

PORCUPINE CARIBOU HERD

DECLINING POPULATIONS

CHRISTOPHER G. FRAGASSI



PORCUPINE CARIBOU HERD

DECLINING POPULATIONS

Christopher G. Fragassi

February 2010

Abstract

This reports provides a summary of the status of the Porcupine Caribou Herd in the Arctic as of 2010. A survey of actual, estimated, and projected populations is included, as well as factors affecting the herd population, such as climate change, pollution, industrial development, and harvest. An overview of current conservation and management policies in Alaska, Yukon, and the Northwest Territories, is also provided, along with an assessment of common conservation policies. This report is designed to inform the general public of the challenges faced by the Porcupine Caribou Herd, and to provide awareness about the herd's uncertain future.

Table of Contents

Abstract	ii
List of Figures	iv
1. Introduction.....	1
2. Porcupine Caribou Herd Population	2
2.1. Range	2
2.2. Population Data (1972 to 2001)	3
2.3. Population Estimates (2001 to 2010)	3
2.4. Population Projections (2010 to 2020)	4
3. Factors Contributing to the Decline of the Herd	5
3.1. Climate Change	5
3.2. Pollution	8
3.3. Industrial Development	9
3.4. Harvest	9
4. Current Conservation Policies	12
4.1. Common Conservation Policies	12
4.2. Alaska Conservation Policies.....	12
4.3. Northwest Territories Conservation Policies	12
4.4. Yukon Conservation Policies	12
4.5. Regional Policy Differences	13
5. Conclusion	14
Work Cited	15

List of Figures

Figure 1: Range of the Porcupine Caribou Herd	2
Figure 2: Porcupine Caribou Herd Population	3
Figure 3: Effect of Snow Depth on Percentage of Day Spent Cratering	6
Figure 4: Effect of Snow Depth on Percentage of Day Spent Eating	6
Figure 5: Effect of Temperature on Mosquito Harassment Index	7

1. Introduction

From a peak of 178,000 individuals in 1989 (Russell), the Porcupine Caribou Herd population is estimated to have reached a low of 90,000 individuals this year (Environment Yukon, "Porcupine Caribou Interim Conservation"). Based on projections by Environment Yukon, the Porcupine Herd could reach less than 50,000 caribous, or even go completely extinct, by 2020 ("Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd" 13, 24).

The main factors behind the herd's decline appear to relate to climate change, pollution, industrial development, and harvest.

Warmer winters, earlier springs, and longer summers in the north are changing the Arctic landscape and affecting the caribou's diet and movements. Several thaws in the winter months are changing the composition of the snow, and thus, the caribou's ability to forage for food, travel over long distances, or escape predators. The change in climate is also introducing predators to new areas used as calving grounds by the herd.

Furthermore, human development is leading to pollution, and as a result, contamination of the herd. Industrial development is also causing stress on the rangifer, affecting its habitat, introducing new conflicts, and facilitating the harvesting of the animal.

Hunting techniques and practices have also evolved, placing the animal at a clear disadvantage, keeping harvest numbers high in relation to the herd population, and leading to adverse evolutionary consequences on the species.

Finally, only limited conservation efforts have been implemented in selected areas, with respect to harvesting only, and without addressing issues such as climate change or human development. Additionally, the fact that the herd range covers two countries, one state, and two territories has further complicated any effort to reach an actual integrated management policy, and any conservation effort to date may therefore be insufficient to save the herd. The Porcupine Caribou could therefore soon follow the path of the Dawson Caribou to extinction.

2. Porcupine Caribou Herd Population

2.1. Range

The range of the Porcupine Caribou Herd covers a 260,000 square kilometers area that extends over the State of Alaska in the United States, as well as the Yukon Territory, and the Northwest Territories, in northern Canada (Porcupine Caribou Management Board, "About the Herd"). In the spring, the herd migrates to its calving grounds in the northern part of the Arctic National Wildlife Refuge in Alaska, as well as Ivvavik National Park and parts of Vuntut National Park in Yukon (U.S. Fish & Wildlife Service, "Caribou Movement Late Spring Year").

Figure 1 shows the range and migration patterns of the Porcupine Caribou Herd.

