numbers suggest high vulnerability to further declines.
Amount of change happening now; *Percent change in total number of mature individuals over any 10 year or 3 generation period which includes both the past and the future*	No indications of major changes currently. Populations still described as low.	Current numbers in the NWT are about 80% less than historic numbers seen 50 years ago and the sustained low numbers suggest high vulnerability to further declines.
If there is a decline (*in the number of mature individuals*), **is the decline likely to continue if nothing is done?**	Sources do not mention risks of further decline.	Uncertain as reasons for current low numbers and possible declines are complex. Some major threats are very difficult to monitor and almost impossible to control (linked to climate).
If there is a decline, are the causes of the decline reversible?	Causes of declines include past overharvesting on NW Victoria Island, which has been reversed. Causes also include the effects	Some major threats are very difficult to monitor and almost impossible to control (linked to climate).

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
	of severe weather events and encroachment by muskoxen on Banks Island. The effects of severe weather are not reversible.	
If there is a decline, are the causes of the decline clearly understood?	On NW Victoria Island, past overharvesting is the most commonly-noted cause. On Banks Island, encroachment by large numbers of muskox, and increasing frequency of severe weather events are reported by many as negatively affecting Peary caribou. Cumulative effects on caribou from interactions between muskoxen and wolves, and the effects of severe weather events, are complex.	Uncertain but causes of declines include interactions between over-hunting, changes in predation, reduced forage availability, changes in weather and possibly competition with muskoxen.
If there is a decline, have the causes of the decline been removed?	To the extent that past overharvesting contributed to Peary caribou decline on NW Victoria Island, this cause seems to have been removed. The effects of encroaching muskoxen, severe weather events, changing wind conditions and climatic warming generally have not been removed.	Partially, as hunting is now restricted
Are there extreme changes in the number of mature individuals?	Peary caribou populations are often reported to fluctuate in cycles. It is unclear whether these are 'extreme'.	Current numbers are about 80% less than historic high numbers seen 40-50 years ago. If these changes are indicative of

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
		fluctuations, they may attain one order of magnitude in the northernmost subpopulations.
Distribution Trends		
Where is the species found in the NWT?; *Estimated extent of occurrence in the NWT (in km2)*	Peary caribou are found in the islands of the Arctic Archipelago.	237,022 km^2
How much of its range is suitable habitat?; *Index of area of occupancy (IAO) in the NWT (in km2; based on 2 × 2 grid)*	Unclear.	167,492 km^2 (IAO); 158,293 km^2 for biological occupancy
How many populations are there? To what degree would the different populations be likely to be impacted by a single threat?; *Number of extant locations in the NWT*	The different causes for Peary caribou declines noted on Banks and NW Victoria Island indicate that different populations may not be impacted by a single threat. However, both populations have declined concurrently. Changes in sea-ice conditions may impact multiple populations by inhibiting their movement. This may also accentuate a tendency for populations on larger islands to be more robust than those on smaller islands. There are no indications as to threats to caribou on the Western QE Islands.	There are three subpopulations (two Arctic Islands and one island complex) – each subject to a different combination of threats – but the number of 'locations' is difficult to determine due to complex weather patterns across a large area.

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
Is the distribution, habitat or habitat quality showing a decline that is likely to continue if nothing is done? ; *Is there a continuing decline in area, extent and/or quality of habitat?*	There is no evidence that distribution or overall habitat has changed significantly, although caribou distributions may fluctuate somewhat on NW Victoria Island. Habitat quality may have declined on Banks Island due to severe weather events and encroachment by muskoxen.	Uncertain due to limited information.
Is the number of populations or amount of occupied area showing a decline that is likely to continue if nothing is done?; *Is there a continuing decline in number of locations, number of populations, extent of occupancy and/or IAO?*	There is no evidence that the number of populations or amount of occupied area is in decline.	No known continuing decline in number of location, or subpopulations. Declines in extent of occupancy are uncertain due to limited information.
Are there extreme fluctuations in the range or the number of populations? ; *Are there extreme fluctuations (>1 order of magnitude) in number of locations, extent of occupancy and/or IAO?*	No.	Some fluctuation but not by one order of magnitude (not extreme). Uncertain in future.
Are most individuals found within small and isolated populations? ; *Is the total population severely fragmented (most individuals found within small and isolated populations)?*	No; while caribou are normally found in small groups, they are highly mobile.	Subpopulations are naturally isolated on islands separated by up to 100 km of ocean/ice. Two of the three subpopulations have more than 1,000 adult caribou, so not all are deemed ‘small’.

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
Immigration from populations elsewhere		
Does the species exist elsewhere?	Yes (Nunavut).	Yes (Nunavut)
Status of the outside population(s)	Peary caribou populations on the southern Arctic islands in Nunavut (including Bathurst Is.) experience wide fluctuations, and were reported as low and unstable in 2005. Peary populations on the northern Arctic islands in Nunavut (Devon and Ellesmere Is.) were reported as healthier and more stable.	Severe decline since the 1960s; apparently "stable" at low numbers for the past 20 years.
Is immigration known or possible?	Implied; Peary caribou are known to move between islands, although no specific observations were reported of immigration of animals from Nunavut.	Possible
Would immigrants be adapted to survive and reproduce in the NWT?	Implied in sources reviewed here.	Yes – same subspecies
Is there enough good habitat for immigrants in the NWT?	Implied in sources reviewed here.	Likely
Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	It is unclear to what extent caribou move between the NWT and Nunavut, therefore it is not possible to assess if immigration plays a key role for long-term survival of caribou in the NWT.	Unknown; may be self-sustaining but may be vulnerable to stochastic events and immigration between subpopulations may be necessary for each to be sustained.

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
Threats and limiting factors		
Briefly summarize negative influences and indicate the magnitude and imminence for each	On NW Victoria and especially Banks Island, encroachment by muskoxen has been reported to negatively affect caribou. Muskox populations have been high since the 1970s. On Banks Island, wolf populations increased in the 1980s and 1990s, which contributed to caribou declines between 1994 and 1998. People feel the threat is being managed adequately. On NW Victoria Island, past overharvesting was reported as the largest contributing factor to declining caribou. However, harvests have been minimal since 1993. Negative effects from severe winter conditions and freezing rain are reported on Banks Island and on NW Victoria Island; this threat seems to be more important on Banks. Trends in climate observations point to an increasing frequency of severe weather events. Changing winds and a warming climate may impede the ability of Peary caribou to travel between islands, which may be a key coping strategy against	• Climate change (ultimate threat) could have significant implications for the survival of Peary caribou; • Periodic and unpredictable lack of forage availability (primarily weather-related, which is climate-related); • Hunting (currently controlled); • Disturbances from human activity (currently low but may be increasing); • Contaminants (currently very low and localized); • Wolf predation (unknown - possibly significant); and • Intra- and inter-specific forage competition (possible - unknown).

Question **TK/CK;** *Science*	Traditional & Community Knowledge	Scientific Knowledge
	the effects of severe weather events. People are concerned about the effects of industrial development on caribou populations, specifically low-flying helicopters, coal exploration, a proposed Melville Island gas pipeline, and potentially increased offshore marine traffic.	
Positive influences		
Briefly summarize positive influences and indicate the magnitude and imminence for each	Hunting pressure on Peary caribou is controlled under quotas and has been minimal in all NWT populations since 1994. Community Conservation Plans include specific land management guidelines for some areas important for Peary caribou. A regular muskox harvest has been conducted on Banks Island since 1981, although harvests are insubstantial compared to the allowable quota and muskox numbers remain high. Some effects of climate change may be positive for Peary caribou, including increased forage, warmer winters, and fewer mosquitoes in summer.	• Voluntary harvest restrictions by Sachs Harbour and Ulukhaktok hunters in the early 1990s (immediate and significant implications); • Management planning, community conservation plans, and recovery planning (useful for awareness and management focus – limited short-term impact); • Habitat protection (longer-term and moderate implications).

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Traditional and Community Knowledge component

Preamble

This report in many ways reflects an absence of documentation for traditional and community knowledge of Peary caribou in the NWT, although there is every indication that extensive knowledge of Peary caribou exists in Sachs Harbour and Ulukhaktok (Nagy 2004; Pearce *et al.* 2011). Peary caribou were a staple for Inuvialuit people on Banks and Victoria Islands until the mid-1980s as a source of meat for food, hides for clothing and tents, and bones for various tools (Whittles 2005). More recently, through fur trading and some big-game hunting (from the mid-1970s until the late 1980s), Peary caribou have also contributed to the wage economy of Sachs Harbour and Ulukhaktok (Condon 1996; Whittles 2005). However, it is evident that only a small portion of community knowledge of caribou has been documented. Of the records that are available, most are from Banks Island and Northwest Victoria Island; almost no information from traditional and community sources has been documented regarding Peary caribou in the Western Queen Elizabeth Islands.

Due to a scarcity in documentation of such knowledge, sources such as community conservation plans, and regional co-management plans have been used in this report, although they tend to combine traditional knowledge and science without any clear indication of which statements are founded in which sources of knowledge. This is not in itself problematic, and may actually reflect constructive interactions between community members and wildlife biologists. But at a more basic level, traditional ecological knowledge in the contemporary north is inevitably informed by various sources, and these likely include wildlife biologists to some extent (Usher 2000; Wray 2010). "For example, field science programs have been employing aboriginal Northerners since at least the 1960s, including some who are elders today. They are aware of what scientists actually do and find out, and even if they do not agree, they have considered scientific knowledge critically against their own" (Usher 2000: 185). Recognizing that "the strict dichotomies between western science and TK for communities… seem inappropriate given the availability and potential influence of scientific information about caribou" (Wray 2010: 72), it is impossible to completely filter out traditional and community knowledge of Peary caribou in many documents reviewed here. The task is further hindered by authors and editors inevitably

interpreting community and traditional views to some extent in the process of presenting them.

The best documentation of traditional and community knowledge of Peary caribou in the NWT seem to be the compilations put together through the Aulavik Oral History Project, although they (especially the original transcripts) are not often specific about years and locations in their references to caribou. Other sources from Victoria Island are also often vague as to whether they pertain to Peary caribou or Dolphin and Union caribou.

Finally, the ability of community and traditional knowledge to inform Peary caribou studies appears to be challenged by a declining trend in harvesting (or 'search effort') (Nagy 1999c; CPCVI 1998; Governments of Northwest Territories and Nunavut 2011; Pearce *et al.* 2011). Thus, for a thorough record of Peary caribou dynamics to be compiled through such sources would likely require more than traditional knowledge studies and interviews with active hunters. A more formal community-based monitoring program appears necessary, similar to programs recommended in Nunavut by Jenkins *et al.* (2011: 156-8), and in the Sachs Harbour Community Conservation Plan (2008: 47).

Names and classification

Tuktu (Plural: Tuktuk) (Kangiryuarmiut; Lowe 1983)

Toktu (OCCP 2008)

Tuktuinak (Inuinnaqtun, 'small caribou'; ENR 2011)

Tuktuaraaluit (Siglitun; 'small caribou'; ENR 2011)

Tuttunguluurat (Ummarmiutun; 'small caribou'; ENR 2011)

Peary Caribou (English)

Caribou de Peary (French)

Rangifer tarandus pearyi (Scientific)

LIFE FORM: large mammal, deer, caribou

Figure 1. Peary caribou (Photo by John Nagy, Environment and Natural Resources (ENR)).

Description

Tuktuk (singular: Tuktu, Peary caribou, or *Rangifer tarandus pearyi*) are recognized by Inuvialuit based on their smaller size, distinctly lighter colour, and different taste and texture of the animals' meat compared to other groups of caribou (Alex Banksland, Agnes Goose, Morris Nigiyok, and Harry Egotak in Elias 1993) (Figure 1). Inuvialuit have historically used them as a primary source of food and clothing while living and traveling on Banks Island and Northwest Victoria Island, and they remain a preferred source of food for residents of Sachs Harbour and Ulukhaktok.

Jenkins *et al.* (2011: 1) report that the distribution of Peary caribou within Canada extends "across the Queen Elizabeth Islands in the north, and east from Banks Island to Somerset and the Boothia Peninsula in the south." However, this distributional classification has undergone several revisions over time leading to potential confusion about what are considered Peary caribou. Some accounts have suggested that caribou on Banks Island and Northwest Victoria Island are an intergrade species between 'Peary caribou' (of the more northerly islands) and barren-ground caribou on the mainland (Usher 1971b; Miller 1990). In the 1970s, COSEWIC (Committee on the Status of Endangered Wildlife in Canada) designations combined what are now considered to be Peary caribou with Dolphin and Union caribou, but then later separated the species into three subpopulations (Banks Island, High Arctic, and Low Arctic) in 1991 (NWT

Peary Caribou Technical Committee 2004). Finally in 2004, previous designations were deactivated, and Peary caribou were assessed separately within the range indicated in Figure 2 (p.8) (COSEWIC 2004).

The complexities of classifying different groups are also evident in ambiguities regarding the number of distinct herds referred to in community reports. For instance, on Victoria Island the Olokhaktomiut Community Conservation Plan (OCCP 2008) refers to 'Peary caribou', 'Victoria Island caribou', and non-specific 'caribou'. In addition, the draft Co-Management Plan for Minto Inlet Caribou, Muskox, Arctic Wolves, Small Herbivores, King Eiders and common Eiders on NW Victoria Island (hereafter referred to as CPCVI 1998) refers to 'Minto Inlet caribou'. On Banks Island, the Sachs Harbour Community Conservation Plan (SHCCP 2008) also refers to 'Peary caribou', 'Banks Island caribou', and 'Arctic Islands caribou'. None of these documents indicate the differences (if any) between such groups, although some of the designations appear consistent with a Species Status Report compiled by Miller (1990).

This report follows the classifications presented by the NWT Peary Caribou Technical Committee (2004) and COSEWIC (2011), as well as Jenkins *et al.* (2011), which advocate caribou populations of Banks Island and Northwest Victoria Island being classified as the *pearyi* subspecies, and assumes all the designations described above refer to Peary caribou (references to 'non-specific caribou' are included where they specify locations where Peary caribou are known to occur).

The history of such name changes and variable local names for groups of caribou, and evolving scientific analyses (see COSEWIC 2011) that have grouped them into specific units have caused a significant level of confusion between communities and wildlife managers. More information from and shared with local hunters is needed to resolve potential ambiguities and bring about a common understanding in the classification of Peary caribou and Dolphin and Union caribou.

Distribution

Peary caribou live in the Canadian Arctic archipelago, and are the most northerly group of caribou in North America (Figures 2 and 3, p.8; Jenkins *et al.* 2011).

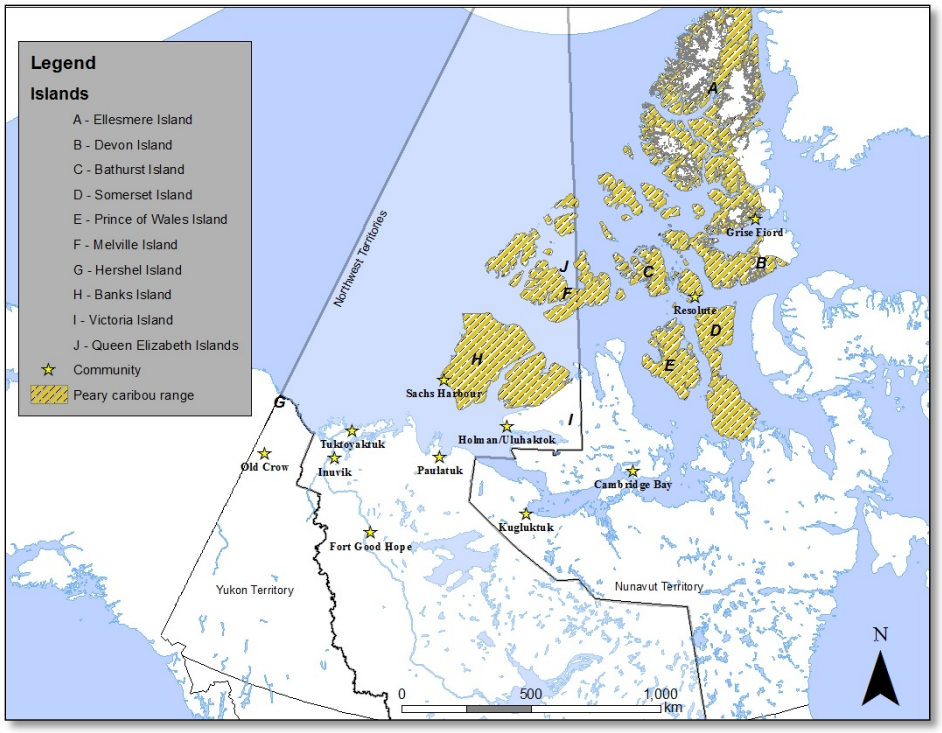

Figure 2. Distribution of Peary caribou.

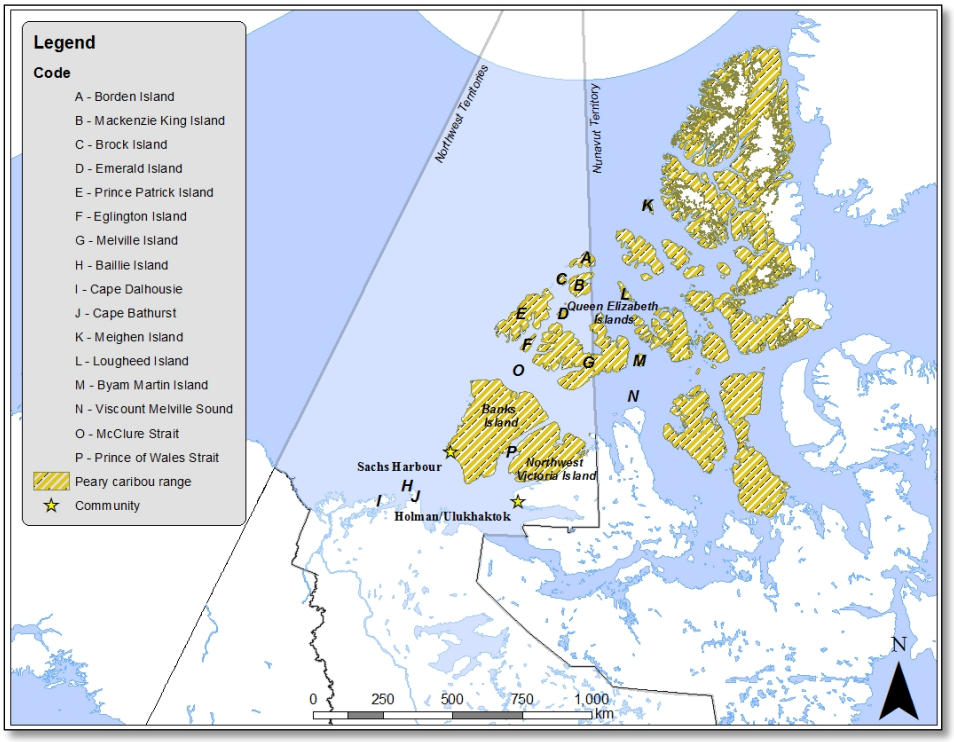

Figure 3. Place names and distribution of Peary caribou.

NWT Distribution

Peary caribou in the Northwest Territories live on the islands of the Arctic archipelago. They are sometimes seen out on sea-ice and are reported to have occasionally travelled to the mainland (Morris Nigiyok in Elias 1993; Larry Carpenter in Sachs Harbour Community Meeting [SHCM] 1998; Larter pers. comm. 2012). In Nunavut, it is known that Peary caribou move to the mainland, particularly Boothia Peninsula (Jenkins pers. comm. 2012). One hunter from Resolute indicated that at one point "Peary caribou went down to a place where there are only supposed to be mainland caribou, and then vice versa" (Parlee and Furgal 2010). Peary caribou were reportedly seen around Coppermine on the mainland in the 1990s (Larry Carpenter in SHCM 1998), and one light-coloured caribou was apparently killed at Old Crow in the Yukon in the winter of 1963-64 (Miller 1990: 14). However, because both Dolphin and Union and Peary caribou are whiter in pelage than barren-ground caribou, it is unclear whether the latter example refers to Peary caribou, or members of the Dolphin and Union population (Miller 1990).

Northwest Victoria Island

At least two distinct populations of caribou inhabit Victoria Island according to knowledge held by residents of Ulukhaktok: Peary and Dolphin and Union (also sometimes locally called 'Mainland' caribou) (Elias 1993). Given that the Dolphin and Union population migrate seasonally from Victoria Island to the mainland, they may also be known as 'Island' caribou to some residents in Paulatuk on the mainland (Gau pers. comm. 2011). This can sometimes make it difficult to identify which group is being referred to in documents recording traditional and community knowledge. As the sources reviewed here come mainly from Ulukhaktok, the terms 'Mainland' caribou and 'Dolphin and Union' caribou are considered synonymous in this report. To some extent, differentiating Dolphin and Union from Peary caribou can be inferred by location based on a consensus that Peary caribou live north of Ulukhaktok, predominantly around and north of the Minto Inlet area, while 'Mainland' caribou are more common inland on the Diamond Jenness Peninsula in the summer, and southeast of Prince Albert Sound in the winter (Alex Banksland, Jimmy Memogana, and William Kagyuk in Elias 1993). However, traditional knowledge from Ulukhaktok (Harry Egotak in Elias 1993, OCCP 2008) also indicates overlapping ranges, insofar as Peary range extends onto the Diamond Jenness Peninsula, making assignments of caribou into groups solely on the basis of location problematic (see also: Gunn and Fournier 2000: 56). This is compounded by the ambiguities in caribou classifications in some documents noted above. Figure 4 (p.10) shows important areas on Northwest Victoria Island identified for caribou other than Dolphin and Union caribou. Notably, this shows Peary

caribou range extending somewhat further south than is indicated in Figures 2 and 3, p.8.

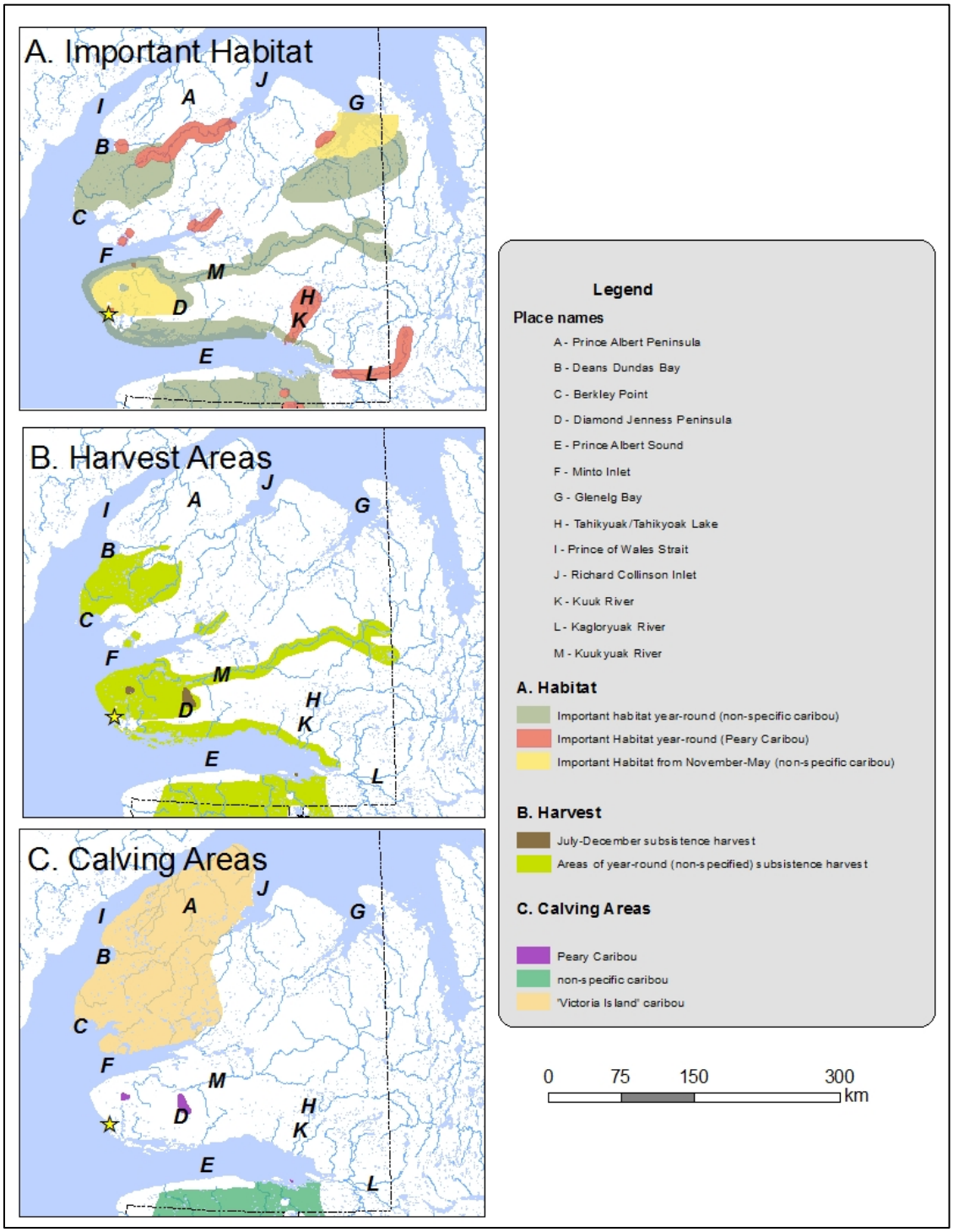

Figure 4. Important areas for Peary caribou, Victoria Island caribou, and non-specific caribou on Northwest Victoria Island identified in the OCCP (2008).

Banks Island

Figure 5 shows important areas on Banks Island identified for 'Banks Island caribou', 'Arctic Islands caribou', and 'Peary caribou' (SHCCP 2008). An older version of the Sachs Harbour Community Conservation Plan (SHCCP 1992) also shows the seasonal movements of caribou ranging over virtually the entire island (Figure 6, p.12). As range maps are not included in later editions of the Plan, comparisons are not possible.

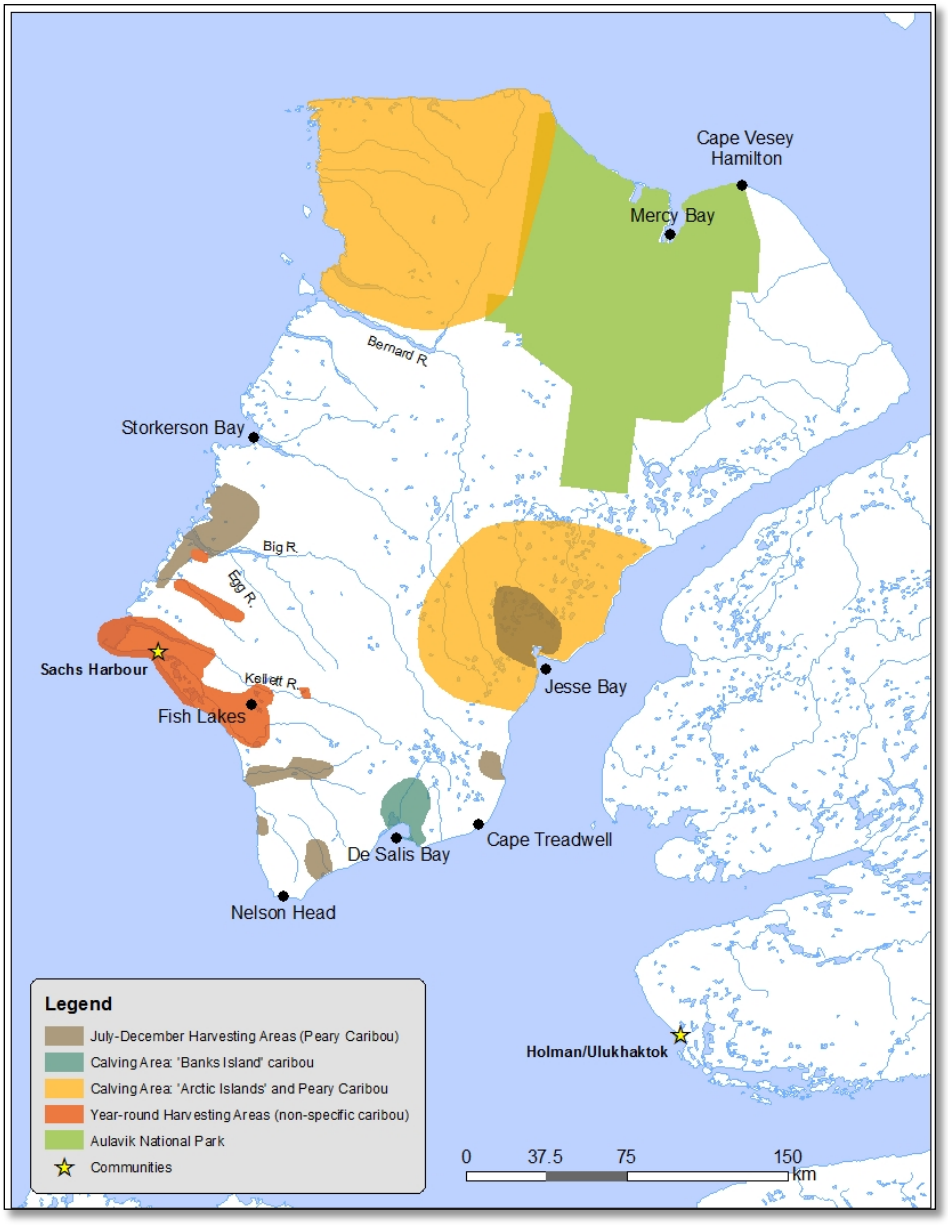

Figure 5. Important areas for caribou on Banks Island identified in the Sachs Harbour Community Conservation Plan (SHCCP 2008).

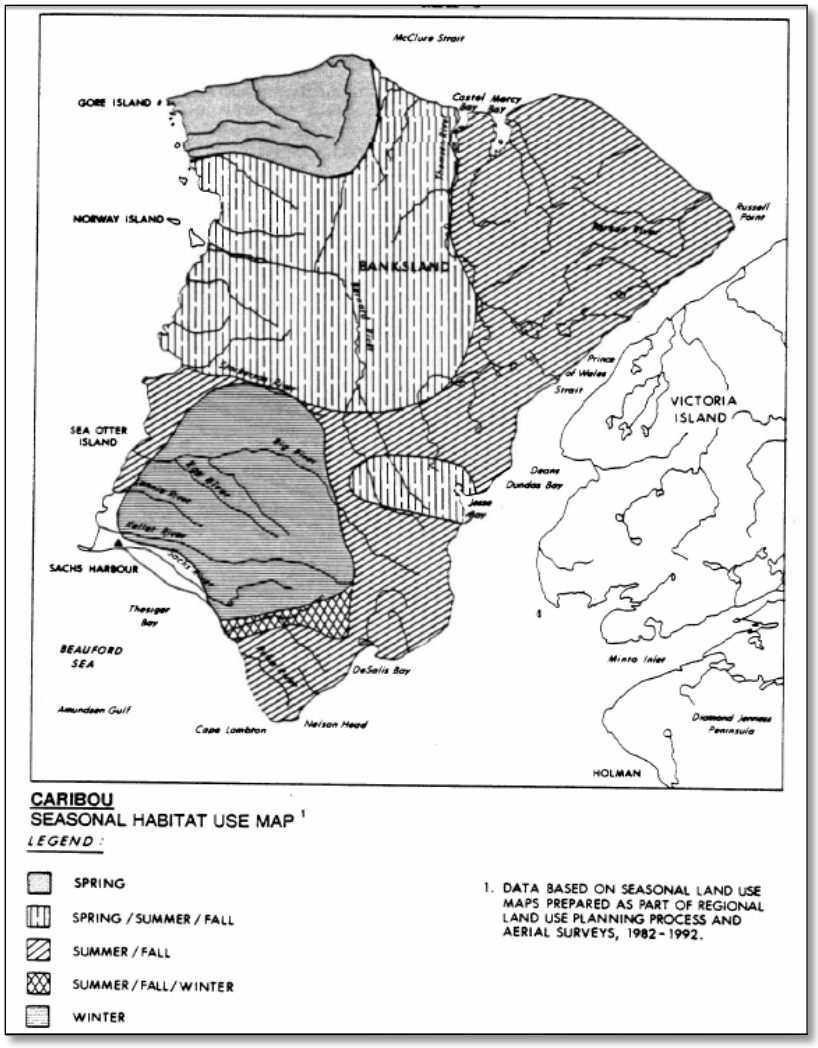

Figure 6. Caribou seasonal habitat use on Banks Island 1982-1992 (reproduced from SHCCP 1992:60, with permission from the Sachs Harbour Hunters and Trappers Committee).

Western Queen Elizabeth Islands

Figure 7 (p.13) shows important areas on the western Queen Elizabeth Islands identified for 'caribou' (assumed to be Peary caribou) (OCCP 2008). The inclusion of such information in the OCCPs (2000, 2008) suggests that traditional and community knowledge does exist about Peary caribou on high arctic islands within the NWT (such as Melville, Prince Patrick, and Eglinton Islands). However, there were no descriptions in the sources to accompany this map, beyond the testimony of Stefansson (1921). He and his party did observe and hunt Peary caribou on many of these islands from 1915 to 1917, and their observations on forage quality for caribou are noted below in the *Habitat* section (p.22).

