Management of caribou post-calving areas in the Kivalliq Region, Nunavut

Report for the Kivalliq Inuit Association

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Summary

Migratory barren-ground caribou (*Rangifer tarandus groenlandicus*) are generally considered to be at highest risk and most sensitive to disturbance during the calving and post-calving periods. The post-calving period occurs over approximately 3 weeks from mid-June to early July when calves are small and fully dependent on the cows. Post-calving movements over the years occur within larger, generally predictable areas, but the annual post-calving area is a smaller portion of that broader area. Presented here is the Kivalliq Inuit Association's approach to managing caribou and industrial development – including roads and other linear infrastructure – within post-calving areas of migratory barren-ground caribou that provides a balance between protection of caribou and opportunities for economic development.

This approach includes Special Management Area designation to post-calving areas, within which seasonal Mobile Caribou Conservation Measures (also known as mobile protection measures or mobile measures) are applied that establish monitoring protocols leading to mitigation thresholds or triggers to protect and minimize effects on caribou when exposed to human disturbance. The approach links monitoring with site-specific mitigation, and is based on numbers and proximity of caribou to development and monitoring thresholds for when mitigations will be stepped up or down. The approach uses concentric monitoring zones to give early warning to mitigation to avoid and minimize the potential for interaction between caribou and development. The approach is designed to minimize disturbance to caribou while acknowledging a trade-off between flexibility for economic development and caribou protection.

Managing caribou and disturbance during the relatively short and predictable post-calving period should include use of planned shutdowns to reduce and eliminate disturbance from industrial sources. However, monitoring can be used to inform caribou presence, allowing development activity to occur in the absence of caribou, or reacting to unexpected presence of caribou. Mitigation measures are proposed, acknowledging that further operational details should be developed after collaborative refinements with other interested parties.

Mobile Caribou Conservation Measures have the advantage that they can accommodate trends in caribou distribution such as changes in size, location and timing of use of post-calving and adjacent areas. Additionally, the Mobile Caribou Conservation Measures accommodate unusual or unexpected caribou movements related to weather and environmental conditions. They offer flexibility for land users and predictability for developments, but require firm commitments to monitoring, mitigation, and follow-up and enforcement.

Table of Contents

Summary ii

Introduction 4

Definition of post-calving period and area 5

Causes of anthropogenic disturbance 5

Mobile Caribou Conservation Measures 6

Monitoring 7

Mitigation 10

Mitigation by design 10

Avoidance 11

Minimization 11

Concluding comments 13

Acknowledgements 13

Literature cited 13

Authors' technical qualifications 17

Introduction

The sensitivity of migratory barren-ground caribou (*Rangifer tarandus groenlandicus*) to disturbance varies seasonally depending on, for example, the presence of newborn calves, how much the caribou group together and their physical condition. The sensitivity of caribou also varies annually depending on the weather, such as the extent of insect harassment and summer temperatures (Poole and Gunn 2015). Caribou are generally considered to be at highest risk and most sensitive to disturbance during calving and post-calving (Murphy and Curatolo 1987, Nellemann and Cameron 1998, Wolfe et al. 2000, Taillon et al. 2012). During calving and post-calving, migratory barren-ground caribou cows occur within relatively predicable small areas, are at high densities, and are at the lowest portion of their physical condition cycle (Gordon 2005; Gunn et al. 2013).

The post-calving period is when the caribou are using generally predictable areas adjacent to the calving grounds (Gunn et al. 2013). The cows and calves usually gather together into large groups, but small size and full dependency of the calf on the cow makes them vulnerable, and if the group is disturbed, small calves are easily left and abandoned. In addition, the cows need uninterrupted foraging time as they are meeting the demands of lactation (Griffith et al. 2002).

In the most recent 2016 Draft Nunavut Land Use Plan (DNLUP) the Nunavut Planning Commission (NPC) proposed that core calving, post-calving, key access, and freshwater crossing areas (as mapped by Government of Nunavut, Department of Environment) be assigned Protected Area[1] designation, which would effectively prohibit any form of industrial exploration and development within these areas (NPC 2016). Presented here is the Kivalliq Inuit Association's approach to managing caribou and industrial development – including roads and other linear infrastructure – within post-calving areas of migratory barren-ground caribou. It provides balance between caribou protection and economic development opportunities while integrating the vulnerability of the caribou herds with environmental changes such as hotter summers. This approach includes Special Management Areas[2] designation to post-calving areas, within which seasonal Mobile Caribou Conservation Measures (Poole and Gunn 2015) (also known as mobile protection measures or mobile measures) are applied to monitor caribou distribution and use thresholds of caribou distribution to trigger protection mitigation actions while enabling opportunities for appropriate economic development for residents of the Kivalliq Region. Suggestions are included for conditions within the Special Management Areas to guide land use to protect caribou habitat and caribou.

