ENVIRONMENTAL DYNAMICS INC.

2195 – 2nd Avenue
Whitehorse, YT Y1A 3T8
P: (867) 393-4882

February 17, 2016

EDI Project No: 15Y0285

NWT/Nunavut Chamber of Mines
P.O. Box 1019,
Iqaluit, NU X0A 0H0

Attention: Elizabeth Kingston, General Manager

RE: GN's recommended caribou protection measures: Technical review

At the request of the NWT/Nunavut Chamber of Mines, EDI Environmental Dynamics Inc. (EDI) was retained to provide a technical review of the Government of Nunavut's (GN) recommended caribou protection measures and protected areas for the Draft Nunavut Land Use Plan (DNLUP). EDI's involvement included support at the DNLUP first technical meeting in Iqaluit in June 2015 (supported by Baffinland), and participation at the second (July 2015) and third (January 2016) technical meetings.

The principle technical issues identified with the GN's recommended caribou protection measures include the following:

- **The recommendations are not supported by a biological rationale** — The proposed protected areas are based solely on the presumption that excluding all industrial activity from calving grounds is "critical" to herd productivity, yet no supporting rationale is provided.
- **The proposed measures are not supported by peer review** — It is not apparent if the GN's approach has been peer reviewed or if there is general acceptance of the approach among the scientific and traditional knowledge community with expertise in northern wildlife biology.
- **The GN's disturbance effects model is overly conservative** — The model overstates potential sensory effects of industrial activities on caribou and there is no acknowledgement of the cumulative effects assessments already conducted for caribou.
- **There is insufficient information regarding the process for implementation of protection measures** — The proposed review period is too infrequent to respond to potential changes in caribou calving areas and there is no documentation of how calving ground habitat protection will be integrated with other population management tools (e.g., harvest monitoring, collection of population demographics, population modeling, etc.).

The intent of this letter is to provide a technical review of the approach used to generate the caribou conservation areas and measures proposed by the GN and to provide constructive suggestions for consideration by the GN and other DNLUP planning partners. This review allows the NWT/NU Chamber of Mines to facilitate industry participation in ongoing discussions regarding maintenance and recovery of Nunavut's mainland tundra migratory caribou herds.

This review examines the GN's proposed "core calving area and key access corridor" zones and other geographically-based land use restrictions being proposed in the draft DNLUP. Following the summary is a technical review of key concerns with recommendations to the GN for revisions to the methods used to generate the baseline caribou habitat data layers and refinement of the protection measures. Finally, to inform broader decision making and to ensure that caribou recovery efforts consider the full range of complementary management tools, the review includes a brief discussion of other factors that parties may need to consider for caribou management.

This review was prepared by Mike Setterington, a Registered Professional Biologist (R.P.Bio.) with the College of Applied Biology in British Columbia and a Certified Wildlife Biologist (CWB) with The Wildlife Society. He has been working since 1996 as a professional biologist and as an environmental impact assessment specialist, and has worked on a number of projects in Nunavut that included the assessment and management of the effects of exploration and mining disturbance on caribou. The report was reviewed by Graeme Pelchat, P.Biol. (EDI), Anne MacLeod, R.P.Bio. (EDI) and Cathy Mackay, R.P.Bio., PAg. (EDI). Errors, omissions or misrepresentations are the responsibility of the senior author.

Suggested citation:

Setterington, M. 2016. GN's recommended caribou protection measures: Technical review. Letter report prepared by EDI Environmental Dynamics Inc. for the NWT/NU Chamber of Mines, February 2016. 29 pp.

EDI Environmental Dynamics Inc.

Michael Setterington, R.P.Bio., CWB
Director/Senior Biologist

1.0 MATERIALS CONSIDERED IN THIS REVIEW

To gain an understanding of the GN's proposal for protected areas and approach to caribou management, the following materials were reviewed:

- Draft Nunavut Caribou Strategy Framework (Government of Nunavut Department of Environment 2010);
- Nunavut Caribou Strategy Framework, submitted to the Nunavut Planning Commission in May, 2014 (Government of Nunavut Department of Environment *Undated*);
- Government of Nunavut's 2014 Draft Nunavut Land Use Plan Review Report submitted to the Nunavut Planning Commission (Government of Nunavut 2015);
- A figure of the GN Recommendation: Caribou Core Calving Areas and Key Access Corridors (Caslys Consulting Ltd. and Government of Nunavut 2015);
- Barren-Ground Caribou Analysis Methods Summary Report Draft (the methods document describing the analytical process used to delineate the polygons presented to the NPC; Caslys Consulting Ltd. 2015);
- A Government of Nunavut presentation at a November 2015 Nunavut Wildlife Management Board Workshop (NWMB) "Resource Development and Caribou In Nunavut: Finding a Balance" (Government of Nunavut Department of Environment 2015);
- Presentations made at the Nunavut Planning Commission (NPC) technical workshops for the DNLUP (1st workshop June 2015; 2nd workshop July 2015, 3rd workshop January 2016; Nunavut Planning Commission 2015a, 2015b).

A number of additional published and unpublished documents related to caribou ecology, habitat protection and management approaches were also reviewed and are cited where relevant.

2.0 SUMMARY OF THE GN'S RECOMMENDED CARIBOU CORE CALVING AREAS

2.1 GN NUNAVUT CARIBOU STRATEGY

The first known mention of the GN's strategy for protecting caribou calving habitat was documented in the 2010 *Draft Nunavut Caribou Strategy Framework "Working Together for Caribou: Nunavut Caribou Strategy"* (Government of Nunavut Department of Environment 2010). That document's Action Item 2.2b stated that the GN would …"*adopt joint policies in areas of mutual interest"* — consideration for protected areas being one of those areas of mutual interest. That is the only reference to protected areas in the draft document.

The GN's 28 May 2014 DNLUP submission included the *Nunavut Caribou Strategy Framework* (Government of Nunavut Department of Environment *Undated*). Among other revisions, that version communicated a change in the GN's views on habitat protection, countering suggestions made in the draft version. For instance:

Draft 2010 version:	Action 3.2g: *Working with regulatory authorities, comanagement* [sic] *partners, and other stakeholders, explore options for preserving calving and post-calving habitat.*
Undated (2014 submission) version:	Action 3.2g: *Working with regulatory authorities, co-management partners, and other stakeholders, explore options for preserving calving and post-calving habitat and migratory corridors through the establishment of official protected areas that exclude commercial exploration/disturbance and development.* [emphasis added]

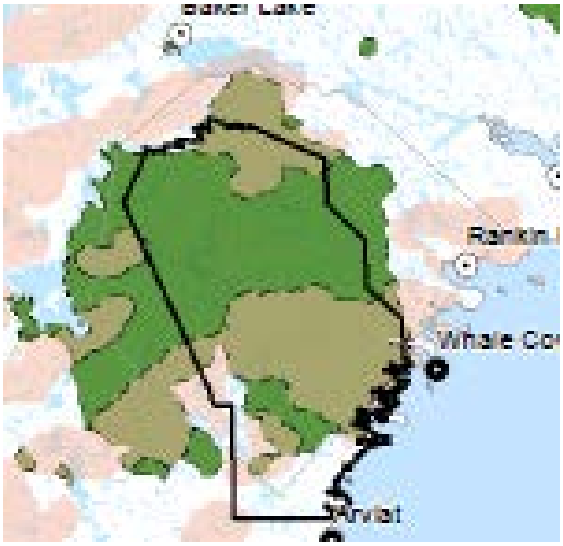
Although the text in the undated version still states "…*explore options for preserving calving and post-calving habitat*,…" the statement now concludes "…*exclude commercial exploration/disturbance and development"*, leaving the reader wondering what options remain available, and what information became available between 2010 and 2014 that led to such a substantial change in the strategy. Regardless, the strategy states on page 12 that it "… *seeks to develop an environment in which caribou management decisions are based on sound information*…" and "*aims to make decisions and take actions that serve and promote the long-term economic social and cultural interests of Inuit*…" To that end, this review focuses on management decisions based on sound information.