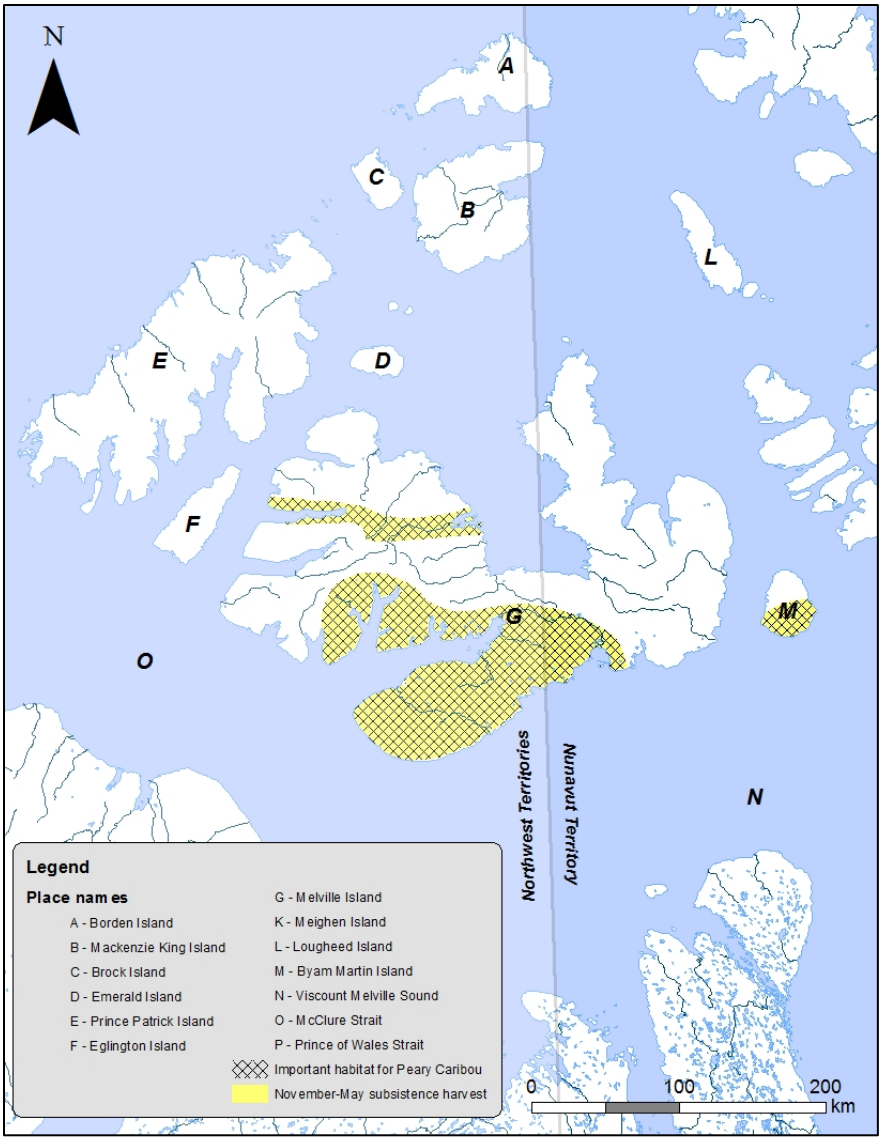

Figure 7. Important areas for caribou on the western Queen Elizabeth Islands identified in the Olokhaktomiut Community Conservation Plan (OCCP 2008).

Search Effort

"Search effort" is a way of describing how well people know where Peary caribou are. To the extent that this is based on traditional and community knowledge, it is formed through iterative experience and informed by the teachings of elders and discussions with other hunters (McMillan 2012). Taylor (2005: 31) describes the concept of search effort as it relates to traditional and community knowledge in Nunavut:

"*The Inuit observations were not the result of a systematic aerial study that attempted to cover*

the given percentage of ground using a repeatable methodology. Instead, they are observations made in areas where people could travel by foot, dogsled, snowmobile and/or boat. Sightings were made as a result of: (i) informed decisions as to where to hunt; (ii) exploration of unknown areas i.e., areas where animals had been known to occur sometime in the past; or (iii) by chance (e.g., not attempting to find caribou... but by camping or working in an area where animals happened to be present)."

From the sources reviewed for this report, Inuvialuit observations of Peary caribou seem to be primarily made in the context of harvesting them for food and clothing across a vast area in the Inuvialuit Settlement Region. Harvesting occurs on trips made specifically for hunting caribou and also during other activities such as trapping, hunting other species, or traveling from one place to another. Riedlinger and Berkes (2001: 321) explain,

"In the community of Sachs Harbour, many families maintain camps at inland lakes that they travel to regularly, often at the same time every year. These trips provide a time series of observations which can be recalled years later, on such things as inland snow conditions, sea-ice, and the appearance of migratory animals… Such observations provide an in-depth, cumulative, relational, diachronic [happening over time] set of information for a given area."

Hunting patterns, and therefore search effort, can also change over time. It is important to account for these changes (especially which areas are traversed, when, and how often) because they affect the observations that are made. In addition, some areas may not be traversed at all, such as the high ground near Nelson Head on Banks Island: "We never go through that, we never hunt in that part because it's too high and lots of rocks there" (Peter Esau in Berger 1976b: 4127-28). Unfortunately, accounts of harvester search effort from the sources reviewed here are not consistent enough to draw specific inferences that might give context to observations about Peary caribou populations, distributions, and dynamics over time.

Overall search effort is likely declining as multiple reports indicate that fewer hunters in Sachs Harbour and Ulukhaktok go for caribou than in the past (Condon 1996: 175; Collings and Condon 1996; Nagy 1999c; Pearce *et al.* 2011). John Lucas explains, "There's some [hunters], but now it's starting to be going down. Now that all these old timers are slowly finishing, we don't have that many. Most of these young guys that are going out, they lack experience. It's getting kind of dangerous too…" (in Nagy 1999c: 153-154). Sam Oliktoak in part relates this to restrictions on hunting, stating that "Even in the summer, the people don't walk the land anymore too that's why… People are staying mostly in town, where there's houses" (in Nagy 1999c: 154).

Riedlinger (2001a, 2001b) also describes climate changes impacting harvesters' search effort.

For instance, she records that less snowfall on Banks Island impedes hunters' ability to travel the land. Specifically, hunters report that they are no longer able to go caribou hunting at the end of September for lack of snow: "We notice because [now] we travel to our cabin in October" (F. and M. Kudlak in Riedlinger 2001a: 73). Unreliable snow conditions leading to more bare ground and open water also means that families prefer to travel along the coast rather than inland (Riedlinger 2001b: 97-98).

Historical search effort

Historical accounts of search effort describe hunters traversing vast areas in order to locate caribou (Stefansson 1921; Berger 1977). This was often a seasonal pattern where in the spring hunters would begin to travel to locations they knew were used by caribou in the summer (William Kuptana [section N92-253-084a] in Nagy 1999a).[1] When caribou were available, hunters and their families would harvest and prepare large amounts of dried meat in preparation for harsher times (Susie Tiktalik and William Kuptana in Nagy 1999a).[2,3] In summertime, this often involved caching meat for the winter. People also hunted caribou in the late summertime as their hair was in prime condition for winter parkas (Farquharson 1976; William Kuptana [section N89-08-009a] in Nagy 1999a). Sometimes it was necessary to make clothing from caribou harvested in the winter, however, even though their hides were in poor shape, and falling apart (William Kuptana [section N89-008-011a] in Nagy 1999a).

Before the introduction of rifles, some groups only hunted caribou on hilly land (presumably because of the cover it afforded) (Farquharson 1976). Sometime before 1923, rifles became available which likely made hunting caribou easier on sea-ice devoid of cover (Farquharson 1976). In the 1970s, caribou hunting became a practice undertaken with skidoos rather than dogsleds during the winter (Condon 1996: 161-64; OCCP 2008). Skidoos made hunting faster and easier, and caribou would not be as likely to run away as they had been when hunters used dog-teams (Condon 1996). Hunters could also cover a greater distance searching for caribou, thus increasing the effectiveness of their search effort (Condon 1996).

Northwest Victoria Island

Residents of Ulukhaktok have historically hunted both Peary caribou and 'Mainland' (Dolphin and Union) caribou populations on Victoria Island. When one herd is less accessible, this can lead to increased hunting pressure on the other (Farquharson 1976; OCCP 1994, 2008). For example, Farquharson (1976) describes that between 1940 and 1962, 'Mainland' caribou became

scarcer south of Prince Albert Sound, which increased hunting of the Peary caribou. Conversely, harvesting pressure can shift to "barren-ground caribou around Prince Albert Sound" (presumably Dolphin and Union caribou) when Peary caribou are scarce (OCCP 1994, 2008: 69). Accounts also seem to suggest that the peak harvesting season may have changed from the late winter/spring (before the 1970s), to the winter (1970s-80s), to the autumn (since the 1990s), although some harvesting may occur year around (Farquharson 1976; Jacobson 1980; OCCP 2008; Kassam 2009). In addition, by the mid-1980s harvesters were using more coastal areas on Northwest Victoria Island than they had previously (Kuptana 1983).

Historically, two Copper Inuit groups occupied Northwest Victoria Island: the Kanghiryuachiakmiut (centred in Minto Inlet), and the Kanghiryuakmiut (centred in Prince Albert Sound) (Farquharson 1976). Kanghiryuachiakmiut (Minto Inlet) would hunt caribou primarily in the spring and fall over much of Northwest Victoria Island, including the Minto Inlet area, Richard Collinson Inlet, Glenelg Inlet, and along the Kuujjuak River (Farquharson 1976). Kanghiryuakmiut hunted seals in the winter, and caribou during the rest of the year along the Kagloryuak and Kuuk Rivers and around North Tahiryuak Lake (areas that may be occupied by either Peary or Dolphin and Union caribou) (Farquharson 1976; OCCP 2008). Most of the Prince Albert Sound group's hunting was conducted in the spring and summer, and to a lesser extent in early fall (August and September) when the animals were at their fattest and their hides ideal for making clothing (Condon 1996: 76).

From 1923-39, hunters from the Minto Inlet group would hunt caribou in the spring along the rivers and inlets of Prince Albert Sound and Minto Inlet, often when the herds were crossing Minto Inlet from the highlands south of the Kuujjuak River (Farquharson 1976: 58; OCCP 2008: 14). In the summer, hunters (including some from the Prince Albert Sound group) travelled around the Prince Albert Peninsula from Deans Dundas Bay to the Shaler Mountains and Glenelg Bay to hunt Peary caribou, while others went across to De Salis Bay or Cape Treadwell on Banks Island. Then, "in late summer, they began to move back toward their winter camps, and they hunted caribou all around Minto Inlet to get skins for winter clothing" (Farquharson 1976: 58). Families obtained only a few caribou while trapping during the winter (Farquharson 1976).

Hunting increased between 1939 and 1965 around Minto Inlet, with the exception of the highland area northeast of Holman (Ulukhaktok) as "…many caribou winter there, but the area is too rough for fast and easy travel" (Farquharson 1976: 61).

Between 1962 and 1976 caribou were hunted along the coast in the fall, but mostly by

snowmobile inland east of Minto Inlet as far as the Shaler Mountains (Farquharson 1976). Hunting also continued in the winter along trap lines, sometimes far inland north of Minto Inlet, along the south coast, and to the east of Ulukhaktok past the Kuuk River (Farquharson 1976). In early spring, caribou were typically accessible close to Ulukhaktok, and were hunted on the Prince Albert Peninsula, and along the Kuujjuak River. The mountainous area to the northeast of Ulukhaktok was still traversed less frequently, however.

Jacobson (1980) describes caribou harvesting in the late 1970s by approximately a dozen residents of Ulukhaktok. The harvesting was usually in conjunction with trapping and occurred on Northwest Victoria Island from October to April, along Prince of Wales Strait and Minto Inlet, as far east as Glenelg Bay. From 1980 until at least 1983, Inuvialuit on Victoria Island did not hunt as far inland as they did previously, instead hunting more along the coast during the summer (Kuptana 1983: 5). In the 1980s, hunting around Minto Inlet was conducted mainly in the winter, and around Prince Albert Sound in the summer (Gunn and Fournier 2000).

Based on interviews in 1998 and 1999, Kassam (2009) presents caribou hunting by Ulukhaktok residents as occurring somewhat from February to May, but at its highest in August, September, and October. He notes these characteristics as related to conservation measures, but does not elaborate (Kassam 2009: 132). Caribou hunting areas included Prince Albert Sound, Minto Inlet, Berkley Point, the west end of Diamond Jenness Peninsula, and the Shaler Mountains. These areas are typically associated with the Peary caribou population, although it is unclear if those areas were in current use in 1998-99. Governments of Northwest Territories and Nunavut (2011) do record a harvest of Peary caribou by Ulukhaktok hunters in 1997-98, but are unclear regarding a Peary caribou harvest for 1998-1999, (see Table 1, p.38). Generally, due to a voluntary zero-harvest policy implemented by the Olokhaktomiut Hunters and Trappers Committee in 1993, people in Ulukhaktok travelled less regularly to the Minto Inlet area (CPCVI 1998; Gau pers. comm. 2011). Only 30 caribou total are reported as being harvested on Northwest Victoria Island after these measures took effect, the last occurring in 1997-98 (GNWT 2011). Such conservation measures will be discussed further below in the *Positive Influences* section, p.47.

Banks Island

Hunting caribou on Banks Island has been and continues to be a mostly seasonal activity, peaking in the autumn. Hunters continue to use areas close to Sachs Harbour, however, inland locations (such as Big River and Egg River) are used less than they were in the past, and coastal

locations farther away from Sachs Harbour are used more.

Banks Island was not regularly occupied by Western Arctic Inuit before 1928 (Usher 1976), although some groups would come across from Northwest Victoria Island on a temporary basis (Farquharson 1976). The Aulavik Oral History Project records a historical pattern of hunting for caribou that continued even after the introduction of rifles and skidoos. Other resources such as seals provided food when caribou were less accessible (Nagy 1999c). Hunters searched for caribou primarily in the summer, fall, and early winter (Nagy 1999c). Usher (1971b) offers the most detailed account of the seasonal harvest of caribou (from 1964-67) that peaked in October and November.[4] Hunting usually declined in the winter, and then increased again in May and June (although hunters did not range as far as in the autumn). He notes in particular that "the summer is thus a period of meat deficit in relation to production, with the greatest shortage occurring in September". Elders reported that much of this time was spent around the Big River and Egg River areas (Joe Apiana, Sarah Kuptana, Edith Haogak, Peter Sydney, and Susie Tiktalik in Nagy 1999a). These areas were especially good for autumn hunting during the 1960s (Usher 1976). Caribou were also taken on trap lines across the island in the early 1970s, although most were harvested on the southern half of the island (Usher 1976). More specific data is available for hunts occurring in 1966-67 (Usher 1971b). These featured a pattern whereby October kills were made in the south central portion of the Island, at the headwaters of Big River, November kills were made in the west portion of the island from Egg River in the south to Storkerson Bay in the north; December and January kills were made in the southwest corner of the island close to Sachs Harbour (Figure 8, p.19).

From 1964-66, Usher records a trend of Sachs Harbour harvesters (in aggregate) spending less time on the land and travelling shorter distances on October caribou hunts. Despite this, he also records a trend of per-hunter effort increasing. Such data might indicate a trend towards fewer active caribou harvesters over those years (although he also notes that in 1966 only one quarter of days spent on the land were actually spent hunting caribou) (Usher 1971b: 72).

By the early 1970s, caribou were so abundant that hunters were able to obtain their winter's supply of meat relatively close to Sachs Harbour, and thus did not as often travel further afield (Usher 1976). However, hunters in 1976 did report travelling as far as Nelson Head in the late fall and winter for caribou (Peter Esau in Berger 1976b: 4085).

Figure 8 (p.19) shows areas where caribou were harvested in 1966-67. A comparison of this map to the harvest areas mapped in 2008 (Figure 5, p.11) suggests that harvesting continues in locations close to Sachs Harbour year around, but that there may be more harvesting along the

coast and less harvesting inland. In particular, substantial autumn harvests along the Big River and Egg River in 1966-67 are not reflected in the harvesting areas of 2008. Instead, coastal areas further away from Sachs Harbour (i.e. around Nelson Head and Jesse Bay) are indicated as seasonally important from July to December.

A small harvest of Peary caribou continues on Banks Island, under a management quota that was set at 36 animals per year (or one animal per household in Sachs Harbour) in 1992, and was raised to 72 animals per year in 2010 (GNWT 2011). Harvests have been less than quota since 1994 (GNWT 2011).

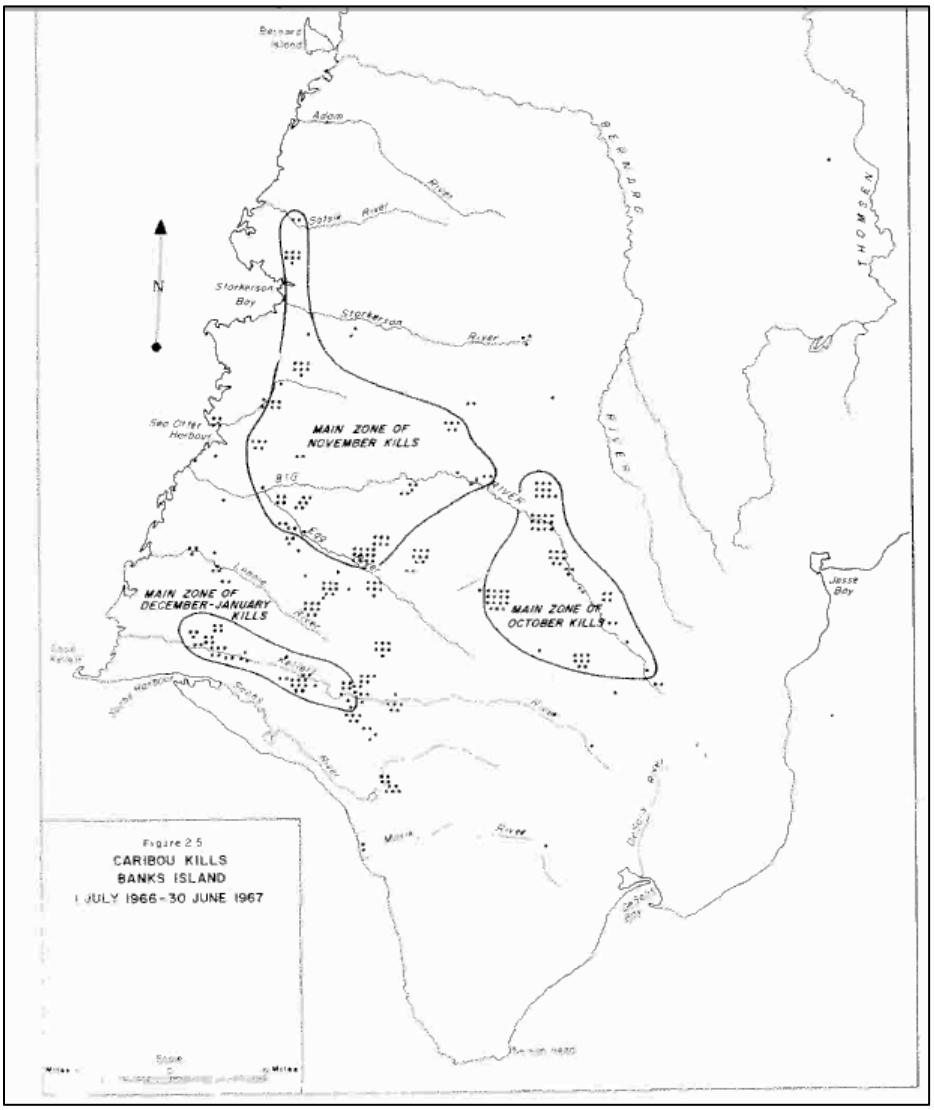

Figure 8. Caribou harvesting locations on Banks Island: 1967-1968 (reproduced from Usher 1971b:69, with permission from Peter J. Usher and Aboriginal Affairs and Northern Development Canada).

Western Queen Elizabeth Islands

Traditional and community knowledge of the higher Arctic islands in the NWT (Melville, Prince Patrick, Eglinton, and Emerald) was not recorded in the sources reviewed here, beyond a brief note that (non-specific) harvesting efforts on Melville Island occur from November to May (OCCP 2008). Other sources also indicate that hunters from Sachs Harbour and Ulukhaktok do continue to periodically visit this region, most notably for polar bears, and therefore may have insights into caribou distributions there (Andy Carpenter in HCM 1998; Morris Nigiyok in Nagy 1999c: 153; Slavik pers. comm. 2011; Larter pers. comm. 2012). In addition, some hunters from Resolute Bay in Nunavut may also occasionally visit the islands hunting polar bears (Imoosie Amagoalik in Nunavut Tusaavut Inc. 1997:66). A Peary caribou hunting quota for the Western Queen Elizabeth Islands has been in place since 1993 although no actual harvests have been reported there; the quota is managed as part of the quota on Banks Island (GNWT 1993a) (see Table 1, p.38 and Figure 9, p.37 in *Positive influences*, p.47).

Distribution Trends

The range of Peary caribou appears to fluctuate in terms of their distance from the communities. However, observed changes in caribou distribution are not consistently comparable to recorded trends in search effort in the sources reviewed, and do not account for potential fluctuations in overall population size. Therefore, it is not possible to distinguish changes in range from changes in search effort or changes in population size.

Victoria Island

Sources describe that the migratory range of caribou on Northwest Victoria Island fluctuated between 1900 and the 1990s, in terms of their distance from Ulukhaktok. When caribou were scarce in one area, reports suggest that they were more abundant in other areas. Sources are vague however, regarding which groups of caribou descriptions pertain to (i.e. Peary caribou, or Dolphin and Union caribou); in areas such as Prince Albert Sound, both groups might occur.

Caribou were very scarce around 1900 (presumably in the area where Ulukhaktok is now located), but became more numerous by 1920, after which freezing rain caused extensive mortality (OCCP 2008). A report in 1933, for instance, suggested that to the north of Prince Albert Sound, harvesters found very few caribou and subsisted mostly on fish (Condon 1996: 117). There were plenty of caribou reported, however, on the Northeast portion of Victoria Island at this time (Condon 1996: 118). In 1937, it was reported that harvesters travelled north to

the central part of Prince Albert Peninsula to find caribou, but that in the 1950s caribou moved south (OCCP 2008). Harvesters reported that in the 1950s caribou started coming closer to the coast, travelling towards the southeast (CPCVI 1998). However, in 1952, caribou (possibly Dolphin and Union caribou) were also reported as having been prevalent around Prince Albert Sound for 'quite some time' (Condon 1996: 130). In the 1960s the number of caribou in the Ulukhaktok region was again very low (Condon 1996: 146), but increased in the early 1970s (Usher 1976). At this time, the caribou typically came close to Ulukhaktok and were hunted on the Diamond Jenness peninsula south of Minto Inlet along Kuujjuak River, and along the coast east of Ulukhaktok as far as Kuuk River. Although local residents had not reported range abandonment between 1986 and 1989, the range of the 'Minto Inlet' group of caribou contracted northwards in the early 1990s (CPCVI 1998). At this time, hunters reported that caribou were exceptionally rare in the area, and that they must be 'elsewhere' (Joe Kuneyuna and Holman residents in Heard 1992: 1). Some speculated they may have even shifted their calving grounds (CPCVI 1998). By 1998, the caribou had returned to their range from the 1940s, further away from Ulukhaktok (CPCVI 1998).

Banks Island

Caribou use almost all of Banks Island at various times of the year (SHCCP 1992). Peary caribou distribution on Banks Island is described by the sources reviewed here as fluctuating in terms of the animals' distance from Sachs Harbour. Most of this fluctuation is in terms of seasonal movements, however, and potential changes in the overall distribution are less clear.

Testimony to the Berger Inquiry indicates that around the 1950s there were hardly any caribou close to Sachs Harbour in the autumn (Andy Carpenter in Berger 1976b: 4128). Encroachment by muskoxen also began in the 1950s, which by the 1970s and 80s affected caribou distributions in terms of the animals staying along the coastline rather than going inland (Agnes Carpenter in Nagy 2004). Interactions between Peary caribou and muskoxen are discussed further in the *Interactions* and *Threats* sections, p.26 and p.35.

A comparison of accounts from the 1970s with those from 1992-2008 suggests a possible change in the distribution during calving. While statements to the Berger Inquiry indicated that in the 1970s, caribou calved on the north end of Banks Island (Andy Carpenter in Berger 1976b: 4025), more recently Sachs Harbour Community Conservation Plans (1992, 2000, 2008) indicate additional calving areas around Jesse and De Salis Bays (Figure 5, p.11).

Habitat

Habitat requirements

Recorded observations from traditional and community knowledge sources often pertain to broad landscape features, such as 'vegetation', and records do not specify differences in caribou diets on the basis of activities such as rutting or calving. However, several sources do indicate that the diet of Peary caribou varies throughout the year. Bandringa (2010) offers the most comprehensive account of Peary caribou foraging habits, in which various lichens play a key role (bold in original):

> *"…Lichens are one group of plants known almost universally as the food of caribou. Lichen species of the genus Cladina (or Cladonia), known broadly as **tuktut niqait** (tuttut niqingi in Uummarmiutun), are especially referred to as 'caribou food'. Sarah Meyook said, it is 'their grub,' the caribou are 'always eating it'… Caribou also known to eat other kinds of lichen from the ground, such as **snow lichen** (Flavocetraria nivalis) and the white **worm lichen** (Thamnolia vermicularis) known as **aqiarungat**. Elsie Nilgak said that caribou are also known to scrape away and eat various kinds of lichen growing on rocks, known generally as **qaviut**. Mary Kudlak agreed. Referring to some kinds of leaf-like lichen found on rocks, she said, 'You can find these rock lichen in caribou stomachs'" (Bandringa 2010: 269).*

Lichen (which the OCCP [2008: 69] refers to as *Akeagonak*) is particularly important in the fall and winter.

In June, caribou show some preference for feeding on moss campion (*Silene acaulis*) which grows on sandy locations (it is referred to as *'Ningnak'* in OCCP 2008: 69). Morris Nigiyok (in Bandringa 2010:268) explains that "it grows where the snow melts [and] in early June, they start growing up and caribou start to eat it right away." Moss campion is known by several names by Inuvialuit, depending on which animals eat the plant. When eaten by arctic hares, the plant is known as '*ukalrit niqautait*' or 'rabbit's food'; when in flower, it is very commonly eaten by caribou, and is known as '*nirnat*'. "Caribou have been known to graze the sweet, pink flowers so much that many Inuvialuit also refer to this plant in English simply as 'caribou food'" (Bandringa 2010: 268).

After snow has gone by mid-July, feeding is more focussed on moist sites that include sedges, grass, willows and mountain sorrel (*Oxyria digyna*) or *'Kongolik'* (OCCP 2008:69; Bandringa 2010). Abundance of mountain sorrel and willow leaves is said to contribute to exceptionally fat caribou on Bathurst Island in Nunavut (Herodier Kalluk in Nunavut Tusaavut Inc.1997).[5] In

addition, Larter (pers. comm. 2012) notes that during fieldwork on Banks Island in the 1990s, local participants focused on flowering legumes (such as pea plants). Agnes Carpenter also emphasizes the importance of certain leaves in Peary caribou's diet: "The lichens and the leaves. It's just leaves. Green leaves, round leaves. Delta [leaves that] are long, narrow ones. On the island we got round ones. It's green leaves. You know, like spinach. It's almost something like that. We even use it ourselves, we put in oil" (in Nagy 1999c: 162). She attributes peoples' preference for caribou meat to these leaves, as they make meat tender and less strong in taste (Nagy 1999c). The plant referred to above is the mountain sorrel or kongilik (WMAC (NWT) 2012).

In Nunavut, the taste of Peary caribou meat varies depending on the animals' diet (Taylor 2005). Vegetation such as blueberry plants and heather (on Somerset Island) may make caribou meat leaner "and the fat is only slightly oily" while caribou foraging on grasses in the summer (on Prince of Wales Island) have more oily fat (Samon Idlout in Taylor 2005: 95).

Peary caribou relocate seasonally to different areas within (and possibly between) islands. On Banks Island, caribou winter in valleys, ravines, and on side-hills (Manning and Macpherson 1958). They spend the spring in inland areas around Jesse Bay and on the northwest corner of the island. In summer they are found in the hills, valleys, and slopes along the coast, before migrating in the fall to the Fish Lakes area just east of Sachs Harbour (SHCCP 2008). Some important habitats for Peary caribou are identified in the Sachs Harbour and Olokhaktomiut Community Conservation Plans (SHCCP 2008 and OCCP 2008); (Figures 4 -7 (p.10 - 13)). The latter plan also includes important habitats on Melville Island. Areas of the Northwest Queen Elizabeth Islands have also been noted as possibly of special importance to Peary caribou by Miller (1990).

Male and female caribou separate during the winter (SHCCP 1992, 2008), and possibly also in May and June (Manning and Macpherson 1958). Stefansson's (1921) account of differences in fat across genders and seasons may also indicate differences in dietary preferences of males and females at certain times of the year, as well as behaviours related to the reproductive cycle.

Habitat availability

Sources reviewed here do not indicate what proportion of suitable habitat in the NWT is occupied by Peary caribou, or if there are suitable habitats that are unoccupied. Also, sources are unclear as to whether new habitats have become available for the species. Given the increasing difficulties travelling the land (Riedlinger 2001a), and an apparent trend towards hunting more

along the coasts, the quality of inland habitats may not be as well known by hunters. In addition, the only sources on the characteristics of habitat on the Western Queen Elizabeth Islands are almost a century old. Most of the available descriptive information regarding these islands is from Stefansson's (1921) journal. He notes an abundance of vegetation on Borden, Prince Patrick, and Lougheed Islands, and a comparative lack of vegetation on Melville and Meighan Islands. Bernier (1910: 174) also noted that the 'pasturage of moss' around Cape Vesey Hamilton (Northeast of Mercy Bay on Banks Island) was plentiful. From interviews in Nunavut, more humid areas may support more vegetation (Herodier Kalluk in Nunavut Tusaavut Inc.1997).

One hunter from Ulukhaktok suggests that larger islands provide caribou more recourse in times where local snow and ice conditions impede access to forage (Harry Egotak in Elias 1993), while testimony to the Berger Inquiry noted the smaller size of Banks Island as problematic for caribou in circumstances where muskoxen were perceived to be foraging competitors (Peter Esau in Berger 1976b: 4126). In Nunavut, however, caribou are also reported to relocate to smaller islands when severe weather events impede access to forage on larger islands (Taylor 2005).

Habitat fragmentation

Peary caribou habitat is naturally fragmented given that the animals inhabit an island archipelago. Stefansson (1921) records substantial differences between islands in terms of the quality of forage. Caribou do travel between islands in the winter, but from the sources reviewed here, there are few indications as to the specifics of such crossings. Most reports pertain to crossings between Northwest Victoria Island and Banks Island across the Prince of Wales Strait (CPCVI 1998), and between Banks Island and the Mainland (Lawrence Ruben in Manning and Macpherson 1958; CPCBI 2000); one report also notes crossings between Melville and Northwest Victoria Island (Andy Carpenter in HCM 1998). Other crossings have been hypothesized between Banks Island and the Queen Elizabeth Islands (Usher 1971b). Caribou may cross between some islands in the summer (as implied by Herodier in Nunavut Tusaavut Inc.1997:57), however none of the sources mentioned the specifics of such crossings.

Habitat trends

Habitat trends affecting Peary caribou stem from increased populations of muskoxen and from climate change.

According to community and traditional knowledge, muskoxen negatively affect caribou forage.

Muskoxen are far larger than caribou, and eat much more. Further, "they eat right to the roots and they don't leave anything" (Sam Lennie in Nagy 1999c:105). On Banks Island, muskox populations greatly increased in the 1960s (Whittles 2005) after a brief poisoning program starting in the late 1950s reduced the number of wolves (Heard 1984; Peter Esau in SHCM 1998). In 1971, Inuvialuit were permitted to harvest 25 muskoxen (Peter Esau in Berger 1976b); this was raised to 150 in 1978 (Nagy 2004), and in 1981 a commercial hunt started (Whittles 2005). Despite this hunting pressure, their population estimates have remained higher than Peary caribou and have ranged between 30,000-70,000 muskoxen between 1989 and 2010 (Davison *et al.* 2010). The relationship between muskox and caribou will be explored in greater depth in the *Interactions* section (p.26).