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[1] Protected Area is a Land Use Designation that prohibits specified land uses that are incompatible with environmental and cultural values and may include Conditions to guide land use. Valued Components may also be identified in these areas.

[2] Special Management Area is a Land Use Designation that may prohibit certain land uses and/or include Conditions to guide land use. Valued Components may also be identified in these areas. Compared to Protected Areas, Special Management Areas provide more flexible management of areas of environmental or cultural importance, and provide management for areas of economic potential as well as areas with existing land uses.

Definition of post-calving period and area

Defining the post-calving period and post-calving area has to accommodate annual variation and how the herd's abundance influences the areas they use. Post-calving is the period covering the first weeks of the calves' life when they depend on their maternal cow for nursing as they leave the calving grounds moving to summer ranges (Griffith et al. 2002). In recent presentations and documents, the Government of Nunavut Department of Environment has restricted the post-calving period to approximately 23 June (after most calving has occurred) to 3 July (about 3 weeks after peak of calving when calves begin to forage on their own), with variation among herds (Caslys Consulting Ltd. 2016; M. Campbell, GN Dept. of Environment, presentation to the Kivalliq Inuit Association Board, Coral Harbour, NU, 14 September 2016). The date range for post-calving differs among herds (Caslys Consulting Ltd. 2016), for example analysis of Bathurst herd movements used 14 June to 5 July as the post-calving period (Gunn et al. 2013). Movement rates during post-calving increase from the calving period, but are not as high as during summer (Gunn et al. 2013; M. Campbell, GN Dept. of Environment, presentation to the Kivalliq Inuit Association Board, Coral Harbour, NU, 14 September 2016). The dates used to map post-calving areas ultimately should be based on a collaboratively agreed upon analysis.

Mapping of post-calving areas is essential to provide predictability for land use plans that depend on fixed boundaries for land use management. Dependence on satellite-collaring requires care as during spring migration, non-breeding or non-pregnant cows often lag behind pregnant individuals, and thus during the calving period may be located great distances from the actual calving grounds where calves are born (Gunn et al. 2013). Even though it may be the peak of calving, the location of these barren or non-breeding cows should not be considered as within a "calving area". Similarly, during post-calving, non-breeding cows may not yet have caught up with the main nursery groups, and thus the location of these individuals should not necessarily be considered as within "post-calving areas".

While the location of calving areas is relatively consistent among years and over time (with relatively rare larger-scale shifts (Gunn et al. 2008, 2012; Nagy et al. 2011; Adamczewski et al. 2015) interspersed by decades of annually consistent use), use of post-calving areas by the majority of cows in a herd is also consistent at least for the Bathurst herd (Gunn et al. 2013). However, use of different areas during post-calving can occur as herd size changes. For example, Bathurst herd cows generally move initially in a southwesterly direction during post-calving, but in some years move immediately towards the west or south (Gunn et al. 2013). Thus, although over many years post-calving areas are a broad area outside of the core calving grounds, the annual post-calving area is a smaller portion of that broader area. The problem is that for most herds the annual area is unpredictable as the data on post-calving distribution have not been analysed at the annual time scale, an essential analysis which would add detail to our understanding of the potential exposure of caribou to human activities during post-calving.

Causes of anthropogenic disturbance

Caribou in tundra may respond to industrial development at greater distances than shown in other areas and by other species, in part possibly related to the open habitat. A 14 km zone of influence was detected during the operational phase of two adjacent diamond mines (including a 29 km haul road) in the Central Arctic, within which caribou abundance was less than would be expected based on the

habitat alone (Boulanger et al. 2012). The Tłı̨chǫ have documented significant changes in migration patterns around these two mines (Dedats'eetsaa: Tłı̨chǫ Research and Training Institute 2016).