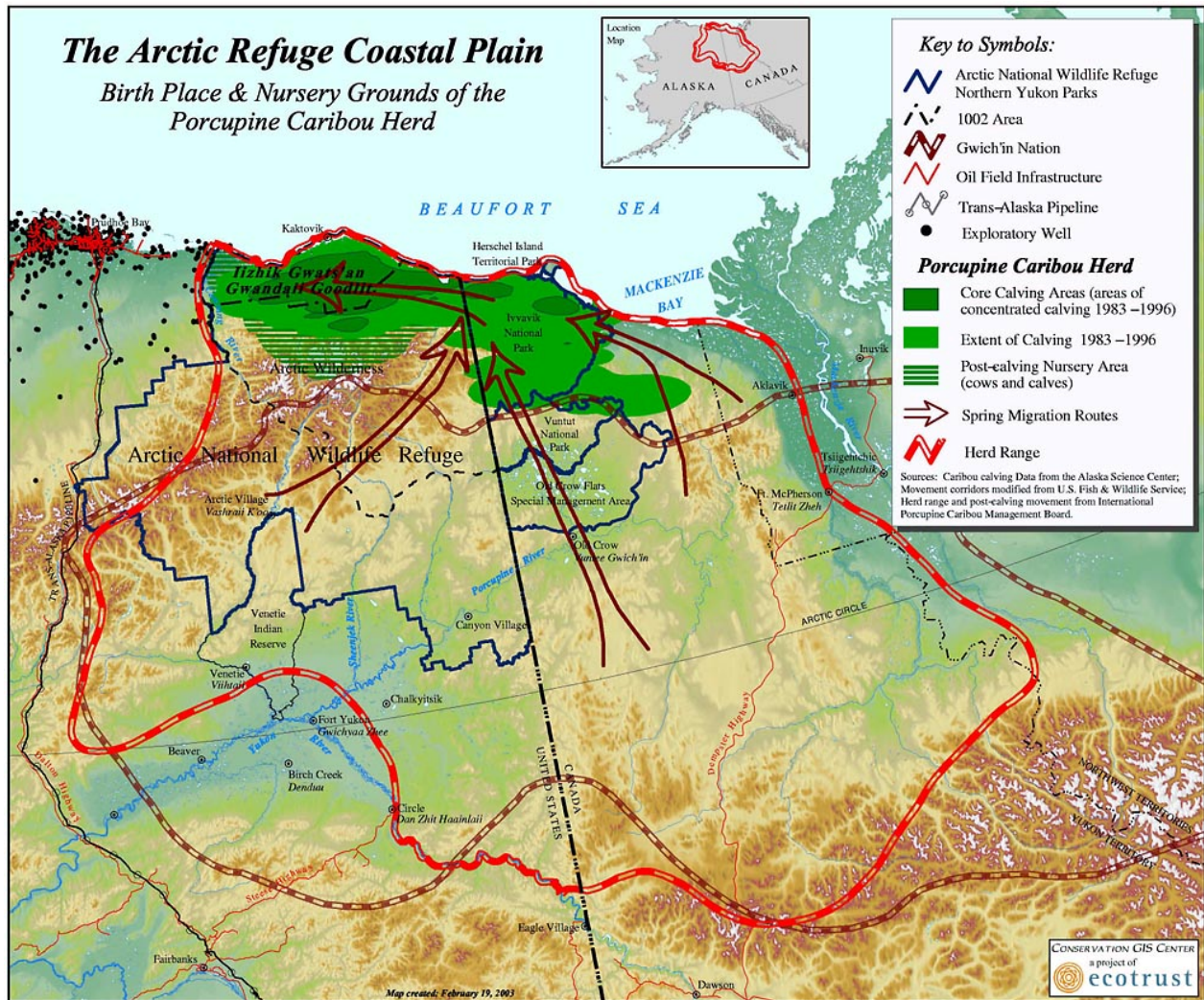
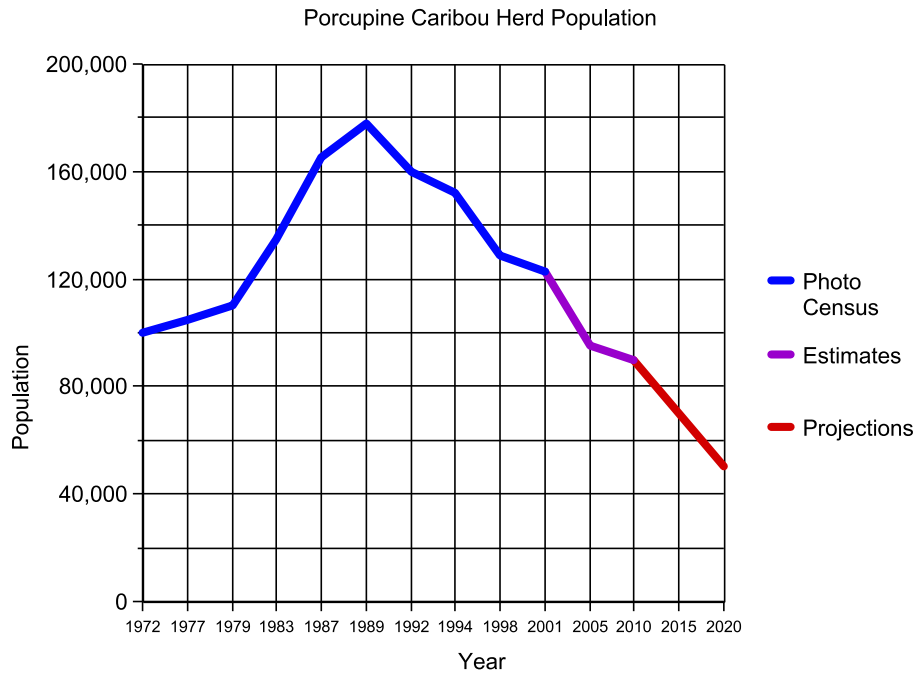


Figure 1

2.2. Population Data (1972 to 2001)

The Porcupine Caribou Herd is the eighth largest herd in North America (Russell). The first census was conducted in 1972 and showed a population of 100,000 individuals at the time. The herd later reached a peak population of 179,000 caribous in 1989, but has been declining ever since, to a population of only 120,000 in 2001 (Russell). Figure 2 shows these population trends.



Source: Environment Canada and Environment Yukon

Figure 2

2.3. Population Estimates (2001 to 2010)

Although population data obtained until 2001 through photo census is deemed to be accurate, current estimates are more uncertain.

Environment Yukon indeed estimate the current population at 90,000 animals (“Porcupine Caribou Interim Conservation”). They however admit that their population assessment may not be entirely accurate, as the population model used to evaluate current herd numbers “makes several assumptions”, and has “limitations on its precision” (Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd” 12). Namely, “missing data are estimated based on historical values”, and limitations include “difficulty in measuring accurate natural mortality”, as well as “significant unknowns of total herd-wide harvest totals or sex ratio” (Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd” 12).

2.3. Population Projections (2010 to 2020)

Population projections greatly vary based on different management scenarios, and evidently, difficulties in accurately assessing current population numbers.