Peary caribou habitat can be affected by the characteristics of weather and climate. For instance, deep, hard snow cover can inhibit access to forage and force caribou to feed in more raised wind-blown areas where there is less snow cover (CPCVI 1998). Freezing weather could have a positive effect on the availability of some types of vegetation. As explained by Agnes Carpenter, "…when the greens grow on the island, and before it even has a chance to spoil or the greens turn brown or anything, it freezes. Everything freezes and [the caribou] feed on fresh green pastures. Green pastures without it spoiling" (in Nagy 1999c: 162). However, most sources communicate the effects of freezing rain as negative. Rain and associated icing on the ground can lead to caribou starvation in the spring and fall (OCCP 2008). The effects of freezing rain on the availability of habitat for Peary caribou may be more severe on Banks Island because of its small size. Some Inuvialuit report that the size of Victoria Island affords caribou more options because it is big enough that when freezing rain occurs in the autumn, the caribou can move away to better grazing land within the island (Peter Esau in Berger 1976b: 4126; Harry Egotak in Elias 1993). Erratic weather is linked to the prevalence of freezing rain, and indications are that erratic weather events are becoming more common on Banks Island due to climate change (Riedlinger 2001a).

Climate change may also play a role in the ability of Peary caribou to cross between islands in search of suitable habitat. Many sources have documented hunters' observations that sea-ice (over which caribou must travel to cross between islands) is becoming less reliable (Riedlinger 1999, 2001a,b; Nuttall *et al.* 2005; Slavik pers. comm. 2011). While such sources do not specify the implications of such changes for Peary caribou, the changes they describe could make inter-island crossings more difficult.

Biology

Life cycle and reproduction

Peary caribou are usually seen in small groups of five to ten, but sometimes singly (Usher 1971b). Occasionally larger groups are observed; the largest group reported was 200 animals on Banks Island (Stefansson 1921).

There was no information in the sources reviewed here regarding the specific breeding strategies of Peary caribou.

Physiology and adaptability

Peary caribou health or body condition is often described in terms of fat, with more fat signifying better health (Stefansson 1921; Herodier Kalluk in Nunavut Tusaavut Inc. 1997; Riedlinger 2001a; Lyver and Gunn 2004; Taylor 2005). Body condition in turn affects mortality, pregnancy, calf survival, and age at first breeding (Lyver and Gunn 2004).

Stefansson (1921:246-7) offers a detailed account of caribou fat variability by age, gender and season. In late November after the rutting season the old bulls are exceptionally thin, while cows and young bulls are at their fattest. Then, by around late December the young bulls have lost most of their fat, the cows become thinner, and the old bulls shed their antlers at which time they begin to slowly restore fat. By February or March, the old bulls begin to accumulate fat on their kidneys and brisket, while the young bulls and cows carrying young are still thin, although the cows have some back fat and considerable intestinal fat. By May or June the cows have lost all their fat, while the oldest bulls have gained enough that they are good to eat. The young bulls are still thin. In July the cows begin to fatten and the old bulls accumulate back fat about one and a half inches thick. "By late August or early September this fat has become three inches thick in extreme cases, and will weigh before drying thirty or forty pounds if the animal is large. At this time the intestinal fat is an additional ten or fifteen pounds besides the great amount on brisket, ribs, pelvis and elsewhere." The cows and young bulls also are moderately fat in August and September, and gain a little for the next month or two (Stefansson 1921).

Interactions

Peary caribou are usually found in small groups. Within groups of Peary caribou, bulls play an important role in guiding the group and maintaining the strength to dig through the snow for

food; older animals are also more passive and reportedly have a calming effect on younger animals within the group (Taylor 2005). Interactions between Peary caribou and other types of caribou are not discussed in traditional and community knowledge sources.

Descriptions from traditional and community knowledge sources regarding the interactions between Peary caribou and other species are limited to muskoxen and wolves. Both are usually considered to have negative implications for caribou.

The Sachs Harbour Community Conservation plans (2000, 2008) and harvesters such as Sam Oliktoak (in Nagy 1999c) note the possibility that wolf predation has been partially responsible for Peary caribou declines. Wolves tend to follow muskoxen and caribou movements (SHCCP 2008), even between islands (Peter Esau in SHCM 1998), and sometimes kill more than they need to eat (Charlie Hoagak, A. Carpenter, and Peter Esau in the Co-Management Plan for Caribou, Muskoxen, Arctic Wolves, Snow Geese, and Small Herbivores on Banks Island 2000 [hereafter referred to as CPCBI 2000]). The most thorough description of interactions between wolves and Peary caribou is given by Stefansson (1921). He observed that wolves prey on older caribou more than younger caribou as the latter are able to outrun the former when they are only a few days old. The oldest bulls are noted as often being the slowest to flee from wolves, especially at the beginning of the breeding season when they are at their maximum weight. "When you see a caribou that has been singled out for pursuit by wolves, it is in the first probability an old bull and in the second an old cow. Skeletons of wolf-killed animals are nearly always found to be skeletons of these two" (Stefansson 1921:248-9). Stefansson also observed a cyclical relationship between wolves and caribou on Brock Island:

> *"We found a striking difference between our New Land [Brock Island] at the time of discovery [June 1915], when caribou traces were more numerous than we have seen them almost anywhere in the Arctic, and that same land in the fall of 1916 when the wolves appeared to be as numerous as the caribou and the caribou not one-tenth as numerous as a year and a half before. In May, 1916, a period intermediate between the plenty of 1915 and the scarcity of the autumn of 1916, we found an intermediate condition as to the number of caribou" (Stefansson 1921:476).*

Hunters reported high wolf populations on Northwest Victoria Island in the 1930s and 1940s (OCCP 2008). Wolf control programs were initiated in 1955 on Banks and Northwest Victoria Islands, which reduced their numbers (Heard 1984; Peter Esau in SHCM 1998; OCCP 2008; SHCCP 2008) but the programs were discontinued in 1959 when wolf 'control' had been attained (Peter Esau in Berger 1976b; Heard 1984; OCCP 2008). Current Community

Conservation Plans specify that residents still do not support the use of poison, aircraft, or systematic wolf control or elimination (OCCP 2008; SHCCP 2008). Wolf numbers began to recover in the mid-1970s on Northwest Victoria Island (OCCP 2008), and were reportedly also increasing in the 1990s (CPCVI 1998). Fifty wolves were seen during a survey of Banks Island in 1998, which was considered to be a healthy number (SHCCP 2008).

Interactions with muskoxen are also described by some sources. These are mentioned in terms of the effects of muskoxen on caribou forage, and the effects of their smell. Muskoxen are known to forage on a wide variety of vegetation, including grasses, sedges, and willows, some of which caribou may also consume at certain times (Taylor 2005; OCCP 2008). The availability of forage for Peary caribou may be reduced by other grazers such as muskoxen according to Agnes Carpenter (in Nagy 1999c). The Olokhaktomiut Community Conservation Plan (1994) also records that although caribou and muskoxen inhabit different areas during most of the year, there is some overlap during the growing season. Other hunters such as Geddes Wolki are less certain whether or not muskoxen and caribou eat the same food, but he notes that muskoxen certainly eat far more. "[Muskox] eat so much, maybe they take all the food and let [the caribou] get short of food, maybe. You know the big muskox can eat three times more than one caribou, or even four times as much. [They have] big guts" (Nagy 1999c:154). Trampling of vegetation by muskoxen may also be a factor: "When muskox is feeding and grazing on the ground, they take everything and they're heavy enough that they trample all the snow, and then caribou can't go there and start feeding right where the muskox been through…" (Peter Esau in Berger 1976b: 4126). The NWT Peary Caribou Technical Committee (2004: 15) also reports that "Some Inuit and Inuvialuit believe… that caribou avoid muskoxen and that muskoxen trample the snow in caribou feeding areas".

The strong smell of muskoxen is said by many to be unpleasant for caribou (Frank Kuptana in Elias 1993; Taylor 2005). David Nasogaluak, for instance, remembers "That Old Lady Tiktalik used to say that the smell of muskox, the caribou don't like it" (in Nagy 1999c:164). Kassam (2009: 131) reports many Ulukhaktok residents stating that 'caribou don't like muskox'.

Indications that interactions with muskoxen are detrimental to Peary caribou are more numerous for Banks Island than Northwest Victoria Island. In addition, some hunters from Ulukhaktok assert that Peary caribou and muskoxen do not compete (Alex Banksland and Morris Nigiyok in Elias 1993). In Nunavut, Taylor (2005) noted that some community members understood caribou and muskoxen to typically feed on different vegetation and occupy different habitats. However, in cases where the two species might compete, Taylor inferred that competition may

have a greater impact on caribou, "who [Seeglook Akeeagok] believes are picky eaters, while muskoxen eat a wider variety of vegetation" (Taylor 2005: 97).

Interactions between wolves and muskoxen may also be important for caribou. For example, Peter Esau suggests the absence of wolves following the poisoning program in the late 1950s has contributed to the growth of the muskoxen population on Banks Island (in Nagy 1999c: 156).

Population

Structure and rates

Peary caribou in good condition (i.e. sufficiently fat) can calve every year after sexual maturity is reached between 2 to 4 years of age (OCCP 1994, 2008). They may not calve every year, however, if they are in poor condition. For example, in the winter and spring of 1952-53 on Banks Island (noted in the CPCBI [2000] as particularly harsh), hunters reported finding no foetuses in harvested caribou (Manning and Macpherson 1958). Peary caribou may live to 15 years in the wild (OCCP 2008). The available sources do not include any information on possible changes in reproduction or lifespan over time.

Movements

Peary caribou are described as being highly mobile animals (Peter Esau in Berger 1976b; Arctic Peoples, Culture, Resilience and Caribou [ACRC] 2010), that travel in order to find suitable forage (F. Kudlak in Riedlinger 2001a). Their movements are discussed in this section in terms of regular inter-island movements and intra-island movements.

Inter-island movements

Inter-island movements of Peary caribou are almost always described as occurring during the winter across frozen straits. However, interviews in Resolute Bay, Nunavut indicate that some caribou may swim between islands in the summer, as is inferred by the word "*singmiujut*", or "caribou migrating through sea water" (Herodier in Nunavut Tusaavut Inc. 1997: 57), although no details are offered regarding the distances and locations of crossings.

Hunters have reported seasonal (winter) movements between Banks Island and Northwest Victoria Island (CPCVI 1998). However, the frequency of these movements may have changed over time. Although it was commonplace for caribou to cross between Banks and Victoria

Islands in the 1960s and 1970s, such movements were more sporadic by the mid-1980s (CPCVI 1998). Hunters interviewed in 1993 suggested that Peary caribou 'do' move back and forth between Banks and Victoria Islands, implying that this continued into the 1990s (Alex Banksland and Sam Oliktoak in Elias 1993). The CPCBI (2000) is the last available record that was found attesting to movements specifically between Banks and Victoria Island, although the OCCP (2008: 69) explains that caribou 'may' move to and from Victoria Island and adjacent islands.

Peary caribou may occasionally move between Banks Island and the mainland. There have been several observations of movements of Peary caribou out onto the sea-ice south of Banks Island (Lawrence Ruben in Manning and Macpherson 1958), which have also been described as 'desperation movements' (CPCBI 2000). Peary caribou have reached as far as Baillie Island, Cape Dalhousie (near Cape Bathurst), and Hershel Island, Yukon (F. Wolki in CPCBI 2000). Two harvesters also note some "Peary caribou" moving from Victoria Island to the mainland (Morris Nigiyok and Harry Egotak in Elias 1993: 26-7), however, given the ambiguities in terminology, it is possible they were referring to members of the Dolphin and Union herd.

The available sources reviewed contained no records of Peary caribou moving between Banks Island and the Queen Elizabeth Islands, although Usher (1971b) noted that this was a possibility. Only one source contained information on potential movements of Peary caribou between Northwest Victoria Island and the Queen Elizabeth Islands. Andy Carpenter (in HCM 1998) reported that, "Some time ago, coming back from Melville Island, there were a number of caribou. There were no caribou tracks coming in from Melville to Holman recently." No sources recorded information on caribou movements between islands in the Western Queen Elizabeth group. Other important questions not addressed in the sources reviewed here are the degree of movements to and from islands in Nunavut, and the routes by which Peary caribou from the NWT and Nunavut might intermix. As Peary caribou are known to be migratory and to travel long distances and between islands, occasional intermixing is likely (ACRC 2010).

Northwest Victoria Island

Peary caribou on Victoria Island make seasonal north-south movements. Alex Banksland reported that seasonal movements of Peary caribou are more regular on Victoria Island than on Banks (in Elias 1993). On Victoria Island Peary caribou migrate north inland to calve in the spring (north and east of Minto Inlet), and south and further east to winter feeding grounds towards the peninsulas (Kuptana 1983; Jimmy Kudlak in Elias 1993; CPCVI 1998). However, a

calving ground for Peary caribou is also identified on central Diamond Jenness Peninsula on the south bank of the Kuujjuak River (OCCP 2008), which may indicate more complex movements (see Figure 4, p.10).

Banks Island

On Banks Island, movements of Peary caribou are typically described as occurring in a north-south pattern. In the springtime they go north to calve, while in the fall time they return south for the winter (likely to the Fish Lakes area near Sachs Harbour) (Peter Esau in Berger 1976b: 4085). Usher (1971b: 68) describes that caribou tend to be in the north and east in the summer, and south and west in the winter. This is roughly consistent with a seasonal range map compiled in 1992 (SHCCP 1992) (Figure 6, p.12). Additional calving areas are also identified in the Sachs Harbour Community Conservation Plans (2000, 2008) around Jesse and De Salis Bays, although most appear to calve on Northwest Banks Island (from the coast inland as much as 50km, from Jesse Bay to Bernard River) (Figure 5, p.11). Caribou may summer along the coast, and although Usher (1971b) noted that caribou were uncommon in the northern and southern extremities of the island, this is not reflected in the 1992 range map (SHCCP 1992) which depicts a widespread distribution across Banks Island at this time, before a fall migration to the southwest (SHCCP 1992). The winter may see the smallest seasonal distribution of caribou, extending from the Storkerson River to the Kellet River and the Fish Lakes (SHCCP 1992).

Changes in the climate may be leading to caribou spending more time in the south of Banks Island around the Fish Lakes (migrating north in the spring slightly later), and returning south slightly earlier (Riedlinger 2001a). Some residents of Sachs Harbour also describe that Peary caribou movements have been affected by increasing numbers of muskoxen on Banks Island. This appears to be linked to caribou staying closer to the coast, and possibly not ranging as far northwards as they had previously. As Agnes Carpenter describes,

> *…gradually the muskox moved from the northern part of the island. That's [where] they were breeding, on the northern part of the island. They gradually came down. They kept pushing the caribou herds down and finally in the end we had hardly any caribou left. The caribou used to migrate up to the northern part of the island during the summer months, and they migrated back down towards the fall. In the end we had nothing coming back. Hardly nothing coming back and there, caribou were sort of going, staying along the coast line... there was hardly anything on the inland... It'll take years and years and years for the caribou to come back (in Nagy 1999c: 161).*

Abundance

Observations regarding the abundance of caribou stem from hunters' excursions on the land and are therefore usually localized. Relative assessments of caribou abundance are also influenced by personal experience (Taylor 2005). As such, it is not possible to infer exact population size from comparing observations recorded in the documents reviewed here. Nevertheless, records indicate that residents of both Sachs Harbour and Ulukhaktok considered that populations of Peary caribou were worryingly low in the 1990s (Elias 1993; Nagy 2004). No sources contained information on the current abundance of caribou on the Western Queen Elizabeth Islands.

Fluctuations and trends

Many harvesters describe cyclical population fluctuations of Peary caribou (Usher 1971b; Nagy 1999c; Riedlinger 2001a; Taylor 2005; Gunn 2008; Parks Canada 2010). They often describe these fluctuations as connected to the availability of forage, and inversely related to muskoxen populations. Unfortunately, recorded observations of forage quality and quantity are relatively few and are too scattered in temporal and spatial terms to clearly indicate larger trends.

An elder in Ulukhaktok reports that the caribou population has gone through three cycles over the past 90 years (CPCVI 1998). On Banks Island, John Lucas (in Nagy 1999c:165) also refers to "…probably what they call a 30 years cycle that they have the caribou. Cause, eventually I think they'd probably gonna come back." One hunter asserted that "as late as the seventies, [there were] caribou with big racks, now caribou decline… My own way of thinking this is natural. Back in the 50s we had the same thing, other way around" (Robert Kuptana in Riedlinger 2001a: 84). Another noted, "You know that old Titalek, that old one that used to be around. She said it was a cycle, after so many years they will come back" (S. Lucas in Riedlinger 2001a: 84). In Nunavut as well, many traditional knowledge holders report that caribou herds undergo cyclical changes and that low populations will eventually recover (Taylor 2005).

However, some harvesters do not support the idea that changes in caribou numbers are part of a natural cycle. Peter Esau states, "I don't believe there is a cycle with caribou. It has to do with the weather" (SHCM 1998: 4). Elsewhere he also reaffirms that during good weather caribou can also increase rapidly (Nagy 1999c). Larry Carpenter contends "I think we had a lot to do with it. Families would take 20-25 cows a winter… almost always cows" (SHCM 1998: 3).

Northwest Victoria Island

The abundance of caribou on NW Victoria Island appears to have fluctuated over the last 100 years. Caribou were reportedly scarce after the turn of the last century, but became abundant by the 1920s, until a spring rain caused extensive mortality (OCCP 1994, 2008). Very few caribou were present thereafter until roughly the 1950s (Harry Egotak and Nicholas Aloakyuk in Elias 1993). During this time, hunters had to travel to Central Prince Albert Peninsula towards Richard Collinson Inlet to find caribou. By the 1960s caribou numbers were increasing and apparently peaked in 1972 (OCCP 1994).

Although the animals were reported as abundant until 1988 (OCCP 2008), people in Ulukhaktok believe that the Minto Inlet herd has been declining gradually since the 1970s (CPCVI 1998). Hunters in Ulukhaktok again had difficulty finding caribou in the winters of 1992-93 (Gunn 2005), and interviews in 1993 recorded their deep concern about a declining population of Peary caribou (Elias 1993). In these interviews, one hunter reported that previously the caribou would be gone for some time but would always return, suggesting that an increase was overdue. "Sam [Oliktoak] acknowledges that the Peary caribou have declined drastically in the last few years. Long ago they would be gone for some time, but always return" (in Elias 1993).

Banks Island

Reports indicate that Peary caribou abundance on Banks Island has also fluctuated; they were rare in the 1950s, became more abundant by the 1970s, and scarce by the 1990s.

Stefansson (1921) reports that he encountered a herd of 200 Peary caribou (an unusually large group) on Banks Island in 1915, while muskoxen were almost nowhere to be found.

Elders recollect that Peary caribou on Banks Island declined in the early 1950s and 1960s (Gunn 2008). Local perspectives indicate that in the early 1950s there were hardly any caribou on Banks Island. This appeared to be linked to a severe icing event in the winter of 1952 (CPCBI 2000). It was also reported that the caribou had again been dying in the winter of 1954-55 (Bertram Pokiak in Manning and Macpherson 1958).

Hunters reported that caribou numbers began to increase in the late 1950s, which was also the time a wolf-poisoning program eliminated most of the wolves from Banks Island (Andy Carpenter in SHCM 1998; Nagy 1999c). However, observations are varied by location. For instance, Frank Kudlak and Martha Kudlak (in Nagy 1999a: 16b) explain that around De Salis Bay there were lots of caribou right after freeze up in 1957, but that the next year there were

hardly any; instead they were moving towards Sachs Harbour. Through the 1960s and early 1970s, Urquhart (1973) and Usher (1976) noted an abundance of caribou around Sachs Harbour. Although Urquhart mentioned significant mortality in the winter of 1970-71, Usher reported the herd to be in generally good condition, with no reproductive failures or signs of detrimental effects from hunting (Usher 1971b).

In the mid-1970s, however, additional observations of dead caribou (and concerns that the causes were not well-understood) were reported (Berger 1976b). A caribou die-off was also recorded in the winter of 1977-78 after a freezing rain event in November 1977. Andy Carpenter noted that die-offs occurred about every three years through the 1970s and 1980s, and that calves and bulls were most severely affected (CPCBI 2000).

In the fall of 1991, hunters reported that caribou became very difficult to get (Beverely Amos and Lawrence Amos in Nagy 1999a: 15a), and Harry Egotak noted in 1993 that the population had declined drastically (in Elias 1993). However, other sources assert that the population was stable between 1991 and 1994 before declining by 1998, possibly due to wolf predation (CPCBI 2000).

In 2001, residents of Sachs Harbour reported that the health of caribou had noticeably declined, although the animals were still in fairly good condition. Observed changes, notably the size of the antlers on the bulls (Larter and Nagy 1996), were attributed to the lack of big, old bulls in the herds (Riedlinger 2001a). Some hunters also reported seeing changes in the fat content of caribou. "One thing you notice now, a lot of caribou now, we get them and the fat on them is anywhere from... in the hindquarters about, when you get them in the fall now is half and inch to an inch, but you used to get caribou with two inches easy. You really notice" (Larry Carpenter in Riedlinger 2001a: 84). These comments are juxtaposed against those referring to muskoxen, described by a hunter as "all the time fat, even in the wintertime, all fat" (Edith Haogak in Riedlinger 2001a: 83).

Some harvesters reported that caribou moved away from Banks Island across to Northwest Victoria Island; this is based on observations that when their numbers declined on Banks, they increased around Holman Island (although no specific timeframes are given; Riedlinger 2001a). However, this observation does not fit with the bulk of the evidence compiled from other sources.

Western Queen Elizabeth Islands

Very few sources discuss population trends specifically on the Western Queen Elizabeth Islands.

Stefansson (1921) notes an extreme decline in the numbers of Peary caribou on Borden Island between spring 1915 and fall 1916, which he links to a simultaneous increase in the wolf population. Miller's (1990) account also documents a large decline in Peary caribou numbers in the Western Queen Elizabeth Islands (based on aerial surveys) between 1961 and 1987. He records that "non-wildlife people who were in the area [Northwestern Queen Elizabeth Islands, including Mackenzie King, Borden, and Brock Islands] during summers in the late 1970s and the early 1980s… suggested that caribou were rare there at that time" (Miller 1990: 20).

Given the lack of information regarding the Western Queen Elizabeth Islands, we include here some accounts of adjacent islands in Nunavut. Taylor (2005) describes reports from hunters in Resolute that Peary caribou were plentiful on Bathurst Island in the 1950s and early 1960s, becoming scarcer by the mid-1970s (prompting a hunting ban). Meanwhile, Lougheed Island was reported to have "plenty of healthy caribou" in the early 1970s (Tony Manik in Taylor 2005: 50). In the late 1980s caribou were again thought to be sufficiently numerous to support hunting on Bathurst Island, although these numbers reportedly declined again after a freezing rain event in the winter of 1994-95 (Taylor 2005). In 1997, however, several residents of Resolute reported a relative abundance of caribou on Bathurst Island (Simon Idlout, Aleeasuk Idlout, Allie Salluviniq, Herodier Kalluk, Issac Kalluk in Nunavut Tusaavut Inc. 1997).

Threats and limiting factors

Traditional and community knowledge sources indicate several contributing factors to Peary caribou population declines on Banks and Northwest Victoria Islands. These include past overharvesting, severe weather events, competition with muskoxen, and predation by wolves. Of these, past overharvesting, severe weather, and competition with muskoxen are the best documented. While overharvesting was important in the past, it is not seen as a current threat.

The effects of industrial development have also been consistently seen as a threat to Peary caribou. Other factors, such as disease, inter-island movement, and drowning, are noted in a small number of sources. While the effects of each of these are described in sources, their cumulative impacts are not well understood (CPCBI 2000; Riedlinger 2001a).

Some differences are evident between threats on Banks Island and Victoria Island, while little information is available regarding the Queen Elizabeth Islands.

Past overharvesting

Regarding historical caribou declines, Sandlos (2007) argues that many official reports have overstated the impact of the Aboriginal subsistence harvesting. However, Peary caribou have been and continue to be a preferred source of food for people in Ulukhaktok and Sachs Harbour (Condon 1996; CPCBI 2000; Nagy 2004) and some have suggested that female caribou are preferred year-round because they provide meat that is more tender and high in fat (CPCBI 2000). As described below, several hunters report that general overharvesting contributed to Peary caribou declines on Northwest Victoria Island, and some harvesters from Banks and Northwest Victoria Islands suggest that harvesting females may be detrimental to Peary caribou populations.

On Northwest Victoria Island, harvesting by humans has often been implicated in local perspectives of past caribou declines. The CPCVI (1998: 7) states, for example, that "People in Holman believe that the [caribou] decline was caused by the high harvests that occurred in the 1980's". More efficient hunting with the arrival of rifles has also been reported as one reason for high harvest (Guy Hologak in Berger 1976a).[6] As rifles became available sometime before 1923 (Farquharson 1976), this suggests that high harvest levels could have begun even before the 1980s. Prior to 1987-88, harvest numbers for Peary caribou were recorded only sporadically. Roy Goose, however, reported that in the early 1970s, an average of six caribou were taken per family during the early winter, or 200-225 caribou in total per year (in Berger 1976a).

In a series of interviews with hunters in Ulukhaktok, new technologies such as snowmobiles and rifles, in addition to the growth of the community itself, were reported to have facilitated overharvesting and wastage of caribou on Northwest Victoria Island (Alex Banksland, William Kagyut, Jimmy Kudlak, Jimmy Memogana, and Nickolas Aloakyuk in Elias 1993).[7] For instance, Alex Banksland attests "it is because of heavy hunting, carelessness and wastage. Snowmachines make it easier to travel long ways in a short time and it is easier to kill and carry more." Nickolas Aloakyuk does note, however, that some of this hunting pressure was directed at the Mainland (Dolphin and Union) herd. One harvester, Jimmy Kudlak, recommends that female caribou and calves should not be harvested (in Elias 1993).

Although overharvesting has been an important factor in past declines on Northwest Victoria Island, the current harvest of Peary caribou is now much lower than in the past (Table 1, p.38). Since 1987, the reported harvest of Peary caribou (the 'Minto Inlet Herd') on Northwest Victoria Island has declined to virtually nothing. This is in part on account of an NWT-wide harvest quota being introduced in 1990, and a zero-harvest policy initiated by the Olokhaktomiut

Hunters and Trappers Committee in 1993 for Northwest Victoria Island (Governments of Northwest Territories and Nunavut 2011) that is enforced by GNWT legislation (Figure 9; GNWT 1993b [accessed 2011]). Harvest quotas will be addressed further in the *Positive Influences* section, p.47.

On Banks Island, one report indicates harvests of 15-20 Peary caribou taken in 1960 (Usher 1966). Between 1962 and 1972, an average of 279 caribou were harvested each year, the majority being female (Urquhart 1973). From the 1970s until the late 1980s, each of the 15 families in Sachs Harbour would take 20-25 (mostly females) per winter; this amounted to about 300-450 animals per year (CPCBI 2000: 17).

The numerous hunters and elders interviewed for the Aulavik Oral History Project (Nagy 1999c) did not make any statements that would suggest overhunting or the preferential hunting of females were primary causes of declining Peary caribou on Banks Island. However, in another document, Larry Carpenter did suggest that hunting (especially females) may have had an impact on caribou on Banks Island (in SHCM 1998).[8]

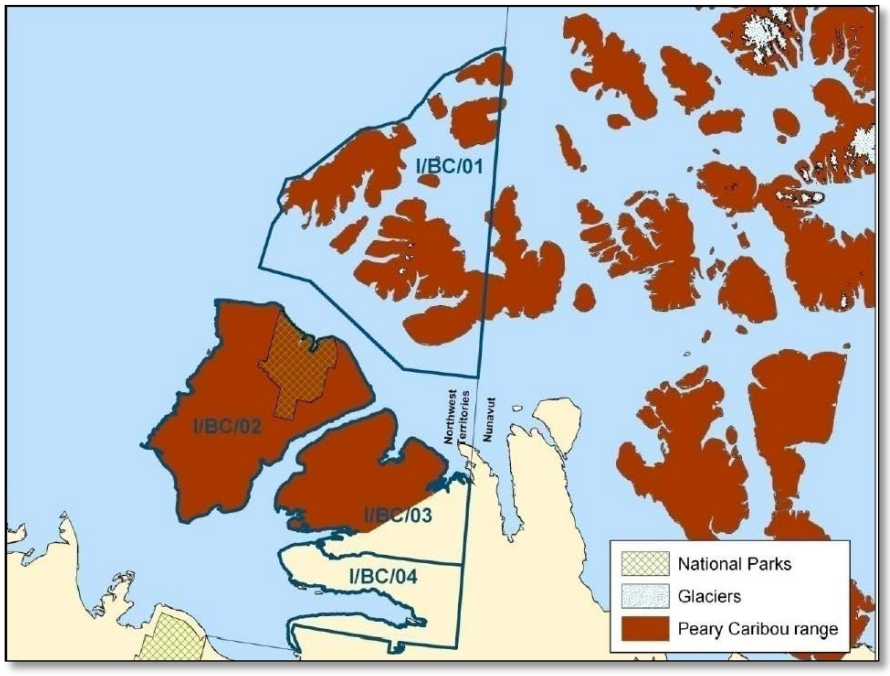

Figure 9. Caribou Wildlife Management Areas in the Inuvialuit Settlement Region (reproduced with permission from Governments of the Northwest Territories and Nunavut 2010).

Table 1. Reported harvest of Peary caribou in the NWT (compiled from GNWT 1993a,b; Nagy *et al.* 1996; CPCVI 1998; Governments of Northwest Territories and Nunavut 2011; GNWT 2011). QEI = Queen Elizabeth Islands; Minto Inlet = Northwest Victoria Island; n/a = no quota.

	Western QEI	**Banks Island**		**Minto Inlet**	
	Harvest	Quota [b]	Harvest	Quota	Harvest
1987-88	?	n/a	615[a]	n/a	600
1988-89	?	n/a		n/a	405
1989-90	?	n/a	361 [a]	n/a	420
1990-91	?	150		n/a	329
1991-92	0	30	21	n/a	192
1992-93	0	36	21	n/a	155
1993-94	0	36	48	n/a	0
1994-95	0	36	24	0	7
1995-96	0	36	14	0	0
1996-97	0	36	17	0	0
1997-98	0	36	17	0	23
1998-99	0	36	9	0	?
1999-2000	0	36	8	0	?
2000-01	0	36	13	0	?
2001-02	0	36	27	0	0
2002-03	0	36	<20	0	0
2003-04	0	36	23	0	0
2004-05	0	36	3	0	0
2005-06	0	36	7	0	0
2006-07	0	36	3	0	0
2007-08	0	36	7	0	0
2008-09	0	36	12	0	0
2009-10	0	36	1	0	0
2010-11	0	72	6	0	0

[a] Harvest estimates of non-calf caribou from July 1987 to June 1989, and from June 1989 to June 1991, are from Fabijan (unpublished data in Nagy *et al.* 1996). [b] Quotas are for male caribou only, and may be issued by the Sachs Harbour Hunters and Trappers Committee for use on either Banks Island (I/BC/02) or the Western Queen Elizabeth Islands (I/BC/01) (GNWT 1993a).

A male-only hunting quota has been implemented on Banks Island since 1990 (Gau pers. comm. 2011), and harvests have been less than this number since 1994 (see Table 1, p.38) (GNWT 2011). However, because the quota is male-only, some residents of Sachs Harbour expressed concern that there may not have been enough mature bulls to breed all the cows in the population (CPCBI 2000: 8). Nunavut resident Liza Ningiuk (in Taylor 2005) also voices concern at male-only hunting quotas, given the importance of older male caribou to herd survival.

Competition with Muskoxen

Many residents of Sachs Harbour report that increased numbers of muskoxen have had a detrimental effect on caribou on Banks Island, either due to competition for food, their trampling caribou forage, or the muskoxen's strong odor (see the *Interactions* section, p.26). Nagy (2004), and Whittles (2005) note that many Inuvialuit elders have seen a correlation between high muskoxen populations and low caribou populations. Sachs Harbour Community Conservation Plans (1992: 23, 2008: 28) indicate that "the Community Working Group would like to see Peary caribou protected from disturbance because of the small size of the herd. They believe the growing muskox population is threatening the caribou, which therefore need to be protected from disturbance." While some hunters agree that muskoxen compete with Peary caribou on Northwest Victoria Island, such indications are generally stronger on Banks Island.

Perspectives on the negative implications of increasing numbers of muskoxen for caribou on Banks Island have been most thoroughly presented by Murielle Nagy (2004), who summarizes Sachs Harbour residents' perspectives from transcripts recorded in the Aulavik Oral History Report. A central figure in hunters' testimony is Susie Tiktalik, who had warned people that the muskox population should be kept low in order to have caribou on Banks Island (Nagy 2004). Several hunters in Sachs Harbour connect increases of muskoxen on the island with declines of caribou and vice versa (Sam Lennie, Sam Oliktoak, Agnes Carpenter, Frank Carpenter, Andy Carpenter, Sarah Kuptana, David Nasogaluak, and Michael Amos in Nagy 2004). Agnes Carpenter explains,

> *"I've known for years. Like we've known for years on the island that the hunters and trappers, when they first started seeing the muskox, the elders were talking about it from past experience. Especially we were going back to the elders in the community at that time. They used to talk about muskox that used to completely wipe out the caribou herd because they were competing for the same food when we saw the signs of muskox coming in to Banks Island" (in Nagy 1999c: 157).*

Given these perspectives, many hunters feel that the muskox population on Banks Island should be tightly controlled (Nagy 2004).