Caribou appear to be reduced in abundance within 18–30 km of the Dempster Highway in Yukon (Johnson and Russell 2014). There is hunting along the Dempster Highway, with an average daily traffic of 63-73 vehicles/day[3]. In some years caribou delayed by 2 weeks crossing a mine haul road in Alaska with fairly low traffic levels (96 vehicles/day; Wilson et al. 2016). The All Weather Access Road from Baker Lake to the Meadowbank mine appears to be a partial barrier to caribou movement, deflecting the travel path of some individuals (Agnico Eagle 2016). However there is hunting from ATVs along the road which may intensify the caribou's behavioral responses to trucks; detailed analyses of the satellite-collared caribou have not been undertaken.

Although these reports suggest that development and human activity can reduce habitat quality and alter movements and migration and deflect caribou from areas of potential high quality habitat, the mechanism for disturbance is unclear. Potential mechanisms are the physical structure of the development (e.g., mine facilities or road bed) and behavioral responses to the sight, smell and sound of the human activity (trucks, smell, dust); those responses included reduced time foraging and/or avoidance by moving away. For example, recent studies at Ekati diamond mine have shown how both fugitive and fine particle dust from roads, in addition to coating the vegetation, changes the acid balance of the soil which affects the growth of forage plants including lichens (Chen et al. 2016). Those behavioral responses can sum up to reduce body reserves and even pregnancy rates (Gunn et al. 2011).

Mobile Caribou Conservation Measures

In this report, Mobile Caribou Conservation Measures are proposed that protect caribou during the post-calving period within the Kivalliq Region. Poole and Gunn (2015) give details on Mobile Caribou Conservation Measures; briefly Mobile Caribou Conservation Measures are defined as those necessary to protect and minimize effects on caribou when exposed to human disturbance through linking monitoring with site-specific mitigation. Although initially targeted at exploration sites, Mobile Caribou Conservation Measures can establish monitoring and thresholds for mitigation measures around permanent developments, such as an operational mine or all-season road. Mobile Caribou Conservation Measures proposed here are designed to conserve caribou use of seasonal ranges. Inuit have long had rules governing human behaviour to ensure respect for caribou, and this approach builds on that knowledge and respect.

Industrial development within post-calving areas must be managed to ensure limitations on the number of appropriate developments and human activity. Managing caribou and disturbance during the relatively short and predictable post-calving period should include use of planned shutdowns to reduce disturbance from industrial sources. However, Mobile Caribou Conservation Measures have the advantage that they will accommodate trends in caribou distribution such as changes in size, location

[3] http://www.hpw.gov.yk.ca/pdf/traf2011.pdf

and timing of use of post-calving areas. Additionally, the Mobile Caribou Conservation Measures accommodate unusual years; for example when the Qamanirjuaq herd calved outside the Caribou Protection Area after the unusual 2004–05 winter with severe icing in the fall, which influenced caribou movements and delaying some cows from reaching the calving ground with implications to subsequent post-calving movements (Campbell et al. 2010). These Mobile Caribou Conservation Measures are more flexible than the Department of Indian Affairs and Northern Development's 1978 Caribou Protection Measures, as measures are not just applied to designated fixed areas, but would, for example, 'travel' with the caribou. Another example of how Mobile Caribou Conservation Measures can accommodate unusual weather conditions is that their thresholds can be made more restrictive during unusually hot weather. Caribou have few sweat glands and may be susceptible to heat stress, decreasing foraging time and increasing movements to find cooler places such as old snowbanks and lakes (Soppela et al. 1986, Mörschel and Klein 1997).

The broad sequence of steps needed to develop and conduct Mobile Caribou Conservation Measures (Poole and Gunn 2015) can be simplified for post-calving areas:

1. Monitoring requirements will be established for a proposed development. The responsibility for monitoring generally will be with the operator/proponent. The monitoring may include aerial or ground-based (locally-hired) monitoring. In some situation (e.g., the proposed Nunavut-Manitoba road), the territorial government would provide caribou collar locations that would provide broad-scale monitoring triggers.
2. Frequency of the monitoring will be flexible and balance between supplying information for the proponent and minimizing disturbance to the caribou.
3. Mitigation thresholds or triggers, which are based on season and area (susceptibility) and numbers and proximity of caribou to the development, are developed, including monitoring thresholds for when mitigations will be stepped up or down. Adaptive management will be a key component of monitoring and mitigation.