Figure 2 shows the herd population decreasing to 50,000 individuals by 2020, based on historical harvest numbers, and maybe optimistic current population estimates (Environment Yukon, "Rationale for Implementing Conservation Measures" 13). With the same population estimates, but now with proposed interim conservation measures, Environment Yukon project a decline of the herd to 80,000 until 2013, an increase to 95,000 by 2020, and thus, a stabilization of the population to current estimated numbers ("Rationale for Implementing Conservation" 23).

Based on the limitations of the population model used to calculate population projections, Environment Yukon also recognizes the possibility of a "worst case" scenario with a current actual population of only 50,000 individuals ("Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd" 24). Under such a scenario, and with the usual harvest numbers, the Porcupine Caribou Herd would go extinct by 2020 ("Rationale for Implementing Conservation Measures" 24).

It should be no surprise therefore that the "Yukon government has serious conservation concerns about the Porcupine Caribou Herd's declining population" (Environment Yukon, "Porcupine Caribou Interim Conservation").

3. Factors Contributing to the Decline of the Herd

3.1. Climate Change

Climate change appears more pronounced in arctic regions, and “over the last decade the temperatures were about 1.0° C above the 20th century average” (United Nations Environment Programme). Furthermore, the Arctic Climate Impact Assessment projects that mean temperatures in the Canadian Arctic are expected to increase by 2.5° C by 2050, and by up to 5.0° C by the end of the century (100). Warmer temperatures are also leading to changes in wind and precipitation patterns (Arctic Change), including a projected precipitation increase of “as much as 35% in certain high Arctic locations” (Arctic Climate Impact Assessment 100).

Such changes are exposing the Porcupine Caribou Herd to a series of new issues that are affecting the animal’s ability to survive and reproduce. This includes feeding challenges, laborious migrations to calving grounds, increased insect harassment, and exposure to new predators.

Feeding Challenges

The Porcupine caribou feeds on a diet comprised of mainly lichens and moss in winter, sedges in the spring, and shrub in early summer, with the rangifer returning to its winter diet by the end of August (Thompson 70).

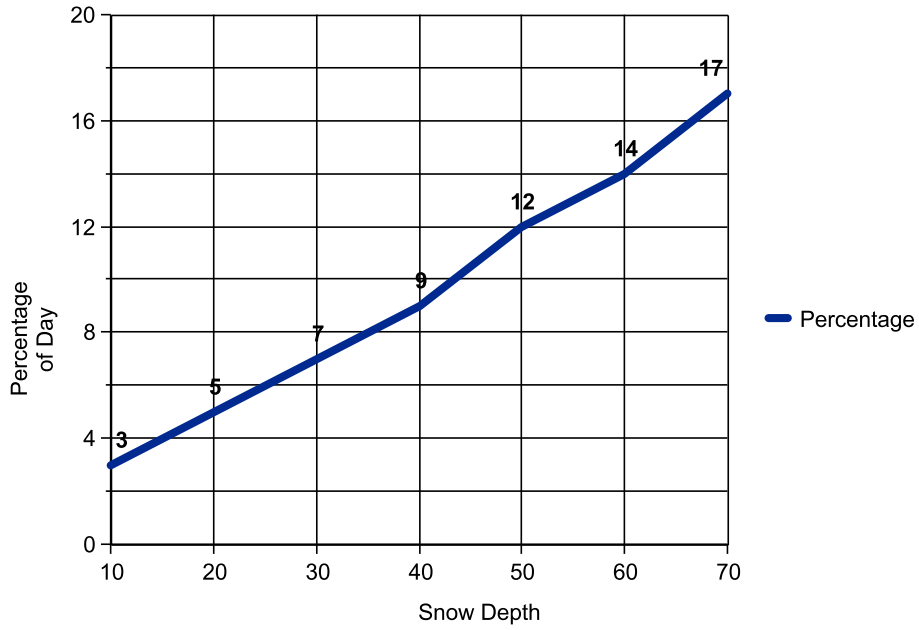
Cratering, or digging at the snow to access lichens and moss, is directly affected by the snow depth, as well as the quality of the snow (Russell and Eamer). The deeper the snow, the more energy and the longer it will take the caribou to access vegetation. Similarly, thaw and freezing cycles can freeze the snow cover, making cratering even more difficult. Figures 3 show the relationship between cratering and feeding: As the snow depth increases, the percentage of the day spent by the animal cratering increases as well. Figure 4 further illustrates that the percentage of day spent eating decreases with an increase of the snow depth.

In addition to difficulties in digging through the snow to access food, a “small decline in lichens and a more significant decline in bare” as well as “an increase in vascular herbs and shrubs” has also been reported around the tree line using remote sensing technology (Olthof 814). Moreover, the burning of a large section of Eagle Plains in Yukon between 2000 and 2005, attributed to climate change, also removed critical lichens from parts of the herd range (Environment Yukon, “Rationale for Implementing Conservation Measures” 16), potentially further affecting the availability of lichens during winter.

Furthermore, the nutritional value of lichens, moss, and shrub ingested by the caribous may be decreasing. Griffith *et al.* indeed report that “climate warming and earlier greening may affect the carbon:nitrogen ratio of individual forage species and decrease their quality” (21).

Under such circumstances, an animal spending more time and energy accessing food of potentially lower nutritional value may therefore not be able to maintain adequate body fat levels in winter, may not have the capacity to fight parasites, the energy to escape predators, or the stamina to migrate to suitable calving grounds. As a result, the rangifer may simply not be able to survive or reproduce.