Stefansson (1921) reports that the muskox population on Banks Island was extremely low in 1915, while Nagy (2004) presents accounts that suggest they were more numerous at some previous time. Andy Carpenter relates a historical decline in muskoxen around the time of early European explorers (who harvested many muskoxen for food), although he did not think that "man had a great impact. It was just that there would be so many, the population would crash" (in SHCM 1998: 3). Nagy (1999c), however, speculates that Inuvialuit may have deliberately managed muskoxen in order to promote caribou during the 1800s and earlier. By the late 1950s, muskox populations were increasing on Banks Island (Nagy 2004), numbering 800 in 1967, 1800 in 1974, and 25,000 by 1985 (Whittles 2005). However, relatively strict hunting restrictions on muskoxen remained in place until the 1980s (Sam Oliktoak in Nagy 2004; Sandlos 2007). As early as the 1960s hunters from Sachs Harbour had begun to seek a muskox quota (Agnes Carpenter in Nagy 2004), and in 1971 were permitted to harvest 25 muskoxen (Peter Esau in Berger 1976b); this was raised to 150 in 1978 (Nagy 2004). Such small quotas have been blamed for allowing an explosion in muskox numbers since the 1970s (Nagy 2004; Whittles 2005). Although a commercial harvest program was initiated in 1981 and quotas were raised substantially, the muskox population (non-calf animals) on Banks Island climbed to 53,000 in 1992 (Larter *et al.* 2009), peaking at more than 64,000 in 1994 (Larter and Nagy 2001). Muskoxen were estimated to number 36,676 in 2010 (Davison *et al.* 2010).

The limited size of the Arctic islands may be one factor that leads to competition between muskoxen and Peary caribou. Peter Esau, for instance, reported that "Maybe the island [Banks Island] maybe not big enough; maybe that's why something is getting over-populated, like maybe muskox. Every time we go trapline we start seeing dead caribou" (in Berger 1976b: 4126). However, cumulative effects are also implicated by Peter Esau, who concluded "I don't think [the muskoxen] really pushed the caribou away"; instead he blames severe weather in the autumn for increased mortality of young caribou (in Nagy 2004: 104).

There is some indication that muskoxen are considered a threat to Peary caribou on Northwest Victoria Island, but views on the relationship between caribou and muskoxen are more mixed in Ulukhaktok than in Sachs Harbour (CPCVI 1998).

In 1992, it was reported that many people believed that the high muskox densities near Ulukhaktok were responsible for the low caribou densities (Heard 1992). At the time, the Olokhaktomiut Hunters and Trappers Committee (OHTC) had proposed regulation changes to

increase the commercial harvest of muskoxen near Minto Inlet in the hopes of reducing muskox numbers and thereby leading to an increase in caribou density (Heard 1992). However, among hunters interviewed in Ulukhaktok in 1993, Frank Kuptana asserted that although caribou may not like the smell of muskoxen, this was not a cause of the caribou decline (in Elias 1993).

Muskoxen populations on Northwest Victoria Island increased from approximately 9,540 in 1980 to almost 20,000 in 1994 (CPCVI 1998). The muskox harvest quota for Northwest Victoria Island (management unit I/BC/03) was set at 1000 animals in 1993; harvestable year-round (GNWT 1993b). Harvests have been between 211 and 270 per year since 2006 (GNWT 2011).

Weather and climate

Riedlinger (2001a) describes many changing characteristics of weather and climate in the arctic islands. Among them, severe weather events and receding sea-ice can pose challenges to Peary caribou (see also: Urquhart 1973; CPCVI 1998; Nagy 1999c; CPCBI 2000; Taylor 2005). However, in general, the effects of weather may be difficult to gauge because of compounding factors like natural population cycles, inter-species interactions, harvesting and predation (Riedlinger 2001a). To Riedlinger's question: "Do you think that those changes you are talking about - more rain and longer summers - do you think that has an impact on caribou and muskox?" A. Carpenter replies that "It is hard to see that - because when changes start occurring here, well... the caribou population is down, and so how can you really tell?" (in Riedlinger 2001a: 81).

The effects of weather and climate can be both positive and negative for caribou. L. Wolki explains there is "Lots of bad weather in the summer now, but in the winter we have good weather" (in Riedlinger 2001a: 69). Also, while some seem to infer that an earlier green-up of vegetation on Banks Island is potentially beneficial to the forage available for caribou (Riedlinger 2001a; Berkes and Jolly 2001), it has also been suggested that an earlier onset of green-up can lead to a reduction in important nutrients for calves and a decrease in their rate of survival (Parks Canada 2010).

Severe weather events

Residents of Sachs Harbour and Ulukhaktok have identified severe weather events as threats to Peary caribou populations in the NWT. Severe weather events affect the ability of Peary caribou to access forage (Larter and Nagy 1994). This can occur through harsh winters, during which

deep hard snow cover forces animals to forage in more raised wind-blown areas where snow cover has been reduced (CPCVI 1998), or when rain falls on top of the snow, freezing it into a layer that is difficult to penetrate (Nagy 1999c).

Especially on Banks Island, Inuvialuit report significant effects from severe weather on Peary caribou. Frank Carpenter explains:

> *[Regarding] caribou, sometimes [...] in the fall, we get freeze-up on the whole island. Then, before the snow is really deep, we get our mild weather and rain. Then it's cold enough for the rain to freeze on top the snow and that's when the caribou try to leave the island, even go out into the ocean. 'Cause they were eating mostly ice. We were still here when one year it happened. When dogs started seeing the caribou, they'd be running. Nothing wrong with them but they'd just stop and start kicking. They have too much water in their stomach, their heads are spinning. So a lot of big bulls died off by spring... there was even one year, that worst year that time, the cows didn't have any calves, they didn't. That hit them just before the rutting season (in Nagy 1999c: 163).*

Rains may be particularly harmful in the spring for newborn caribou (Peter Esau in Nagy 1999c). However, most freezing rains seem to occur in the autumn, which affects bulls and young calves most significantly (Riedlinger 2001a). Cows and young bulls have been described as comparatively more resilient (P. Esau in Riedlinger 2001a), although after one particularly bad episode of freezing rain just before the rutting season, the cows did not have any calves the following spring (Nagy 1999c: 154-164).

In the interior of Banks Island, autumn rain is more prevalent when warm weather follows the first snowfalls (Lawrence Amos in Nagy 1999c). On Banks Island, freezing rain in the autumn has been associated with caribou remaining in the south longer the following spring before migrating north, and then also returning south later the next fall (Riedlinger 2001a). Freezing rains also cause Peary caribou to move off the island, out onto the sea-ice (F. Kudlak in Riedlinger 2001a). In Nunavut it has been speculated that freezing rain may also drive caribou to search for other islands, explaining carcasses found out on open ice (Taylor 2005).

Years when deep snow and freezing rain were reported to have severely reduced forage availability for wildlife on Banks Island include the winters of 1951-1954, 1971, and 1977-1978 (Urquhart 1973; CPCBI 2000; Riedlinger 2001a). In 1952, a harsh winter on Banks Island was associated with a large number of Peary caribou going southwards onto the sea-ice (CPCBI 2000; Riedlinger 2001a), some of which later returned starving (Manning and Macpherson 1958). Regarding the winter of 1977-78, it is also recorded that while caribou were healthy

through the fall, thirty were found later to have died of starvation (CPCBI 2000), and harvesters recall that it was mostly calves and mature bulls that died (Peter Esau and Andy Carpenter in SHCM 1998). During the winter of 1993-1994, freezing rain covered 50% of caribou range on Banks Island (Larter and Nagy 1994), and two orphaned calves found in poor condition led to concerns about a wider winter die-off. Several female calf caribou were then collected, but found to be in reasonably good condition (Larter and Nagy 1995), and despite a low cow-calf ratio, calf survival over the winter was high (CPCBI 2000: 9-11).

Observations indicate that severe or unseasonal weather events are becoming increasingly common on Banks Island. This is described in terms of changes in the frequency, timing, and severity of weather events (Riedlinger 2001a: 68). Such changes are most noticeable in the transitional seasons of autumn and spring. At both times, rainfalls have increased, rains fall for longer and more frequently (Riedlinger 2001a: 71). Autumn also features more storms and a faster freeze-up of sea-ice, while ice breaks up faster in spring (Riedlinger 2001a). Riedlinger (2001a) reports that most concerns about weather events as they relate to caribou are in terms of more freezing rains in the spring and fall.

In contrast to accounts from Banks Island, the CPCVI (1998) asserted that no die-offs of Peary caribou had occurred during severe winters from 1980-1993 on Northwest Victoria Island, and reported that although harvesters were aware of starvation of caribou on Banks Island, there was no traditional knowledge to indicate that die-offs occurred during unusual winters or that deaths occurred from starvation or malnutrition on Victoria Island (see also: Andy Carpenter and Morris Nigiyok in HCM 1998). However, some harvesters did note implications of weather events on Northwest Victoria Island. Observations from Nickolas Aloakyuk, Alex Banksland, and Jimmy Memogana attest that caribou disappear, move away, or starve when there have been freezing rains on the ground (in Elias 1993). One such event was reported in the mid-1960s. The OCCP (2008: 69) also records that a spring rain in the 1920s caused “extensive mortality”.

Receding sea-ice

Riedlinger (2001a) documents Sachs Harbour residents’ concerns about more treacherous ice conditions. Residents report less sea-ice (annual and multi-year), fewer ice floes, less landfast ice, and more open water in winter and spring (Riedlinger 2001a). Residents link these conditions to warmer weather in winter, and to changes in wind direction, strength and frequency (Riedlinger 2001a). F. Kudlak explains,

“Long ago there was always ice all summer. You would see icebergs all summer... ice moving

back and forth this time of year. Now no ice. Should be icebergs. You used to be able to see that old ice from the West side to Sachs. No more. Now between Victoria Island and Banks Island there is open water. Shouldn't be that way" (in Riedlinger 2001a: 57).

While residents do not explicitly connect such sea-ice conditions to the health of Peary caribou, less secure sea-ice would likely inhibit caribou to some degree from moving between islands. F. Kudlak also notes that after an autumn rain caribou "even go to open water, try to go someplaces. Must be hungry, starving I guess" (in Riedlinger 2001a: 72). Therefore, caribou may be less able to cope with severe weather events when sea-ice conditions are less robust.

Predation by wolves

Harvesters have cited predation by wolves as a contributing factor in caribou declines, particularly on Banks Island. On Northwest Victoria Island, hunters report that wolves feed primarily on caribou. Wolf populations have fluctuated over the years and were reported to be increasing on both Banks Island and Northwest Victoria Island in the 1990s.

Around 1954, Morris Nigiyok and Peter Esau observed many wolves on Banks Island, before a poisoning program reduced their numbers drastically (in Nagy 1999c: 92, 156). The poisoning program on Banks (from 1955 to 1959) was part of a larger effort across the much of the Northwest Territories (from 1951 to 1961), which ended when it was deemed that wolf 'control' had been achieved (Kelsall 1968; Heard 1984). Peter Esau links the decline of wolves with the growth of the muskox population on Banks Island. After the control program ended wolves began to recover on Banks during the 1980s and 1990s (C. Haogak, A. Carpenter, and P. Esau pers. comm. in NWT Peary Caribou Technical Committee 2004). Hunters like Sam Olikoak observe that such an abundance of wolves has an effect on the caribou. "Lots of them would get together and kill a caribou and eat it. That's why the caribou are depleting" (Nagy 1999c: 163). The CPCBI (2000) agrees that predation by wolves is implicated in a caribou decline between July 1994 and July 1998. It further specifies hunter reports of significant wastage of caribou and muskox meat by wolves, and that wolf numbers were increasing in the 1990s.

Increasing wolf populations impact caribou especially when the herds are less healthy (Riedlinger 2001a). Peter Esau and Larry Carpenter considered wolf predation near caribou calving grounds in the north of Banks Island to be a particularly serious risk (in SHCM 1998). The inter-relationships between wolves, muskoxen, and Peary caribou are clearly complex on Banks Island, as wolves are also noted as preying mostly on muskoxen (Larry Carpenter in SHCM 1998; Riedlinger 2001a).

Wolf predation also occurs on Northwest Victoria Island, and hunters reported in 1990 that wolves feed primarily on caribou as opposed to muskoxen (John Kuneyuna, David Kuptana, Allen Joss, Roy Inuktalik, Alex Banksland, George Okheena, Patsy Ekpakohak, and John Alikamik in Adjun 1990). Nevertheless, harvesters did not describe wolf predation as contributing significantly to Peary caribou declines on Northwest Victoria Island. One hunter (Morris Nigiyok) interviewed in 1993 asserted that it was not a significant factor, while none of the other Ulukhaktok hunters interviewed mentioned wolves as influencing caribou populations on Northwest Victoria Island (in Elias 1993).

Wolf populations on Northwest Victoria Island were high in the 1930s and 1940s (OCCP 2008), and again in the 1980s and 1990s (CPCVI 1998). Specifically, hunters reported higher wolf populations in December 1990 relative to 10-20 years before (John Kuneyuna, David Kuptana, Allen Joss, Alex Banksland, George Okheena, Patsy Ekpakohak in Adjun 1990). Although the CPCVI (1998) referred to wolf predation as a potential cause of caribou decline, it cites a lack of information regarding the seasonal diets of wolves in the area and the effect of wolf predation on the caribou population.

Industrial development

The Olokhaktomiut and Sachs Harbour Community Conservation Plans (OCCP 2008; SHCCP 2008) record community concerns regarding development in sensitive caribou habitat. In a formalization of 'Community Values', for instance, conservation is listed first; "All uses of the land in the Planning Area, including renewable and non-renewable resource development, must recognize conservation of the renewable resource base as the foremost priority" (OCCP 2008: 20; SHCCP 2008: 16). An incremental scale of land designations also reflects concern regarding development, exemplified by the most stringent classification (Category E) which specifies "Lands and waters where cultural or renewable resources are of extreme significance and sensitivity. There shall be no development on these areas" (OCCP 2008: 22; SHCCP 2008: 18). Many areas of potential development identified in these plans pertain to the offshore oil industry, and thus Peary caribou are seldom specified as being potentially impacted by such developments. However, the premise is clear that development presents a threat to wildlife more broadly.

These concerns are not new and appear in testimony against oil exploration made in the 1970s to the Berger Inquiry (i.e. Jimmy Memoganak, Paul Pagotak, Simon Kataoyak, Isaac Aleekuk, Roy Goose, Bill Goose, Annie Goose [in Berger 1976a], Peter Esau, William Kuptana, Fred Carpenter, David Nasogaluak, Noah Elias, Andy Carpenter [in Berger 1976a,b]). William

Kuptana, for instance, warns "if this exploration goes on and there happens to be some accident of some sort, the animals will die", while Noah Elias describes finding a caribou ensnared in wire left by seismic crews (in Berger 1976b: 4044, 4065). Andy Carpenter also explains that exploration should not happen in the spring and summer when the animals are looking after their young (in Berger 1976b: 4097). A 1973 report on oil exploration and Banks Island wildlife was also specifically motivated by the trappers on Banks Island expressing their concern that oil exploration would threaten their livelihood (although the report concluded that Inuvialuit in the area had not seen noticeable effects of oil exploration activities on the availability of caribou by the end of the study) (Urquhart 1973).

Currently, specific concerns from communities include stress on caribou from low-flying helicopters performing geological surveys, and increasing interest in coal exploration driven by demand from Asian markets (Gau pers. comm. 2012). As of February 2012 there were several active Prospecting Licences and Coal Exploration Licences on Banks Island in particular, predominately clustered on the southeast and northwest portions of the Island, and inland from Jesse Bay (AANDC 2012). Current leases, permits and licences can be viewed at: http://nwt-tno.inac-ainc.gc.ca/ism-sid/index_e.asp. The licenced areas to the northwest and those close to Jesse Bay notably overlap with areas identified as caribou calving grounds.

Other concerns include a proposed Melville Island gas pipeline (OCCP 2008). On Melville Island itself, "The Ulukhaktok (Holman) Community Working Group is concerned that future oil and gas development in the area will have a negative impact on the habitat of the wildlife found in this site" (OCCP 2008: 34).

Several sources also note that open water shipping channels related to industrial development would impede travel of wildlife between Banks and Northwest Victoria Islands (SHCCP 2008; OCCP 2008). One Community Working Group recommendation is "that no winter ship traffic be allowed through the Prince of Wales Strait (November to June inclusive)" (OCCP 2008: 57).

In Nunavut, fluctuations in Peary caribou and muskoxen distributions was attributed by local hunters in part to petroleum exploration (Taylor 2005). In particular, more numerous ground vehicles, aircraft, and dust from seismic activities (especially on Bathurst Island) was reported to have detrimentally affected wildlife (Taylor 2005; Simon Idlout in Nunavut Tusaavut Inc. 1997: 26), and concerns are evident regarding the potential effects of noise, dust, and pollution from further exploration (Ludy Pudlu and Herodier Kallak in Nunavut Tusaavut Inc. 1997: 51, 56).

Other threats

Human disturbances other than industrial development are also indicated as threats to Peary caribou. This includes the possibility of increasing tourism, which is noted as a risk to some habitats such as calving areas (SHCCP 2008).

Disease is not reported as a factor in Peary caribou declines, and very few indications of abnormal diseases were found in the sources reviewed here. Andy Carpenter did report that hunters were finding frequent tapeworm cysts in caribou in the 1980s, but the tapeworms appeared to die off after a few years (SHCM 1998). The CPCVI (1998), the CPCBI (2000), and Gunn (2005) all specifically affirm an absence of serious diseases in Peary caribou populations in the NWT.

Harvesters reported caribou drowning while crossing between islands in the 1950s, and some suspect such events to be a cause of the decline in caribou (William Kagyut in Elias 1993; Kassam 2009). Harvester reports that recent declines have not been accompanied by observations of carcasses on the landscape (SHCM 1998) could also imply they either relocated or drowned. Changing weather patterns causing Peary caribou to move onto sea-ice and ice between islands that is becoming less stable may lead to further drowning events similar to past observations (William Kagyut in Elias 1993; Kassam 2009).

Positive influences

Traditional and community knowledge sources indicate that several factors may have a positive influence on Peary caribou populations in the NWT. These include reduced hunting pressure on Peary caribou, some hunting pressure on muskox populations (particularly on Banks Island), and some aspects of climate change.

Additionally, Peary caribou were listed as Endangered in Canada under the federal *Species at Risk Act* in 2011 (www.sararegistry.gc.ca). A national Recovery Strategy must be developed by 2014. This process has raised the profile of the Peary caribou, and has prompted engagement of wildlife managers in the Inuvialuit Settlement Region and collaboration with the communities of Sachs Harbour and Ulukhaktok to better understand the circumstances behind the Peary caribou decline and identify strategies to facilitate their recovery (Gau pers. comm. 2012).

Reduced hunting pressure

Interestingly, an RCMP report from 1933 indicates that certain areas on Victoria Island were not hunted for several generations in the late 19th century due to local taboos (in Condon 1996).[9] More recently, as described in *Past overharvesting* (p.36), Peary caribou harvesting in the NWT is managed at very low levels. The current annual quota for Banks Island is 72 male-only[10] caribou from Banks Island and the Western Queen Elizabeth Islands combined (Table 1, p.38; GNWT 2011). Tags are issued by the Sachs Harbour Hunters and Trappers Committee.

The caribou quota for Northwest Victoria Island remains zero, and legislation reaffirms that "no person shall hunt caribou in Area I/BC/03" (GNWT 1993b). Hunters focus instead on Dolphin and Union caribou in the Prince Albert Sound Area (OCCP 2008: 69). Gunn (2008) reports that restrictions on harvesting did lead to increases in Peary caribou numbers on Banks Island and Northwest Victoria Island before 2003-04.

Management of muskox and wolf populations

Nagy (2004) includes many statements of harvesters in Sachs Harbour suggesting a need to rigorously control muskox populations on Banks Island. Deliberate control of muskox populations by Inuvialuit hunters may therefore be historically precedented:

> *"Michael Amos recalled that Susie Tiktalik often said that three years after people killed off the muskox, the caribou started coming back: 'they never saw any more muskox, they cleaned them right out that time. The muskox, they had been killing them all that time because there was going to be no more caribou' (MA: Aulavik-78A:3). Sarah Kuptana also heard from her husband William Kuptana that 'long ago they finished the muskox by doing that. The Qangmalit [eastern Arctic people] would surround big herds and kill them. Then, there was no more muskox, but the herds grew again" (Nagy 2004: 96).*

As described in the section called *Competition with muskoxen* (p.39), there is a commercial harvest program for muskoxen on Banks Island. However, harvest numbers have been consistently under the quota. In 1993 the quota was raised to 10,000 animals with no restrictions of age or sex (GNWT 1993a). The muskox harvest in 1997 was 1300 (Nagy 2004), and has been between 60 and 419 animals per year since 2006 (GNWT 2011).

The current muskox harvesting quota on Northwest Victoria Island is 1000 animals per year (GNWT 1993b); harvests have been between 211 and 270 per year since 2006 (GNWT 2011). There is a muskox quota of six animals per year from the Western Queen Elizabeth Islands (GNWT 1993a,b).

According to wildlife management legislation, wolves can be hunted by Inuvialuit on Banks, Northwest Victoria, and the Queen Elizabeth Islands (areas I/BC 01, 02, 03, and 04) from August 15 to May 31 (GNWT 1993a). A series of Sachs Harbour Community Conservation Plans (1992: 23, 2008: 28) recommend to "continue to harvest wolves as normal; the Community does not support systematic wolf control or elimination."

Conservation of habitat

Community-based planning documents called Community Conservation Plans have been created under the objectives of the 1988 Inuvialuit Renewable Resource Conservation and Management Plan to help ensure the conservation of Peary caribou and other species' habitat. Conservation priorities for local wildlife have been formalized in these plans (SHCCP 1992; OCCP 2000; OCCP 2008; SHCCP 2008). The 2008 versions recommend that "all uses of the land in the Planning Area, including renewable and non-renewable resource development, must recognize conservation of the renewable resource base as the foremost priority. This applies to uses of the land by the community and by other interests" (OCCP 2008: 20; SHCCP 2008: 16). This indicates community resolve for responsibly managing the local landscape with a long-term view. Specific conservation measures in 2008 included recommendations that harvesters "identify and protect important habitats from disruptive land uses" (OCCP 2008: 70; SHCCP 2008: 28). Additionally, Aulavik National Park has been established on northern Banks Island, protecting 12,000 km^2 of the island from development (Government of Canada 1992).

If large enough, proposals for development projects within the range of Peary caribou may be screened by the Inuvialuit Land Administration (ILA), and reviewed by the Sachs Harbour and Olokhaktomiut Hunters and Trappers Committees. The ILA normally requires the approval of the HTCs before approving project proposals, and also can attach conditions on the projects to ensure that land and resources are not harmed (OCCP 2008; SHCCP 2008).

Aspects of climate change

Some of the effects of climate change may benefit Peary caribou. Warmer summers and more rain mean more vegetation, which is good for animals (Berkes and Jolly 2001), and warmer winters are also better for caribou and muskoxen (Riedlinger 2001a) (presumably because they require less energy and fat reserves to survive). Peter Esau reports that when there is 'good weather' in the spring, caribou numbers can 'increase very fast' (in Nagy 1999c).[11] Riedlinger (2001a: 82) summarizes several local observations on this topic:

> *"Vegetation has increased on the [Banks] Island as a result of warmer temperatures and increased rain. This is evidenced by the fact that muskox are staying in one place longer. This increase in vegetation is most noticeable in the flats and along the rivers. There is more moss around. This will be good for the caribou. Vegetation is increasing despite the high muskox numbers."*

Another effect of climate change is reported to be more wind, which is said to make it easier for caribou to cope with mosquitoes in the summer (Riedlinger 2001a).

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Authorities Contacted

Aboriginal organizations and wildlife management boards

Bruce Hanbidge	Resource Biologist, Wildlife Management Advisory Council (NWT), Inuvik NT.
Cathy Cockney	Manager, Inuvialuit Cultural Resource Centre, Inuvik NT.
Myrna Buttons	Archivist, Joint Secretariat Archives, Inuvik, NT.
Steven Baryluk	Resource Management Coordinator, Inuvialuit Game Council, Inuvik NT.

Territorial government contacts

Bob Turner	Aboriginal Relations Coordinator, Environment and Natural Resources, NT.
Dr. Jan Adamczewski	Wildlife Biologist (Ungulates), Environment and Natural Resources, Yellowknife NT.
Marsha Branigan	Manager, Wildlife Management, Environment and Natural Resources (Inuvik Region), Inuvik NT.
Rob Gau	Wildlife Biologist (Species at Risk), Environment and Natural Resources, Yellowknife NT.
Tracy Davison	Regional Biologist, Environment and Natural Resources (Inuvik Region), Inuvik NT.

Federal government contacts

Donna Bigelow	Species at Risk Biologist, Environment Canada. Yellowknife NT.
Ifan Thomas	Western Arctic Field Unit Superintendent, Parks Canada, Inuvik NT.
Linh Nguyen	Biologist, Parks Canada, Inuvik, NT

Other species experts

Dr. Anne Gunn	Independent consultant, Salt Spring Island BC.
Dr. Donna Hurlburt	Co-chair, COSEWIC Aboriginal Traditional Knowledge Subcommittee, Annapolis Royal NS.
Dr. John Nagy	Ph.D. Student, University of Alberta, Edmonton AB.
Lena Wolki	Principal Investigator, Sachs Harbour Elders Council Traditional Knowledge Project, Sachs Harbour, NT.
Dr. Micheline Manseau	University of Manitoba, Winnipeg MN.
Murielle Nagy	Adjunct Professor, Université Laval, QC.
Tina Steen	Inuvialuit Regional Corporation, Tuktoyaktuk NT.

Biography of Preparer

Roger McMillan recently completed a Master of Science degree in the Rural Sociology program at the University of Alberta. His work focussed on local responses to a reduced availability of barren-ground caribou in terms of community hunts and food-sharing, in the *K'asho Got'ine* Dene community of Fort Good Hope, NWT. Through the project, he used methods such as focussed ethnography and participant observation on various hunts to gain a better perspective of the roles of traditional knowledge in harvesting and management.

SCIENTIFIC KNOWLEDGE COMPONENT

Names and classification

Scientific Name: *Rangifer tarandus pearyi* J.A. Allen 1902

Common Name (English): Peary caribou
Common Name (French): Caribou de Peary
Inuvialuktun: Tuktu

Peary caribou (*Rangifer tarandus pearyi*) (Wilson and Reeder 2005) are a small distinctive form of caribou found on the Canadian Arctic Islands.

Name of subpopulation(s): 1. NWT Western Queen Elizabeth Islands (Melville, Prince Patrick, Eglinton, Borden, Mackenzie King, Brock)
2. Banks Island
3. Northwest Victoria Island (Minto Inlet)

Family: Cervidae (Deer Family)
LIFE FORM: Vertebrate, terrestrial mammal, ungulate, deer, reindeer, caribou

Figure 10. Peary caribou in summer pelage on Banks Island (photo A. Gunn, Environment and Natural Resources (ENR)).

Systematic/taxonomic clarifications

The current taxonomy (Manning 1960; Banfield 1961; Wilson and Reeder 2005) identifies Peary caribou as a subspecies of caribou (reindeer). The taxonomic classification of caribou near northwest Victoria Island has not been formally assessed, although Manning (1960) noted the occurrence of resident caribou on northern Victoria Island, but he did not have samples. The taxonomy is outdated in methods, which could be a problem for considering the status of Peary caribou relative to Dolphin and Union caribou (*R. t. groenlandicus* × *pearyi*), which shares part of its range on Victoria island.

Older taxonomy did not include DNA analyses. Nuclear DNA analyses have been used to assess genetic diversity and describe the relationships within and among caribou on the Arctic islands (McFarlane *et al.* 2009). Peary and Dolphin and Union caribou are considered separate designatable units by COSEWIC (2011). In this regard, Dolphin and Union caribou (*R. t. groenlandicus* × *pearyi*) are distinct from *R. t. groenlandicus*.

Mitochondrial DNA analyses do not fit with the current sub-speciation of caribou which reflects the effect of post-glacial conditions shaping appearance and behaviour of the caribou rather than their origins (Eger *et al.* 2009). A likely evolutionary history for western Arctic Peary caribou (Eger *et al.* 2009) is that caribou persisted on Banks Island, some sections of which were refugia during the last glaciation. Banks Island was isolated by large ice shelves from Beringia to the south and Prince Patrick, Eglinton, and Melville islands to the north until 12,000 years before present (ybp). As the Laurentian Ice Sheet receded from around Banks Island, caribou from Banks Island colonized Prince Patrick, Eglinton, and Melville islands (approximately 6,300 ybp), Victoria Island to the east (approx. 3,000 ybp) and Prince of Wales Island by 1,500 ybp.

Description

Peary caribou are highly recognizable and can be easily distinguished from both barren-ground (mainland) and Dolphin and Union caribou. Peary caribou are small in stature and have noticeably short legs and face. The winter coat is distinctive in being white with a pale brown back in early winter. In summer, the coat is slate above and does not have the pronounced flank stripe typical of barren-ground caribou (Fig. 10, p.54). The belly is white and the legs are white except for a narrow frontal stripe. The pale gray antler velvet is a striking distinguishing characteristic compared to the brown velvet of barren-ground or woodland (*R. t. caribou*) caribou.

On the basis of skull size and shape, Manning (1960) found a stepped gradient from the smallest caribou in the Queen Elizabeth Islands through Banks Island to the Dolphin and Union caribou of Victoria Island, to mainland caribou.

Distribution

Global distribution

Peary caribou only occur in Canada (except occasional sightings on the northwest Greenland coast) (Fig. 11). They are restricted to the High Arctic (Queen Elizabeth Islands) and the mid-Arctic islands as well as the northern extension of the mainland (Boothia Peninsula). In Canada, Peary caribou only occur in Nunavut and NWT with a few sporadic historic sightings in the Yukon Territory.

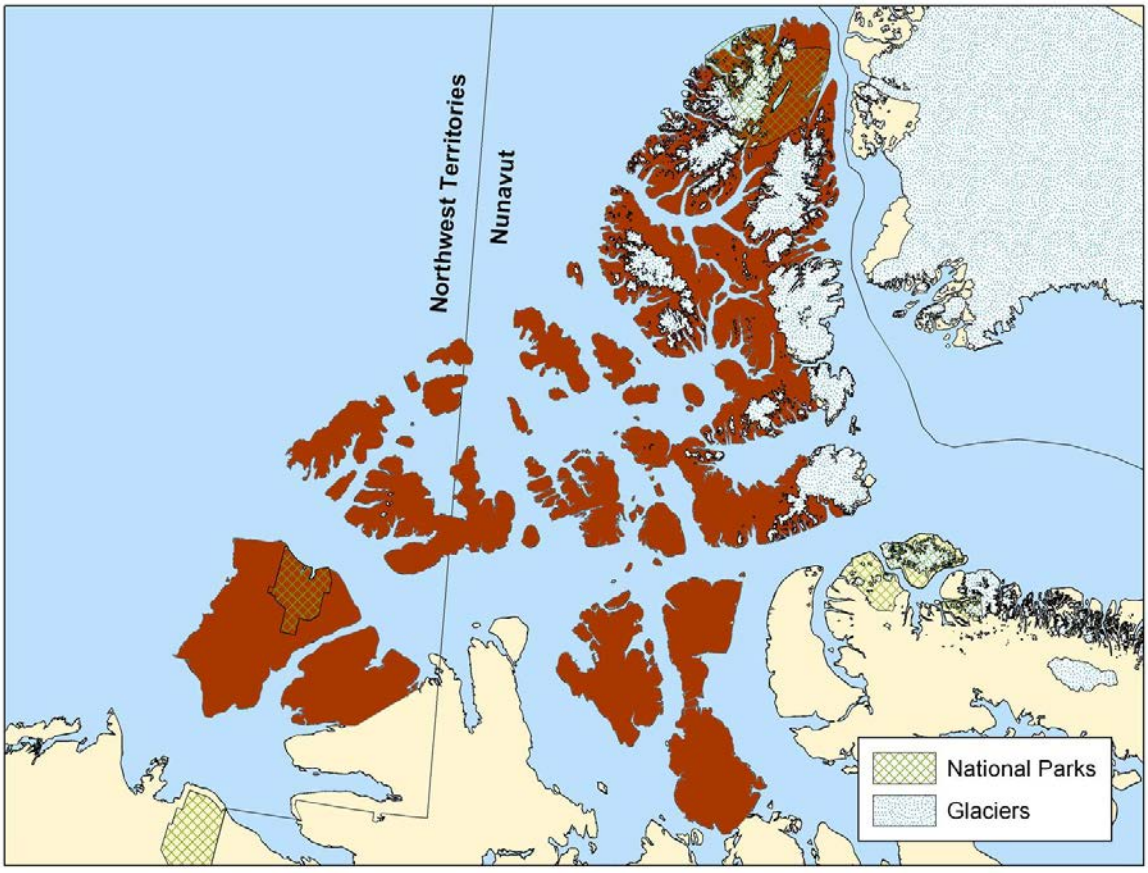

Figure 11. Global distribution of Peary caribou (R. Gau, Government of the Northwest Territories (GNWT) Environment and Natural Resources, unpubl. data 2011).