Monitoring

Monitoring is required both to know when the caribou are in the proximity of industrial activity (to trigger mitigation) and also to determine if mitigation is effective. The DNLUP provides maps of post-calving areas within which there is an expectation of caribou presence during that period (NPC 2106: Schedule A). However, post-calving movements are not always annually consistent and may change over the years especially if herd size changes. Monitoring provides the flexibility to react to caribou if present, but not restrict human activities if caribou are not present. Mobile Caribou Conservation Measures can also be effective outside of mapped areas as they travel with the caribou. Local knowledge (Inuit Qaujimajatuqangit (IQ), elder's knowledge), caribou trails, archaeological information and scientific information (aerial- and ground-based surveys, collar data) can determine the likelihood that caribou will be seasonally present. The mitigation measures will need to be more protective when monitoring is minimal or absent and uncertainty about caribou distribution is high.

The monitoring objective for the Mobile Caribou Conservation Measures is achieved through monitoring around an exploration site, development or linear infrastructure. While collared caribou may provide the first level of monitoring, the development operator would be responsible for conducting and financing local monitoring.

The Mobile Caribou Conservation Measures operate with three concentric zones, as a hierarchy of increasing monitoring effort (Fig. 1). An outer 'Early Warning Zone' relates to the presence or absence of collared caribou, or an estimated likelihood of caribou presence based on local or scientific knowledge. The size of the Early Warning Zone is scaled to the caribou season as movement rates and directionality varies seasonally. Given daily movement rates of up to 15 km/day during post-calving (Caslys Consulting Ltd. 2016; M. Campbell, GN Dept. of Environment, presentation to the Kivalliq Inuit Association Board, Coral Harbour, NU, 14 September 2016), a **50-km radius Early Warning Zone** would provide at minimum of 3 days lead time before caribou may interact with the development

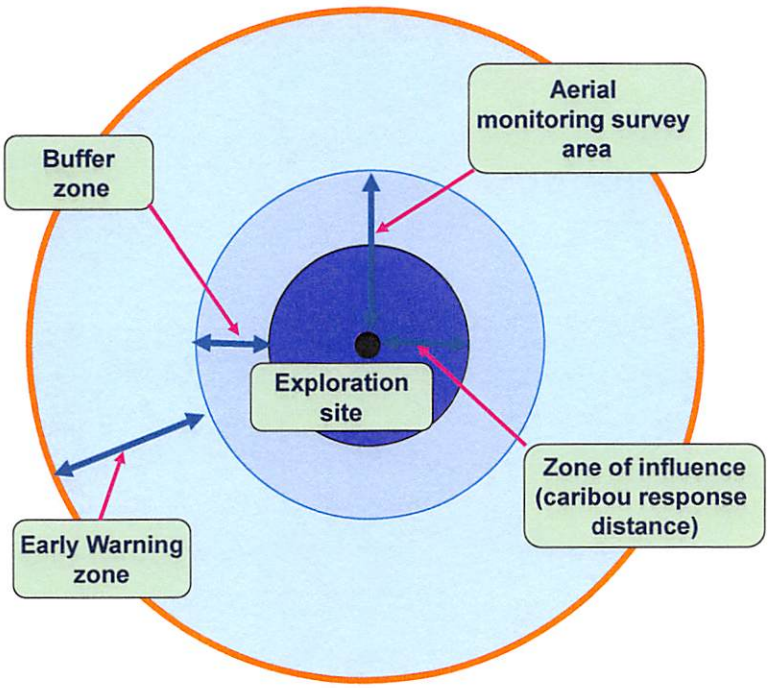

Figure 1. Schematic relationship between an exploration site or development, Zone of Influence, Buffer Zone, Early Warning Zone, and monitoring survey area. These zones could equally be applied to linear infrastructure. From Poole and Gunn (2015).

Inside the Early Warning Zone, a **15-km radius 'Buffer Zone'** is where aerial surveys, collared caribou or possibly ground monitoring are used to assess the presence of post-calving caribou. These two outer zones operate as information zones, indicating the possibility of caribou moving into the third, most inner 'Zone of Influence'. The **Zone of Influence, proposed as a 10-km radius** during the post-calving period, is the area around an exploration site or development where the behaviour and relative abundance of caribou may change in response to human activity.