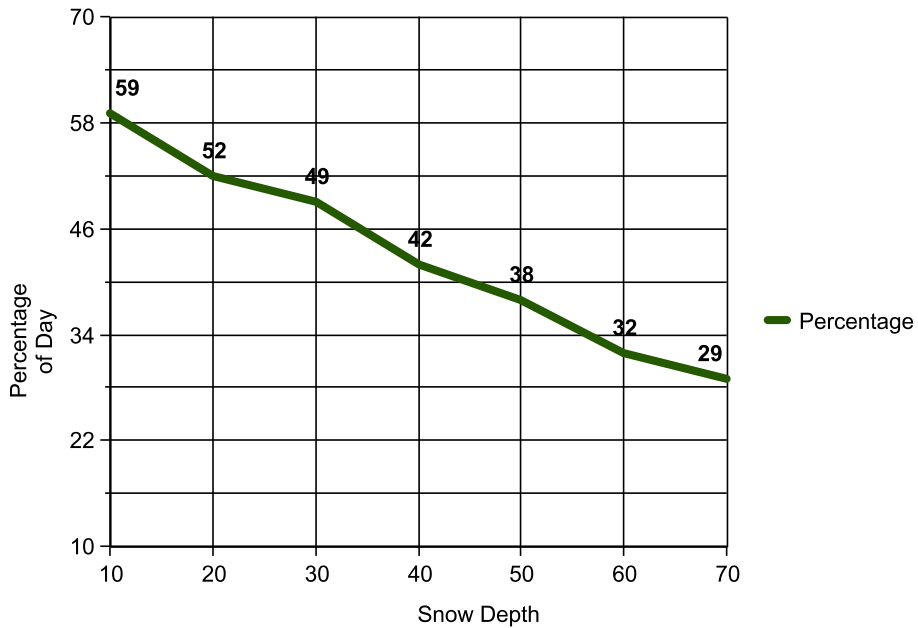
Effect of Snow Depth on Percentage of Day Spent Cratering



Source: Porcupine Caribou Management Board

Figure 3

Effect of Snow Depth on Percentage of Day Spent Eating



Source: Porcupine Caribou Management Board

Figure 4

Laborious Migrations

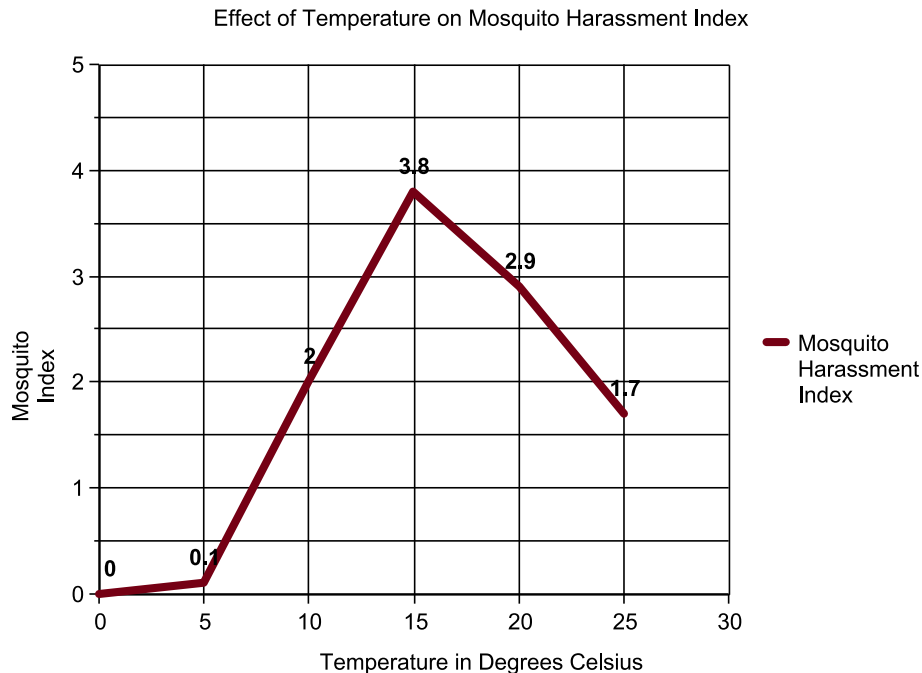
A change in weather patterns and climate is also affecting the herd's ability to travel and migrate every year to its calving grounds in the northern part of the Arctic National Wildlife Refuge (See figure 1).

Warmer spring temperatures are causing thawing and freezing of the snowpack, and in addition to making cratering and feeding more difficult for the herd as discussed earlier, it also makes travel more laborious. The animal, already potentially weakened by difficulties in accessing food, must now spend even more energy traveling on an icy, unstable, and slippery snow pack. As Environment Yukon points out, "this may be why for the past 4 years in a row the herd has not calved on its [traditional] calving grounds in Alaska" ("Rationale for Implementing Conservation Measures" 14).

The icy conditions, combined with a thicker snow pack, may also further affect the caribou's ability to escape predators.

Increased Insect Harassment

With warmer temperatures, insects such as mosquitoes appear sooner, in larger numbers, and for longer periods of time every year. Figure 5 shows the effect of temperature on mosquito harassment.



Source: Porcupine Caribou Management Board

Figure 5

Mosquitoes are considered micro-predators of the caribou (Porcupine Caribou Herd Management Board, "Health"). In addition to taking 0.125 liters of blood daily from the animal, the insects interfere with its feeding habits, prevent the cows from nursing their young, and aggravate the animals that sometimes rush in frustration, resulting in injuries to themselves or other caribou in the herd (Porcupine Caribou Herd Management Board, "Health").

Exposure to New Predators

Grizzly bears and wolves are the main predators of adult caribou, while golden eagles and wolverines prey on calves, cows giving birth, and other adults (Porcupine Caribou Management Board, "Health").

