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Review of Caribou Impacts for the Baffinland Phase 2 Development Proposal Hearing

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Acronym List

DOE	Department of Environment
MSES	Management and Solutions in Environmental Science
MHTO	Mittimatalik Hunters & Trappers Organization
NQL	non-quota limitation
NWMB	Nunavut Wildlife Management Board
TAH	Total Allowable Harvest

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1.0 Introduction

Management and Solutions in Environmental Science (MSES) has been asked by the Mittimatalik Hunters & Trappers Organization (MHTO) to identify any barren ground caribou literature relevant to understanding and assessing the impacts of the proposed Baffinland Iron Mines Corporation's (Baffinland) Phase 2 Development Proposal related to the Mary River Project (the Project).

MSES has developed an annotated bibliography identifying literature containing information on the effects of human development on barren ground caribou and woodland caribou. Existing research and associated literature have generally shown that caribou avoid anthropogenic disturbance such as mines (Weir et al. 2007, Boulanger et al. 2012, Plante et al. 2018), roads (Cameron et al. 2005, Leblond et al. 2015, Plante et al. 2018), and railways. Such avoidance has been linked to energetic costs to caribou (Bradshaw et al. 1998). The table below summarizes some relevant research findings regarding spatial areas of avoidance by caribou to human activities and infrastructure. There is overwhelming evidence in scientific literature that caribou avoid human activities. While such avoidance varies a great deal with the context of the disturbance, the effects are inevitably negative on caribou. Caribou avoidance behaviour could result in changes to the distribution and movement patterns of individuals and functional habitat loss. Human activity can also result in direct habitat loss and mortality.

2.0 Status of Baffin Island Caribou

The abundance of caribou on Baffin Island appears to be cyclical, fluctuating over periods of 50-90 years. Population sizes at the peak of these fluctuations are at least ten times larger than when the population size is at a minimum (Campbell et al. 2015; Ferguson 1998; Stenton 1991). These large-scale fluctuations have been observed in other caribou populations throughout the Arctic (Ferguson 1997, Gunn 2003, Morneau and Payette 2000) and are believed to be natural, resulting from interactions of caribou, vegetation, predation, and disease.

For the sake of caribou management, these cycles are divided into 4 phases (DOE 2019), the lengths of which are estimated during the previous caribou cycle (Ferguson et al. 1998).

Red Phase

Caribou abundance is at a minimum (<10% of peak), and extirpation is possible for some or all of Baffin Island. Near the end of the Red Phase, caribou range will begin to recover, and population size and distribution of caribou will increase. As of 2019, we were in the Red Phase (DOE 2019) which began sometime between 2010-2015, and it is assumed that we are still in the same phase. The previous Red Phase spanned 25-30 years between 1935-1965 (Ferguson 2005).

Yellow Phase

During the Yellow Phase, there are increases in caribou abundance and range, especially near the latter part of this phase. The last Yellow Phase spanned 25-30 years between 1965-1990 (Ferguson 2005).

Green Phase

Caribou abundance peaks and begins to decline during the Green Phase. During this phase, caribou numbers far exceed the carrying capacity of their habitat. The larger the population grows, and the longer it lasts, the longer the recovery will be during the next Red Phase. Increased harvest of caribou during this phase could theoretically reduce the period between Green Phases. The last Green Phase spanned about 10 years between 1990 and 2000 (Ferguson 2005).

Orange Phase

With the number of caribou greatly exceeding the carrying capacity of their habitat, caribou abundance drops drastically during the Orange Phase. The last Orange Phase spanned 10-15 years from about 2000-2010 (Ferguson 2005).

Baffin caribou were determined to be in the Red Phase in 2019 (DOE 2019) and are assumed to currently still be in the Red Phase. Estimates from two studies incorporating IQ (Inuit Qaujimagatuaqangit – the Inuktitut phrase that is often translated as "Inuit traditional knowledge") from hunters across Baffin suggested a severe decline in population from the 1990's to the early 2000's. In February/March of 2014, the Government of Nunavut, Department of Environment (DOE) conducted aerial surveys across Baffin Island (Campbell et al. 2015). The survey estimated that there were 4,652 ($\pm 1,190$; 95% CI) caribou on Baffin Island, with a majority of the caribou concentrated in south Baffin and Prince Charles Island.