2.2 GN DNLUP SUBMISSIONS

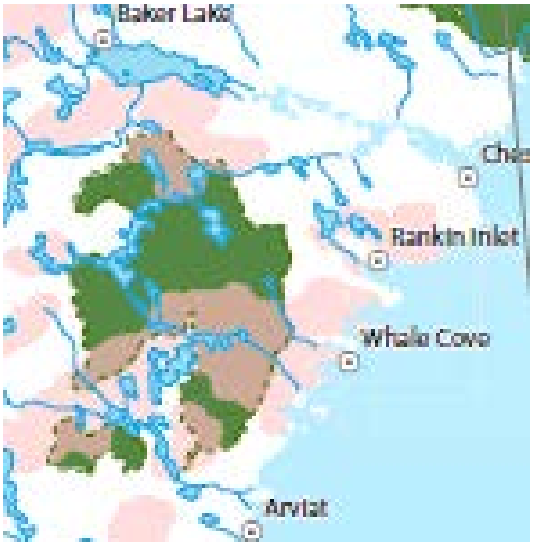
The GN submitted a number of recommendations to the NPC in regard to protection of caribou habitat (Government of Nunavut 2015). The GN proposed that "caribou core calving areas and key access corridors" be identified as protected areas where industrial activity would be excluded. The GN also recommended that many other areas of caribou habitat be designated as Special Management Areas, including post-calving grounds, rutting areas, migration corridors, and seasonal ranges (summarized in Table 1). The spatial data used to define and delineate these areas have not been made available on the NPC's website.

It is unclear exactly what areas are proposed as core caribou calving grounds. Part of the GN submission to NPC in June 2015 included a map depicting "core caribou calving areas" (Caslys Consulting Ltd. and Government of Nunavut 2015). The areas identified on that map do no match the polygons shown in the NPC's Schedule A Nunavut Land Use Plan Land Use Designations (Nunavut Planning Commission 2014). An example is provided in Figure 1.

Following the first technical meeting, the methodology used to generate the caribou habitat polygons proposed by GN were provided in a July 2015 document (Caslys Consulting Ltd. 2015). A technical review of that document is provided below. The absence of a documented biological rationale for the overall approach is described in the next section.



A: Excerpt from NPC data showing what would be proposed as the Qamanirjuaq caribou core calving ground based on data available to the Nunavut Planning Commission (2014_DNLUP_Data_Schedule_A shapefiles, http://www.nunavut.ca/en/downloads).



B: Excerpt from the GN's June 2015 submission to the NPC illustrating the Qamanirjuaq core caribou calving ground (Caslys Consulting Ltd. and Government of Nunavut 2015).

Figure 1. Discrepancies between the core caribou calving area polygons in the DNLUP (Image A) and the calving area information provided by the Government of Nunavut (Image B).

Table 1. Summary of Government of Nunavut recommended land use designations and protection measures to address protection of caribou relevant to mineral exploration and mining projects.

GN No.	Area[1]	Season	Status	Land Use Guidance	GN's Supporting Evidence[2]
#2-001	Core Calving Area (and "key access corridors" in post-calving polygons)	Year-round	Protected	Industrial development and activity are not permitted, regardless of the existence of high mineral potential.	"…*disturbance effects during calving have severe consequences for herd productivity and health.*" Further, for "key access corridors" to core calving habitat… "*Development and/or disturbance along these routes present an extremely high risk of causing caribou to shift or abandon their calving areas.*" There are various other statements reiterating those conclusions, but no supporting evidence or reference to GN or other studies.
#2-001	Post-calving Area	Approximately Jun 15–Aug 1	Special Management	Seasonal restrictions apply to development activities when and where caribou are present. Seasonal restrictions would apply to exploration and production projects and any activity with a high likelihood of disturbance to caribou.	"…*defined areas used by caribou for the nursing of calves and nutrition uptake to sustain the high energy demands required by lactating females. Disturbance in these areas while caribou are present can lead to demographic impacts to populations resulting in higher calf mortality because of reduced nursing time, or cow-calf abandonment.*" There are various other statements reiterating those conclusions, but no supporting evidence or reference to GN or other studies.
#2-002	Rutting Areas	Approximately Oct 10 – Nov 10	Special Management	When and while caribou are present, restricted activities could include air and vehicle traffic, loud or repetitive noise, and/or vibration disturbances.	Rutting areas are when "…*caribou are known to be particularly vulnerable to disturbance during the breeding process. This disturbance can result in lower pregnancy rates.*" There are various other statements reiterating those conclusions, but no supporting evidence or reference to GN or other studies.
#2-003	Migration Corridors	(approximately Oct. 10 – Nov. 10 [Fall Migration], and Apr 15 – Jun 1 [Spring migration]	Special Management	Includes a conformity requirement where proponents must demonstrate in their project proposal that consideration has been given to their location within a designated migration corridor, and that any linear feature proposed within a designated migration corridor will not impede the movement of caribou. When and while caribou are present, restricted activities could include air and vehicle traffic, loud or repetitive noise, and/or vibration disturbances.	"*Disturbance and obstacles along the migration route can displace herds and alter access to critical habitat and forage. Disrupting these migratory routes can lead to a change or loss of migratory behaviour over time resulting in lower productivity and abundance,…*" There are various other statements reiterating those conclusions, but no supporting evidence or reference to GN or other studies.

Table 1. Summary of Government of Nunavut recommended land use designations and protection measures to address protection of caribou relevant to mineral exploration and mining projects.

GN No.	Area[1]	Season	Status	Land Use Guidance	GN's Supporting Evidence[2]
#2-004	Seasonal Ranges	Unspecified	Mixed-use	Includes a conformity requirement whereby proponents proposing to operate within a mainland migratory caribou seasonal range must demonstrate consideration for these areas by recognizing the potential impacts of proposed activities, and identify mitigation measures accordingly.	*Seasonal ranges represent vast areas of Nunavut that are important for the survival and success of caribou herds.* *"…will require regulators and proponents to consider potential impacts that may impede the ability of caribou to effectively access summer and winter range and ensure feeding behavior is not significantly disrupted."*
#2-005	Potential for calving areas to shift			The GN will regularly exchange information and research with the NPC to ensure that land use designations are informed by the current knowledge of caribou habitat and behaviour.	"*…punctuated events displaying geographic shifts in core calving areas do occur in rare circumstances.*"

Notes:

1. The spatial extent for these areas is either incorrectly identified on the NPC maps (for core caribou calving habitat when compared to the GN's June 2015 submission), or not at all identified.
2. Provided in the GN's June 2015 submission to the Nunavut Planning Commission (Government of Nunavut 2015).

3.0 BIOLOGICAL RATIONALE

The rationale for the GN's proposed land use designations appears to be contained entirely within the GN's DNLUP submission (Government of Nunavut 2015) and follow-up presentations by the GN to a November 2015 workshop to the Nunavut Wildlife Management Board (NWMB; Government of Nunavut Department of Environment 2015) and in the DNLUP technical meetings. Notes from the GN's DNLUP submission are summarized in the "GN Supporting Evidence" column in Table 1.

As presented, the GN's supposition appears to be that protection of those areas (by excluding "industrial disturbance") is critical to caribou population sustainability or recovery. Further reasoning appears to be based upon: 1) presumed sensitivity of caribou on the calving ground and that calving grounds are "critical" to populations (Government of Nunavut Department of Environment 2015); 2) that no effect on calving habitat is acceptable (DNLUP 1st technical meeting transcripts); and 3) that industrial activities should be controlled because it is one of the few activities that can be controlled (Government of Nunavut Department of Environment 2015). Beyond those statements, there is a lack of evidence supporting the recommendations or consideration of what factors may be limiting to mainland Nunavut caribou populations.

Providing a well-documented biological rationale for protection measures is not unprecedented and reflects management decision-making based on sound information. A biological rationale would describe the issues, provide a compilation of the information and data used to define protected areas, and provide the scientific and traditional knowledge evidence of how and why protection measures were derived. The rationale could be in a peer-reviewed compendium of the scientific and expert advice used to inform management decisions. A few examples of this provided either by or for other government agencies include:

- A biological rationale for assigning human activity-restricted timing windows in habitat areas for a variety of wildlife species (British Columbia Ministry of Environment 2009);
- A rationale for implementing conservation measures (harvest restrictions) for the porcupine caribou (Yukon Government, Department of Environment 2009);
- A rationale for the delineation of wildlife habitat areas for the boreal ecotype of caribou in northeast British Columbia (Goddard 2009)
- A scientific assessment to inform the identification of critical habitat for woodland caribou, boreal population, in Canada (Environment Canada 2011).