Warmer temperatures and the loss of sea ice in the Arctic are however forcing additional predators, such as the polar bear, to extend their range to the south in search for food. This new trend was best illustrated on August 13, 2007, when a polar bear was seen on the Dempster Highway south of Fort McPherson (Associated Press), in the heart of the McKenzie Valley's tundra, hundred of kilometers south of the animal's typical range.

The possible introduction of a new carnivorous predator, such as the polar bear, could therefore potentially be having a further negative impact on a Porcupine Caribou Herd already under stress.

3.2. Pollution

Pesticides

Concentrations of pesticides such as "chlorinated hydrocarbon contaminants (CHCs), including major polychlorinated biphenyl (PCB) congeners and organochlorine (OC)" (Verreault 580), were found in the fat tissues of polar bears in the Canadian Arctic (Verreault 580). Other contaminants, including over "151 organohalogen chemicals (OHCs)" (Bentzen 352), were also found in polar bears in Alaska.

In a study of small mammals exposed to small doses of pesticides, "incidence of reproductive condition was found to be reduced 20 to 80% and 33 to 100% in diazinon-exposed males and females, respectively" (Lochmiller 284). Numerous other studies have reported a strong link between pesticide contamination in mammals, and reproductive defects, higher mortality rates in off springs, and various other ailments.

Although biological magnification is more pronounced in top predators such as the polar bear, it is possible that the Porcupine caribou is not only contaminated with pesticides, but is also most likely adversely affected by the chemicals, thereby potentially impeding the herd's reproductive process, and the survival of the young.

Heavy Metals

Additional heavy metal contaminants, such as cadmium and mercury, were also found in the Porcupine Herd's caribous (Porcupine Caribou Management Board, "Health"). Only the potential health risks to human consuming caribou meat were considered, and no assessment was conducted in regards to the actual effect of heavy metal contamination on the rangifer (Porcupine Caribou Management Board, "Health"). Heavy metal contamination in humans,

however, has been linked to neurological damage in adults, and risk to the foetus in pregnant women (Järup 167). A similar effect on other mammals, such as the Porcupine caribou, cannot therefore be excluded.

3.3. Industrial Development

The decision by the United States to abandon its oil drilling plans in the Arctic National Wildlife Refuge have effectively prevented any industrial development on the Alaska side of the Porcupine Caribou Herd. Industrial development has however already taken place in Yukon and the Northwest Territories in Canada.

Roads

The most significant industrial development occurred when the Dempster Highway was completed in 1979 to connect the Arctic to the rest of Canada. In addition to opening a previously sparsely settled region to human development, the road effectively cut through prime Porcupine Caribou Herd habitat.

This has unavoidably resulted in vehicle collisions with the animals, contributing yet again to decreasing the herd population. The presence of vehicles has also exposed the caribous to a “Stress Syndrome” (Porcupine Caribou Management Board, “Health”). “Sudden and violent exertion causes changes in the muscle as chemicals from the functioning of the muscles build up faster than the blood can remove them” (Porcupine Caribou Management Board, “Health”), leading to the caribou dying hours, days, or weeks later. In addition to a panicked caribou being susceptible to injury, the animal can also “suffer frostbite in the lungs from panting in extreme cold” (Porcupine Caribou Management Board, “Health”).

Neither the Yukon Government or the Government of the Northwest Territories require mandatory reporting of any collision with wildlife. As a result, the actual number of rangifer lost to vehicle collisions in Canada are generally unknown.

Oil and Gas Development

In addition, the development of oil fields in the MacKenzie Delta is continuously increasing traffic on the Dempster Highway, and thus, further adversely affecting the herd population. In 1979, there were only a few vehicles a day at the southern end of the road in the summer months (Arctic Borderland Ecological Knowledge Co-op). The traffic however peaked to close to 300 vehicles per day in 2002 (Arctic Borderland Ecological Knowledge Co-op), when gas and oil exploration were particularly active in the MacKenzie Delta region.

Infrastructure Improvement

With more traffic comes the need to improve and to expand the Dempster Highway. The extensive construction work undertaken on the Dempster Highway at the Yukon and Northwest Territories border in 2007, the continuous presence of heavy machinery and equipment, as well as the establishment of camps in order to accommodate workers, have further contributed to the stressing of the Porcupine Herd caribou located in the region.

3.4. Harvest

Traditional versus Modern Hunting

Possibly one of the most important factors in the decline of the herd was however a shift from traditional sustenance harvest, to highly assisted large-scale hunting, only made possible with the opening of the Dempster Highway.

As Darius Elias, First Nation Member of the Legislative Assembly in Yukon representing Vuntut Gwitchin points out, the Gwich'in people had three ancient ways of harvesting the caribou, namely with "caribou fences", "hunting on the Porcupine and Crow Rivers with boats", and hunting with "snow shoes and dog teams". A dire contrast with the current "harvesting (of) 20, 30, 40 caribou at a time out on the open tundra with pick up trucks along the Dempster highway".

Modern hunting practices are indeed placing the herd under more stress. In addition to hunters' ability to harvest more animals, the current harvesting techniques used no longer give a targeted animal any chance of survival. An already possibly stressed, tired, and malnourished animal is no match to a pick up truck, an ATV, or an aircraft, and a rifle that can shoot a target from 2 kilometers away.

Finally, the nature of caribou hunting requires that an animal be field dressed within minutes of being shot, in order to avoid spoilage of the meat. The diet of the rangifer indeed causes its stomach to bloat faster than any ungulate, causing the organ to rupture and thus spoil the meat in a very short amount of time. The predominance of hunting techniques involving the shooting of an animal from large distances therefore doesn't usually allow the hunter to attend his or her catch quickly enough, causing a high incidence of wastage.