NWT distribution

The distribution of Peary caribou is on all the Arctic islands within the NWT (Fig. 12). This includes the NWT portion of the western Queen Elizabeth Islands, Banks Island, and northwest Victoria Island. The distribution is largely based on sightings during systematic aerial surveys (Appendix A) since 1961 (western Queen Elizabeth Islands), 1972 (Banks Island) and 1980 (northwest Victoria Island). The aerial surveys are island-wide except for northwest Victoria Island where a similar area has been surveyed during 1980-2010. On northwest Victoria Island, the distribution of the caribou is also based on movements of satellite-collared cows during 1987-89 and 1996-2006 (Gunn and Fournier 2000a, Poole *et al.* 2010, ENR unpubl. data 2011a). On Banks Island, the distribution is also based on movements of satellite-collared cows during 1999-2002 (ENR unpubl. data 2011a).

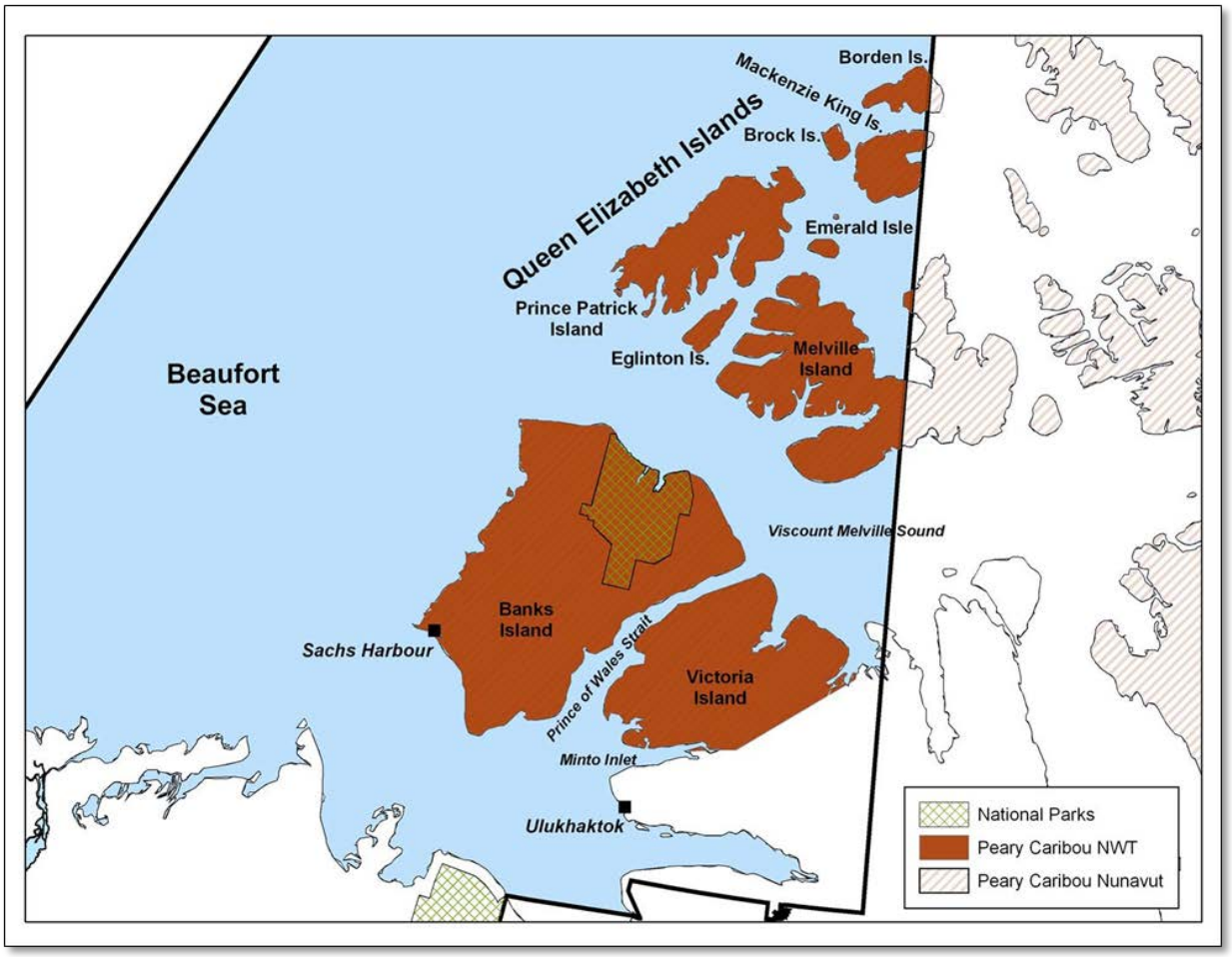

Figure 12. Distribution of Peary caribou in the Northwest Territories (R. Gau, GNWT Environment and Natural Resources, unpubl. data 2011).

The historic distribution (prior to commencement of aerial surveys in the 1960s and 1970s) is incompletely recorded. European explorers reported caribou on Melville, Banks and northwest Victoria islands, but the scattered nature of the sightings adds little to known distribution based on more recent aerial surveys and Inuvialuit observations. Archaeological evidence has not yet been compiled.

The current distribution is naturally discontinuous (fragmented) through extrinsic (island geography) and intrinsic (behaviour) into three geographical subpopulations. The Peary caribou on the NWT western Queen Elizabeth Islands are relatively isolated from Banks and northwest Victoria islands with DNA analyses indicating a lack of recent gene flow (McFarlane *et al.* 2009). The 100km wide Viscount Melville Sound is at least a partial barrier to movements because it is rough multi-year ice in most years. The ice conditions and the lack of incidental observations suggest that seasonal movements across Viscount Melville Sound are unlikely. However, desperation movements during extreme winter weather cannot be discounted and have been reported historically.

Although Peary caribou on Banks and northwest Victoria islands were previously considered as a single subpopulation (COSEWIC 2004), currently these may be considered as two geographic subpopulations as seasonal migration across the sea-ice between the islands has apparently ceased since the 1980s. During the mid-1970s and 1980s, caribou crossed the ice between Banks and northwestern Victoria islands (Miller 1986; Nagy *et al.* 1998, RWED 1998). However, there is little information on the scale of the movement and no recent information since the 1980s. Irregular coastal flights in early June 1982, 1983 and 1985 (triggered by plans to ship Beaufort Sea oil though Prince of Wales Strait) did not find caribou or tracks crossing between Banks and northwest Victoria islands (Kiliaan and Thomas 1983; Miller 1986).

The range of the Peary caribou subpopulation on northwest Victoria Island (Minto Inlet area) is adjacent to the summer range of Dolphin and Union caribou. The separation of the northwest Victoria Island subpopulation from Dolphin and Union caribou is based on the movements of satellite-collared cows during 1987-89 and 1996-2006 (Gunn and Fournier 2000a; Poole *et al.* 2010; ENR unpubl. data 2011a) and aerial surveys (1980-2010 – Appendix A). Radio-telemetry supports the finding from aerial surveys that caribou inhabiting the areas northwest of the Shaler Mountains on Victoria Island are Peary caribou and not Dolphin and Union caribou (Nishi and Buckland 2000; Nagy *et al.* 2009d). The different origins and longer-term separation of Peary

caribou and Dolphin and Union caribou is based on nuclear DNA (McFarlane *et al.* 2009).

The Banks and northwest Victoria islands subpopulations are relatively isolated from Peary caribou subpopulations in Nunavut to the east, as Dolphin and Union caribou occur on central and southern Victoria Island and the former large Peary caribou subpopulation on Prince of Wales Island has either disappeared or is at critically low numbers (Gunn and Dragon 1998; Jenkins *et al.* 2011). However, on Melville Island, the Nunavut/NWT border likely crosses a continuous distribution as Peary caribou on Prince Patrick, Eglinton and Melville islands are considered one geographic subpopulation, although information is limited to the early 1970s. Many caribou in the Melville complex wintered on Prince Patrick Island and migrated in spring to Eglinton, Emerald, Melville and Byam Martin islands for the summer, at least in the early 1970s, based on seasonal aerial surveys and dye-marked caribou (Miller *et al.* 1977b).

The longer-term relationships between subpopulations has also been described through microsatellite DNA analyses (McFarlane *et al.* 2009). These analyses were based on sampling across the western range of Peary caribou, including Melville, Banks and northwest Victoria islands, to assess distinctiveness and genetic variation among subpopulations. The samples were recently cast antlers from calving areas on Melville Island (n = 31) and northwest Victoria Island (n = 12), and tissue from Banks Island (n = 64). Peary caribou from Banks and northwest Victoria islands were not significantly different from each other (but the sample size from northwest Victoria Island was relatively small). The Peary caribou from Melville and Eglinton islands were distinct from Banks Island and northwest Victoria Island. Peary caribou from Melville Island were less genetically diverse, and showed stronger evidence for past bottlenecks (small population size). The nuclear DNA analyses showed that Dolphin and Union and the Banks/northwest Victoria Island caribou were significantly different (Zittlau 2004). The genetics and morphological differences indicate local adaptations (McFarlane *et al.* 2009).

Small numbers of Peary caribou have sporadically appeared on the mainland as far west as Old Crow, Yukon, during or shortly after winters with fall icing on Banks Island and/or Victoria Island (Manning and Macpherson 1958; Banfield 1961; Youngman 1975). Youngman (1975) reported a small, whitish caribou killed by a hunter from Old Crow, Yukon, that matched *R. t. pearyi* and caribou from Dolphin and Union caribou (*R. t. groenlandicus* × *pearyi*) skeletal measurements. Between 30 and 40 Peary caribou were reported at Herschel Island (Yukon), Baillie Island (NWT) and Cape Dalhousie (NWT) in the early 1950s, which were linked with fall icing on Banks Island (McEwan 1952). Youngman (1975) also reported that Kutchin (Dene) hunters from Old Crow often commented on the occasional occurrence of small caribou mixed

with groups of larger animals. A "Banksland caribou" was seen amongst a group and harvested during a community hunt for barren-ground caribou out of Tuktoyaktuk in 1995 (Larter pers. comm. 2011).

Extant locations

The NWT Species at Risk Committee's (SARC's) criteria for considering extant locations in the assessment of status define 'location' as a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the species present (SARC 2010 following IUCN). We describe Banks Island, northwest Victoria Island, and the NWT western Queen Elizabeth Islands as at least three extant locations using this definition, because the regional climate and harvesting (see *Threats*, p.89) differ among the three areas. In addition, different climate patterns within each area could be the basis for several more locations.

Extent of occurrence

'Extent of occurrence' as defined by SARC is the area included in a polygon without concave angles that encompasses the geographic distribution of all known populations of a species (SARC 2010). The extent of occurrence for Peary caribou in the NWT was estimated based on the area of islands where Peary caribou have been observed since 1961 (listed in Appendix A). These areas encompass all the known sites of use and contain the waterbodies between the islands within each subpopulation, as individuals are known to travel on sea-ice between islands. On Melville Island the distribution to the Nunavut/NWT territorial boundary was mapped. On northwest Victoria Island the eastern boundary of Peary caribou was drawn from Richardson Collinson Inlet Bay to Minto Inlet, which encompassed the distribution of the satellite collared cows during 1987-89. The line is the same as the eastern boundary of the 1994 aerial survey for Stratum IV (Gunn and Fournier 2000a; Nishi and Buckland 2000; Fig. 6 in Nagy *et al.* 2009f). The sea-ice between Banks and northwest Victoria islands was included as this has been used as a migratory corridor (approximately 8,000 km^2). The sea-ice between Melville and Banks or Victoria islands was not included as there is no information on whether caribou use it. The sum of the area of occurrence was 237,022 km^2.

Area of occupancy

'Area of occupancy' as defined by SARC is the area within the extent of occurrence that is occupied by a species, excluding cases of vagrancy. This measure reflects the fact that the extent of occurrence may contain unsuitable or unoccupied habitats.The area of occupancy is measured both as an estimate of the actual area occupied (the "biological occupancy") and as an index of

area of occupancy (IAO) which uses a scale-correction factor to standardize this estimate across different spatial scales (SARC 2010). The biological occupancy for Peary caribou was calculated as the area of occupied islands in the NWT, excluding the sea, and totalled 158,293 km^2. While acknowledging that the standard 2 x 2 km cell size used by SARC to calculate IAO may not be the best spatial scale for Peary caribou because aerial survey transects are generally done at 5 km spacing, IAO was estimated as 167,492 km^2.

Search effort

The qualitative effort to determine the species range in the NWT uses data from systematic aerial surveys where transects have covered Banks Island, the NWT western Queen Elizabeth Islands and northwest Victoria Island (Appendix A).

Within the overall ranges, the search effort to measure spatial distribution is based on the coverage of each island in a group, where coverage is a function of transect spacing, transect width, flight altitude and speed. Coverage during surveys conducted for Peary caribou within the NWT has varied among areas and over time (Table 2, p.62). All surveys provided systematic coverage through strip transects, generally using a number of strata (blocks) within the survey area. Transect width decreased over time, likely with the realization that sightability is a function of distance from aircraft, and drops off markedly beyond 400-500m. Most recent surveys have used 500m transect width on each side of the aircraft. Although some of the earlier surveys used very low coverage (e.g., 4-6%), surveys have generally used a standard 20% coverage (5 km spacing on transects, 1 km strip width) with increased coverage in higher density strata. Survey aircraft generally flew about 150m above ground level. Standardization of survey methods has facilitated more equitable comparison of results over time.

The systematic effort and extent of coverage make it unlikely that there are unexplored areas (at the scale of tens of km) that could harbour Peary caribou. The negative data (areas searched and Peary caribou not found) are available in the individual survey reports. The scale of daily movements relative to the frequency of surveys makes it unlikely that any areas can be assumed not to be potential habitat (except ice caps on western Melville Island).

The temporal search effort to describe distribution and trends in distribution has varied at the annual and seasonal scales. The frequency of the annual effort (aerial surveys) has varied among subpopulations with long gaps between surveys on the NWT western Queen Elizabeth Islands (Table 2).The extent and timing of seasonal effort is described in *Distribution trends* (p.63).

Table 2. Years and survey coverage for Peary caribou aerial surveys for subpopulations in the NWT, 1961-2012.

Survey Month Year	Coverage (%)	Comments	Reference
Western Queen Elizabeth Islands			
Northwestern Queen Elizabeth Islands (Mackenzie King, Brock, Borden)			
Aug 1961	4		Tener 1963
Apr 1973	~25-50		Miller *et al.* 1977a
Apr 1974	~25-50	Brock, Borden islands not done	Miller *et al.* 1977a
Jul 1997	20	Borden island not done	Gunn and Dragon 2002
Southwestern Queen Elizabeth Islands (Melville Group)			
Jul 1961	4	Byam Martin not done	Tener 1963
Mar-Apr 1972	~25-50	Prince Patrick, Emerald islands not done	Miller *et al.* 1977a
Aug 1972	~25-50	Prince Patrick, Emerald islands not done	Miller *et al.* 1977a
Mar-Apr 1973	~25-50		Miller *et al.* 1977a
Jul-Aug 1973	~25-50		Miller *et al.* 1977a
Apr 1974	~25-50	Melville Is. not done	Miller *et al.* 1977a
Jul-Aug 1974	~25-50	Emerald not done	Miller *et al.* 1977a
Jul 1986-87	27		Miller 1988
Jul 1997	20		Gunn and Dragon 2002
Jul-Aug 2012	18	Brock, Borden, Mackenzie King islands not done	Davison and Williams 2012
Banks Island			
Jun 1970	Unknown	Northern Banks	Kevan 1974
Sep 1972	6-25		Urquhart 1973
Mar 1979-80	25-26		Vincent and Gunn 1981
Jul 1982	15		Latour 1985
Jul 1985	9-24		McLean *et al.* 1986
Jun 1987	5-15		McLean 1992
Jun 1989	10-20		McLean and Fraser 1992
Sep 1990	5		McLean *et al.* 1992
Jun-Jul 1991	10		Fraser *et al.* 1992
Aug 1992	20-40		Nagy *et al.* 2009b
Jul 1994	20-40		Larter and Nagy 2001d
Jul 1998	20-40		Larter and Nagy 2001d
Jul 2001	20		Nagy *et al.* 2006c
Jul 2005	20		Nagy *et al.* 2009c
Jul 2010	20		Davison *et al.* in prep.
Northwest Victoria Island (Minto Inlet)			
Jun 1987	6		Gunn and Fournier 2000a
Mar 1992	10-31		Heard 1992a
Mar 1993	5-10		Gunn 2005
Jun 1993	10		Gunn 2005
Jun 1994	10-30	Stratum IV of W Victoria	Nishi and Buckland 2000
Jul 1998	20		Nagy *et al.* 2009d
Jul 2001	20		Nagy *et al.* 2009e
Jul 2005	10-20		Nagy *et al.* 2009f
Jul–Aug 2010	20		Davison *et al.* in prep.

Distribution trends

Trends in Peary caribou distribution are described using the period of aerial surveys (40-50 years). Although this period is longer than three generations (assumed to be 21 years; see *Structure and rates*, p.73) the 40-50 year period of aerial surveys is used because a relationship between abundance and distribution is likely, based on caribou biology where typically as abundance decreases, the boundary of winter range contracts (Bergerud *et al.* 2008). The abundance of Peary caribou measured over the longer period of aerial surveys includes an apparent peak, decline and period of low numbers (absence of recovery) for most subpopulations. Because of information gaps in calculating generation time (see *Structure and rates*, p.73), long-term trends in abundance (see *Abundance*, p.80), and the extreme climatic variability characteristic of the region, it is appropriate to also assess trends in distribution over 40-50 years.

Detecting overall distributional changes is difficult because there is only one year (1987) when almost the entire range of NWT western Queen Elizabeth Islands, Banks Island, and the calving distribution on northwest Victoria Island were surveyed. Within each of the subpopulation ranges there is a greater potential to detect distributional changes, as relatively standardized surveys with island-wide coverage in about the same season were conducted in each area.

One documented change in distribution is that migrations of Peary caribou between eastern coastal Banks and northwest Victoria islands halted by the late 1980s (Miller 1986; SARRAMT 2004). In November 1950 and during the mid-1970s people in Ulukhaktok saw caribou crossing the ice between Banks and Victoria islands (McEwan 1952, Nagy *et al.* 1998). Movements back and forth between Banks and Victoria islands occurred during the early 1980s, and the last movements were observed in the late 1980s (Nagy *et al.* 1998; RWED 1998).

The extent of analyses of the aerial survey data and limitations of the data (sampling frequency) do not allow discrimination between loss of subpopulations or changes in behaviour along with declines in abundance. We lack information to interpret whether the halt in migration between Banks and northwest Victoria islands (Manning and Macpherson 1958; Urquhart 1973; Wilkinson and Shank 1974; Fraser *et al.* 1992; Nagy *et al.* 1996) was due to a loss of a subpopulation or a contraction of the range of the existing subpopulation on Banks Island.

Reduced use of smaller islands during times of reduced abundance is likely for Peary caribou (Miller *et al.* 1977b). There is some evidence (one year's data) to suggest a contraction in summer range in the NWT western Queen Elizabeth Islands. In 1997, Peary caribou were not

seen on three islands (Brock, Eglinton and Emerald islands) during aerial surveys covering the island complex (Gunn and Dragon 2002); however, Peary caribou had been consistently seen on those islands in 1961, 1972-74 and 1987-88 aerial surveys, and were seen there again in 2012 (Appendix A). It appears Peary caribou may have returned to Eglinton Island before 2012 as researchers observed a group of two Peary caribou on Eglinton Island in July 2006, and a group of 11 caribou in June 2007 (ENR and Environment Canada, unpubl. data 2011).

Trends in seasonal distribution within Banks Island are unknown and would be restricted to post-calving and summer distribution (Appendix A), which is the timing of all surveys since 1980. Surveys of the late winter ranges on Banks Island occurred in 1971 and 1972 and then on north and south Banks Island in 1979 and 1980, respectively (Vincent and Gunn 1981). Since the decline in abundance, the winter ranges have not been surveyed and muskox (*Ovibos moschatus*) numbers on these ranges have increased, with a potential impact on Peary caribou distribution (see *Interactions with other herbivores*, p.70). Using the information from post-calving and summer aerial surveys within an island to examine trends in distribution is complicated by annual variation in the timing of plant phenology (Larter and Nagy 2001b), which influences caribou movements (e.g., timing of movement inland to higher elevations or to the coast). Currently, analyses of the post-calving summer distribution are limited to cumulative frequency of use, which cannot be used to identify trends (Community of Sachs Harbour 2008; Nagy *et al.* in prep.). The low numbers of Peary caribou recorded on northwest Victoria Island since the 1990s and their scattered dispersion make it difficult to describe any changes in seasonal distribution.

Aerial surveys timed to coincide with calving on Banks Island occurred in 1971 and 1972 (Urquhart 1973). Those surveys identified calving on the northwest corner (Ballast Beach), Jesse Harbour on the east coast and scattered low density calving on northeast Banks Island. Miller (1986) flew unsystematic searches in June 1985 and described calving at Jesse Harbour. Most subsequent aerial surveys were not timed to describe calving distribution on Banks Island. The 10 cows fitted with satellite collars in 1999 had dispersed calving sites mostly on the southern half of the island with only one returning to the northwest calving area around Ballast Beach (ENR unpubl. data 2011a).

Trends in calving distribution on Melville Island are unknown because information is limited. Miller *et al.* (1977a) believed that post-calving aggregations of Peary caribou on Melville Island moved from the coastal to the higher inland plateaus of Dundas Peninsula. Surveys in 1998, 1999, and 2000 indicated congregations of Peary caribou in the south central uplands of Dundas

Peninsula (Larter and Nagy 2000a; Larter and Nagy 2003). The basis for describing calving areas on eastern Melville Island is unsystematic aerial searches in 1973-74 (Miller *et al.* 1977b; Gunn and Fournier 2000a). On northwest Victoria Island, four satellite collared cows during 1987-89 (Gunn and Fournier 2000a) migrated north in spring to calve and south in winter to the Minto Inlet area and aerial surveys in the 1980s indicated calving inland from Dean Dundas Bay (Gunn and Fournier 2000b).

Habitat

Habitat Requirements

Peary caribou habitat requirements are relatively well-documented through studies during the 1970s and 1990s on Banks Island (Wilkinson *et al.* 1976; Shank *et al.* 1978; Larter and Nagy 2001 a,b,c), and a short-term study on Melville Island (Parker 1978). The approach to assessing habitat requirements is dependent on describing diet, distribution of forage by habitat types, and the distribution of caribou feeding craters relative to snow conditions and habitat type (Wilkinson *et al.* 1976; Shank *et al.* 1978; Larter and Nagy 1994, 1997, 2001a,b,c, 2004; Larter *et al.* 2002). Various studies described diet, summer habitat use and responses of Peary caribou foraging to threefold variation in snow conditions on south central Banks Island between 1993 and 1998 (Larter and Nagy 2001a). Some information on diet and habitat selection was collected on western Melville Island in the early 1970s (Parker 1978) and eastern Melville Island (Thomas *et al.* 1999).

Peary caribou use a relatively wide variety of habitats (terrain and vegetation types). The range of Peary caribou is within the Northern Arctic Ecozone and the available habitat is mostly prostrate dwarf-shrubs and cryptogams (Gould *et al.* 2003). Ranges are snow-covered from September to May (Banks Island) or mid-late June (Melville Island). Consequently, a key habitat requirement is terrain and vegetation features that offer choices as caribou adjust their foraging to changing snow conditions. On Banks Island, the key habitat requirement for winter foraging was upland habitats with a shallow snow-cover, even though vegetation was sparse (Larter and Nagy 2001a). Similarly on eastern Melville Island, caribou in winter used sparsely vegetated upland ridges with sedges and lichens (Thomas *et al.* 1999). The amount of lichens in the winter diet of Peary caribou on eastern Melville Island varied depending on snow conditions – in years with deeper harder snow there was a lower occurrence of lichen in the diet (Thomas *et al.* 1999). During winter, legumes (*Astragalus* spp. and *Oxytropis* spp.) are important dietary items high in

nitrogen (Larter and Nagy 1997, 2003).

Habitat requirements during the snow-free season appear to be tied to forage selection for the flower and leaf buds and newly emerged leaves and flowers (Larter and Nagy 2001b). Peary caribou select leaves and flowers such as purple saxifrage (*Saxifraga oppositifolia*) and arctic poppy (*Papaver radicatum*) to maximize protein intake in summer. Willows (*Salix* spp) comprise almost half the summer diet on Banks Island. The caribou move first to higher elevations then to coastal areas during the summer while selecting the most nutritious forage (Miller *et al.* 1977a; Larter and Nagy 2001b). On eastern Melville Island, caribou in summer were associated with willow and arctic poppies as well as lichens and forbs (Thomas *et al.* 1999).

Little is known about the habitat requirements for calving areas other than the generalities that calving areas are mainly associated with major drainages and coastal sites with varied terrain providing snow-free or shallow snow-covered sites, at least shortly before and during calving each year (Urquhart 1973; Miller *et al.* 1977b; Nagy *et al.* 1996; Gunn and Fournier 2000a,b). The question of fidelity to calving areas and the degree of gregarious behaviour is covered in the section on *Life cycle and reproduction*, p.67.

Habitat requirements for fall and rutting areas are only known in general terms, although Peary caribou on Banks Island select habitats where they feed on sedges (*Carex* spp), pea plants (*Astragalus spp*, *Oxytropis spp*), and mountain avens (*Dryas spp*) (Larter and Nagy 1995, 2001b,c, 2004). Caribou rut in coastal areas on Melville Island based on the distribution of shed prime bull antlers (Miller and Barry 1992). On Banks Island in 2004, the northwest and the west coasts were the only areas where cast prime bull antlers were found, suggesting that they were rutting areas (Gunn and Williams 2006).

Habitat availability

Habitat availability is only partially addressed in range studies on Banks Island although island-wide vegetation mapping has been completed (Larter *et al.* 2009). Larter and Nagy (2001c) described the distribution of forage plant species among different habitat types and found that it varied according to local topography. The authors acknowledged that plant standing crop and quality would need to be incorporated to assess habitat availability; these data have been collected but not thoroughly analyzed. The next steps would also require island-wide habitat type mapping. Information is lacking on habitat availability for Peary caribou on northwest Victoria Island and the NWT portion of the western Queen Elizabeth Islands.

Habitat availability for 8-9 months of the year is strongly influenced by snow conditions. Larter and Nagy (2001a) describe annual variations in snow conditions from 1993 to 1998. The influence of snow and ice conditions on habitat availability is discussed in *Threats*, p.89. Influence of caribou or muskox numbers is covered in the section on *Interactions*, p.70. At the scale of available information it is only practical to map distribution rather than specific occupied habitats or potential or unoccupied habitats.

Habitat fragmentation

Activities that can potentially fragment habitat such as ice roads and seismic lines were more frequent in the early 1970s on Banks Island and the NWT western Queen Elizabeth Islands during exploration for oil and gas. Limited information on Peary caribou behavioural responses indicates activities associated with oil and gas exploration were not at a scale to fragment habitat at that time (Urquhart 1973; Miller *et al.* 1977b).

Habitat trends

In the western continental Arctic, there are measured trends for increasing plant productivity based on satellite imagery and changes in vegetation such as an increase in shrub growth (Callaghan *et al.* 2005; Hudson and Henry 2009). Specific trends for ranges of Peary caribou have not been analysed. Changes in the timing of snow melt for eastern Banks and western Victoria islands have been noted. The mean date of snow melt on Banks Island was 7.5 days earlier for 1987-2004 compared to 1967-86 although melt has actually occurred later in the 2000s than in the 1990s (Foster *et al.* 2008). More information relating to habitat trends and a warmer climate is included in *Threats*, p.89.

Biology

Life cycle and reproduction

Peary caribou life-history strategies likely include female survival taking precedence over reproduction if forage is restricted (Russell and White 2000). Peary caribou are like many other large-bodied herbivores in that adult survival, especially for females, is relatively high (Gaillard *et al.* 2000). Although there are few data for Peary caribou, this is likely true except during years of environmental extremes when adult survival can be low in addition to reduced productivity. In winters 1951-54 and 1977-78, hunters reported finding carcasses of adult Peary caribou on

southern Banks Island when fall snowfall was deeper than average and icing had occurred, which together reduced forage availability (McEwan 1955; Morrison 1978; McLean 1992). Such die-offs are usually more extreme for adult males and juveniles than for adult females (Miller and Gunn 2003). If a die-off resulted in a preponderance of adult females, the subsequent rate of increase for the subpopulation would be high (Heard 1990). However, after a freezing rain event in November 1977 on Banks Island, it was found that that half of the adult carcasses were females (Morrison 1978).

The breeding strategies of Peary caribou are unknown other than the fact that it is typical for a caribou bull to mate with more than one cow (Mysterud *et al.* 2003). It is unknown whether a bull defends a harem or if or how the breeding strategy changes after caribou abundance declines.

At higher abundances such as in the early 1970s on Banks Island, Peary caribou were recorded as migrating in groups between the winter ranges on southern Banks Island and the calving and summering ranges which were on northern and eastern portions of the island. Urquhart (1973) based this on five island-wide seasonal aerial surveys in 1971 and 1972, and described observations of small groups of caribou moving north in early May. Subsequent surveys have not been systematic and the extent of seasonal migration has not been assessed. Distances and extent of gregariousness (group size) may have changed since the peak numbers in the early 1970s.

The aerial surveys on Banks Island since the 1990s have been flown during early post-calving (late June-early July). The highest densities are in the northwest which suggests fidelity to a calving area. However, only one of the 10 cows fitted with satellite collars in 1999 migrated across Banks Island, where this cow moved from summering in the southwest to wintering in the northwest in 2 of 4 years of monitoring; the other collared caribou generally remained year-round on southern and western Banks Island (ENR unpubl. data 2011a). These telemetry data have not been analysed or reported.

The difference in the scale of migratory behaviour between the aerial survey data and the collared cows may be a consequence of low densities and or variability in migratory behaviour. In mule deer, for example, there are non-migratory individuals with contiguous seasonal ranges and migratory individuals that trade-off the risks of migration against high quality habitat (Nicholson *et al.* 1997). As well or alternatively, cows may be now following different calving strategies (more dispersed in nature) along with declines in abundance. As caribou numbers decline, the advantages of gregarious calving such as safety in numbers from predation may be decreased, causing caribou to reduce length of their seasonal migrations. At lower densities, the proximity of seasonal habitats may be sufficient to allow caribou to occupy relatively small

home ranges. On Bathurst Island (Nunavut), for example, Peary caribou remained year-round within individual home ranges either within a single island or a group of islands (Miller 2002; Miller and Barry 2003). This is similar to the pattern seen in reindeer (*Rangifer tarandus platyrhynchus*) on Svalbard, Norway (Tyler and Øritsland 1989).

Physiology and adaptability

The physiology and adaptability of Peary caribou in the NWT has not been specifically studied. Although Peary caribou are adapted to extreme cold, their tolerance of heat is unknown. Peary caribou have relatively broad hooves for their body mass (Manning 1960), which is a likely adaptation to snow-covered forage for 8-9 months a year. Their molariform tooth row is relatively long for their skull size (Manning 1960) which may be an adaptation for relatively sparse vegetation and consequently higher levels of dust on the forage. Their dwarfism (small bodies and short legs) may be an adaptation to either hard packed or shallow snow.

Annual variability in winter conditions is characteristic of Peary caribou habitat. Dry or moist summer weather in turn affect the timing of snowmelt and summer forage quality (Larter and Nagy 2001a,b). Peary caribou are adapted to this variability through their foraging strategies which include local or long-distance movements and migrations when winter snow and ice conditions are exceptionally restrictive (Miller 1990). Peary caribou foraging strategies also include shifting between foraging on legumes or mountain avens (*Dryas octopetala* and *D. integrifolia*), which differ in digestibility and protein content (Larter and Nagy 2001b).

In order to attain full adult size in two years, winter growth may be necessary for high arctic caribou and reindeer. In barren-ground caribou, growth occurs in summer but ceases in winter (Dauphiné 1976). However, Larter and Nagy (1995) showed evidence that Peary caribou calves continue to grow during winter, similar to what has been implied from Svalbard reindeer based on growth curves (Tyler 1987b).

Captivity

Peary caribou have been raised in captivity (on the Alberta Game Farm in the early 1970s) but little is recorded about this. The idea of releasing captive-raised animals into the wild was extensively discussed in the 1990s (Government of the Northwest Territories, unpubl. files) and while possible, would depend on both the conditions in which the caribou were held and how they were released.

Interactions

Peary caribou depend on a wide variety of forage plants and the stage of growth (flower bud, leaf bud) is likely as important as the particular species. At the beginning of summer (June), plants such as *Saxifraga oppositifolia* are especially important for their flowers. Unlike for barren-ground caribou, lichens are not a key part of winter diet for Peary caribou because they are scarce on the Arctic Islands (Larter and Nagy 2004).