Proposed wildlife management actions are stronger and more defensible when supported by a clear and justified rationale. A rationale for protected area restrictions should include a consideration of the factors that limit migratory caribou populations on mainland Nunavut. There is no documented consideration, or discussion, of factors that limit these caribou populations, and no reference to the relationship of industrial disturbance to those limiting factors in the information provided by the GN.

As an example of reviewing rationale, in 2000, the Department of Indian Affairs and Northern Development (DIAND) initiated a process for the development of a policy statement regarding the management of human activities in barren-ground caribou calving and post-calving areas (Weihs and Usher 2001). That review included consultation with organizations involved in management of caribou and caribou habitat, and included the territorial governments (GNWT and GN), the Beverly and Qamanirjuaq Caribou Management Board (BQCMB), Regional Inuit Associations, the Nunavut Wildlife Management Board (NWMB), Nunavut Tuungavik Inc. (NTI) and others. The report stated that there was a "*strong consensus*" among the agencies favouring "*…a comprehensive herd and ecosystem management approach rather than focusing on complete protection of specific components of herd range.*" While it was noted that protected areas unquestionably provided the most complete protection, it was not seen as a "*…proven necessity or the most desirable approach.*" Finally, the discussion ends "*…that, while protected areas should not be entirely ruled out, there would have to be convincing evidence on a case by case basis that this is not only the best, but the only way of ensuring herd health if other measures are not working.*" Based on those findings, one of the conclusions was that a protected areas approach to managing calving and post calving habitat be given low priority relative to the use of other protection tools (pg. 31, Weihs and Usher 2001).

3.1 CARIBOU POPULATION LIMITING AND REGULATING FACTORS

The general limiting factors to caribou populations are summarized in Chapter 11 (*Limiting Factors*) and Chapter 16 (*Population Regulation*) in Bergerud et al. (2008). The beginning of that chapter states "*Wildlife management in North America has a history of searching for the most limiting factor… i.e., the mortality loss that holds down the potential rate of increase more than any other factor. Once it is found, steps are taken to reduce or manage this loss.*" Unless documented elsewhere, consideration of those factors, and the steps necessary to reduce or manage the loss, have not been explicitly identified by the GN.

Limiting factors, for the mainland herds include the following (as summarized in Bergerud et al. 2008):

- Starvation (lack of forage, over grazing on range);
- Accidents (e.g., drowning,)
- Hunting mortality
- Weather
- Disease and parasites
- Predation
- Differential mortality of males and females

Regulation factors include:

- Pregnancy rates
- Summer calf mortality
- Winter calf mortality
- Adult mortality
- Foraging carrying capacity
- Winter starvation
- Range fecundity and calf survival

Based on the identification of those factors, it is unclear how protection of caribou habitat alone will work to help manage caribou populations.

Those basic biological factors and related mechanisms that limit and regulate caribou populations were considered in the Government of Northwest Territories (GNWT)'s technical review of the decline of the Bathurst herd (Adamczewski et al. 2009). That review listed a number of factors that, when combined, were the likely cause of the decline of that herd including: harvest mortality, recruitment, calf survival, and the diamond mines on the summer range. Overall, it is likely that the recovery of the Bathurst herd would require an increase in cow survival and good calf survival with good fecundity (Adamczewski et al. 2009). The paper states that the effects of the diamond mines (albeit on summer range) are limited and unlikely to have been related to the rapid decline of the caribou. It is not apparent from that review that the need for protecting habitat is a high priority for recovery of that population. Some of the findings of that draft GNWT technical report were published in the peer reviewed literature in 2011 (Boulanger et al. 2011).

3.2 INDUSTRIAL DISTURBANCES' INFLUENCE ON CARIBOU POPULATIONS

Following is a brief review of some of the more recent literature that has considered human disturbance as a potential effect on caribou populations. This is not intended as a complete review of the effects of human disturbance on caribou, because those were discussed at length in several publications (e.g., Reimers and Colman 2009, Wolfe et al. 2000), and that was one of the purposes of the NWMB *Protecting Caribou and Their Habitat* workshop in Iqaluit in November 2015 (http://www.nwmb.com/en/public-hearings-a-meetings/workshops/november-2015-protecting-caribou-and-their-habitat-workshop). Rather, this summary is intended to communicate that studies continue, caribou response is sometimes observed, effects are debated, and management options vary. This debate has existed among caribou biologists and managers in the literature since at least 1984 (Bergerud et al. 1984; Whitten et al. 1984; Miller et al. 1985).

A broader review of the conservation needs of caribou in Canada was recently published as *Conservation of caribou in Canada: an uncertain future* (Festa-Bianchet et al. 2011). Concerns about the effects of development activities on caribou habitat are identified in that paper. The authors, when discussing migratory tundra caribou, note that large scale population fluctuations are typical, and are likely explained by decadal climate pattern interactions with forage growth, particularly on calving and summer range. When discussing threats, the authors note that "*Predation and harvesting have a driving role in declines as small reductions in adult female mortality strongly influence population trends.*" The paper notes the potential threats of disturbance to caribou on calving and post-calving grounds and other habitats, and notes the potential effect on energy expenditure, but the demographic effects of those behavioural responses are unknown. Importantly, the paper notes that even in the face of migratory tundra caribou population declines, predation and harvesting levels remain mostly unchanged (and likely not monitored at all for mainland herds in Nunavut). The authors state that two key information gaps that need to be filled to help ensure caribou conservation are: 1) filling key information gaps related to population size, trends and geographic ranges; and 2) addressing a lack of knowledge about how caribou populations are affected by habitat alterations, or how much habitat must be protected to ensure survival of populations. Based on the evidence provided in the paper, the authors' conclusions state that over the short term, conservation must focus on reducing mortality. They also state that long-term management to address changing land use on caribou ranges are required, but that the effects of industrial activity on migratory tundra caribou habitat are not as intense as elsewhere in caribou range, although effects are likely increasing. They suggest that an assessment of cumulative effects has not yet occurred,

although several cumulative effects assessments have in fact been undertaken for a number of industrial projects in mainland caribou range (see Section 5.2 and Attachment 1).

Studies of caribou response to a number of industrial-type and other human disturbances are documented in the literature. Perhaps the most thorough reviews are the response of reindeer and caribou to human disturbance (Wolfe et al. 2000), reindeer and caribou response towards human activities (Reimers and Colman 2009), and a review of an extreme example of the cumulative impacts of the evolving Kuparuk oil-field complex on the distribution of calving Central Arctic Caribou Herd in northern Alaska (Nellemann and Cameron 1998). There is some indication that calving habitat quality for that herd may affect calf fitness, but it is unclear if the difference in calf weights are the result of disturbance, or a density-dependent response to calving habitat use (Arthur and Del Vecchio 2009). A general conclusion, still after many years of research, is that while some level of cumulative effect is likely, "*a clear separation of cumulative effects of development from natural variation in caribou habitat use and demography will be difficult"* (Wolfe et al. 2000). The dilemma of determining the *effects* of caribou response to human disturbance continues, as noted in another recent publication studying the long-term distribution response of the migratory Porcupine Caribou Herd to human disturbance (Johnson and Russell 2014). While the authors of that paper found that there is a large-scale behavioural response to disturbance, the *response* is variable through time, and it is not clear what type or if it is having a discernable *effect* at the population level.

4.0 TECHNICAL RECOMMENDATIONS

The GN's methods of delineating the core calving and key access corridor polygons are provided in a draft July 2015 report (Caslys Consulting Ltd. 2015). The document describes the analytical methods used to develop the polygons, using up to ~20 years of satellite collar location information, with variable sample sizes across years and across herds. The data are pooled across all years to derive broadly defined areas. Various distance buffers were used to form enclosed polygons. There are many unexplained isolated polygons that do not appear to reflect tundra migratory caribou gregarious calving behavior. There is no indication that these methods have been peer reviewed or whether they incorporate Inuit Qaujimajatuqangit (IQ) — the methods cited three publications, two of which were peer reviewed, the third was a cross-reference to the author's previous report. Issues related to these concerns, with recommendations for addressing them, are presented below.

Issue 1: The analysis used to define core calving areas does not appear to differentiate potential calving caribou from potential non-calving caribou. Consequently, the calving areas may be partially defined by non-calving caribou data.