Harvesting Data

The actual number of caribou harvested from the Porcupine Herd is unknown. As Foster of the Yukon Government Fish and Wildlife Branch points out, "there are 3 Yukon First Nations and aboriginal people from the Northwest Territories that harvest this herd, as well as an Alaskan harvest", making harvest data gathering for the herd, a "bit complicated". In Yukon, the First Nation of Nacho Nyak Dun, the Trondek Hwechin, and the Vuntut Gwitchin First Nation actively hunt the Porcupine Caribou, but are not required to disclose harvests. In the Northwest Territories, the aboriginal people and the resident hunters have the same prerogative.

This lack of transparency does not allow for an accurate assessment of caribou harvest. Moreover, the estimated figure of a total annual take of about 4,000 animals has no scientific basis (Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd" 12), and could be substantially under-estimated. Nonetheless, such numbers still appear unsustainable for the herd, as current harvest numbers would indeed account for about 4.5% of the herd under the best case population scenario of 90,000 animals, and for about 8.5% of the herd under a worst case scenario of only 50,000 rangifer remaining in the herd.

Enforcement

The vast area that constitutes the Porcupine caribou Herd habitat, along with a limited number of enforcement resources, are contributing factors to the Yukon and Northwest Territories governments' most probable inability to effectively enforce hunting regulations, and thus, keep harvest numbers under control.

The Yukon Government has no conservation officer permanently posted in Old Crow, a prime habitat area for the Herd. Additionally, only one to two officers are assigned to the Dempster highway area, the most sensitive region for the hunt of the caribou due to its ease of access. Overall, Yukon only has 21 conservation officers in the field (Anderson), for a territory the size of France.

Such lack of resources are promoting illegal hunting activities, including motorized hunting, the taking of animals, such as cows, otherwise excluded from the hunt, as well as the poaching of caribou.

Undesirable Evolutionary Consequences

Although the challenges, physical and otherwise, of traditional hunting would have inherently favored the taking of weaker caribou within the herd, modern hunting does not need to focus on weaker animals, and even tends to target the best specimen. Coltman indeed reports that the targeting of rams with bigger horns by trophy hunters has resulted in a significant decline in the horn size and body weight of the ram population in Alberta (655). “Both traits were highly heritable, and trophy-harvested rams were of significantly higher genetic ‘breeding value’ for weight and horn size than rams that were not harvested” (Coltman 655). Further, “rams of high breeding value were also shot at an early age, and thus did not achieve high reproductive success” (Coltman 656).

It is therefore reasonable to assume that the harvesting of the largest and healthiest caribou with the biggest antlers is resulting in a predominance of smaller and weaker specimen among the herd, in complete opposition to the concepts of natural selection, and with likely adverse consequences on the fitness and long term sustainability of the herd.

3. Current Conservation Policies

3.1. Common Conservation Policies

In 1987, “Canada and the United States signed an International Conservation Agreement, creating the International Porcupine Caribou Board”, and “in 1993, a Plan for the International Conservation of the Porcupine Caribou Herd was accepted as a framework for coordinating international aspects of managing the herd” (Porcupine Caribou Herd Satellite Collar Project).

In practice, however, the International Porcupine Caribou Board has been unable to actually manage the herd as per its mandate. On the one hand, the United States, and more specifically the Bush Administration, have failed for several years to appoint a representative on the board. On the other hand, the International Porcupine Caribou Board must work with 22 different government agencies managing areas under 12 different management regimes (Porcupine Caribou Herd Satellite Collar Project), making any decision process so lengthy and cumbersome that an effective management plan for the herd has yet to be defined. The fact that some aboriginal land claims have yet to be settled in both Yukon and the Northwest Territories is also contributing to the status quo.

3.2. Alaska Conservation Policies

The State of Alaska does not have a conservation or a management policy reflective of the Porcupine Caribou Herd’s circumstances.

As a matter of fact, although the herd’s range and calving grounds are located in the Arctic National Wildlife Refuge in Alaska, a protected area, hunting of the rangifer is still permitted. Residents can harvest up to 10 animals, while non-residents can take up to 5 animals (Wildlife Conservation). There are no requirements as to the sex of the caribou except for 7 days every year, and northern residents are not required to report their harvest (Wildlife Conservation).

3.3. Northwest Territories Conservation Policies

As it is the case with the State of Alaska, the Northwest Territories have not implemented a conservation and management policy specific to the Porcupine Caribou Herd. With limited resources, the territory seems focused on attempting to salvage the Bathurst Caribou Herd which has gone from 259,000 individuals in 1970, to only 31,900 in 2009 (Environment and Natural Resources, “Bathurst Caribou Herd”).

The Northwest Territories do not even list the Porcupine Caribou as a subspecies in their hunting regulations. Based on hunting areas, however, residents and non-residents alike are allowed to take two animals, and only non-residents are required to report their harvest (Environment and Natural Resources, “NWT Summary of Hunting Regulations” 20).

3.4. Yukon Conservation Policies

Environment Yukon is the only jurisdiction to have taken the step to implement interim conservation measures until the situation of the Porcupine Caribou Herd is better assessed, and a suitable management plan developed and implemented.

Accordingly, hunters are now only allowed to take one bull and to report such harvest

(Environment Yukon, “Revised Caribou Bag Limits for Licensed Hunters”).