The presence of caribou in the Buffer Zone would indicate to the land manager of a potential requirement for mitigation should caribou enter the Zone of Influence. The presence and number of caribou within the Zone of Influence are a threshold to initiate mitigation, ranging from altered or reduced activity to a temporary suspension of activity and other mitigation methods to protect caribou and eliminate disturbance.

Although the use of **satellite collars** contributes to monitoring, this method has limitations that include sample size of collared individuals, location upload timing (how frequently the caribou locations are summarized by the satellites) and frequency relative to daily movement distances (how often collar locations are transmitted to the project manager by the Government of Nunavut Department of Environment), availability of and access to the information, and variable support for collaring within communities (e.g., AREVA Kiggavik final hearings, Baker Lake, NU, March 2015[4]).

Frequently, the number of collars is low relative to the size of the herd and only fitted to mature cows, which raises a question of how well the satellite-collared caribou represent the entire herd's distribution. Experience at diamond mines in the Northwest Territories found that the incidental and remote camera sightings did not correlate with the encounter rates of collared caribou (Jay Project Developer's Assessment Report, Information Request Responses[5]). This suggests that at most sites supplementary information will be required, such as aerial and/or ground monitoring of caribou distribution.

The Government of Nunavut has raised concerns about **aerial surveys** disturbing caribou and has consequently placed greater emphasis on using collars, mostly deployed on mature cows (e.g., Golder 2014:8, Agnico Eagle 2016). However, communities also have strong concerns about the use of collars which makes the point that monitoring is a trade-off between the need for information and effects on caribou. Despite the concerns, well-designed aerial surveys can minimize disturbance and provide accurate and instantaneous monitoring of distribution of all sex and age classes of caribou within a study area (as opposed to the distribution of selected collared individuals), and can be conducted in ways to minimize potential disturbance. Aerial surveys to monitor caribou distribution can be flown at higher altitudes (>300 m agl) than normally used for population surveys (125 m agl) as an accurate count of individuals is not required. Responses to both fixed-wing and rotary-wing aircraft are less at higher flight altitudes of 300–400 m agl (Wolfe et al. 2000). Helicopters are often available but are noisier and at lower altitudes often cause greater reactions in caribou than fixed-wing aircraft (Wolfe et al. 2000). Reductions in noise production should be considered during selection of survey aircraft.

Technology is advancing such that use of **unmanned aerial vehicles** (UAVs) may become feasible to monitor caribou. UAVs have been tested in relation to mining projects in several areas of the Arctic (H. O'Keefe, Dominion Diamond Ekati Corp., pers. comm.), and have been used in other open habitats (e.g.,

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[4] ftp://ftp.nirb.ca/02-REVIEWS/ACTIVE%20REVIEWS/09MN003-AREVA%20KIGGAVIK/2-REVIEW/10-FINAL%20HEARING/08-TRANSCRIPTS/

[5] DAR-MVEIRB-IR2-08; http://www.reviewboard.ca/upload/project_document/EA1314-01_ORS_Review_comment_table_IR2_and_Response.PDF

Koh and Wich 2012, Hodgson et al. 2013). While there will be development costs and effort, over the long term proponents may realize significant cost savings using UAVs, and greatly reduce or eliminate concerns over disturbance of caribou from aircraft.

Ground monitoring may be feasible in some situations. **Height-of-land surveys** (essentially scanning from hilltops) can detect approaching caribou at some distances, although the scale needed for use with Mobile Caribou Conservation Measures may not be adequate. **Road surveys** by dedicated environmental staff can detect caribou in close proximity to roads, with greater frequency as monitoring and mitigation are intensified. **Remote live cameras** and camera towers may also be useful.

For the Mobile Caribou Conservation Measures the **thresholds of caribou numbers** in zones to trigger monitoring within the next zone and mitigation within the Zone of Influence depends on the degree of potential risk to caribou. These thresholds are proposed to be most stringent (lower numbers of caribou) during the crucial post-calving period (Poole and Gunn 2015). During post-calving, for example, the number of collared cows (1) or observed (10) cows within the Early Warning Zone would trigger monitoring within the Buffer Zone, where observation of >20 cows would trigger intensified monitoring with the Zone of Influence. More than 10 cows observed within the Zone of Influence would trigger mitigation actions. Less stringent thresholds of caribou numbers could be developed for non-nursery groups during post-calving.