Recommendation 1: Follow the methods described in Gunn et al. (2007) that investigate individual caribou movement rates, and reduced movement when calving to determine which caribou were likely calving before including them in the caribou core calving area dataset.

Issue 2: The point data are pooled across all years to define areas. The pooling of data among years will not reflect annual variation. In some cases, data from 1993 through 2014 are combined, when there have been known shifts in calving areas (see Issue 6). The pooled data inflates the extent of a herd's annual calving area and does not incorporate the variation in caribou behaviour; consequently, the polygons are unlikely to represent "core" areas with suitable precision.

Recommendation 2: Consider using annual data to determine extent of habitat use, and layer annual ranges to determine "core" habitats.

Issue 3: Individual point data are buffered with various distances ranging from 11 to 20 km, using either predicted avoidance behaviour or line-of-sight as justification. Applying a simple distance buffer to each point does not seem relevant to the analysis for identifying seasonal habitat.

Recommendation 3: Provide a biological rationale for the buffers used or, as with methods used in Gunn et al. (2007), do not buffer the data.

Issue 4: Reference is made to following the methods of Nagy et al. (2011), but there seems to be substantial variation in how those methods were interpreted and applied in this analysis. In fact, the methods seem to be entirely different.

Recommendation 4: Provide a complete description of methods that includes a biological rationale for the analytical methods and references to literature where appropriate.

Issue 5: The method creates polygons around point data, but there is no relationship drawn to the "habitat" identified, nor correlation to important habitat features requiring protection. What habitat attributes are associated with core calving areas? Are these attributes at risk of disturbance?

Recommendation 5: To better quantify the importance of caribou calving habitat, consider a habitat identification process that incorporates habitat attributes of caribou locations (e.g., a Resource Selection Function; Boyce and McDonald 1999, Manly et al. 2002), or Resource Selection Probability Function (e.g., Lele 2009), and not simply collar locations. Consider using the habitat information described in the Kivalliq Ecological Land Classification Map Atlas: A Wildlife Perspective (Campbell et al. 2012).

Issue 6: There is no clear approach to accounting for abrupt spatial changes over time. The identified areas may not encompass changing calving area habitat use. How can abrupt changes in calving behavior be accommodated within the land use plan?

The GN's 2015 DNLUP submission (Government of Nunavut 2015) suggests that a review be based on 15–25 years of collar data. It is unclear how often the GN will evaluate what it determines to be caribou core calving areas and key access corridors. It is likely that caribou will shift core areas of calving and movement within that time frame, often abruptly and for long time periods (e.g., as recently summarized for the migratory Rivière-George and Rivière-aux-Feuilles caribou herds in northern Quebec, Taillon et al. 2012).

Regularly updating boundaries, or re-considering existing protection measures is warranted. For instance, existing critical wildlife areas identified >30 years ago remain identified in the Nunavut Wildlife Act Regulations that came into force in July 2015. It is assumed that those areas were intended to provide some type of protection when they were established, but they no longer serve a conservation purpose.

Recommendation 6: Consider regular reviews of seasonal ranges on an annual (as was done during implementation of the original Caribou Protection Measures beginning in 1978), or at least on a 5-year basis to either match the GN's statutory reporting on the wildlife act (*Nunavut Wildlife Act*), or the presumed frequency of review of the final land use plan.

Issue 7: Numerous and unexplained isolated core calving area polygons are included in the DNLUP. For eight herds, there are ~30 identified "core calving area" polygons in the NPC database (Figure 2,

particularly in the north-east portion of the area). What is the frequency or current use of those areas?

Recommendation 7: a) Consider re-analysis of data and examining individual movement rates to determine if caribou were likely calving; b) identify the sample size and years upon which each area is based and determine if supported by other evidence (e.g., Inuit Qaujimajatuqangit, other survey data, field observations); c) Consider other attributes about caribou ecology and presence to better describe what would qualify as a "core calving area", or provide distinct criteria to identify areas. For instance, Taillon et al. (2012) state that "*Legally-defined calving grounds in Québec include areas used by at least 5 females/km²*"

Issue 8: There is no documentation of internal or external peer review of methods and results.

Recommendation 8: Fully develop and describe the methods, provide a biological rationale, and have the information peer reviewed as a matter of good scientific and management practice.

Figure 2. A clip from the GN's Core Caribou Calving Areas and Key Access Corridors figure (Caslys Consulting Ltd. and Government of Nunavut 2015) showing numerous isolated calving areas (blue arrows) that are not clearly associated with a herd, and based on unknown data analysis methods.

5.0 COMMUNICATING AND ASSESSING DISTURBANCE EFFECTS

5.1 OVERESTIMATION OF DISTURBANCE EFFECTS

Based on information that the GN presented at the November 2015 NWMB workshop, and again in January 2016 at the 3rd DNLUP technical meeting, it appears the level of disturbance and effects of exploration activities have been overestimated. In both presentations, the GN provided a model (Government of Nunavut Department of Environment 2015) of a 50 day exploration program, and its' potential effect on caribou foraging (i.e., energy intake). The model calculates that a 50 day drilling operation would result in 4,500 minutes of reduced foraging time to caribou. Given a 15 minute disturbance for each helicopter overflight, the associated assumptions would need to be: 1) that caribou do not move in 50 days; 2) that the operation stays in the same place for 50 days; and/or 3) that the entire area is exposed to the same amount of disturbance. This model is a misrepresentation of both exploration program disturbances (which, for example, work with minimum altitude restrictions when working near caribou), and a misrepresentation of migratory caribou ecology (which are not sedentary for 50 days).

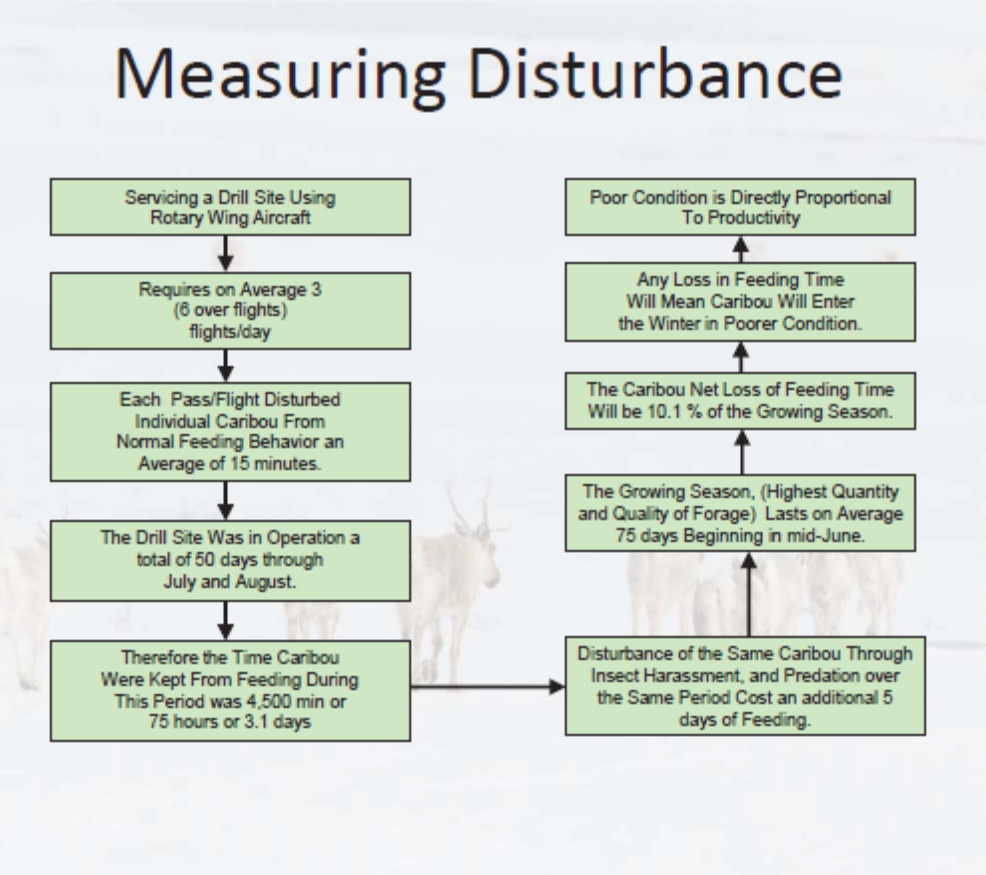


Figure 3. An excerpt from a GN presentation (Government of Nunavut Department of Environment 2015) at a NWMB workshop and the 3rd DNLUP technical meeting. The model is neither a realistic representation of a drill program, nor a representation of tundra migratory caribou ecology.