Interactions with other herbivores

Peary caribou share their ranges with smaller-bodied herbivores. Arctic hare (*Lepus arcticus*), ptarmigan (*Lagopus* spp), and lemming (*Dicrostonyx groenlandicus*, *Lemmus trimucronatus*) numbers fluctuate on the Arctic Islands. On Banks Island, Arctic hare and ptarmigan numbers were high in 1986-87 and 1993-94 (Nagy *et al.* 1998). Arctic hares feed almost exclusively on willow in winter and in summer they feed on willow, pea plants, sedges, and other flowers (Larter 1999). Ptarmigan forage on willows during the winter. Lemmings were high in summers 1993 and 1997. When lemming numbers are high their summer diet is almost exclusively mountain avens (Larter 1998). However, it is uncertain how or under what conditions the smaller-bodied herbivores affect foraging of Peary caribou or, as alternate prey, sustain predation on Peary caribou.

On Banks Island when muskox densities were high in the mid-1990s, caribou and muskox diets overlapped for willows, sedges and legumes (Larter and Nagy 1997, 2004). In the early 1970s, when muskox densities were lower and caribou densities higher, willow was reported in the diets of both animals (Wilkinson *et al.* 1976; Shank *et al.* 1978). Overall it appears that diet similarity tends to be higher in areas of high muskox density and during winter with deeper snow. Under these conditions, muskoxen may increase their use of upland habitats, potentially reducing forage availability for caribou. Larter *et al.* (2002) concluded that on Banks Island, "the potential for caribou numbers to increase may be constrained by the availability of suitable forage in the presence of muskoxen". However, the 2001-09 decline in muskox numbers on Banks Island has not yet contributed to caribou recovery. Muskox abundance was at its highest levels at 64,608 ± 2,009 (95% confidence interval) in 1994 and 68,585 ± 6,972 in 2001, then declined to 47,209 ± 3,997 in 2005 with a further decline to 36,676 ± 4,031 non-calf muskoxen by 2010 (Nagy *et al.* 2006a,b,c, 2009c; Davison *et al.* in prep.). It is uncertain what is driving the muskox decline and what it will mean for Peary caribou foraging, predation rates or parasites.

Predation

Inuvialuit report wolves (*Canis lupus*) killing caribou and muskoxen (Nagy and Larter 2000). There is essentially no direct information on predation rates. The only information to index predation is sightings of wolves during aerial surveys and the number of harvested wolves.

Wolves were rarely seen on Banks Island during the late 1970s (Vincent and Gunn 1981) as their recovery from poisoning in the 1950s was slow. Wolf numbers likely increased on Banks Island during the 1980s and 1990s (Larter and Nagy 2003). Wolf sightings during island-wide aerial surveys increased from less than 10 in the early 1990s to 30-50 from the mid-1990s to 2010 (Table 3, p.72). As well as increases in wolf sightings during aerial surveys[12], the number of wolf observations increased during annual Banks Island field work from 1993-1999 (Larter pers. comm. 2011). Most wolves seen in 1994, 1998, and 2001 were in areas of high muskox density in the Thomsen River drainage. Larter and Nagy (2003) commented that post-calving movements of caribou would be adjacent to the high density area of wolves and muskoxen. In 2010, no wolves were sighted in the Thomsen River drainage.

Grizzly bear sightings on Melville Island in 2007 (Canadian Wildlife Service unpubl. data 2012) and on northwest Banks Island in 2010 (ENR pers. comm. 2012) add to the sightings and range expansion reported for grizzly bears in the Canadian Arctic (Doupé *et al.* 2007). Grizzly bears are being seen with increasing frequency on the NWT Arctic islands and given their known use of caribou as a dietary source (Gau *et al.* 2002), it is possible that grizzly bears are a predator of Peary caribou. Although grizzly bear predation is likely, the extremely low numbers of grizzly bears observed so far in Peary caribou range suggest that population effects on Peary caribou are negligible (ENR pers. comm. 2012).

On northwest Victoria Island, hunters reported seeing more wolves in the 1980s than before (C. Adjun in Gunn 2005). Wolf sightings during surveys increased from 5 to 19 between the late 1990s and 2010 (Table 3, p.72).

The level of wolf predation on the western Queen Elizabeth Islands is unknown. However, wolves are often seen which might suggest their numbers are relatively high (Miller and Reintjes 1995). Thirty-two wolves were observed during the survey of Melville Island in 1997 (Gunn and Dragon 2002), 12 wolves were observed on a ground survey of Melville Island in 1998 (Larter and Nagy 2000a), and 17 wolves were observed on Melville Island in 2012 (Davison and Williams 2012).

Aerial surveys are usually conducted with standardized methodologies. The number of wolves

observed during aerial surveys is potentially an index to wolf abundance. Such an index might include the number of wolves observed within transect or on transect per 100 hours of flying (Heard 1992b). The index could not be calculated for this report due to differences in how flying hours and wolf sightings were reported, especially opportunistic observations collected during ferry flights.

The increase in muskox numbers and wolf sightings on Banks and northwest Victoria islands during 1972-2001 was coincidental with the Peary caribou decline (see the section on *Abundance*, p.80). Muskox numbers increased between 1973 and 1987 on Melville Island then decreased between 1987 and 1997 (Gunn and Dragon 2002). The extent to which increasing abundances of muskoxen support increased wolf numbers and thus subsidize predation rates on Peary caribou is unknown, although probable.

Table 3. Wolves observed during aerial surveys on Banks, northwest Victoria, and several of the western Queen Elizabeth Islands, 1985-2012.

Islands (Area)	Year	Total	Adults	Pups	No. of groups	Reference
Banks	1985	13	9	4	2	Nagy *et al.* 1998
	1987	0				McLean 1992
	1989	13	8	5	3	McLean and Fraser 1992
	1992-93	2	2		1	Nagy *et al.* 1998
	1992	7	7	0	2	Nagy *et al.* 2009b
	1994	23			11	Nagy *et al.* 2006a
	1994	47	38	9	14	Nagy *et al.* 1998
	1998	26			11	Nagy *et al.* 2006b
	1998	50	46	4	13	Nagy *et al.* 1998
	2001	40			11	Nagy *et al.* 2006c
	2005	28			10	Nagy *et al.* 2009c
	2010	34	28	6	13	Davison *et al.* in prep.
NW Victoria	1998	5			1	Nagy *et al.* 2009d
	2001	11			5	Nagy *et al.* 2009e
	2005	12			5	Nagy *et al.* 2009f
	2010	19	18	1	8	Davison *et al.* in prep.
Prince Patrick	1997	3	3	0	2	Gunn and Dragon 2002
Eglinton	1997	3	3	0	1	Gunn and Dragon 2002
Melville	1997	32	20	12	7	Gunn and Dragon 2002
	2012	17	17	0	5	Davison and Williams 2012

Parasites and disease

Trends and current conditions of parasites and diseases are largely unknown, although they may cause individual effects or sub-clinical effects. At the population level, effects may have been mostly under-estimated in wildlife ecology (Gunn and Irvine 2003). Parasitic invasions and altered transmissions are already evident in the Arctic and are expected to continue (Davidson *et al.* 2011). Elsewhere for caribou and specifically for caribou on Arctic islands, there is increasing

recognition that parasites can influence host body reserves and pregnancy rates (Albon *et al.* 2002; Hughes *et al.* 2009). For example, high levels of gastro-intestinal round worms depress pregnancy rates in Svalbard reindeer (Langvatn *et al.* 1999), probably through a combination of effects including reduced forage intake.

In general, the prevalence and intensity of parasite infections and diseases in Peary caribou is little known, as are the conditions under which they could become prevalent and affect rates such as pregnancy or survival. The status of warbles parasitizing caribou on Banks or northwest Victoria islands is not known. However, on Melville and Prince Patrick islands, 11 and 16% of Peary caribou, respectively, collected in 1974-79 had warbles (Thomas and Kiliaan 1990). Some parasite infections, such as warble flies, increase with warmer temperatures (Hagemoen and Reimers 2002) and Banks Island has warmer summers than Melville and Prince Patrick islands (Maxwell 1981). Almost the only information on other parasites and diseases is from Banks Island. Hunters report tapeworm cysts in the muscle of Peary caribou: the primary hosts of the tapeworms are wolves or foxes (*Vulpes* spp); numbers of cysts in the caribou vary and may be related to fox cycles (Nagy *et al.* 1998).

More is known about diseases in muskoxen on Banks Island, but it is unknown if muskox diseases and parasites can cause enough mortality to be a threat to Peary caribou, specially if caribou numbers are low. Hughes *et al.* (2009) for the Dolphin and Union caribou discussed whether there was a relationship between levels of intestinal nematode worms and warble flies in muskoxen and caribou. Some parasites and diseases recorded for muskoxen have not been found in caribou, including Yersiniosis, which was first diagnosed in 1986 (Blake *et al.* 1991) and is widespread and prevalent among muskoxen (Larter and Nagy 1999). *Giardia* is found in muskoxen but not in caribou although another protozoan parasite *Cryptosporidium* was in 22% of Peary caribou fecal samples from Banks Island in the 1990s (Nagy *et al.* 1998). There is no evidence for caribou being exposed to brucellosis although the bacterial disease was found in two individual muskoxen on western Victoria Island in 1996 and 1998 (Elkin pers. comm. 2011).

Population

Structure and rates

Peary caribou life-history strategies are similar to barren-ground caribou in the sense that accessibility of forage affects a caribou cow's body condition which, in turn, determines the age of first pregnancy and the annual likelihood that a cow will conceive (Thomas 1982; Gerhart *et*

al. 1997). Most information on reproduction for Peary caribou is from caribou harvested in the 1970s on the western Queen Elizabeth Islands (Thomas *et al.* 1976, 1977; Thomas and Broughton 1978; Thomas 1982).

Peary caribou usually calve at 3 years of age, although under high forage availability and a corresponding high rate of body growth, cows can calve at 2 years of age (Thomas 1982). Under high forage availability, cows can have a single calf every year. Peary caribou cows can cope with occasional years of restricted forage access either by not becoming pregnant, or by weaning a calf prematurely, as lactation uses the cow's protein reserves. Variation between condition of individual cows and reproductive output may be high (Moyes *et al.* 2011) which affects optimum sample sizes for design of monitoring programs. Peary caribou are relatively long-lived, with females living as long as 12-16 years, and males for a few years less (Thomas *et al.* 1976, 1977; Thomas and Broughton 1978; Thomas 1982).

COSEWIC (2004) assumed a generation time for Peary caribou of 7 years (thus three generations is approximately 21 years), but the basis for this was not provided. Calculation of generation time is complicated (Hernandez-Suarez 2011), and depends on the age structure and average age of the population, which for Peary caribou can change over time. In addition to population changes over 3 generations (assuming a generation time of 7 years), we examined population changes over the 40-50 year range of survey data. These two time periods will help to better undertand and quantify population trends in each subpopulation of Peary Caribou.

In other long-lived mammals, the importance of age structure is well recognized (Festa-Bianchet *et al.* 2003; Coulson *et al.* 2004). The existence of variability in age classes (cohorts – animals born in a given year [Caughley 1977]) for Peary caribou is evident from the annual variations in productivity (Tables 4 and 5, p.78 and p.79; Figs. 13 and 14, p.75 and p.76). Thomas and Joly (1981) described the strong variation in cohorts among caribou collected and aged from NWT western Queen Elizabeth Islands during 1964-74, which included mostly cohorts with fewer individuals and only two cohorts with more individuals. Age structure influences rate of change in caribou populations and the probability of persistence, but there are few data or population models to assess the age structure for Peary caribou as it depends on age specific rates of survival and productivity. In other caribou subpopulations, shifts in age structure can accelerate rates of decline and influence recovery (Eberhardt and Pitcher 1992; Tyler *et al.* 2008). Shifts in age structure for example toward older females have not been explored through modelling (females are now generally not harvested so the female age structure is unknown) despite their importance in population dynamics (Eberhardt 1985; Bergerud *et al.* 2008; Tyler *et al.* 2008).

Rate of change for a population is the outcome between recruitment into the breeding population and mortality. Recruitment to breeding age is indexed by productivity which varies among the three NWT subpopulations and over time (Figs. 13 and 14, p.75 and p.76). Productivity is the sum of pregnancy rate and calf survival. Calf survival depends partially on the calf's body size, which reflects the cow's condition during pregnancy and lactation. Reproductive rates are unknown except for western Queen Elizabeth Islands, where rates varied between 6-7% for 1974-76 (after 1973-74 winter which had above average snowfall – Miller *et al.* 1977a; Miller and Gunn 2003) and 88% in 1977 (Thomas 1982).

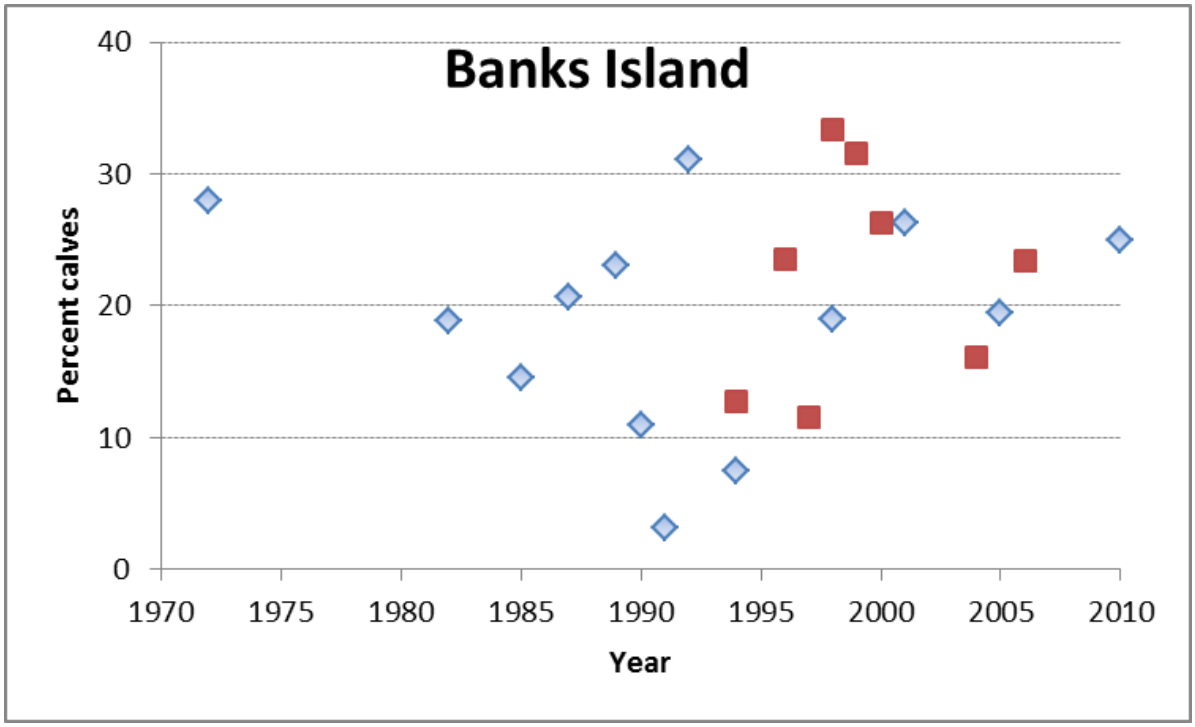

Figure 13. Percent calves observed on Banks Island, 1970-2010, during aerial surveys (blue diamonds) and composition surveys (red squares). Data are from late June to late July except for 1991 (September, low value of 11%) and 1992 (late August, high value of 31%). See Appendix A for references for surveys; data from Larter and Nagy (2001d), Gunn and Williams (2006), and Nagy and Gunn (2009).

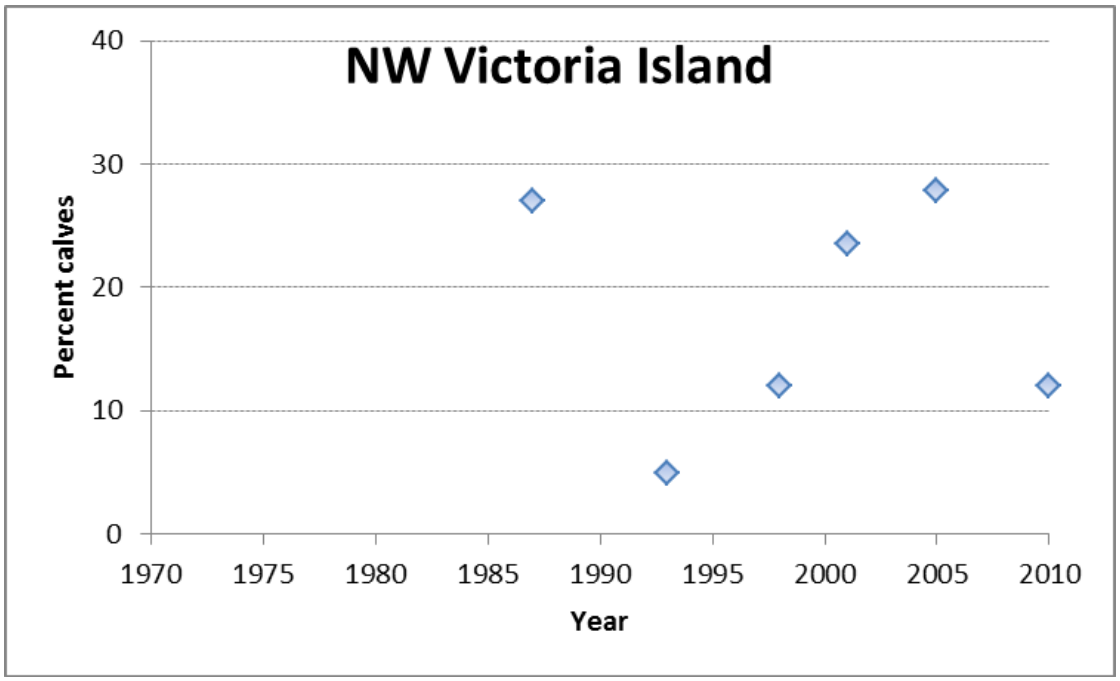

Figure 14. Percent calves observed on northwest Victoria Island, 1987-2010, during aerial surveys. All data were collected during mid-June to mid-July except for 2010 (early August). In 1993 and 2005 the estimated number of caribou (including calves) was low (20 and 66, respectively). See Appendix A for references for surveys.

Productivity is based on two sets of data: calf survival based on the ratio of calves to cows recorded during sex and age composition surveys, and the percentage of calves to total caribou seen during aerial surveys (Tables 4 and 5, p.78 and p.79, Figs. 13 and 14, p.75 and p.76). Larter and Nagy (2000c) analysed the sex and age composition data for Banks Island collected in 1982 and during 1990-99. The months for the surveys and sample size varied, although for the period 1993-99 the composition surveys were flown in June-July (Larter and Nagy 2000c). Calf production varied but was >50 calves per 100 adult cows for 8 of 11 years. Over-winter survival of calves varied from 23-86%. Neither calf survival nor calf production were significantly related to snow hardness or snow depth. Larter and Nagy (2000c) concluded that either their data on calf production and survival had not sampled the full range of winter conditions or that snow depth or snow hardness do not adequately sample the winter condition which affects calf production and winter survival. The lowest calf ratio (24:100 2+ year cows) followed the winter of 1993-94 with increased snow hardness and icing conditions during the previous October-November, however the overwinter survival of calves calculated for winter 1993-94 was the highest in seven years reported (Larter and Nagy 2000c). Rain falling after snowfall in early October 2003 led to ground fast ice (Rennert *et al.* 2009), and also was followed by lower calf productivity in 2004 as

sex and age composition surveys revealed 29 calves:100 adult cows (Nagy and Gunn 2009).

On Banks Island, trends in productivity (as measured by the percentage of calves to total number of caribou seen during aerial surveys) were poorly discernable, largely because of high annual variation. During high and relatively stable numbers between 1972 and 1982 (see *Abundance*, p.80), percent calves were only recorded in 1972 (28%) and 1982 (19%). During the decline on Banks Island between 1982 and 1991, the percent calves was lower and the variance relatively large ($\bar{x}$ = 15 ± 8.9% (SD), n = 4), and during the period of comparatively low and stable abundance between 1992 and 2010 the percent calves was slightly higher and variance slightly lower ($\bar{x}$ = 21 ± 8.0%, n = 6). Percent calves did not differ significantly between these two periods (t = 1.1, 6 df, P = 0.31). Thus, the period of decline was characterized both by slightly fewer calves in the subpopulation and greater variability in calf production and survival among years. The lowest proportion of calves was recorded in 1991, although no explanation was offered (Fraser *et al.* 1992). However, this could be due to low detectability of calves as the survey was flown in late June and early July with 10-100% snow cover over higher ground.

The limited numbers of surveys and relatively small sample sizes prevent identifying a trend in calf production on northwest Victoria Island (Fig. 14, p.76). The low value of 5% calves in 1993 likely was because the survey was during 13-15 June before the peak of calving. Surveys in 1998 and 2010 observed only 22 and 30 caribou on transect, respectively, limiting conclusions.

Percent calves observed during summer surveys of the western Queen Elizabeth Islands varied widely, although sample size (number of years) was small (Table 5, p.79). Very low percent calves (0-7%) were observed in some years (1972, 1974, 1986, and 1997) that followed winters with icing and above average snowfall (Miller *et al.* 1977a; Gunn and Dragon 2002).

Information on adult sex ratios was collected during summer surveys in 1996-2004 (Table 4, p.78). Bull to cow ratios varied widely, possibly related to the spatial distribution of sampling effort and sample size. Only in 1982 were ratios described after the rut. In November 1982, the ratio was 24 adult males to 41 adult females but the surveys were hampered by a small sample size as few caribou migrated to southwestern Banks Island that fall (Latour 1982).

Mortality is difficult to measure unless a large sample of individuals is marked and their fate determined. An alternative approach is population modelling using productivity, harvest levels and population trends. Neither approach has been attempted for Peary caribou in the NWT.

Table 4. Peary caribou composition data and percent calves from surveys on Melville and Banks Islands, 1972-2010[a]. Composition surveys (C) are designed to provide information on numbers of different sex and age classes, yielding data on calf:cow and bull:cow ratios. Population surveys (P) are aerial surveys designed to provide information on the number of animals, yielding data on percent calves.

Year	% Calves seen in surveys	#Calves per 100 adult females	Recruitment rate (%)[b]	#Bulls per 100 adult females	Island	Survey type	Reference
1998		80	17	107	Melville	C	Larter and Nagy 2003
1999		45	24	76	Melville	C	Larter and Nagy 2003
2000		63	25	15	Melville	C	Larter and Nagy 2003
2001		37	12	52	Melville	C	Nagy and Gunn 2009
1972	28				Banks	P	Urquhart 1973
1982	19				Banks	P	Nagy *et al.* 1996
1985	15				Banks	P	Nagy *et al.* 1996
1987	21				Banks	P	Nagy *et al.* 1996
1989	23				Banks	P	Nagy *et al.* 1996
1991	3				Banks	P	Nagy *et al.* 1996
1992	31				Banks	P	Nagy *et al.* 1996
1994	8				Banks	P	Larter and Nagy 2000c
1994		24	26		Banks	C	Larter and Nagy 2003
1995		-	-	-	Banks	C	Larter and Nagy 2003
1996		67	25	83	Banks	C	Larter and Nagy 2003
1997		40	21	153	Banks	C	Larter and Nagy 2003
1998		74	19	26	Banks	C	Larter and Nagy 2003
1999		71	24	21	Banks	C	Larter and Nagy 2003
2000		57	27	22	Banks	C	Larter and Nagy 2003
2001	26				Banks	P	Nagy *et al.* 2006c
2004		29	7	44	Banks	C	Nagy and Gunn 2009
2005	19				Banks	P	Nagy *et al.* 2009c
2006		55		85	Banks	C	Gunn and Williams 2006
2010	25				Banks	P	Davison *et al.* in prep.

[a] Number of calves per 100 adult females (2+ years of age) is used as the best estimate of calf production.
[b] Recruitment rate = (no. of yearlings:100 adult Females)/(100+(no. yearlings:100 adult Females) expressed as %; Larter and Nagy 2003.

Table 5. Percent calves observed during population surveys of the main western Queen Elizabeth Islands, 1961-2012. All surveys occurred during July and August.

Area	Year	% calves	Reference
Mackenzie King, Brock and Borden	1961	22	Tener 1963
	1997	25	Gunn and Dragon 2002
Melville	1961	19	Tener 1963
	1972	0	Miller *et al.* 1977a
	1973	12	Miller *et al.* 1977a
	1974	1	Miller *et al.* 1977a
	1987	19	Miller 1988
	1997	0	Gunn and Dragon 2002
	2012	13	Davison and Williams 2012
Prince Patrick	1961	20	Tener 1963
	1973	11	Miller *et al.* 1977a
	1974	7	Miller *et al.* 1977a
	1986	30	Miller 1987
	1997	0	Gunn and Dragon 2002
	2012	9	Davison and Williams 2012

Movements

The relationship between abundance, gregariousness (indexed by group size) and extent of migration is a significant gap in current understanding of Peary caribou ecology. Migration is the regular, usually seasonal, movement of all or part of an animal population to and from a given area. Migration may occur within an individual's home range, which encompasses all areas an animal uses throughout the year. Ungulates are thought to undertake seasonal migration as a strategy to access higher abundance or quality of forage (McCullough 1985), or to reduce the risk of predation (Fryxell and Sinclair 1988). Snow is considered a driver of migration in many areas. Spatially, migration can be assumed to have occurred if winter and summer ranges (e.g., calculated via 90% fixed kernels) do not overlap (Mysterud 1999).

Peary caribou are adapted to polar habitats that contrast with barren-ground caribou habitat with respect to productivity of seasonal ranges, length of plant growing season, and numbers of predators and parasites, all of which influence abundance and gregarious behaviour. The most conspicuous difference between Peary and barren-ground caribou migrations is that the levels of abundance differ as barren-ground caribou reach hundreds of thousands in a single subpopulation. Although the scale of numbers differs between the two subspecies, the available information does suggest that at higher numbers, Peary caribou migrate to calving grounds,

returning in fall to the wintering ranges.

Peary caribou could potentially disperse between the known subpopulations as sea-ice connects the islands for most of the year. However, almost nothing is known about dispersal in Peary caribou. Dispersal is usually classified as innate or environmentally forced, directional movement (as opposed to migration). Environmentally forced dispersal could relate to forage inaccessibility due to high densities, or imposed by icing and snow conditions. No information is available for dispersal at high densities, but there are a few sightings to support environmentally forced dispersal during winters with above average snow fall or icing. Such movements are known from hunters' reports for Banks Island caribou in 1952 (e.g., Urquhart 1973) when Peary caribou were seen on the sea-ice and on the mainland; their subsequent survival is unknown. The fate was known for a Peary caribou cow fitted with a satellite-collar in 1994 on the group of islands off the northwest coast of Bathurst Island, NU. In October 1995, after heavy snowfall the cow left the islands she had previously used and moved northwest roughly 250 km over sea-ice to Borden Island, NT, but she died in December 1995 (Miller 1998). Similar unusual movements during fall icing and difficulty accessing forage are known from reindeer in Svalbard and the scale of the movements is related to the extent of icing (Stien *et al.* 2010).

Neither immigration nor emigration rates are currently known among the three subpopulations in the NWT. The nearest source of colonists is from the Bathurst Island Group in Nunavut and from the other islands to the east and north of Borden and Prince Patrick islands, known as the Ringnes Islands Group, in Nunavut. These areas are connected to the NWT from Nunavut by multi-year sea-ice. Peary caribou from other subpopulations are likely to be able to survive and reproduce within the NWT subpopulations as the habitats and climate are similar. There are no conspicuous geographical barriers to immigration, which is not the case for the eastern islands of the Queen Elizabeth Islands such as Ellesmere Island. Petersen *et al.* (2010) describe possible fragmentation of subpopulations imposed by the glaciers and mountains.

Additional information on dispersal and seasonal movements was provided in *Distribution*, p.56. The status of and trends in Peary caribou outside of the NWT is covered in the section on *Abundance*, below.

Abundance

The most current information indicates that there are approximately 7,250 adult Peary caribou (i.e., excluding calves) in the NWT (1,100 caribou on Banks Island and 150 caribou on northwest Victoria Island in 2010, and about 6,000 caribou on western Queen Elizabeth Islands

in 2012; Appendix A).

There are insufficient data to estimate the number of mature individuals in the subpopulations, as there is no age structure information available. A further complicating factor is that age structure varies among years, and cows may mature at 2, 3, or >3 years of age, depending upon condition. Also, there is no basis for splitting distribution of Peary caribou on Melville Island between NWT and Nunavut (see *NWT distribution*, p.57). Although about 2/3 of the island is within the NWT, this is a shared subpopulation with animals moving back and forth seasonally and among years. The numbers reported here are for the entire Melville island.

Prior to 2010-12, the most recent time when all three NWT geographic subpopulations were assessed in the same time frame was during 1997 and 1998. The total number of Peary caribou was about 1,450 animals (1+ year old caribou) in 1997 and 1998 (including 907 for western Queen Elizabeth Islands – shared between NWT and NU, 451 for Banks Island and 95 for northwest Victoria Island) (Appendix A).

Abundance estimates are extrapolations from the numbers of Peary caribou seen and counted on strip transects during aerial surveys. The sampling effort of the surveys is the coverage which reflects the spacing between, the width of, and the number of the transects (Appendix A). The method of extrapolation from the numbers counted has varied slightly. The variance around estimates from earlier surveys was not always provided in original reports, which means the precision is unknown. In some recent surveys, variance (standard error, confidence limits, coefficient of variation) around the mean estimate was relatively wide, partly because of low overall densities, patchy distribution, and standardised stratification. For example, the coefficients of variation (CV) during surveys on northwest Victoria Island in 1992 and 2001 were 33% and 24%, respectively (Heard 1992a; Nagy *et al.* 2009e). Even with these uncertainties in estimating abundance, it has been possible to detect significant declines (see *Fluctuations and trends*, p.82).

The aerial survey methods used to estimate abundance are relatively well standardized, which increases the validity trend estimates. The speed, altitude and strip width are typical for caribou surveys and this should contribute to standardizing bias. Bias is an index to accuracy which is the probability of detecting caribou within the strip transect as well as counting them accurately. Although methods to quantify bias such as double counting exist, they have not been applied to Peary caribou. Bias is acknowledged as difficulty in seeing caribou that do not move as the aircraft flies past them (McLean 1992). McLean (1992) commented that reducing survey altitude from 180 to 150 m above ground level and reducing strip width from 2 to 1 km in July 1987

improved sightability of caribou. Nagy *et al.* (2006c:11) suggest that the 1998 estimate for Banks Island was an under-estimate although without indicating the reasons.

In summary, the estimated number of Peary caribou in the NWT (7,250) is almost twice the number in Nunavut, which is estimated at about 4,000 for the period 2001-08 (Jenkins *et al.* 2011). In the 1990s, the NWT had about 1/3 the number in Nunavut. Thus, the NWT holds about 30-60% of the global population of Peary caribou.

Fluctuations and trends

Timeframe

The NWT Species at Risk Committee's criteria for considering population declines in the assessment of status follow the recommendation of the International Union for the Conservation of Nature and Natural Resources (IUCN) to consider declines over three generations or 10 years, whichever is longer (IUCN 2001; SARC 2010). However, considering trends only within this timeframe may limit understanding of the historical status of Peary caribou, for which generation time is uncertain and likely highly variable. The trends over the previous 50 years, covering the period of aerial surveys in the three subpopulations are similar: historically high numbers were followed by a steep and rapid decline over a roughly 10-year period then a prolonged period of low numbers (20-40 years).

Global trends

Across the range of Peary caribou in Nunavut, the trends in abundance are poorly known as surveys have been infrequent. The estimate of 12,400 Peary caribou for the Queen Elizabeth Islands in Nunavut (from 1961; Tener 1963) and Prince of Wales and Somerset Islands (early 1970s; Gunn and Decker 1984) is almost certainly an under-estimate as it was based on low coverage and some guesses more than quantitative estimates. For the same area, the estimate is about 4,000 Peary caribou for the period 2001-08 (Jenkins *et al.* 2011). Within that overall decline, there were some recoveries, aided by Inuit who reduced their harvest (COSEWIC 2004) such as on Bathurst Island. However, the recovery was lost in a series of winters with markedly above average snowfall (Miller and Gunn 2003). The formerly large subpopulation inhabiting Prince of Wales and Somerset islands essentially disappeared in the 1990s (Gunn and Dragon 1998; Gunn *et al.* 2006).

The overall estimate of Peary caribou abundance across the NWT (Appendix A) and Nunavut

(Jenkins *et al.* 2011) for 1997-2012 is about 11,000-12,000 caribou compared to possibly some 44,000 Peary caribou estimated during the period 1961-1980 (Queen Elizabeth Islands 1961; Bathurst complex 1961; Banks Island 1972; northwest Victoria Island 1980; Prince of Wales-Somerset group 1974-75). This represents an overall decline of approximately 75% for the past 50 years (7 generations) for the global population; most of this decline was in the first 30 years.

These years were selected for comparison because they are the best available data and estimates. Surveys in the Arctic did not occur simultaneously over large areas, and thus amalgamation of estimates from islands among years is required to obtain overall trends in population estimates.

Over approximately the past three generations (21 years), the average exponential rate of change for NWT and Nunavut combined was -0.005, which is not different than stable given survey frequency and accuracy.