The new policy, however, does not entirely apply to “First Nations and Inuvialuit subsistence hunters eligible to harvest under the Porcupine Caribou Management Agreement (as they may take as many bulls as they need (Environment Yukon, “Porcupine Caribou Interim Conservation”). Additionally, the requirement to report any harvest does not apply to First Nation hunters (Environment Yukon, “Porcupine Caribou Interim Conservation”).

3.5. Regional Policy Differences

Clearly, there are major differences in conservation and management policies for the Porcupine Caribou Herd in Alaska, Yukon, and the Northwest territories.

The management of the Porcupine Caribou Herd involves “2 federal governments, 3 state or territorial governments, 8 native land claim agreements, 5 national parks or preserves, 2 native special management areas, and 2 specific ordinances” (Porcupine Caribou Herd Satellite Collar Project).

The range of the herd is also made up of 12 different management regimes, namely:

Ivavik National Park, Vuntut National Park, Inuvialuit Special Conservation Area, Order-in-Council Withdrawal, Territorial Land Use Regulations, Old Crow Flats Special Management Area, Dempster Highway Area Development Ordinance, Yukon Flats National Wildlife Refuge, Yukon Charlie Preserve, Arctic National Wildlife Refuge (1002 Lands), Arctic National Refuge (Wilderness), State of Alaska, Alaska Native Lands, and Bureau of Land Management”. (Porcupine Caribou Herd Satellite Collar Project)

The number of stakeholders, each with different priorities, goals, and visions, has prevented so far the development of a true common conservation and management policy for the Porcupine Caribou Herd, and the introduction of the International Porcupine Caribou Board has yet to show concrete results.

5. Conclusion

The Porcupine Caribou Herd population is in substantial decline. Actual population numbers are uncertain, and there could be as much as 90,000, or as little as 50,000 rangifer remaining. Actual harvest numbers are an unknown as well, but it is estimated that around 4,000 animals are taken every year (Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd" 12).

The only certainty is that the Herd is under unprecedented stress, from climate change, to pollution, industrial development, and continuous harvest, with the situation not showing signs of improvements.

Indeed, Swann writes that "Arctic climate is projected to change dramatically in the next 100 years and increases in temperature will likely lead to changes in the distribution and makeup of the Arctic biosphere", and that the resulting deciduous trees will in turn contribute to greenhouse warming through "enhanced transpiration associated with the expanded forest cover" (1295). Such a scenario would mean less lichen and moss for the caribou, a deciduous landscape impeding travel, and yet warmer temperatures.

As for pollution, it is not expected to decrease, especially in view of our booming world populations. Position statements against oil drilling and exploration in the Arctic National Wildlife Refuge by organizations such as the Wildlife Society were successful so far in preserving the habitat of the Porcupine Caribou Herd in Alaska. Canada, however, has failed so far to take similar action, and the MacKenzie Valley Gas Project will most likely proceed (MacKenzie Gas Project). The building of a pipeline between Inuvik and northern Alberta will certainly dramatically increase traffic and collisions with the herd on the Dempster Highway, as well as further facilitate the harvesting of the caribou.

On the conservation front, the situation appears to be of equal concern. Effective common management and conservation policies are impeded by the number of stakeholders across borders and cultures, as well as the powerlessness or plain inefficiency of the International Porcupine Caribou Board.

Additionally, the situation of the Bathurst Caribou Herd, which could be on the verge of extinction, has also demonstrated that hunters, outfitters, and aboriginal people alike are still unwilling to agree to emergency conservation measures even in view of a complete collapse of a herd population. Outfitters have indeed recently launched a lawsuit over the Northwest Territories government decision to ban all hunting of the Bathurst Caribou Herd (CBC News, "Outfitters Sue N.W.T. Government over Caribou Quota Cuts"), and Aboriginal groups have quickly followed suit as well (CBC News, "Debate over N.W.T. Caribou Hunting Ban Goes Public").

Conservation efforts also seem focused on the species rather than the eco-system as a whole, and fail to take a bio-integrity approach to the problem. Indeed, even a substantial reduction in harvesting number would not address issues affecting the integrity of the arctic ecosystem, such as climate change, pollution, or industrial development.

Although the situation of the Porcupine Caribou Herd is not currently as dire as that of the Bathurst Herd, it is reasonable to expect under the circumstances that the Porcupine Herd will continue to decline. The Yukon Government worst case scenario of the Herd going extinct

within 12 years might therefore become a reality (“Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd” 24), leading to yet another loss of a caribou sub-species in North America.

Work Cited

Anderson, Ronalane. "Conservation Officers." Message to the author. 1 Feb. 2010. E-mail.

Arctic Borderlands Ecological Knowledge Co-op. "Dempster Highway Traffic, Yukon."

Taiga.net/coop. Taiga Net. 14 Nov. 2009. Web. 3 Mar. 2010.

Arctic Change. "A Near-Realtime Arctic Change Indicator Web Site." *Arctic.noaa.gov*.

National Oceanic and Atmospheric Administration, 2009. Web. 12 Feb. 2010.

Arctic Climate Impact Assessment. "Impact of a Warming Arctic." *Acia.uaf.edu*. Arctic Council,

2004. Web. 20 Feb. 2010.

Associated Press. "Polar Bear Sought Southern Exposure in McKenzie Valley." *Cbc.ca*.

Canadian Broadcasting Corporation. 13 Aug. 2007. Web. 1 Feb. 2010.

CBC News. "Debate over N.W.T. Caribou Hunting Ban Goes Public." *Cbc.ca*. Canadian

Broadcasting Corporation. 9 Feb. 2010. Web. 1 Mar. 2010.

CBC News. "Outfitters Sue N.W.T. Government over Caribou Quota Cuts." *Cbc.ca*.

Canadian Broadcasting Corporation. 2 Jul. 2007. Web. 1 Feb. 2010.