5.2 DISTURBANCE EFFECTS FORMALLY ADDRESSED IN ENVIRONMENTAL ASSESSMENT

Mining proponents have conducted a number of disturbance effects assessments for projects proposed in tundra migratory caribou range. Models to characterize those effects were developed based on caribou ecology, known and predicted disturbance effects, published literature and evidence from ongoing project effects monitoring. These assessments use realistic potential disturbance scenarios and were subject to technical and regulatory scrutiny during the environmental assessment review process. Some of those assessments included modelling the potential for disturbance effects on calving grounds (e.g., the Kiggavik cumulative effects caribou energetics model, even though the project itself is not located within calving areas). Generally, the findings to date have shown that industry has an effect that is cumulative to existing disturbances, but those effects are generally site-specific and manageable. Regardless, through ongoing mitigation and monitoring plans, the approved projects have focused protection measures on reducing disturbances to caribou when present. A summary of the key points of each of those effects assessments are summarized in Attachment 1.

6.0 EXISTING CARIBOU PROTECTION MEASURES ARE EFFECTIVE

Caribou protection measures have been in place since 1978 (e.g., described in Mychisaw 1984 and Gunn et al. 2007) and disturbance to caribou, particularly on the calving and post-calving grounds, has been addressed by those measures to date. The Kivalliq Inuit Association recently updated those protection measures in an effort to make them relevant to modern land use permitting, data availability and modern industry practices (Poole and Gunn 2015).

There are a number of other mitigation and management tools employed by various agencies that should be considered when determining the priority of excluding industrial activity versus other forms of wildlife and land use management, including:

- The Nunavut Wildlife Act provisions and Regulations relating to harassment of caribou;
- Land use permits issued by land managers (e.g., AANDC, KivIA, KitIA, QIA);
- Recommended flight altitudes, usually presented as a component of land use permits or in Nunavut Impact Review Board (NIRB) Project terms and conditions for when and where caribou are present; and
- Mobile, seasonal caribou protection measures (based on the intent of the Caribou Protection Measures), which are applied by Inuit land managers on all Inuit-Owned Lands, and which have typically been applied to all land uses within caribou ranges in Nunavut.
- Existing parks and conservation areas;
- Caribou herd management plans (although none are known to exist in Nunavut);
- Project specific screening, review, environmental assessment and wildlife protection and habitat reclamation plans developed by exploration and mining project proponents through the NIRB review process;
- The land and resource management systems in Nunavut established under the land claims. This includes the Nunavut Land Use planning process and general protection measures that have been included in existing land use plans.

7.0 CLOSING NOTES

After a review of nearly 50 years of published research on tundra migratory caribou and general understanding of traditional knowledge and Inuit Qaujimajatuqangit, it is unclear exactly how much or if habitat protection will contribute to recovery or sustainability of caribou. It is clearly an overstatement to suggest that habitat protection (to the point of not disturbing *any* habitat) is "critical" — it is not. Caribou habitat use is dynamic. The level of habitat loss that will trigger an *effect* is unknown and there is no evidence to date suggesting that there has been one, or will be one in the near future for the mainland Nunavut caribou herds.

Since at least 1978, when caribou protection measures were first implemented to protect Qamanirjuaq and Beverly caribou, the measures have been used throughout the territory on various projects, including exploration and development. Those measures have continued to focus on reducing disturbance to caribou, and that protection will continue into the future regardless of the results of this land use planning process. The exploration and mining industry should continue to implement and develop those protection measures and incorporate new tools and develop enhanced measures with new data and analytical methods. That, in combination with other management tools (e.g., managing or reducing caribou mortality), and continuing research and response to knowledge about habitat effects, will be key to caribou population sustainability. In addition to the current protection of the caribou themselves, habitat protection may one day become an important management focus.

The GN's habitat protection recommendations could be based on a more sound information base. Habitat protection needs to be considered in the context of an overall approach to caribou conservation. Regardless of the issues with specific methods used to date (i.e., data, consideration of alternatives), sound management decisions have to be made on clear evidence, justification of what will work, and a commitment to follow-up management effectiveness monitoring. Without a strategy and having those tools in place, it is premature to jump to habitat protection.

7.1 SUGGESTIONS SPECIFIC TO THE NPC DNLUP REVIEW

If "Caribou Core Calving Areas and Key Access Corridors" are to remain in Schedule A as protected areas where industry activity and other disturbing activities will be excluded, recommendations are as follows:

1. The boundaries of the core calving areas and key access corridors be reconsidered.
    - Consider alternative methods of defining caribou core calving areas and other seasonal ranges.
    - Consider refining the data used to define the areas, and justify the ~ 30 individual polygons identified as "core areas" for eight herds.
    - Have the information and analyses reviewed by peers — make the data available to interested parties.
2. The boundaries of the seasonal ranges be made available to land users.

3. To ensure that the management recommendation remains relevant, a regular timeline to review and update the boundaries has to be in place, either through the Land Use Plan process or though statutory reporting from the GN on the *Nunavut Wildlife Act*.

4. The GN Recommendation: "Caribou Core Calving Areas and Key Access Corridors" and other recommendations for seasonal ranges and land use restrictions should be supported by a detailed and peer-reviewed biological rationale.

8.0 LITERATURE CITED

Adamczewski, J., J. Boulanger, B. Croft, D. Cluff, B. Elkin, J. Nishi, A. Kelly, A. D'Hont, and C. Nicolson (2009). Decline in The Bathurst Caribou Herd 2006–2009: A Technical Evaluation Of Field Data And Modeling. [Online.] Available at http://www.enr.gov.nt.ca/sites/default/files/reports/technical_report_on_decline_of_bathurst_caribou_herd.pdf.

Arthur, S. M., and P. A. Del Vecchio (2009). Effects of oil field development in calf production and survival in the central arctic herd. Final Research Technical Report. Grants W-27-5 and W-33-1 through W-33-4. Project 3.46. Alaska Department of Fish and Game, Division of Wildlife Conservation. Juneau, Alaska USA. 36 pp. [Online.] Available at https://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/research_pdfs/ca-oil_finaltr.pdf

Bergerud, A. T., R. D. Jakimchuk, and D. R. Carruthers (1984). The buffalo of the north: caribou (*Rangifer tarandus*) and human developments. Arctic:7–22.

Bergerud, A. T., S. N. Luttich, and L. Camps (2008). The return of caribou to Ungava. McGill-Queen's University Press, Montreal.

Boulanger, J., A. Gunn, J. Adamczewski, and B. Croft (2011). A data-driven demographic model to explore the decline of the Bathurst caribou herd. The Journal of Wildlife Management 75:883–896. doi: 10.1002/jwmg.108

Boyce, M. S., and L. L. McDonald (no date). Relating populations to habitats using resource selection functions. Trends in Ecology & Evolution 14:268–272. doi: 10.1016/S0169-5347(99)01593-1

British Columbia Ministry of Environment (2009). Peace Region Least-risk timing windows: biological rationale. Peace Region Technical Report, October 2009. 45 pp.

Campbell, M. W., J. G. Shaw, and C. A. Blyth (2012). Kivalliq ecological land classification map atlas: A wildlife perspective. Government of Nunavut, Department of Environment Technical Report Series #1-2012.

Caslys Consulting Ltd. (2015). Barren-Ground Caribou Analysis Methods Summary Report Draft. Prepared for Government of Nunavut Department of Environment, Wildlife Research Branch. July 2015. 12 pp.

Caslys Consulting Ltd., and Government of Nunavut (2015). GN Recommendation: Caribou Core Calving Areas and Key Access Corridors. Map submitted to the Nunavut Planning Commission, dated June 19, 2015 [Online.] Available at http://www.nunavut.ca/files/2015-06-19_GN%20Recommendation_CoreCalvingKeyAccess.pdf.