Mitigation

The Mobile Caribou Conservation Measures detailed below are examples of mitigation options, but further operational details should be developed after collaborative refinements to the framework from industry, government, Elders, regional Inuit organizations, Hunters and Trappers Organizations and other interested parties. Those parties will advise on thresholds to determine whether mitigation should be reduced or intensified.

Mobile Caribou Conservation Measures can reduce encounters and exposure of caribou to human activities through avoiding and minimizing impacts. The hierarchy of mitigation is to avoid, minimize, rehabilitate, and offset (compensatory mitigation) (Jakle 2012, BBOP 2015). Rehabilitating disturbed habitat and offsetting are not currently addressed in these mitigation options. Proposed mitigations depend on risk timing (season), and thus the high-risk post-calving season will generate faster application and lower numeric thresholds (fewer collars or individuals) to trigger mitigations.

Mitigation by design

The physical structure of all-season roads has the potential to deflect caribou movement, creating a semi-permeable barrier to movement (Agnico Eagle 2016, Wilson et al. 2016). Road designs in the Arctic have become more "caribou-friendly" to reduce deflections resulting from the physical road structure. Designated caribou crossings at key areas have been constructed at the Ekati diamond mine (Dominion Diamond Ekati Corp. 2016). Remote camera studies conducted at the Ekati diamond mine suggest that caribou were not deflected by road construction using <0.3 m rock material, a berm slope of <27°, and berm height (the vertical distance between the surrounding landscape and the road bed) of <1.75 m (Rock 2016). Permeability of an all-weather road would presumably be higher if the majority of road

length were conducive to caribou movement (i.e., low profile), rather than selected "caribou crossing" sites. Roads should be designed to maximize line-of-sight so drivers can see caribou in time to slow or stop.

Avoidance

The first category of mitigation is **avoiding** effects through area and season-based measures such as reducing the size of the development footprint, and avoiding construction of structures and operational activities in seasonal ranges at certain times. The strongest avoidance is to avoid placing developments within post-calving areas, and land managers will make decisions regarding the potential benefits of a development versus risks to the environment and caribou. If development is accepted, the next strongest avoidance is to avoid activity until the high-risk period is over and or caribou are not present. In the case of larger developments and linear infrastructure such as roads, **shutdowns and road closures** during construction and operation will be required during post-calving when caribou are present or likely to be present. As a precautionary measure, these shutdowns and closures can be scheduled based on traditional post-calving movements, but the monitoring detailed above can adaptively accommodate changes in movement patterns, timing, and areas used.

Minimization

The second broad category of mitigation of human disturbance is **minimizing** effects, such as reducing or eliminating vehicles, aircraft, and other above-ground activities, with progressive intensification of mitigation intended to reduce the frequency and duration of encounters and the exposure of caribou to human disturbance. Encounters between vehicles and nursery groups during post-calving along an all-weather road should be largely eliminated because of road closures triggered when a >10 cows are present within the Zone of Influence. However, additional mitigation measures may be required if caribou are expectantly encountered.

Sensory disturbance

Mitigation can be implemented to minimize or eliminate effects on caribou movement and behavioural responses during post-calving to potential human disturbance. Human disturbance can cause caribou to alter their behaviour and movements (Nellemann and Cameron 1996). Increases in alert behaviour and activity and decreases in foraging have energetic costs which can reduce calf survival and accumulate to reduce the chance of a cow having enough body fat to become pregnant (Russell and White 2000).

- Set speed limits, use signage for known caribou crossings and always provide wildlife the right-of-way;
- Use a hierarchy of responses at caribou distance thresholds (Table 1);
- To minimize behavioural responses, direct movement of equipment and people toward caribou should be avoided;
- Vehicles including all-terrain vehicles should neither approach caribou nor stop within the sight of caribou;
- Use of convoying should be considered to reduce sensory disturbance;

- Aircraft and helicopter flights over occupied post-calving areas should be at least 610 m above ground level and avoid areas of known caribou concentrations when possible (subject to pilot discretion regarding aircraft and human safety) (e.g., AREVA 2014).