As a result of the 2014 survey, an eight-month moratorium was put in place on January 1, 2015. Following the moratorium, a Total Allowable Harvest (TAH) and a non-quota bull only limitation (NQL) was put in place by the Nunavut Wildlife Management Board (NWMB). The total number of bull-only tags allocated to communities on Baffin Island was 170 in 2015/16 and 250 from 2016 to 2019. In July of 2019, NQL was changed to allow for up to 25 cows without calves to be harvested within the TAH.

3.0 Impacts to Barren-Ground Caribou

Type of Activity	Amount or Type of Avoidance	Impact Description	Source
Mines			
Diamond Mine (Ekati and Diavik Diamond Mines – Open Pit)	11-14 km in winter	Possibly related to dust deposition from mine activities and non-dustfall sensory disturbance. Zone of influence identified in this study are used in the Bathurst caribou range plan (GNWT 2019).	Boulanger et al. 2012
Quartzite (Sydvaranger Mine – Surface Mining)	1.5 km	Change in distribution and habitat use. Stronger effects were	Eftestøl et al. 2019

		noted during periods of high human activity. Given terrain barriers, the study area was limited to include an area extending up to 10 km from the mine. Caribou movement was limited by steep mountains, fjords, and fencing.	
Diamond Mine (Ekati and Diavik Diamond Mines – Open Pit)	Increased movement	Increased movement rate in vicinity of mine sites and selection of habitat by caribou at further distances from the mine sites over time. Please see Boulanger et al. (2012) for a more recent and refined analysis of the zone of influence.	Boulanger et al. 2004
Diamond Mine (Ekati)	Change in behaviour	Increase in time spent alert after man-made disturbance/stressor event.	Erm Rescan 2014
Linear Features			
Roads	~1 km (Misery Haul Road)	Caribou forage - dust on leaves 3 – 9 times greater than background sites. Potential impacts to forage quality. Within 1000 m of the road, reduced lichen (main caribou forage) density was also reported.	Chen et al. 2017
	5-6 km - change in caribou density in areas 5-6 km from roads	Increase vigilance behaviour, partial movement barrier, and collision mortality. Literature review found that “individuals and groups of reindeer/caribou 1)	Wolfe et al. 2000

		<p>move away from point sources of disturbance; 2) increase activity and energy expenditure near disturbance; 3) delay crossing or fail to cross linear structures; 4) shift away from areas of extensive and intensive development; and 5) are killed by collision with vehicles and by hunting along roads”.</p> <p>Reindeer/caribou reaction to roads and railways may be accentuated by heavy traffic.</p>	
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	4 km - avoidance within 4 km resulting in lower energy intake	Calving caribou abundance less than expected within 4 km and declined exponentially with road density. Calving shifted away from infrastructure into areas with lower forage biomass. Abundance and movements were lower in the oil field complex and road/pipeline crossings were relatively unsuccessful (July/August). Compared to disturbance-free caribou, those caribou exposed to petroleum development may have lower energy balance due to lower forage consumption. Likely consequences were poor body condition and lower birth rates (also see Cameron et al. 1992 re: body condition and calf production).	Cameron et al. 2005
	18.5 - 30 km	Potential for short-term behavioural response or abandonment of portions of seasonal range.	Johnson and Russell 2014
Railways	increased vigilance, changes to movement, and potential for mortality events.	Reindeer/caribou reaction to roads and railways may be accentuated by heavy traffic. Increase vigilance behaviour, partial movement barrier, and collision mortality.	Wolfe et al. 2000

Infrastructure (roads, pipelines, well pads, stations, and support facilities)	1 – 5 km	This study evaluated the ability of caribou to habituate to energy development. After 40 years of exposure to development, caribou displayed avoidance responses to infrastructure during calving (5 km), post-calving (2 km), and mosquito harassment (1 km) periods resulting in avoidance of important habitat during these periods. Authors concluded that habituation by caribou to development activities is likely to be weak or absent.	Johnson et al. 2020
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4.0 Impacts to Woodland Caribou

Four subspecies are defined with the caribou species (*Rangifer tarandus*), including woodland (*Rangifer tarandus caribou*), Peary (*Rangifer tarandus pearyi*), barren-ground west of the Mackenzie River (*Rangifer tarandus granti*), and barren ground east of the Mackenzie River (*Rangifer tarandus groenlandicus*). Scientific literature on the different subspecies is relevant for understanding potential responses by caribou overall. Generally, the literature indicates that all subspecies of caribou display avoidance responses to anthropogenic activities. In order to provide a fulsome review of the scientific information that is available and relevant to understanding potential Baffin Island caribou responses to anthropogenic disturbance, we have included information from studies on woodland caribou to supplement the information provided above, which is specific to barren ground caribou.