Environment Canada (2011). Scientific assessment to inform the identification of critical habitat for woodland caribou (*Rangifer tarandus caribou*), boreal population, in Canada. 2011 update. 102 pp. + appendices. Canadian Wildlife Service, Ottawa. [online] http://epe.lac-bac.gc.ca/100/200/301/environment_can/2011/scientific_assessment_inform-ef/CW66-296-2011-eng.pdf

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

Goddard, A. D. (2009). Boreal caribou in northeastern British Columbia: Biological Rationale, Data Summary & Literature Review. Prepared for British Columbia Ministry of Environment. May 2009. 21 pp. [Online.]

Available at http://www.env.gov.bc.ca/wld/speciesconservation/bc/documents/boreal_caribou_biol_rationale_may8_2009.pdf.

Government of Nunavut (2015). Government of Nunavut's 2014 Draft Nunavut Land Use Plan Review Report. Submitted to the Nunavut Planning Commission on June 19, 2015. 90 pp. [Online.] Available at http://www.nunavut.ca/files/2015-06-19_GN_DNLUP_Submission.pdf.

Government of Nunavut Department of Environment (Undated). Working together for caribou: Nunavut caribou strategy framework. Submitted to the Nunavut Planning Commission May 28, 2014. [Online.] Available at http://www.nunavut.ca/files/04%20GN%20Caribou%20Strategy.pdf.

Government of Nunavut Department of Environment (2010). Working together for caribou: Draft Nunavut caribou strategy framework. March 2010.

Government of Nunavut Department of Environment (2015). Resource Development and Caribou in Nunavut: Finding a Balance. Presentation made at a November 2015 Nunavut Wildlife Management Board Workshop: Protecting Caribou and their Habitat, Iqaluit, Nunavut [Online.] Available at http://www.nwmb.com/en/public-hearings-a-meetings/workshops/november-2015-protecting-caribou-and-their-habitat-workshop#document-resource-development-and-caribou-in-nunavut-finding-a-balance-eng.

Gunn, A., K. G. Poole, J. Wierzchowski, and M. Campbell (2007). Assessment of caribou protection measures. Prepared for Indian and Northern Affairs Canada, Gatineau, Quebec. March 2007. 45 pp. [Online.] Available at http://www.arctic-caribou.com/PDF/CPM_assessment_report_final_Mar07.pdf.

Johnson, C. J., and D. E. Russell (2014). Long-term distribution responses of a migratory caribou herd to human disturbance. Biological Conservation 177:52–63. doi: 10.1016/j.biocon.2014.06.007

Lele, S. R. (2009). A New Method for Estimation of Resource Selection Probability Function. Journal of Wildlife Management 73:122–127. doi: 10.2193/2007-535

Manly, B. F. J., L. L. McDonald, D. L. Thomas, T. L. McDonald, and W. Erickson (2002). Resource Selection by Animals: Statistical Design and Analysis for Field Studies. The Journal of Animal Ecology 63:745. doi: 10.2307/5247

Miller, F. L., A. Gunn, A. T. Bergerud, and R. D. Jakimchuk (1985). Letters to the Editor. Arctic 38:154–156.

Mychisaw, L. (1984). Five- year review of the Beverly and Kaminuriak Caribou protection measures. File Report No. 42, Government of Northwest Territories, NWT Wildlife Service. 133 pp.

Nellemann, C., and R. D. Cameron (1998). Cumulative impacts of an evolving oil-field complex on the distribution of calving caribou. Canadian journal of Zoology 76:1425–1430.

Nunavut Planning Commission (2014). Schedule A Nunavut Land Use Plan Land Use Designations. [Online.] Available at http://www.nunavut.ca/files/2014DNLUP/2014_DNLUP_Schedule_A_Designations.pdf.

Nunavut Planning Commission (2015a). Draft Nunavut Land Use Plan, Nunavut Planning Commission 1st Technical Meeting Transcript. [Online.] Available at http://www.nunavut.ca/files/DNLUP%20June%202015%20Technical%20Meeting-Transcript.pdf.

Nunavut Planning Commission (2015b). Draft Nunavut Land Use Plan, Nunavut Planning Commission 2nd Technical Meeting Transcript. [Online.] Available at http://www.nunavut.ca/files/DNLUP%202nd%20Technical%20Meeting%20Transcript%20July%202015.pdf.

Poole, K. G., and A. Gunn (2015). Mobile Caribou Conservation Measures for the Kivalliq Region, Nunavut. Draft Report for the Kivalliq Inuit Association. November 12, 2015.

Reimers, E., and J. E. Colman (2009). Reindeer and caribou (*Rangifer tarandus*) response towards human activities. Rangifer 26:55–71.

Taillon, J., M. Festa-Bianchet, and S. D. Côté (2012). Shifting targets in the tundra: Protection of migratory caribou calving grounds must account for spatial changes over time. Biological Conservation 147:163–173. doi: 10.1016/j.biocon.2011.12.027

Weihs, F. H., and P. J. Usher (2001). Towards the development of a policy on the management of human activities in caribou calving and post-calving grounds. Prepared for Department of Indian Affairs and Northern Development. 14 June, 2001. 32 pp.

Whitten, K. R., R. D. Cameron, D. R. Klein, R. G. White, A. T. Bergerud, R. D. Jakimchuk, and D. R. Carruthers (1984). Letters to the Editor. Arctic 37:293–295.

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

Yukon Government, Department of Environment (2009). Rationale for implementing conservation measures to protect the Porcupine Caribou Herd. September 4, 2009. 42 pp. [Online.] Available at http://www.env.gov.yk.ca/publications-maps/documents/pch_scientific_rationale_conservation.pdf.

8.1 ENVIRONMENTAL EFFECTS ASSESSMENTS CITED

De Beers Canada Inc. 2010a. Gahcho Kué Project Environmental Impact Statement, Section 13: Cumulative Effects. Prepared by Golder Associates Ltd., Submitted to Mackenzie Valley Environmental Impact Review Board.

Dominion Diamond (2014). Barren-ground caribou, Section 12: Developer's Assessment Report, Jay Project. Submitted to the Mackenzie Valley Environmental Impact Review Board. October 2014. 159 pp.

EDI Environmental Dynamics Inc. 2014. Final Environmental Impact Statement (FEIS) — Kiggavik Project, Nunavut: Tier 2 Volume 6: Terrestrial Environment, Section 13: Effects Assessment for Caribou and Muskox. Prepared for AREVA Canada, Submitted to the Nunavut Impact Review Board.

Golder Associates Ltd. 2011. Effects of Development on Barren-ground Caribou: Insight from IQ and an Ecological Model. Submitted to Kugluktuk Hunters and Trappers Organization. August 19, 2011. 84 pp.

Golder Associates Ltd. 2014. Final Environmental Impact Statement (FEIS) — Meliadine Gold Project, Nunavut: Volume 6.0 Terrestrial Environment and Impact Assessment. Prepared for Agnico Eagle Mines, Submitted to Nunavut Impact Review Board.

Sabina. 2015. The Back River Project Final Environmental Impact Statement: Volume 5 Terrestrial Environment. Prepared by Environmental Resource Management (ERM), Submitted to Nunavut Impact Review Board.

ATTACHMENT 1. SUMMARY OF CUMULATIVE EFFECTS ASSESSMENTS PREPARED FOR NUNAVUT MAINLAND CARIBOU HERDS

This attachment summarizes some example cumulative effects assessments completed for several of the mainland herds that were included in environmental assessment materials reviewed for the following projects:

- Meadowbank Project (a project near Baker Lake that addressed cumulative effects on the Ahiak, Beverly, Qamanirjuaq and Wager Bay herds);
- Gahcho Kué Project (a project near Kennady Lake, ~300 km NE of Yellowknife, addressing the cumulative effects on the Bathurst and Ahiak herds);
- A report prepared for the Kugluktuk Hunter and Trappers Association comparing IQ to an ecological model, considering cumulative effects on the Bathurst and Ahiak herds (associated with the Gahcho Kué Project);
- Meliadine Project (a project near Rankin Inlet that addressed cumulative effects within the Qamanirjuaq caribou herd's post-calving range);
- Kiggavik Project (a project near Baker Lake that considered cumulative mortality risk to Qamanirjuq, Beverly and other herds, and Qamanirjuaq caribou seasonal exposure to multiple disturbances within their traditional range);
- Jay Project (an expansion of the existing Ekati Diamond Mine, ~300 km NE of Yellowknife, considered cumulative effects on the Bathurst caribou herd); and
- Back River Project (on Coronation Gulf, east of Kugluktuk, that considered cumulative effects on the Bathurst caribou herd's combined post-calving and summer range, and the Beverly caribou herd's separate summer and winter ranges and the annual ranges for both herds).