Trends in the NWT

All three subpopulations in the NWT display similar trends: high abundance was recorded in either the 1970s-80s (Banks and northwest Victoria islands; Figs. 15 to 18, p.84 - 85) or the early 1960s (western Queen Elizabeth Islands; Fig. 19, p.86), followed by steep declines (averaging >90%) and then no clear evidence for recovery to the higher numbers over a 20-year period. The trends in abundance are based on aerial surveys of adequate coverage, comparable and relatively standard methodology, especially since the early 1990s. The weakest trend data are for the western Queen Elizabeth Islands as surveys were infrequent, averaging less than one subpopulation estimate per 12 years (Fig. 19, p.86; Appendix A). Details on surveys and trends for each subpopulation are given below.

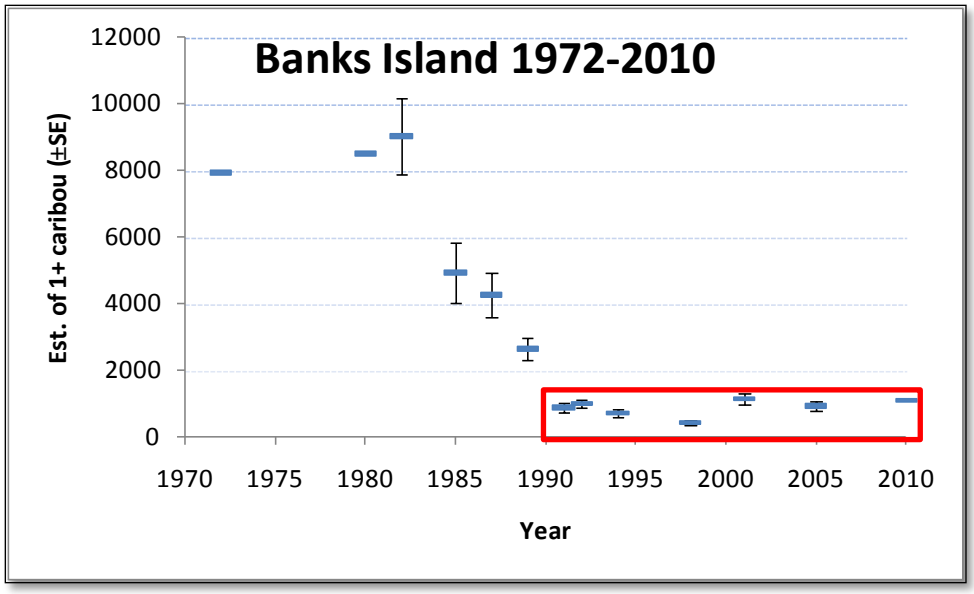

Figure 15. Estimates of Peary caribou numbers on Banks Island, 1972-2010. All estimates are for 1+ year old caribou (1972 survey estimate of 11,000 total caribou converted using percent calves). All surveys took place between late June and late August. Standard error bars are shown where available. See Appendix A for references. The area within the red box is expanded in Figure 16.

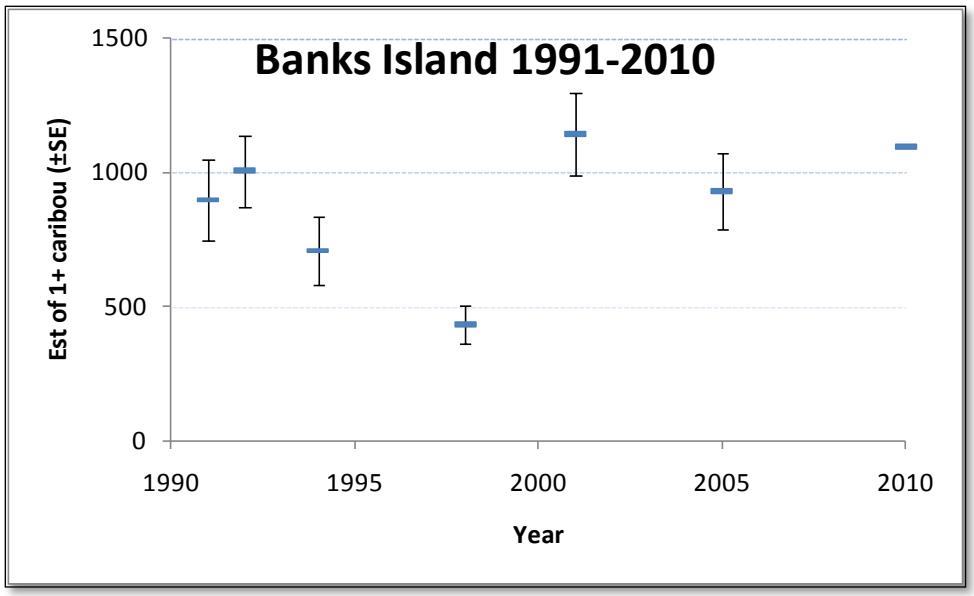

Figure 16. Recent estimates of Peary caribou numbers on Banks Island, 1991-2010. All estimates are for 1+ year old caribou. All surveys took place between late June and late August. Standard error bars are shown where available. See Appendix A for references.

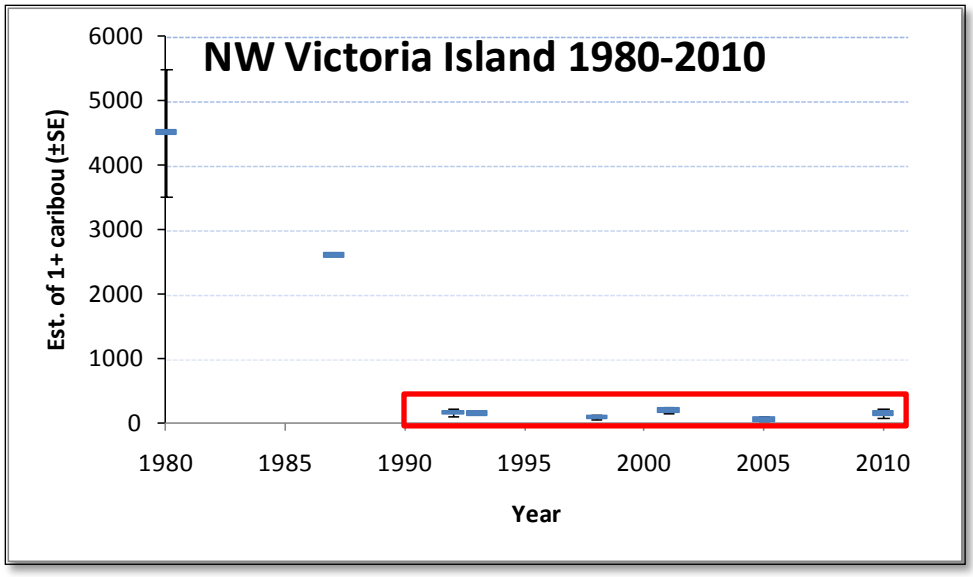

Figure 17. Estimates of Peary caribou on northwest Victoria Island, 1980-2010. All estimates are for 1+ year old caribou, except for 1980 (including calves). All surveys took place between late June and late August, except for 1992 (March). Standard error bars are shown where available. See Appendix A for references. The area within the red box is expanded in Figure 18.

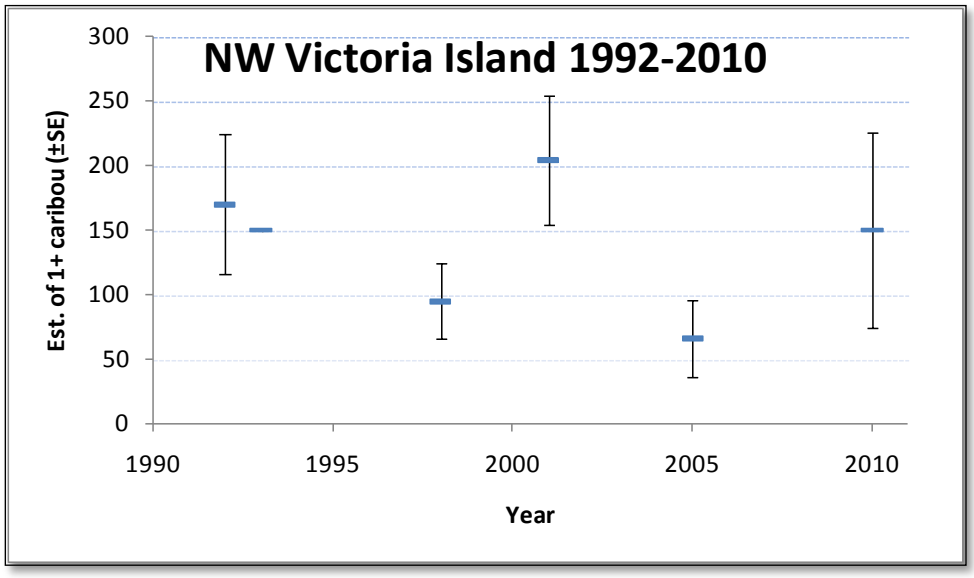

Figure 18. Recent estimates of Peary caribou on northwest Victoria Island, 1992-2010. All surveys took place between late June and late August, except for 1992 (March). Standard error bars are shown where available. See Appendix A for references.

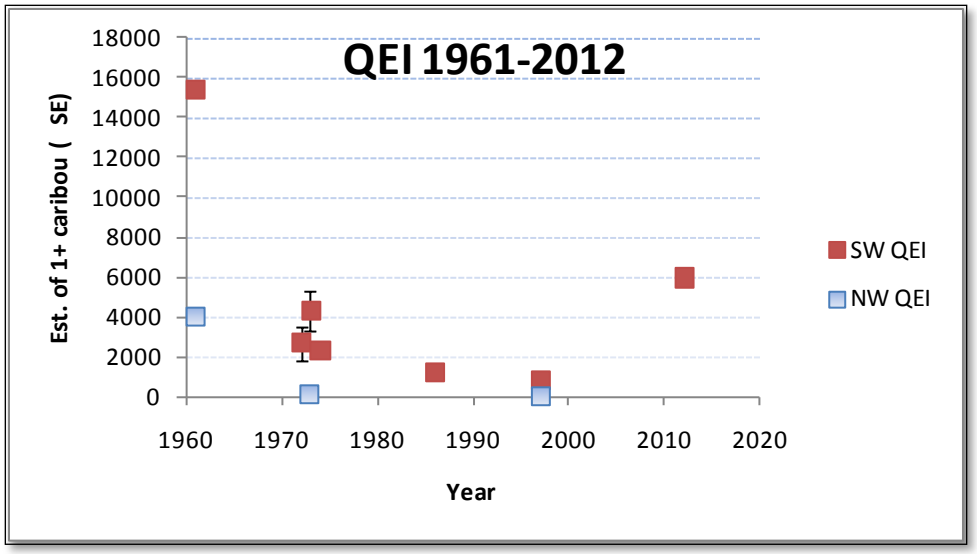

Figure 19. Estimates of Peary caribou on the northwestern (NW QEI) and southwestern (SW QEI) Queen Elizabeth Islands, 1961-2012. The Queen Elizabeth Islands subpopulation is depicted in two groups because of temporally non-overlapping surveys. All surveys took place during summer, except northwest QEI in 1973 (April). Standard error bars are shown where available. See Appendix A for references.

Banks Island

Inuvialuit hunters report that there were few caribou on Banks Island in the early 1950s, then in the late 1950s caribou numbers increased (Nagy *et al.* 1998). The increase was shortly after wolf numbers on Banks Island were greatly reduced during the 1955 to 1959 poisoning program. People did not start seeing wolves again until the early to mid-1970s. On northwest Victoria Island, elders reported that there were also few caribou in the 1950s with reports that caribou have gone through three cycles over the past 90 years (RWED 1998). Hunters reported that caribou numbers were increasing during the 1960s and 1970s and then declined during the 1980s (RWED 1998).

Aerial surveys over Banks Island have tracked the trend in Peary caribou numbers since the early 1970s (Figs. 15 and 16, p.84 and p.84; Appendix A). Caribou numbers appeared stable between 1972 and 1982 (average exponential rate of change (Caughley 1977) of 0.013), then declined from an estimated 9,036 caribou in 1982 to 897 caribou in 1991 (all 1+ year old caribou), an average exponential rate of change of –0.257 (a halving rate of 2.7 years). The overall trend between 1991 and 2010 has shown no evidence for recovery (average exponential rate of change 0.007). Instead the trend is relative stability at low densities, with an initial declining trend until 1998, then relative stability at slightly higher densities since 2001 (Nagy *et al.* 2006c, 2009c;

Davison *et al.* in prep.) (Fig. 16, p.84).

NW Victoria Island (Minto Inlet)

Between 1980 and 1993, Peary caribou from northwestern Victoria Island were surveyed five times. The surveys showed a rapid decline from a high of 4,512 caribou in July-August 1980 (Jakimchuk and Carruthers 1980) to an estimated 114 ± 22 in March 1993 (Gunn 2005), an average exponential rate of change of –0.283, a halving time every 2.4 years (Fig. 17, p.85). Only 4 caribou were observed on what was considered the range of the northwestern Victoria Island herd in June 1994 (Nishi and Buckland 2000), which was considered too low to generate a reliable subpopulation estimate. Subsequently, there has been no strong recovery and instead stability at low numbers between 1998 and 2010 (Figs. 17 and 18, p.85 and p.85; Appendix A).

Western Queen Elizabeth Islands

Determining trends in Peary caribou abundance on the western Queen Elizabeth Islands is complicated by the irregular timing of surveys (Fig. 19, p.86; Appendix A). An additional complication is that surveys have not always covered all the islands at one time, which is potentially problematic as some caribou may seasonally migrate between Melville and Prince Patrick islands (Miller *et al.* 1977b). Between 1961 (the first range-wide aerial survey) and 1997, the overall trend was a 95% decline on Prince Patrick Island (1,797 to 84 1+ year old caribou) and a 92% decline on Melville Island (10,366 to 787 1+ year old caribou) (Tener 1963; Gunn and Dragon 2002), average annual exponential rates of change of -0.085 and –0.072, respectively. Similar steep declines of 87-99% were detected on islands within the Mackenzie King, Borden and Brock group – Mackenzie King Island: 1, 710 1+ year old caribou in 1961 to 60 in 1974, average exponential rates of change of –0.258; Brock Island: 190 in 1961 to 24 in 1973, –0.172; Borden Island: 1,271 in 1961 to 16 in 1973, –0.365) (Tener 1963; Miller *et al.* 1977a; Gunn and Dragon 2002). Results from the latest survey in 2012 show that this subpopulation can increase to higher levels given good conditions. In 2012, Melville, Prince Patrick, Byam Martin, Eglinton, and Emerald Islands were systematically surveyed (Davison and Williams 2012). Mackenzie King, Brock and Borden Islands (see Figure 12, p.57) could not be reached because sea-ice between the islands was not solid and the required ceilings to cross open water in a single engine survey aircraft were not achieved (Davison and Williams 2012). There is evidence that Peary caribou are present on at least some of the these northernmost islands: in 2011, a crew doing the Ecological Classification of the the NWT surveyed, in one day, portions of the Mackenzie King, Borden and Brock islands. They observed one Peary caribou bull on the

southern end of Brock Island, but none on either Borden or Mackenzie King islands (Downing pers. comm. 2012).

As the previous systematic survey was conducted 15 years ago (1997), it is difficult to determine the current population trend. Nevertheless, even with the northernmost islands unsurveyed, the estimates in 2012 were five times higher (+13.7% per year) than in 1997 (Davison and Williams 2012). These numbers, however, remain 60% less then the recorded high numbers in the 1960s (Appendix A).

The overall estimated decline for all three subpopulations in NWT only is from about 36,000 Peary caribou (in 1961, 1972 and 1980) to about 7,250 (in 2010 and 2012, combining totals from different years). This represents an overall decline of approximately -80% (about -3.1% / yr) for the past 50 years (7 generations) for the NWT population.

Population Dynamics

There is controversy over the population dynamics of Peary caribou. It is uncertain whether Peary caribou show regular fluctuations depending on a relationship between amounts of forage and caribou abundance, or whether Peary caribou could be considered in a 'non-equilibrium grazing system' where sporadic, unpredictable abiotic variables affect vital rates and population trends (Caughley and Gunn 1993; Behinke 2000, Miller and Barry 2009). Tews *et al.* (2007a,b) used modelling to argue for interaction between Peary caribou density and weather based on Peary caribou numbers on Bathurst Island, Nunavut which would drive regular fluctuations. Bathurst Island is the only island in the range of Peary caribou where scientific information describes a decline and a recovery to a similar level between the early 1960s and the early 1990s which is a 'regular (symmetrical)' fluctuation.

Even in situations with more information such as for wild reindeer on Svalbard, controversy remains about how forage availability and weather interact to affect rates of population change and population size. Annual rates of productivity, deaths and dispersal are recorded and in the absence of predation, most (83%) deaths are winter starvation. The population dynamics are complex with non-linear and lag effects between density and weather (Aanes *et al.* 2000; Tyler *et al.* 2008). It is also important to note that the ecology of Svalbard reindeer is quite different from Peary caribou. Svalbard reindeer have small home ranges, subpopulation ranges isolated by glaciers and rugged terrain, and no predators or other large-bodied herbivores. Although Aanes *et al.* (2000), Tyler *et al.* (2008) and Tyler (2010) vary in their rating of the strength of how abundance interacts with weather, they do not argue against the effects of winter severity as an

important factor governing population dynamics for northern ungulates.

Again, considering only short term trends (e.g. three generations or 21 years) is inappropriate for Peary caribou relative to what we know and do not know about caribou ecology. Pauly (1995), a fisheries biologist, identified a tendency toward what he called shifting baselines. A shifting baseline means that as populations slowly dwindle, each of our human generation's standard for how "it used to be" is gradually degrading. For example, the number of caribou in the last generation is the baseline we try to manage for – but there were already fewer caribou around then than in previous generations. In other words the extent of the reduction is lost as each generation redefines what is "natural".

Available data do not allow us to determine whether the documented high numbers of Peary caribou followed by a decline and prolonged low numbers are part of regular fluctuations, or whether they represent a period of relative stability within an unusually prolonged decline, or whether the peak high numbers were atypical. It is interesting that relatively regular (cyclic) fluctuations within a 30-60 year time span are being increasingly documented for barren-ground caribou (Zalatan *et al.* 2006; Bergerud *et al.* 2008).

SARC (2010) defines a "continuing decline" as "a recent, current or projected future decline, which may be smooth, irregular or sporadic, that is liable to continue unless remedial measures are taken". At low numbers in recent years, it is difficult to detect whether "stability" is a slow decline, or a slow recovery, or no trend. However, the sustained low numbers suggest high vulnerability to further declines.

Threats and limiting factors

Limitations in describing threats to Peary caribou are the consequence of gaps in data, especially on adult survival (predation rates, accidents, diseases), and shortfalls in our understanding about how limiting factors interact. For example, mortality as a consequence of wolf predation and hunting acts on populations against the background of annual variations in environmental conditions (chiefly the effects of weather on forage availability and plant growth). When the depth, density, layer structure, and hardness of the snow pack limit forage availability, Peary caribou are more vulnerable to other causes of low survival, although it can be difficult to partition the effects of the individual factors. For example, the decline in Peary caribou on Banks and northwest Victoria islands during the 1980s and early 1990s was likely caused by the cumulative effects of human harvest, winters with deeper than average snow depths, and wolf

predation. Inter-island movements and competition from the expanding muskox population have also been proposed as contributing factors, although without supporting evidence those factors are difficult to evaluate (Nagy *et al.* 1996).

The difficulty of allocating what factors, and what interaction of factors, influence population dynamics is typical for most wildlife, including caribou. Even a relatively "simple" system such as on Svalbard where the wild reindeer are regularly monitored and there are no predators or other large herbivores, the interaction between numbers of reindeer, their forage supply and winter conditions is complex and drives the fluctuations in abundance (Tyler *et al.* 2008).

There is uncertainty on what threats are responsible for little recovery in the three NWT populations. Although productivity has been variable, it has not been consistently low and trends are not apparent. There are no measures of adult survival. There are known temperatures and precipitation fluctuations, but the current stage of knowledge prevents understanding of how those trends influence forage growth and productivity relative to winter forage availability; their effect on parasites or diseases is unknown. What we do know is detailed below.

Availability of forage and weather

Climate variability plays a large role in the population dynamics of Peary caribou through weather influencing forage availability directly as effects on plant growth and flowering, as well as relative availability as mediated by the depth, density, layer structure, and hardness of the snow pack (Tyler 2010). The effects of weather on forage availability are complex and limited information contributes uncertainty to describing climate variability as a threat. There are only three long-term (>10 years) data sets and they are from weather stations which are coastal (Sachs Harbour, Mould Bay and Ulukhaktok).

There are also gaps in the records where data are missing (for examples see Figs. 20 and 21, p.93). In general, there appears to be a clear increase in both temperature and fall-time snowfall at all stations.

Climate over the Peary caribou range in the NWT is regionalized (Maxwell 1981), and some limited generalizations can be made about climate effects for the different subpopulations[13]. For example, there is a north-south continuum in climate across the geographic range of Peary caribou. On average, over the long-term, mean daily temperatures are above 5^{o}C only 4.1% of the year at Mould Bay (Prince Patrick Island) but 10.2% of the year at Sachs Harbour (Banks Island) (Environment Canada 2011a). The regional nature of the climate is a consequence of low pressure weather systems (cyclonic activity), the sea-ice seasonal melting pattern, large-scale

landscape features, and net radiation (Maxwell 1981).

The timing of snowmelt and freeze-up is annually variable and fall incursions of moister warmer Pacific air masses periodically cause Rain-On-Snow events (rain falling and freezing as ice within or on snow-covered ground), which restrict access to forage (Rennert *et al.* 2009). Restrictions in availability of wintertime forage because of Rain-On-Snow events are infrequent and can influence Peary caribou abundance at unpredictable intervals. The effect of the warmer temperatures in the fall and winter that can cause either rain or melting within the snowpack is moderated by snow depths. For example, more is known from Svalbard where winter weather is characterized by relatively frequent periods of warmer weather >0^{o}C which can be associated with icing (Kohler and Aanes 2004). The effect of the above zero temperatures melting within the snowpack is complicated as it depends on snow depth. In shallow snow, the warmer temperatures will improve forage availability as the snow disappears, but in deeper snow the melting causes ground fast ice reducing forage availability (Tyler *et al.* 2008). However, not all winters with deeper snow are detrimental to forage availability as temperatures and wind strength affect the snow pack characteristics (Miller and Gunn 2003).

Given the complexities of the relationships between snow depth, temperature and then wind packing, it is not surprising that the effects of winter weather on forage availability are difficult to monitor from just a few scattered weather stations. Most often, ground measurements of snow and ice conditions are lacking, a point made by Tyler (2010). The snow and ice conditions can make foraging energetically costly or make it impossible. The degree of the effect and its geographical extent influences how severely caribou are affected, whether they can find alternate foraging and the proportion of the population affected.

An example of an unusual weather event that likely restricted forage availability was a freezing rain storm on Banks Island in late November 1977. The weather station meteorologist at Sachs Harbour reported a widespread intense freezing rain storm which left up to 5 mm of ice on the ground. In December 1977, hunters from Sachs Harbour were reporting widespread caribou carcasses and seeing fewer live caribou than expected (Morrison 1978). Morrison (1978) reported finding 36 caribou carcasses during a snowmachine survey over about 166 km^2 on southern Banks Island in May 1978. The appearance of the marrow fat for most (n = 30) of the carcasses was typical of starvation. The population-wide effect of the freezing rain and icing in 1978 is unknown although it would have been largely additive to the harvest (see following section).

In February 1971, trappers from Sachs Harbour reported seeing dead caribou (mostly bulls and

calves); earlier in the winter (November 1970), trappers reported caribou out on the sea-ice and many dead caribou, mostly calves and bulls, on the land (Urquhart 1973). Urquhart (1973) reported unusually heavy snowfall in mid-October 1970 and estimated 1,000-2,000 caribou had died during winter 1970-71. The observations of caribou on the sea-ice and carcasses on the land were also reported for Banks Island, as McEwan (1952) reported deaths from starvation and Peary caribou moved out onto the sea-ice in November 1952, with at least 20 reaching the mainland (McEwan 1952, Nagy *et al.* 1998). However, McEwan (1952) did not report the causes of the starvation.

During the 1982-92 caribou decline on Banks Island, winters were not exceptionally severe and no measure of winter severity statistically correlated with either calf production or overwinter survival, nor was there any evidence of a die-off (Larter and Nagy 2000c). In fall 1993, widespread icing coincided with the reduced condition of Peary caribou (Larter and Nagy 1994, 1996) although not to the point of known deaths. Productivity was reduced, as the calf:100 cow ratio was 24:100 in 1994 compared to the 1992-2006 mean of 52 calves:100 cows (Table 4, p.78); however, overwinter survival of calves for winter 1993-94 was higher than in any of the other 7 years recorded (Larter and Nagy 2000c). In fall 2003, icing occurred after rain fell following snowstorms. Composition surveys on Banks and Melville Islands the following summer found almost 500 muskox carcasses, but only 5 caribou carcasses, indicating no caribou die-off as a result of the October icing. The surveys recorded 29 and 37 calves per 100 adult females on Banks and Melville Islands, repectively (Nagy and Gunn 2009).

Winters with reduced forage availability probably caused die-offs on the western Queen Elizabeth Islands, when up to 46% (1973-74) and 30% (1996-97) of the caribou died during a single winter with deep snow and icing apparent in the snow pack (Miller *et al.* 1977a; Gunn and Dragon 2002). On Prince Patrick Island, high winds and a 14.0 cm snowfall were recorded at the Mould Bay weather station on 13 September 1996 with >0°C a few days later with 0.2 mm freezing rain. The snowfall in September totaled 46.6 cm (1950-89 mean is 14.9 ± 10.3 [SD]). An incomplete snowfall record exists for the remainder of the winter, with 69.5 cm recorded compared to a long-termaverage of 65 cm, but data were missing for December 1996, April 1997, May 1997 and June 1997 (Gunn and Dragon 2002). Gunn and Dragon (2002) counted 31 caribou carcasses and live caribou but no calves on Prince Patrick Island in July 1997. The four antlered carcasses from prime bulls indicate that their deaths occurred in early winter during late rut or shortly after the rut.

An aspect of summer weather that should be considered is the influence of low rainfall.

Typically Peary caribou forage in the drier plant communities (polar desert communities) and elsewhere in the Arctic (Svalbard) Tyler (1987a) reported that summer moisture can limit plant growth for the upland plant communities which caribou tend to use in winter. On Banks Island, Larter and Nagy (2001b) reported that crude protein levels in a sedge varied between wet and dry years.

Examples of mean monthly temperature for Sachs Harbour, Banks Island, and September-October snowfall for Mould Bay, Prince Patrick Island, are provided to illustrate the annual variability and trends (Figs. 20 and 21, p.93).

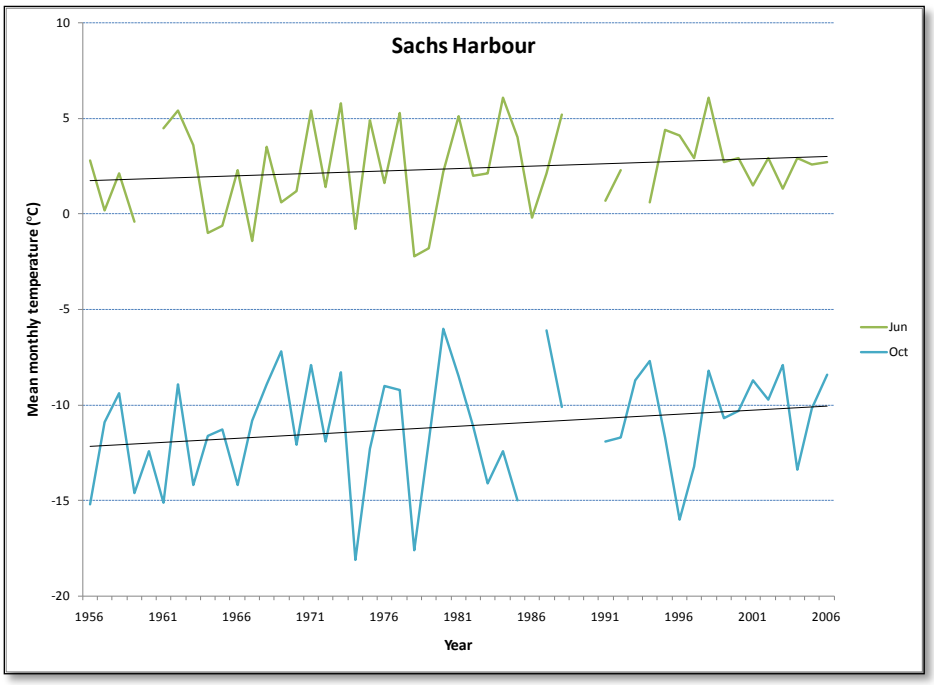

Figure 20. Mean monthly temperature data from Sachs Harbour, Banks Island for June and October, 1956-2006 (Environment Canada 2011a).

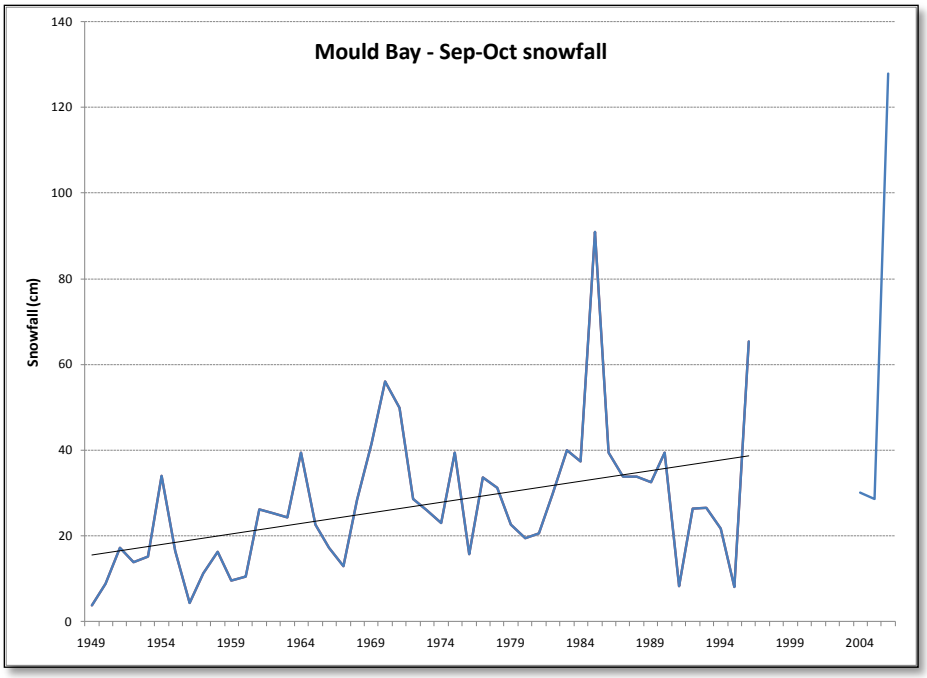

Figure 21. Snowfall (cm) for September and October, Mould Bay, Prince Patrick Island, 1949-1996 and 2004-2006 (Environment Canada 2011a). Note that after 2003 weather data were collected at a remote weather station in a different location; it is unclear whether the steep increase is real or an artefact of the remote monitoring.

It is evident from the temperature data for Sachs Harbour that there has been a 1.2°C average rise over the past 50 years for June, and a 2.1°C rise for October (Fig. 20, p.93). Similarly, snowfall at Mould Bay during September and October on average doubled between 1949 and 1996 (Fig. 21, p.94). October 1985 snowfall was the highest record amount (38.6 cm) for the period (1949-96) which may have also included heavy snowfall on northern and central Banks. Snowfall recorded at Sachs Harbour was above average in May 1986 and the melt was unusually late (Gunn *et al.*1991). Nagy *et al.* (1996) reported that severe winter weather events (based on freezing rains) occurred during the winters of 1987–88, 1988–89, and 1990–91 on Banks Island, where annually 60-300 caribou deaths were recorded.

Hunting

Hunting is part of Aboriginal culture and Aboriginal people can be considered as a part of wildlife ecology. Hunting can be a benefit to conservation as it provides information about distribution, health and condition (Gunn 2001). Without data to inform management decisions about the effects of hunting, it can also serve as a threat.

During the 1970s and 1980s on Banks Island, people annually harvested an estimated 300-450 caribou, mostly cows (Nagy *et al.* 1998). Between 1987 and 1992 on Banks Island the subpopulation decreased from 4,251 to 1,469 and from 1987 to 1991 approximately 1,000 caribou were harvested (Nagy *et al.* 1996; Tyler 2010). In 1990, an initial quota of 150 caribou was set in response to the decline in Peary caribou abundance and that quota was reduced to 30 males after the July 1991 subpopulation survey (Nagy *et al.* 1998). At the request of Sachs Harbour Hunters and Trappers Committee the quota was increased to 36 males, or one per household in the community in 1992. This quota is annually reviewed and is currently set at 72 male-only tags (Gau pers. comm. 2011). The full quota has not been taken since 1994-95 (Fig. 22, p.96). Given general estimates of 700 to 1,100 adult caribou on Banks Island during this period (Fig. 16, p.84), the harvest rate has generally been <2-3%, and as low as 1% since the mid-2000s.