Coltman, David, *et al.* "Undesirable Evolutionary Consequences of Trophy Hunting." *Nature*

426 (2003): 655-58. Print. 2 Feb. 2010.

Bentzen, T.W., *et al.* "Organohalogen concentrations in blood and adipose tissue of Southern Beaufort Sea polar bears." *Science of the Total Environment* 406. 1/2 (2008): 352-67. Academic Search Premier. Web. 8 Feb. 2010.

Elias, Darius. Letter to Peter Harms. 27 Oct. 2008. Web. 4 Mar. 2010.

Environment and Natural Resources. "Bathurst Caribou Herd." *Enr.gov.nt.ca*. Northwest Territories. 24 Sep. 2009. Web. 3 Mar. 2010.

Environment and Natural Resources. *NWT Summary of Hunting Regulations: July 1, 2009 to June 30, 2010*. Yellowknife: Northwest Territories, 2009. Web. 1 Feb. 2010.

Environment Yukon. "Porcupine Caribou Interim Conservation." *EnvironmentYukon.gov.yk.ca*. Yukon Government. 9 Nov. 2009. Web. 2 Feb. 2010.

Environment Yukon. "Rationale for Implementing Conservation Measures to Protect the Porcupine Caribou Herd." *EnvironmentYukon.gov.yk.ca*. Yukon Government, 4 Sept. 2009. Web. 29 Jan. 2010.

Environment Yukon. "Revised Caribou Bag Limits for Licensed Hunters." *EnvironmentYukon.gov.yk.ca*. Yukon Government, 28 Sept. 2009. Web. 29 Jan. 2010.

Environment Yukon. *Yukon Hunting: Regulations Summary 2009-2010*. Whitehorse: Yukon Environment, 2009. Web. 1 Feb. 2010.

Foster, Carol. "Porcupine Caribou Herd." Message to the author. 2 Feb. 2010. E-mail.

Griffith, Brad, *et al.* "Section 3: The Porcupine Caribou Herd." *Biological Science Report USGS-BRD 2002-0001* (2002): 8-37. Web. 29 Jan. 2010.

Järup, Lars. "Hazards of Heavy Metal Contamination." *Oxford Journal of Medicine: British Medical Bulletin* 68. 1 (2003): 167-82. Web. 3 Mar. 2010.

Lochmiller, Robert, *et al.* "Effects of Field Exposure to Diazinon on Small Mammals Inhabiting a Semienclosed Prairie Grassland Ecosystem. I. Ecological and Reproductive Effects ." *Environmental Toxicology & Chemistry* 20. 2 (2001): 284. Academic Search Premier. Web. 3 Mar. 2010.

MacKenzie Gas Project. "The Project." *MacKenzieGasProject.com*. ExxonMobil, 30 Dec. 2009. Web. 29 Jan. 2010.

Olthof, Ian, and Darren Pouliot. "Treeline Vegetation Composition and Change in Canada's Western Subarctic from AVHRR and Canopy Reflectance modeling." *Remote Sensing Of Environment* 114 (2010): 805-15. Academic Search Premier. Web. 2 Feb. 2010.

Porcupine Caribou Herd Satellite Collar Project. "Porcupine Caribou Herd Management." *Taiga.net/satellite*. Taiga Net. *n.d.* Web. 28 Feb. 2010.

Porcupine Caribou Management Board. "About the Herd." *Taiga.net/pcmb*. Taiga Net. 2010. Web. 2 Feb. 2010.

- Porcupine Caribou Management Board. "Health." *Taiga.net/pcmb*. Taiga Net. 2010. Web. 2 Feb. 2010.
- Russell, Don. "Porcupine Caribou: An Indicator of Wildlife Sustainability in the Northern Yukon." *ecoinfo.ec.gc.ca*. Environment Canada. 19 Nov. 2005. Web. 2 Feb. 2010.
- Russell, Don, and Joan Eamer. "Porcupine Caribou and Climate." *Taiga.net/caribou*. Environment Canada. *n.d.*. Web. 2 Feb. 2010.
- The Wildlife Society. "Final Position Statement: Arctic National Wildlife Refuge." *Wildlife.org*. Wildlife Society Council. Sept. 2009. Web. 3 Mar. 2010.
- Thompson, D.C., and K.H. McCourt. *Seasonal Diets of the Porcupine Caribou Herd*. Notre Dame: University of Notre Dame, 1981. Academic Search Premier. Web. 4 Feb. 2010.
- Swann, Abigail, *et al.* "Changes in Arctic vegetation amplify high-latitude warming through the greenhouse effect." *Proceedings of the National Academy of Science of the United States of America* 107. 4 (2010): 1295-1300. Academic Search Premier. Web. 2 Feb. 2010.
- United Nations Environment Programme. "Global Outlook for Ice and Snow." *Unep.org*. United Nations, 2008. Web. 20 Feb. 2010.
- U.S. Fish & Wildlife Service. "Caribou Movement in a Late Spring Year." *Arctic.fws.gov*. Arctic National Wildlife Refuge. 12 Sept. 2008. Web. 2 Feb. 2010.

Verreault, Jonathan, *et al.* "Composition of Chlorinated Hydrocarbon Contaminants Among Major Adipose Tissue Depots of Polar Bears (*Ursus maritimus*) from the Canadian High Arctic." *Science of the Total Environment* 370. 2/3 (2006): 580-87. Academic Search Premier. Web. 8 Feb. 2010.

Wildlife Conservation. "Alaska Hunting Regulations No. 50." *wc.adfg.state.ak.us*. Alaska Department of Fish & Game. 1 Jul. 2009. Web. 2 Feb. 2010.