Meadowbank Project Caribou Cumulative Effects (Cumberland Resources Ltd. 2005)

The Meadowbank Gold Project is located in the Kivalliq region approximately 70 km north of the Hamlet of Baker Lake. Exploration began in 1995, and the mine has been producing gold since 2010, with mine life expected through 2017.

Individual caribou from several herds were known to occur in the Meadowbank area, including Ahiak, Beverly, Qamanirjuaq and Wager Bay. The project's Final Environmental Impact Statement (FEIS) included a cumulative effects assessment, including an assessment of caribou. The assessment considered mineral exploration, mines and mining projects, and the hamlet of Baker Lake as disturbances in the study area that included the outer geographical extent of the annual range of the caribou populations from which individual

animals that potentially use the Meadowbank project area could originate (i.e., a large portion of mainland Nunavut). The assessment considered cumulative effects on caribou habitat, movement and energetics, and mortality risk. The quantitative conclusion for habitat was that the cumulative total habitat loss due to project footprints was a very small fraction of the total area occupied by the herds. The qualitative conclusion about cumulative effects on movement and energetics included a discussion about the fact that the Meadowbank mine is known to not be in a major migration corridor and included a review of modelling from the Diavik project that is known to be in a movement corridor for another herd of barren-ground caribou. The qualitative assessment of mortality risk included the statement "…*it is anticipated that effects of increased access as a result of the all-weather road will change the spatial distribution of hunter kills, rather than substantially increase the total number of kills (i.e., more kills may occur closer to the road, but overall numbers of animals killed will remain similar to present numbers)*," and that the effect would persist through the life of that project.

Gahcho Kué Project Caribou Cumulative Effects Assessment (De Beers Canada Inc. 2010a)

The Gahcho Kué Project is a proposed open pit diamond mine project located at Kennady Lake, approximately 300 kilometres northeast of Yellowknife and 90 kilometres east of De Beers' Snap Lake diamond mine. The environmental review was completed in 2012, construction started in autumn 2014, and production is expected to begin in 2017.

The project may interact with caribou from the Bathurst and Ahiak herds. Cumulative effects assessed included 1) direct habitat loss and fragmentation from development footprints (including winter roads); 2) indirect changes to habitat quality from sensory disturbance; 3) assessed using population models, and 4) an energetic model.

1. The cumulative direct disturbance to the landscape from the previous, existing, and future developments was predicted to be less than or equal to 1.7% of the Bathurst and Ahiak caribou herds seasonal ranges relative to reference conditions. The cumulative impact on habitat fragmentation from a winter access road was predicted be <1.7% in either the Bathurst or Ahiak ranges.

2. Indirect changes to habitat quality from sensory disturbance (i.e., Zone of Influence [ZOI]) are expected to result in a low magnitude cumulative decline in preferred habitat across seasonal ranges of the Bathurst and Ahiak caribou herds (ranged from 1.1% to 7.3% — further analyses showed loss of preferred habitat had no statistical effect on population abundance and persistence of caribou).

3. Population models predicted that the incremental impacts from the Project and the Taltson Hydroelectric Expansion Project had little influence on the abundance and distribution of the caribou herd relative to reference conditions. Specifically, the relative decrease in modelled final abundance was 1.5%.

4. Energetic and population model results indicated that insect harassment and harvest levels had stronger effects on caribou populations relative to the cumulative changes resulting from development disturbances. For a summer with average insect harassment levels, the model

determined that almost 500 disturbance events would be required before a female lost sufficient weight to result in failed reproduction the following year. Further, a spatial examination of existing satellite collar data from 1996 to 2009 showed that caribou encountered relatively few ZOIs during summer and fall movements. Based on past, present and future cumulative development predictions, a typical Ahiak or Bathurst caribou may encounter approximately 19 disturbance events during summer to fall movements.

5. Based on evidence, analyses and modelling, they concluded that cumulative disturbances should be reversible and not significantly affect the future abundance and distribution of caribou populations. Subsequently, cumulative impacts from development were predicted to have a not significant adverse effect on continued opportunities for use of caribou by people.

Effects of Development on Barren-ground Caribou: Insight from IQ and an Ecological Model (Golder Associates Ltd. 2011)

This report summarized an approach to quantifying Bathurst caribou encounter and residency rates identical to those used by the same authors for the Gahcho Kué Project with similar results. The difference in that report is that comparisons were made between those results to information provided through IQ interviews and meetings. The summary integrated conclusions about cumulative disturbances to caribou derived from an ecological model and IQ. There was general agreement that mineral development effects may not be having as much of an effect on caribou behaviour as climate change and insect harassment. There was some disagreement among interviewees about the magnitude of effect that human disturbance is having on caribou. Both the IQ and the modeling approach highlighted the difficulties of predicting effects on caribou.

Meliadine Project Caribou Cumulative Effects Assessment (Golder Associates Ltd. 2014)

The Meliadine project summarized cumulative effects within the Qamanirjuaq caribou herd's post-calving range — the Caribou Effects Study Area (CESA; Golder Associates Ltd. 2014, Sec. 6.1.1.3, pg. 6-5). The cumulative effects assessment focused on three primary pathways: 1) changes to habitat quantity and fragmentation; 2) changes to habitat quality, movement and behaviour; and 3) changes to survival and reproduction. The cumulative effects assessment of the Meliadine project included consideration of the Kiggavik Project (described below) in the calculation of cumulative effects of projects in the post-calving range of the Qamanirjuaq caribou.

1. To assess changes to habitat, the total area removed for projects (i.e., known and estimated project footprints) in the CESA was compared to baseline conditions using available ecological land classification classes. The cumulative effects assessment of that project concluded that the direct incremental and cumulative changes in land area developed in the CESA as a result of known and expected future developments were expected to be less than 0.5%. The cumulative effect to lichen tundra was a loss of 0.36% within the CESA (Golder Associates Ltd. 2014, Sec. 6.6.4.1.2).

2. To assess changes to habitat quality and behaviour, hypothetical ZOIs were applied to projects in the CESA. Disturbance coefficients were associated with the various ZOIs and were used as

multipliers of habitat quality reduction. For that analysis, the reduction in habitat quality was represented by a reduction in habitat quantity (Golder Associates Ltd. 2014, Sec. 6.6.4.2.1). Direct incremental and cumulative changes in area in the CESA as a result of known and expected future developments and their ZOI were expected to be less than 3.0% of the CESA (Golder Associates Ltd. 2014, Sec. 6.6.4.2.2).

3. The effects on survival and reproduction were assessed qualitatively through a literature review, existing IQ and interviews to determine potential for increased access for harvesting. The presumption is that increased harvester access may have a negative effect on the overall survival and reproduction of the Qamanirjuaq caribou herd. Specific results were not stated, but it was acknowledged that harvester access was likely due to public use of the all-weather road used to access the Meliadine mine site.

Kiggavik Project Caribou Cumulative Effects Assessment (EDI Environmental Dynamics Inc., 2014)

The caribou cumulative effects assessment for the Kiggavik Project considered potential caribou exposure to cumulative project footprints (e.g., loss of habitat), to sensory disturbances (e.g., to development ZOIs), and potential increased mortality risk. Based on those results, the assessment considered the cumulative effects on caribou energy-protein and population projections of the Qamanirjuaq caribou herd.

1. The cumulative effect on caribou mortality was negligible presuming traffic controls to reduce potential road mortality risk, and presuming that harvest management measures for the herd would be in place to reduce excessive harvest pressure beyond sustainable limits.

2. The cumulative habitat loss assessment considered potential future projects of the Qamanirjuaq caribou traditional range. The results showed a loss of, at most 0.43% of habitat within the range.

3. To predict potential Project and cumulative effects on caribou energetics and the long-term Qamanirjuaq caribou population, a population-level energy-protein (E-P) model that analyzed the expected range of fall body weights of cows and calves incorporated the variability observed in the individual caribou encounters with infrastructure ZOIs within the Qamanirjuaq caribou range. The hypothetical ZOIs were based primarily on what had been used in a number of caribou effects assessments for northern projects and from those published in the literature. The ZOIs include a 14 km radius around mine sites, 15 kms around municipalities, 5 kms around exploration sites, and other sizes proportional to the hypothetical disturbances. The ZOIs erred on the side of precaution in overestimating the likely areas of disturbance. The post-calving portion of the range experiences the greatest disturbance (6.0%), followed by spring migration and calving (2.7% each). By far, the greatest contributor by area covered by a ZOI was the municipalities in the post-calving range (accounting for 5.8% of the total 6% coverage).