On northwest Victoria Island, caribou are a preferred subsistence food for people in Ulukhaktok and the annual harvest in the 1960s was 150 to 200 caribou. Harvest levels then increased, and by 1983-84 the annual harvest for Peary caribou from northwest Victoria Island was 738 caribou (but it is unclear whether these include Dolphin and Union caribou; RWED 1998). The harvest then declined to 192 in 1991-92 and 155 in 1992-93 (ENR 2010). In 1993, the Olokhaktomiuk (Ulukhaktok) Hunters and Trappers Committee initiated a voluntary zero harvest on Peary Caribou from Northwest Victoria Island to help ensure that only Dolphin and Union caribou were harvested from the island.

Although the Inuvialuit have the right to hunt caribou on the western Queen Elizabeth Islands, hunting rarely occurs on these northern-most islands as there are no communities and hunters can rarely reach them.

Hunting is the means to sample caribou health and condition – information that is otherwise unavailable. Hunters from Sachs Harbour have monitored caribou health and condition since 1994 by collecting information on caribou sex and age, amounts of back, rib cage and kidney fat. The hunters collect samples of rumen and fecal pellets and a long bone. Sample sizes are low, and the data have not yet been compiled (Branigan pers. comm. 2011). In summary, for all subpopulations hunting is currently controlled and likely has low impact on Peary caribou, but any reduced survival of adult female Peary caribou may impede the population from increasing.

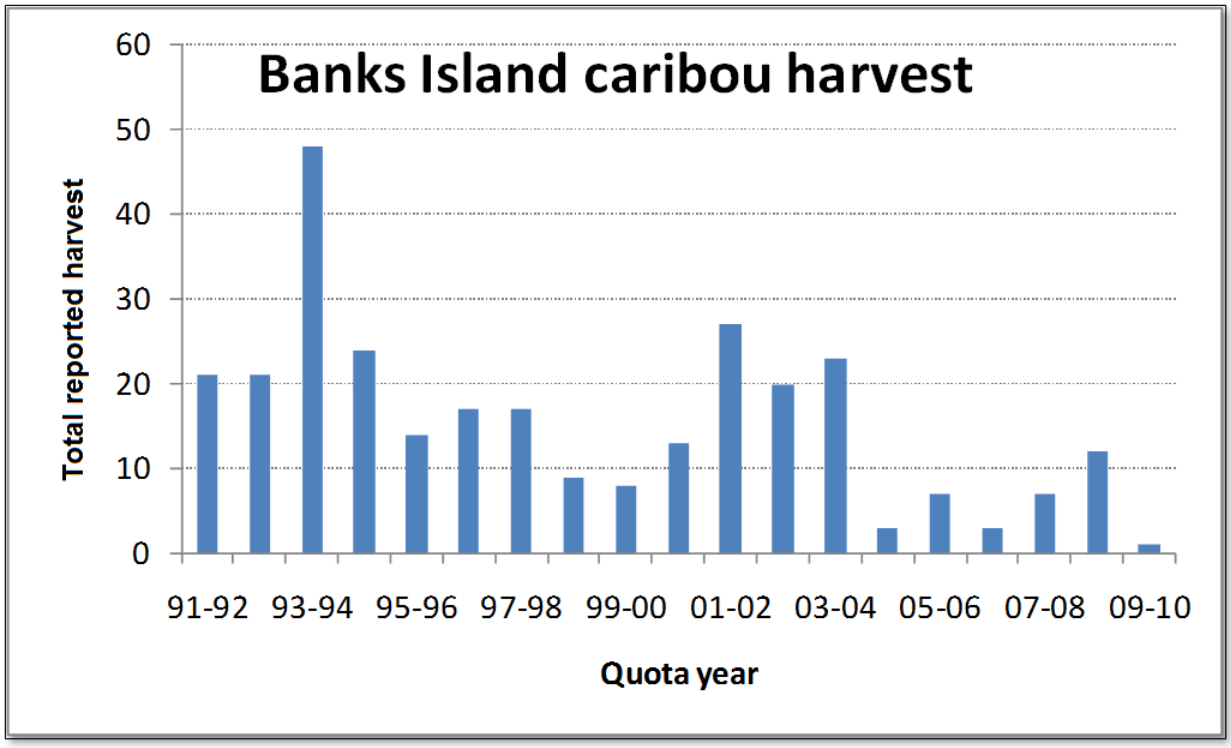

Figure 22. Number of Peary Caribou reported harvested on Banks Island (ENR 2010).

Wolf predation

Although wolf sightings have increased during aerial surveys since the 1990s for Banks Island (Table 3, p.72), coinciding with an increase in muskox abundance, there are insufficient data to measure predation as a threat relative to the continued low abundance of Peary caribou. However, even small declines in the survival rate of adult female Peary caribou are likely to prevent the population to increase, so even incidental predation could be a factor in maintaining low abundance. Muskox abundance has declined since the early 2000s (Davison *et al.* in prep.), which raises questions about the presence and timing of the wolf population's numerical response and incidental predation on Peary caribou. Therefore, wolf predation is an unknown but likely threat to Peary caribou populations especially when Peary caribou abundance is low.

Intra- and inter-specific forage competition

The magnitude of intra- and inter-specific forage competition is uncertain. Inter-specific competition for forage between other herbivores and caribou may occur as there is some evidence for overlap in diet between Peary caribou and muskoxen but the consequences of that are unknown. At high muskox numbers, inter-specific competition may have included intra-specific competition among muskoxen for forage and possibly more use of caribou forage

(Larter and Nagy 2001d). This may have changed since the decline in muskox abundance after 2001. It is also uncertain how weather influences inter and intra-specific competition. For example, icing or deep snow could cause muskoxen to forage on upper slopes and ridges where Peary caribou typically forage.

Intra-specific competition among Peary caribou may be less likely as densities have stayed low for 20 years. It is not certain how either the annual variations in forage productivity or the trend toward increased forage productivity (see *Climate change*, p.99) would change intra-specific competition for forage.

Disturbances from human activity

The magnitude and immediacy of human activities as a measurable threat to Peary caribou are low but uncertain given the lack of information. Disturbance is included as a potential threat because concerns are often expressed about effects of industry, which if increased, would influence behaviour and local distribution. Based on experience elsewhere, disturbances such as low level aircraft flights, people on foot and vehicles can increase caribou energetic costs if those human activities interrupt caribou foraging or cause the caribou to move away in response (Weladji and Forbes 2002). Human activity on the Canadian Arctic Islands has not yet reached a scale at which habitat loss through displacement of Peary caribou can be identified (Hodson pers. comm. 2012). However, the low densities of caribou mean that the displacement would have to have a large effect to be measurable.

On Banks, Melville and Prince Patrick islands, although seismic activity was widespread during the early 1970s (Usher 1971a,b; Miller *et al.* 1977a), currently there is no seismic exploration. However, there is potential for more seismic activity in the future (Hodson pers. comm. 2012). Current leases, permits and licenses can be viewed at http://ism-sid.inac.gc.ca. The potential for mining exploration and development appears moderate (Dewing *et al.* 2007). Mineral exploration has occurred in the Shaler Mountains of northwest Victoria Island in the 1990s. The concerns about the effects on caribou led to studies (CEAA 2010), but so far the exploration has not led to development.

Shipping increased by 75% from 1990 to 2011 inclusive, reaching a record of 19 transits in 2010 (NORDREG in ENR 2011b, updated to 2012). A few large vessels, all icebreakers, are taking the northern route between Melville and Banks Island (McClure Strait: 6 times from 1993 to 2011). It is unclear what influence increasing shipping will have on Peary caribou in the NWT, but any transits that result in open leads may impede movements of caribou between islands.

The levels of access on these islands are generally very low. For example, tourist, staff, and youth camp participants (total visits) to Aulavik National Park on northern Banks Island averaged <50 individuals per year over the past decade (Fig. 23), with spikes in numbers often the result of a single day-visit by a cruise ship (2001) or single season visits by private, often European, groups (2005). Similar trends of low numbers were observed in Tuktut Nogait National Park on the adjacent mainland (Fig. 23).

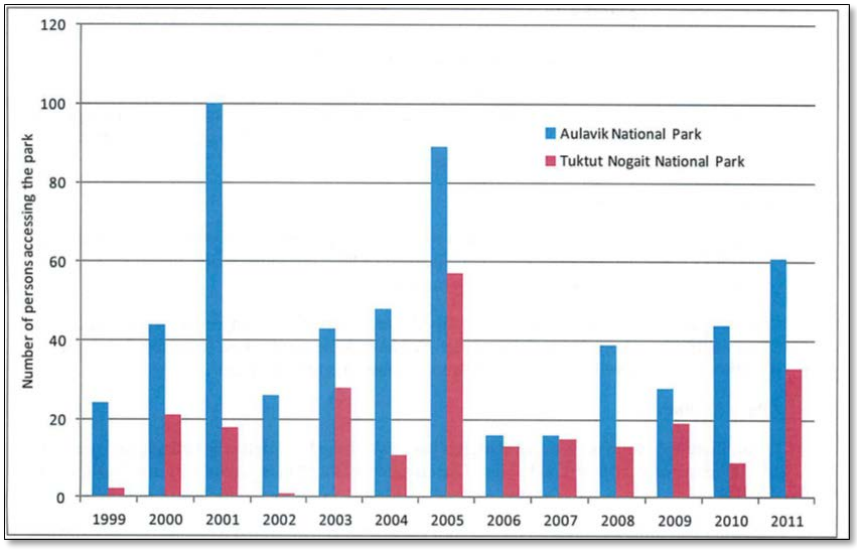

Figure 23. Numbers of registered visitors to NWT national parks in the southern and northern Arctic, 1999-2010 (Parks Canada pers. comm. 2012).

Contaminants

The evidence based on sampling in the 1990s suggests that contaminants do not appear to be current threats to caribou health. Contaminant levels were measured in Peary caribou on Banks Island in the 1990s. Levels of metals in Banks Island caribou are the lowest reported in the study of 15 Canadian caribou subpopulations and are similar to background levels found in humans (MacDonald *et al.* 1996; Larter and Nagy 2000b). Levels of radionuclides including ^{137}Cesium (from the fallout after the Chernobyl reactor meltdown) were not detectable in muscle or liver tissues and were very low in kidneys (MacDonald *et al.* 1996).

Despite these findings from the 1990s, contaminants were included among potential threats because over time the types of contaminants change as new chemicals come into common use. For example, use of brominated flame retardants and fluorinated surfactants have increased since the 1980s (Stow *et al.* 2004).

Climate change

Climate change is already occurring in arctic regions at higher rates than other global ecosystems (ENR 2011b, and references below). Because Peary caribou are already responsive to the effects of weather on forage, climate change will likely cause a cascade of interacting positive and negative effects. Many signals of a warmer Arctic are being measured (Hinzman *et al.* 2005; Lim *et al.* 2008). For example, an increase in plant productivity (the Normalized Difference Vegetation Index or NDVI) is measurable across the western ArcticIslands especially the interior of Banks Island (www.arctic.noaa.gov/reportcard/vegetation.html). Increased forage productivity and extended periods of greenness would increase the availability of quality forage during the growing season. Such a scenario may promote increased fattening and improved condition of animals prior to the winter, all of which may have a positive impact on calf survival and possibly adult survival (Larter pers. comm. 2012).

Examination of changes in pollen profiles suggests a strong warming trend (~1^{o}C) on northwest Victoria Island over the last 100 years (Peros and Gajewski 2008). People in Sachs Harbour have commented on many recent changes associated with a warmer climate (Ashford and Castleden 2001, Ford and Pearce 2010). Those changes include a longer mosquito season and warmer summers. Summer weather likely affects the timing and amount of plant growth and in turn the amount of forage influences pregnancy rates as well as caribou winter survival. Changing weather patterns are unpredictable but a warming climate will likely increase fall temperatures which would increase the frequency of freeze-thaw cycles (Rennert *et al.* 2009). The cumulative effects of these changes and how they will be either compensatory or additive for caribou ecology are unknown. The trend toward warmer summers will modify conditions for parasites and diseases although the effects will be complex (Kutz *et al.* 2009; Davidson *et al.* 2011) and are currently unknown. Thus, climate change could have significant implications for Peary caribou.

Positive Influences

A key positive influence that likely halted the decline of Peary caribou in the 1990s was that Sachs Harbour and Ulukhaktok hunters voluntarily restricted their hunting of Peary caribou (Nagy *et al.* 1998; RWED 1998). These steps were outlined in community conservation plans which summarized the status of Peary caribou on Banks and northwest Victoria islands, and produced co-management goals (Nagy *et al.* 1998; RWED 1998). Harvest restrictions undoubtedly had a tangible positive influence that resulted in subpopulation-scale impacts.

The Sachs Harbour Community Conservation Plan, a community-based planning document, was initiated in 1992, updated in 2000 and 2008 (Community of Sachs Harbour 2008), and is a working document with scheduled reviews and updates. The document is to guide land use planning on Banks Island through identifying important habitats and a community-based approach for the use of those habitats. Some known Peary caribou calving grounds are identified as recommended for the highest degree of protection under the Community Conservation Plan. The Ulukhaktok Community Conservation Plan (OCCP 2008) identifies important areas for Peary caribou on southern Melville and western Victoria Island.

In addition, a limited amount of Peary caribou summer ranges are protected within Aulavik National Park (Parks Canada 2010) and The Banks Island No. 1 Migratory Bird Sanctuary. For the latter, the surface lands are being protected for migratory birds and are administered by Environment Canada under the *Migratory Birds Convention Act.* Peary Caribou likely would receive some conservation benefit from this Migratory Bird Sanctuary because of the limitations on disturbance to migratory birds, their nests, and their associated habitat. As Peary caribou are listed as "Endangered" in Canada since 2011 (www.sararegistry.gc.ca), the federal *Species at Risk Act* provides Peary Caribou some protection within the National Park and the Migratory Bird Sanctuary because they are federal lands. Environment Canada's protected areas policy document states that Environment Canada will consider species at risk and their associated critical habitat before issuing permits for any proposed activity (Environment Canada 2011b:3). These protected areas may have long-term implications for Peary caribou through habitat protection.

Some steps have been taken to clean up industrial exploration sites. The Department of Indian and Northern Affairs (now Aboriginal Affairs and Northern Development Canada) initiated a clean-up of the Johnson Point staging area and camp on eastern Banks Island in 2005. Clean up of contaminants and removal of buildings was scheduled to be completed by 2010 (Contaminants and Remediation Directorate 2009).

Peary caribou have been the focus of national status assessments and recovery planning since 1979 (COSEWIC 2004) although no plans were finalized or actions taken. Efforts included an IUCN workshop for Peary caribou held in Yellowknife, February 1998, which brought together stakeholders and interested people. The 2004 NWT Species at Risk Recovery and Management Team (SARRAMT 2004) drafted technical options for recovery (S. Carrière, J. Nagy and A. Gunn) which listed potential management options for recovery planning; however, these were never implemented. Peary caribou were added to Schedule 1 of the *Species at Risk Act* in

February 2011 which will require a national Recovery Strategy by 2014 (Bigelow pers. comm. 2011). To this point in time, all previous assessments and planning have led to limited real impacts on Peary caribou management, except for raising the species' profile.

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We thank Kim Poole and Dr. Anne Gunn for their work preparing the drafts of this scientific knowledge component. This report benefited from the many comments received during the review process and we thank all of those that contributed their views to the content and structure of this report.

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Authorities Contacted

Aboriginal organizations and wildlife management boards

Bruce Hanbidge	Resource Biologist, Wildlife Management Advisory Council (NWT), Inuvik, NT.
Steven Baryluk	Resource Biologist, Wildlife Management Advisory Council (NWT), Inuvik, NT.

Territorial government contacts

Bonnie Fournier	Data Analyst, Environment and Natural Resources - Wildlife Division, Yellowknife, NT.
Dr. Brett Elkin	Disease/Contaminants Specialist, Environment and Natural Resources - Wildlife Division, Yellowknife, NT.
Dr. Jan Adamczewski	Wildlife Biologist-Ungulates, Environment and Natural Resources - Wildlife Division, Yellowknife, NT.
Marsha Branigan	Manager, Wildlife Management, Environment and Natural Resources - Inuvik Region, Inuvik, NT.
Dr. Nicholas(Nic) Larter	Dehcho Regional Biologist, Environment and Natural Resources, Fort Simpson, NT.
Rob Gau	Wildlife Biologist-Species at Risk, Environment and Natural Resources – Wildlife Division, Yellowknife, NT.
Tracy Davison	Wildlife Biologist, Environment and Natural Resources - Inuvik Region, Inuvik, NT.

Federal government contacts

Dr. Don Russell	Research Scientist – Emeritus, Environment Canada, Whitehorse, YT.
Donna Bigelow	Species at Risk Biologist, Environment Canada, Yellowknife, NT.
Ifan Thomas	Western Arctic Field Unit Superintendent, Parks Canada, Inuvik, NT.

Other species experts

Debbie Jenkins	Qikiqtani Regional Biologist, Wildlife Research Section, Department of Environment, Government of Nunavut, Pond Inlet, NU.

Biography of Preparers

Anne Gunn (B.A., Ph.D., Independent consultant, Salt Spring Island, BC). Anne has some 30 years of experience with caribou field studies, management and research. She has extensive experience with Peary caribou status assessment and recovery planning and has considerable field experience with Peary caribou on the western Queen Elizabeth Islands, Banks and northwest Victoria Island.

Kim Poole (M.Sc., R.P.Bio., Aurora Wildlife Research, Nelson, BC). Kim has 30 years of wildlife research and management experience in northern and western Canada, 15 years of which was spent in Yellowknife with the territorial government. He has considerable experience with caribou in both British Columbia and NWT/Nunavut, having worked on impact assessments, movement and distribution modelling, survey design and implementation, surveys, and habitat studies.

Status and ranks

Region	Coarse filter (Ranks) To prioritize	Fine filter (Status) To provide advice	Legal listings (Status) To protect under species at risk legislation
Global	G5TNR – Species secure, subspecies not yet assessed (NatureServe)		
Canada	TNR – Subspecies not yet assessed (NatureServe Canada)	Endangered (COSEWIC 2004)	Endangered (SARA 2011)
Northwest Territories	At Risk (NWT General Status Ranking Program 2011)	Threatened (SARC 2012)	**To be determined**
Adjacent Jurisdictions			
Nunavut	Not available		

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Appendix A: Peary caribou survey data (Northwest Territories)

Modified from Jenkins *et al.* (2011), updated with data from new surveys based on Davison and Williams (2012)

Island and Survey Year	Season	Estimate incl. calves	SE or 95% CI	Estimate 1+ year	SE or 95% CI	% Calves or Not Observed	Carcass counts (estimates)	Comments	Reference
Western Queen Elizabeth Subpopulations									
Northwestern Queen Elizabeth Islands									
Mackenzie King Island									
1961	17-Aug	2,192				22			Tener 1963
1973	15-Apr	NA				N			Miller *et al.* 1977a
1974	11-Apr	60				N			Miller *et al.* 1977a
1997	18-Jul			36	22	25	(24+/-14)	1 cow-calf pair	Gunn and Dragon 2002
Brock Island									
1961	17-Aug	190				unk		partial survey due to fog	Tener 1963
1973	15-Apr	24				N			Miller *et al.* 1977a
1997	18-Jul	0		0		0	0		Gunn and Dragon 2002
Borden Island									
1961	17-Aug	1,630				22			Tener 1963
1973	14-15 Apr	16				N			Miller *et al.* 1977a
Southwestern Queen Elizabeth Islands (Melville Group)									
Melville Island (Half in Nunavut)									
1961	8-22 Jul	12,799				19			Tener 1963
1972	20 Mar-6 Apr	705	159			N			Miller *et al.* 1977a
1972	13-24 Aug	2,551	724	2,551	724	0		only strata I-VI	Miller *et al.* 1977a
1973	19 Mar-7 Apr	1,648	181			N			Miller *et al.* 1977a
1973	5 Jul-2 Aug	3,425	618			12			Miller *et al.* 1977a
1974	4-21 Aug	1,679	NA			1		extrapolated for 3 missed strata	Miller *et al.* 1977a
1987	1-22 Jul	943	126	729	104	19			Miller 1988
1997	2-20 Jul	787	97	787	97	0	(150+/-48)		Gunn and Dragon 2002
2012	31 Jul-20 Aug			3,033	852	18	0	119 calves observed	Davison and Williams 2012
Byam Martin Island (Nunavut)									
1972	22-23 Mar	4	3			N			Miller *et al.* 1977a
1972	07-Aug	86	65			0			Miller *et al.* 1977a
1973	27-Mar	34	13			N			Miller *et al.* 1977a
1973	15-Jul	43	36			11			Miller *et al.* 1977a
1974	01-Apr	6	2			N			Miller *et al.* 1977a
1974	20-Aug	6	4			0			Miller *et al.* 1977a
1987	08-Jul	98	37	70	26	19			Miller 1988
1997	20-Jul	0		0		0	(26+/-11)		Gunn and Dragon 2002
2012	8 Aug			119	114	26		8 calves observed	Davison and Williams 2012

Island and Survey Year	Season	Estimate incl. calves	SE or 95% CI	Estimate 1+ year	SE or 95% CI	% Calves or Not Observed	Carcass counts (estimates)	Comments	Reference
Western Queen Elizabeth Subpopulations									
Prince Patrick Island									
1961	23-24 Jul	2,254				20			Tener 1963
1973	8-15 Apr	1,381	269			N			Miller *et al.* 1977a
1973	28 Jul-21 Aug	807	259			11			Miller *et al.* 1977a
1974	10-16 Apr	1,049	212			N			Miller *et al.* 1977a
1974	18-25 Jul	621	177			7			Miller *et al.* 1977a
1986	4-13 Jul	151	12-182	106	11-114	30			Miller 1987
1997	29 Jun-1 Jul	84	34	84	34	0	(178+/-37)		Gunn and Dragon 2002
2012	21-26 Aug			2,649	855	12	0	70 calves observed	Davison and Williams 2012
Eglinton Island									
1961	24-Jul	204				*31*		4 calves observed	Tener 1963
1972	04-Apr	574	122			N			Miller *et al.* 1977a
1972	10-Aug	83	59	83	59	0			Miller *et al.* 1977a
1973	08-Apr	90	15			N			Miller *et al.* 1977a
1973	08-Aug	12	9	12	9	0			Miller *et al.* 1977a
1974	Apr	301	60			N			Miller *et al.* 1977a
1974	25-Jul	18	10			4		1 calf observed	Miller *et al.* 1977a
1986	04-Jul	79	0-229	65	0-183	18			Miller 1987
1997	02-Jul	0		0		0	0		Gunn and Dragon 2002
2012	20 Aug			181	143	18		2 calves observed	Davison and Williams 2012
Emerald Island									
1961	24-Jul	161				3			Tener 1963
1973	15-Apr	0				N			Miller *et al.* 1977a
1973	30-Jul	39				N			Miller *et al.* 1977a
1974	17-Apr	12				N			Miller *et al.* 1977a
1986	04-Jul	14	0-49	11	0-37	25			Miller 1987
1997	19-Jul	0		0		0	(17+/-16)		Gunn and Dragon 2002
2012	19 Aug			61	118	0		No calves	Davison and Williams 2012
Melville Group amalgamated (including NU sectors)									
1961	Jul	15,418						Byam Martin (NU) not done	Tener 1963
1972	Apr	1,283						Prince Patrick, Emerald not done	Miller *et al.* 1977a
1972	Aug	2,720						Prince Patrick, Emerald not done	Miller *et al.* 1977a
1973	Mar-Apr	3,153							Miller *et al.* 1977a
1973	Jul-Aug	4,326							Miller *et al.* 1977a
1974	Apr	1,368						Melville not done	Miller *et al.* 1977a
1974	Jul-Aug	2,324						Emerald not done	Miller *et al.* 1977a
1986-87	Jul	1,285							Miller 1988
1997	Jul	871							Gunn and Dragon 2002
2012	31-Jul-26 Aug	6,000						Mack-King, Brock, Borden not done	Davison and Williams 2012

Island and Survey Year	Season	Estimate incl. calves	SE or 95% CI	Estimate 1+ year	SE or 95% CI	% Calves or Not Observed	Carcass counts (estimates)	Comments	Reference
Banks Island Subpopulations									
Banks Island									
1970	23-28 Jun	5,300						Northern Banks only	Kevan 1974
1972		11,000				28			Urquhart 1973
1979-80				8,000-9,000					Vincent and Gunn 1981
1982	4-10 Jul			7,233	998			Calves not recorded	Latour 1985
1982	4-10 Jul			6,970	1,133	19		Area verification	Nagy *et al.* 1996
1982	4-10 Jul			9,036	6,110-11,370			Retrospective	Nagy *et al.* 2009a
1985	6-14 Jul			5,000	910	15		Calves likely minimum est.	McLean *et al.* 1986
1985	6-14 Jul			4,931	914	15		Area verification	Nagy *et al.* 1996
1987	27-30 Jun			4,500	660	23			McLean 1992
1987	27-30 Jun			4,251	663	21		Area verification	Nagy *et al.* 1996
1989	22-28 Jun			2,600	340	26	(300)	29 carcasses observed	McLean and Fraser 1992
1989	22-28 Jun			2,641	334	23		Area verification	Nagy *et al.* 1996
1990	14-19 Sep			526	302	11			McLean *et al.* 1992
1991	27 Jun-3 Jul			888	151	5	(60)	6 carcasses observed	Fraser *et al.* 1992
1991	27 Jun-3 Jul			897	151	3		Area verification	Nagy *et al.* 1996
1992	21-30 Aug			1,018	133	29	2		Nagy *et al.* 2009b
1992	21-30 Aug			1,005	133	31		Area verification	Nagy *et al.* 1996
1970	23-28 Jun	5,300						Northern Banks only	Kevan 1974
1972		11,000				28			Urquhart 1973
1979-80				8,000-9,000					Vincent and Gunn 1981
1982	4-10 Jul			7,233	998			Calves not recorded	Latour 1985
1982	4-10 Jul			6,970	1,133	19		Area verification	Nagy *et al.* 1996
1994	Jul			742	132	8	7		Nagy *et al.* 2006a
1998	Jul			451	60	19	0		Nagy *et al.* 2006b
2001	7-15 Jul			1,142	155	26	0		Nagy *et al.* 2006c
2005	24 Jul-1 Aug			929	143	19	0		Nagy *et al.* 2009c
2010	17-26 Jul			1,097	754-1440	25			Davison *et al.* in prep.
Northwest Victoria (Minto Inlet) Subpopulations									
Northwest Victoria Island									
1980	Aug	4,512	988						Jakimchuk and Carruthers 1980
1987	21 Jun			643	132	27			Gunn and Fournier 2000a
1992	24-26 Mar			170	54				Heard 1992a
1993	18-20 Mar			114	22				Gunn 2005
1993	13-15 Jun			20	-	5		Total observed; 1 calf	Gunn 2005
1994	5-17 June			39	28			Stratum IV of western Victoria	Nishi and Buckland 2000
1998	early Jul			95	29	12	0		Nagy *et al.* 2009d

Island and Survey Year	Season	Estimate incl. calves	SE or 95% CI	Estimate 1+ year	SE or 95% CI	% Calves or Not Observed	Carcass counts (estimates)	Comments	Reference
Northwest Victoria (Minto Inlet) Subpopulations									
2001	16-21 Jul			204	50	24	0		Nagy *et al.* 2009e
2005	6-8 Jul			66	30	28	0		Nagy *et al.* 2009f
2010	28 Jul-15 Aug			150	46-254	12			Davison *et al.* in prep.

Appendix B: Endnotes with additional details

[1]"[Hunters would] Start going north hunting caribou since there was no more caribou where they were. Both dogs and their master would start out north with their packs. They had blankets of caribou skins and most of the time, they would be hungry as there was no caribou so they were also trying to get to where there was fish… This is how they got enough to eat while they kept traveling straight north where there was caribou. Maybe they would get one caribou and share with everyone, whoever they travel with. Whoever got caribou would keep the skin for himself, for their clothing. This is why they would go north and spend all summer where there was caribou. Those old time people really suffered as they had no fish nets or guns. This was the way before the white people ever came. They would make hunting blinds for women and men while hunting caribou. After making a blind, they built inukshuk out of moss on both sides of the shade. They built this inukshuk just right for a man to shoot in between the inukshuk. The women would herd caribou and the men aimed their bow and arrow behind inukshuk" (William Kuptana [N92-253-084a] in Nagy 1999a).

[2]"When the people were getting caribou, it was just like they had lots of meat… When people started coming and making dry meat, there was a lot of dry meat racks with lots of meat drying. They prepared all the meat so they wouldn't spoil. They would cook the insides to be put away. They used everything and put it away because they were thankful for the food" (Susie Tiktalik [N92-253-216b] in Nagy 1999a).

[3] "People long ago they sure used to suffer a lot, they just tried to look for food to eat, all the time. They try to do their best. When they had enough food for themselves, when they feel as if they have enough food, it is like a white person would do when they have a lot of groceries. They make big bags in the fall with caribou and with the fish that are frozen… They always become big bags, they can't even lift it up anymore. Two people could go into one of them big bags. It's called a puguhiq. The same thing with the caribou meat" (William Kuptana [N89-008-011a] in Nagy 1999a).

[4] "[Bankslanders have a] seasonal pattern of caribou hunting. After sealing ends in September there is a brief lull in activity. Those who do not go to the mainland may hunt ptarmigan or owls around the settlement, work on sealskins, haul up their boats and repair winter travelling gear. The tenor of life is relaxed and there is much visiting from house to house. Men who have not hunted in October do so while setting traps in November. The caribou are more spread out and a man can usually count on seeing a few while travelling on the trap line without making special hunts. Most caribou killed at this time are cached, mainly because the toboggan is already partly full... Hunting declines during the dark days, although a few men may make short hunting trips from the settlement as the caribou are normally close. As the days lengthen, there is a slight increase in the number of caribou taken, but the kills occur on the trap line and no special trips are made. Some men go inland to hunt in May or June, but only for a few days and generally not so far inland as in the autumn. One old Copper Eskimo woman walks inland with pack dogs to hunt in July and August; otherwise there is no summer hunting on the Island. The summer is thus a period

of meat deficit in relation to production, with the greatest shortage occurring in September. Most fall kills are made in the upper valley of the Big River, or in its tributaries above the Egg River. Sometimes the hunters come upon a small herd, other times upon solitary young bulls. The latter tend to be curious at this time of year, and will approach hunters if the dogs can be kept quiet. [From 1964-1967] Per hunter effort seems to have increased over the period, although this is complicated by toggling and fishing activities which were included in some trips. Indices of time and distance per caribou remained relatively constant. Data from 1966 showed that less than one quarter of the days out were actually spent in hunting caribou, the rest being used for travelling or other activities" (Usher 1971b).

[5] "Yes, compared to this community [Resolute Bay] the area [Bathurst Island] has more vegetation, and I think that is why there are more caribou there. More humid areas usually have a lot more vegetation. It has mountain sorrel plants and willow leaves, though it has no trees (laughs)" (Herodier Kalluk in Arreak 1997: 60)

[6] "In those years when they start getting their first rifles they had a lot of shells so they were slaughtering caribous in those days and that's the reason why in those days they ran out of caribou. The caribou were extinct for a while in those days. That's when they first get their rifles they got too smart, they kill them off" (Guy Hologak in Berger 1976a).

[7] "People population increase in one settlement such as Holman is the main cause of Peary caribou decline. [It has led to] hunting competition caused by Inuit coming from 26 different regions to Holman" (Jimmy Memogana in Elias 1993).

[8] "I think we had a lot to do with it. Families would take 20-25 cows a winter - about 30. Almost always cows - few bulls" (Larry Carpenter in SHCM 1998: 3).

[9] "Apparently, there is a taboo on the northeast part of Victoria Land. The story is to the effect that a very long time ago, there were large herds of caribou and plenty of Eskimos in this part of the country. The different tribes fought battles amongst themselves and since then the natives will not go into this section of the country. This is all supposed to have happened when the present generation of men were small boys. It is quite possible that there may still be large herds of caribou there yet, as the country is well suited and wonderful feeding grounds" (RCMP Patrol Report 1933 in Condon 1996: 118).

[10] Current regulations are missing the 'male only' restriction but corrections are pending (Carpenter pers. comm. 2012).

[11] "…in the fall time, spring time, when the weather is not good, the ones that are born, they just freeze when the weather is not good. When it's bad weather in the spring time, they don't really increase. And then when it's good weather, they could increase very fast all right" (P. Esau in Nagy 1999c: 164).

[12] The numbers of wolves observed in 1994 and 1998 differ between those reports by Nagy *et al.* (2006a,b) and the Banks Island Co-management Plan (Nagy *et al.* 1998); the numbers reported in the text of Nagy *et al.* (2006a,b) were assumed correct.

[13] Southern Banks and coastal western Victoria Islands are in the Western (Climatic) Region (III) whereas central and northern Banks Island are grouped with inland western Victoria Island (South-central Climate Region IIa). Prince Patrick, Mackenzie King, Brock, and Borden Islands are in the Northwestern Region Ib, while Melville Island is in 1a (Maxwell 1981).