Type of Activity	Amount of Avoidance	Impact Description	Source
Mines			
Not Specified	2 km in winter	Indirect habitat loss. Caribou avoided mines in the summer season when human activity was higher (compared to winter).	Polfus et al. 2011

Gold Mine (Hope Brook Gold Mine – Open Pit and Underground)	Up to 4 km year-round Up to 6 km during calving	Changes in caribou distribution. Change structure of caribou groups: decrease in group size near mine; reported absences of females and calves near mine site. Caribou responded to mine disturbance in all seasons.	Weir et al. 2007
Nickle and Copper Mine (Raglan Mine – Underground)	Up to 19-23 km (only summer was analyzed)	Changes in caribou distribution and quantity and quality of habitat. Caribou avoided all disturbance types, except power lines. Avoidance distances ranged up to 23 km and resulted in cumulative habitat loss.	Plante et al. 2018
Coal Mine (Wolverine and Trend Mines – Open Pit)	3 km	Changes in caribou distribution (GPS-collar locations) and quantity and quality of habitat.	Johnson et al. 2015
Linear Features			
Roads, pipelines, and seismic lines, harvested areas, well pads, and facilities.	500 m	A 500 m buffer on human-caused features is used to define ‘anthropogenic disturbance’, based on known negative adjacency effects of these features on caribou.	GoA. 2017
Seismic Lines	100-200 m	Changes in caribou distribution and quantity and quality of habitat. Activity on seismic lines was not collected.	Dyer et al. 2001
	2-2.5 km	Changes in caribou distribution (GPS-collar locations) and quantity and quality of habitat.	Johnson et al. 2015

Roads	Up to 8 km (gravel road)	Changes in caribou distribution and quantity and quality of habitat. Decreased habitat use within 8 km of road to the mine.	Plante et al. 2018
	250 m	Changes in caribou distribution and quantity and quality of habitat. Traffic level data was incomplete and potentially ranged between 40 and 800 vehicles /day depending on the time period and road.	Dyer et al. 2001
	1-1.75 km	Changes in caribou distribution (GPS-collar locations) and quantity and quality of habitat.	Johnson et al. 2015
	1 –2 km	Indirect habitat loss. Caribou avoided high and low use roads in the winter and summer seasons.	Polfus et al. 2011
	0.0-0.3km/km ² 0.6-0.9km/km ²	Caribou density declined 63% at road density of 0.0-0.3km/km ² ; declined 86% at road density of 0.6-0.9km/km ² . Caribou displacement.	Nellemann and Cameron 1998 (mountain reindeer)
Power Lines	2.5 km	Decrease in caribou density within 2.5 km zone and an increase in density in further distances (change in spacing strategy). Depletion of lichen cover in background areas.	Nellemann et al. 2001 (mountain reindeer)
Power Lines	4 km	Habitat loss and fragmentation. Decline in reindeer densities measured.	Vistnes and Nellemann 2001 (mountain reindeer)

	4 km	Habitat loss and fragmentation. Decline in reindeer densities measured.	Nellemann et al. 2003 (mountain reindeer)
Railways	Mortality events	Mortality caused by collisions of caribou with trains. 8 caribou killed in vehicle or train collisions between 1984 and 2010.	McLellan et al. 2012
	Mortality events	Mortality caused by collisions of caribou with trains. 12 caribou killed in one train incident in winter season.	Cumming and Beange 1993
	Mortality events	Mortality caused by collisions of caribou with trains.	Stevenson and Hatler 1985
	Changes to movement	Obstructed movement in wild reindeer with increasing frequency of trains (although see arguments in Bergerud et al. 1984 that lack of crossing was due to range contraction).	Klein 1971
	Mortality events	Mortality caused by collisions of caribou with trains and increased access by hunters.	Bergerud et al. 1984

5.0 Conclusions

Given the information available on caribou responses to anthropogenic disturbance, it is highly likely that Baffin Island caribou are currently impacted by the existing Mary River Project and will experience increased impacts from the proposed Phase 2 of the Project. The Project overlaps with the North Baffin Group/Subpopulation Range (DOE 2019; Figure 4) and includes infrastructure similar to those discussed in the articles cited above (including both linear and area based human disturbance features). The avoidance responses, behavioural changes, and sources of mortality that have been documented for caribou suggest that the North Baffin subpopulation could also experience (and likely already have experienced) changes to their distribution and movement patterns, functional habitat loss, and mortality due to industrial activities.

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