   Using results of energetic effects from encounters with ZOIs on the seasonal ranges (including encounters with exploration projects in the calving and post-calving ranges), the Qamanirjuaq population was modeled over 26 years (2014–2040) and used the population size as the indicator of

population effects. The assessment concluded that the population level effects resulting from the Kiggavik project were not different from populations in the absence of the Kiggavik project. Any residual effects would be substantially masked by natural variability.

Jay Project Caribou Cumulative Effects Assessment (Dominion Diamond 2014)

The Jay Project is an expansion of the existing Ekati Diamond Mine, ~300 km NE of Yellowknife. The effects assessment considered cumulative effects on the Bathurst caribou herd, incorporating natural disturbance features with the cumulative effects of the Jay Project mine activity.

Direct habitat loss from the Project and previous, existing and approved developments (Application Case) varied among seasonal ranges, but the Project accounted for less than a 0.1% reduction in area for any habitat and season. When reasonably foreseeable developments were added to the landscape, all habitats in all seasons showed less than a 0.5% reduction in area from the Application Case to Reasonably Foreseeable Development (RFD) Case. The cumulative direct disturbance from the Project and all previous, existing, and reasonably foreseeable future developments was predicted to be less than 0.6% of the total area in each seasonal range.

The Project and previous, existing and approved developments were determined to reduce the amount of preferred habitat (including physical footprints and zones of influence that decrease habitat quality) by 0.9% on the spring range (including the calving grounds), 5.5% on the post-calving range, 6.1% on the autumn range, and 5.4% on the winter range. The proximity of the Project to existing Ekati Mine operations resulted in declines of preferred habitat from 0.0% to 0.2% among seasonal ranges. This means that greater than 94% of preferred habitats in the Bathurst annual range remain intact after the Project is developed and will be available for caribou, and likely have little limiting effect on the herd during the increasing phase of the population cycle.

The assessment suggested that density-dependent resource selection in a declining population should allow more selective use of habitat and use of smaller seasonal ranges, which suggests habitat should be less limiting at the low phase of the population cycle. With the addition of uncertain, future developments (i.e., reasonably foreseeable) there was an increase in the loss of high quality habitat, particularly on the post-calving and autumn ranges. For the RFD Case, preferred habitat decreased by 1.7% in the spring range, 13.3% in the post-calving range, 12.0% in the autumn range, and 5.9% in the winter range.

Results indicated that encounters with development and insect harassment can have negative effects on adult female body condition in the autumn and reduce parturition rates the following spring. However, the key variable in the model was insect harassment. Even with the maximum previous, existing and future developments on the landscape (RFD Case), female caribou would have to increase their encounter rate with zones of influence by approximately 14 to19 times to result in no calf production the following spring. The residual effects from the Project were expected to contribute little to the cumulative effects on barren-ground caribou energy loss, calf production and survival. The incremental decrease in fecundity from the Project was predicted to be 0.3 percent for low insect levels.

The population model parameters were selected to examine the maximum potential effects of all human-related development on the Bathurst herd. Despite the application of maximum effects, the conclusion of the population modelling was that additional energetic costs from changes in movement and behaviour associated with the Project and other developments were not expected to decrease population resilience and increase the risk to the viability of the Bathurst herd at any phase of the population cycle. The negative trend in Bathurst herd population growth associated with the current estimates of vital rates for reference conditions were predicted to be similar with and without the development-related cumulative changes in habitat quantity and quality, and caribou behaviour and energetics. The population modelling demonstrated that the Bathurst herd's ability to increase is dependent on caribou vital rates and is not prevented by cumulative effects of development disturbance.

Additional analyses provided in the Adequacy Review and Information Request responses indicates that previous and existing developments had little measurable effects on caribou survival and reproduction, and no significant contribution to the population decline. As a result, the Jay Project would have no significant incremental and cumulative effects on the Bathurst herd.

Back River Project Caribou Cumulative Effects Assessment (Sabina 2015)

The Back River Project is a gold exploration project in the Kitikmeot region of western Nunavut along the western shore of southern Bathurst Inlet. The Back River project's FEIS summarized cumulative effects with the Bathurst caribou herd's combined post-calving and summer range, and the Beverly caribou herd's separate summer and winter ranges and the annual ranges for both herds. The Back River Project's cumulative effects assessment evaluated 1) habitat loss, 2) disturbance, and 3) reduction in productivity. The Back River Project's Project Disturbance Areas (PDAs) do not overlap the current seasonal ranges of the Bathurst caribou herd. However, the herd was included in the cumulative effects assessment due to concern for this herd given its current population decline status.

1. Habitat loss was assessed by combining the estimated total habitat area removed by all project footprints, including all-weather roads, and the likely area adjacent to the footprints which may be degraded by dust or other direct disturbances. For the Beverly herd winter range, this included a habitat loss due to winter roads. Habitat loss was also assessed as the combined loss of high quality habitat as a result of all projects within the herds' boundaries. High quality habitat for the Bathurst caribou herd was based on a Resource Selection Function (RSF) conducted on the post-calving and summer range for the Bathurst caribou. High quality habitat for the Beverly herd, where an RSF was not available, was estimated proportional to that available in the Project's RSA. The total habitat loss (including a 100 m radius degraded due to dust) in the post-calving and summer range of the Bathurst herd was 0.28% and equivalent to 0.1% of the annual range for Bathurst herd; and 0.06% of the Beverly's summer range, and 0.06% of the Beverly herd's winter range and equivalent to 0.05% of the annual range for Beverly herd caribou (Sabina 2015, Section 5.6.2.1).

2. Disturbance was assessed by using a zone of influence approach to evaluate different disturbance buffer scenarios. A 1.5 km disturbance buffer was used around all-season roads, and a 200 m buffer

was assigned around winter roads except for the Back River Project where noise modelling calculated noise to be contained within the winter road PDAs. For mines, two scenarios were evaluated, including a 4 and 14 km disturbance buffer around active mines to encompass the variability in caribou responses reported in literature (Sabina 2015, Section 5.6.2.2). The total area disturbed within the seasonal ranges and annual range of each herd was calculated as well as the area of high quality forage habitat measured by an RSF for the Bathurst herd on the post-calving and summer range. For the Bathurst herd, the total disturbance of all past, present and reasonably foreseeable projects, depending on the ZOI scenario, ranged from 2.9 to 9.8% of the post-calving and summer range and was equivalent to 0.8 to 2.9% of the high quality post-calving forage and 0.9 to 3.0% of the high quality summer forage. The total disturbance on the annual range was 1.1 to 4.0% (Sabina 2015, Table 5.6-5). For the Beverly herd, cumulative disturbance ranged from 0.5 to 2.2% on the summer range, and 0.7 to 2.7% on the winter range, and was equivalent to 0.5 to 1.9% of the annual range depending on disturbance scenario (Sabina 2015, Table 5.6-7).

3. Effects on productivity in caribou were assessed qualitatively based on the magnitude of all other effects (disturbances) they experience on their range (Sabina 2015, Section 5.6.2.3). The cumulative effects assessment discussed the potential interaction between industrial developments on the seasonal and annual ranges of the Bathurst and Beverly herd caribou and factors that can affect reproductive productivity on these ranges. Disturbance leading to displacement of females with young to lower quality habitats adjacent to the development, separation of females and young as a result of disturbance, or mortality of females or young, would likely lead to the greatest effects on caribou populations in the region.

   The post-calving, summer and winter range of the Beverly caribou is considerably larger than that of the Bathurst caribou, and there is comparatively little development planned in the Beverly herd's range. As a consequence, it was concluded that there was little chance for an adverse effect on the energetic balance of Beverly herd females and calves on their post-calving and summer range. The winter range of the Beverly caribou also has little industrial development and is away from most communities where harvesting may be conducted. Hence, no cumulative effect on reproductive productivity was predicted for the winter season as well. Thus, the cumulative effects of all projects on the productivity of the Beverly herd were anticipated to be minimal.