Table 1. Proposed example caribou distance thresholds, criteria for resuming traffic speed limits and duration of the stop during the post-calving period.

Distance of Caribou from the Road	Less than 10 adults in a nursery group	More than 10 adults in a nursery group
Less than 200 m	Driver to remain stopped for 30 minutes, then may proceed at 20 km/hr if behaviour is unchanged and caribou are not moving towards the road	Driver to remain stopped until caribou are greater than 500 m from the road
200–500 m	Driver to remain stopped for 10 minutes, then may proceed at 20 km/hr if behaviour is unchanged	Driver to remain stopped until caribou are greater than 500 m from the road
In sight and >500 m	Driver to proceed at 30 km/hr	Driver to proceed at 30 km/hr

Non-vehicle mortality

Injuries and mortalities to caribou can occur that are not related to vehicle movement. Examples include entanglement in fencing or wires, entrapment in semi-liquid tailings or other hazardous terrain within the project footprint. Operators should ensure that best management practises are followed to minimize injury and mortalities (e.g., AREVA 2014, Golder 2014). Minimizing caribou deaths includes ensuring that waste management reduces attractions to predators and that no feeding of wildlife and no-dog rules are strictly enforced. Any fences to exclude wildlife have to be maintained at sufficient tension to reduce chance entanglements with antlered caribou. The fences have to be constructed to allow escape routes such that wolves cannot take advantage of structures such as fences or berms to ambush caribou.

Mortality from vehicle collisions

Mitigation measures designed to minimize caribou mortality from collisions (as well as reduce deflections on roads) ensure drivers understand when and how they may encounter caribou on roads and what actions they take.

- Provide employee education and caribou awareness training;
- Set speed limits, flexible use signage for known caribou crossings and always provide wildlife the right-of-way;
- Use a hierarchy of responses at caribou distance thresholds (Table 1);
- Establish the predictability of encounters with caribou on permanent roads by zoning sections of any roads as low, moderate or high probability of caribou encounters based on available scientific and IQ data.

- Use driver-to-driver radio for updating information to drivers; and
- Design and modify road configuration to maximize sightlines for drivers and avoid blind spots (corners and steep berms onto the road surface);
- Provide drivers with a set of pre-designed measures to implement including reduced speed or waiting at designated areas to allow caribou on or near the road to leave. These measures would include education about typical caribou behaviour on a road and crossing a road, including the tendency to move parallel to vehicles or cut across.

Concluding comments

Mobile Caribou Conservation Measures offer considerable benefits to land users through their flexibility and through predictable rules for developments. However, the flexibility for land-users requires a commitment to monitoring and for land managers to have follow-up and enforcement capabilities. Mobile Caribou Conservation Measures should have annual reporting requirements to land and wildlife managers. The reports should ensure that details of monitoring, caribou numbers detected, and any land management decisions are documented.

The Mobile Caribou Conservation Measures are an example of adaptive management through monitoring relative to thresholds and subsequent actions. Although initially targeted at exploration sites (Poole and Gunn 2015), Mobile Caribou Conservation Measures can be used for monitoring and mitigation at industrial developments such as mines and all-season roads. Conducting monitoring (surveys, whether aerial or ground based, and telemetry) relative to thresholds trigger enhanced or reduced intensity of mitigation, for example, in the Caribou Roads Mitigation Plan (CRMP) for the proposed Dominion Diamond's Jay project (Dominion Diamond Ekati Corp. 2016). Proposed developments, primarily mineral developments and all-season roads, are subject to environmental assessment within the Nunavut Impact Review Board and Mackenzie Valley Environmental Impact Review Board processes within Nunavut and the NWT, respectively, and have associated detailed and comprehensive management and monitoring plans developed (e.g., Golder 2014; Dominion Diamond CRMP, cited above).

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Anne Gunn (B.A., Ph.D., Independent consultant, Salt Spring Island, BC). Anne has over 35 years of experience with caribou field studies, management and research in northern Canada. She has experience with assessing cumulative effects for caribou and field experience in describing caribou ecology including behavioral responses to disturbance. Anne has reviewed environmental impact assessments for Regional Inuit Organizations in Nunavut, environmental assessment boards and co-management boards. Anne has worked collaboratively in designing, implementing and reporting studies and has a number of refereed journal articles and technical reports.