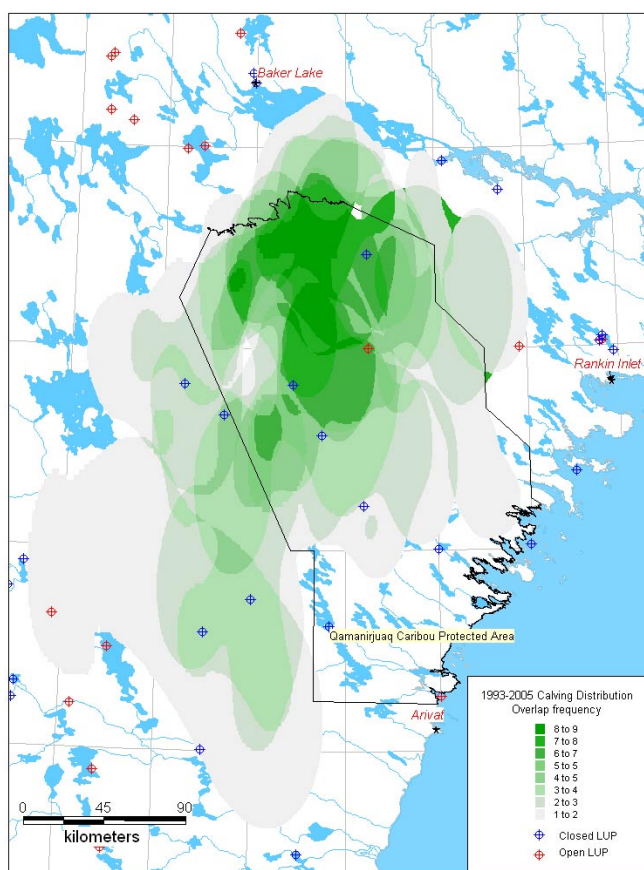


Assessment of Caribou Protection Measures

Submitted in fulfillment of NCR # 830359
Indian and Northern Affairs Canada, Gatineau, Québec



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SUMMARY

In 2006, the Department of Indian Affairs and Northern Development (DIAND) requested that we assess whether Mobile Caribou Protection Measures could be effective in providing protection for barren-ground caribou (*Rangifer tarandus groenlandicus*). We first examined the original (1978) Beverly Qamanirjuaq Caribou Protection Measures to see if they were effective in separating pre-calving, calving, and early post-calving caribou from land use activities. Between 1980 and 2006, the Caribou Protection Measures prevented caribou exposure to 81 Land Use Permits within the Caribou Protection Areas. However, outside the Caribou Protection Areas, caribou were less protected. Based on aerial monitoring (1980–1990) there were two instances when Land Use Permit activities outside the Qamanirjuaq Caribou Protection Areas were suspended when caribou were in the vicinity. For after 1993, we assessed the location of caribou based on satellite collar data relative to Land Use Permits outside of the Qamanirjuaq Caribou Protection Area, and found 14 permits (17%) had caribou within 50 km during 15 May to 31 July.

We did not find evidence to support any suggestion of the mobility of the Qamanirjuaq and Beverly calving grounds. Instead the evidence attests to strong geographic fidelity of the cows to their calving grounds. If the years when calving by Beverly caribou occurred across the boundary within the Thelon Game Sanctuary are included in the Caribou Protection Area, then calving was within protected areas for 13 of 15 years between 1978 and 1994. For 2 years (1984 and 1987), the extension of calving outside the Caribou Protection Area was relatively minor (within 10–20 km of the boundary). For the Qamanirjuaq herd, calving was within the Caribou Protection Area from 1978 to 1990 for 12 of 13 years. The 1993–2005 satellite telemetry data for the Qamanirjuaq herd also supports strong geographic fidelity for calving. The geographic centres of the annual calving grounds were within the Caribou Protection Area 12 of 13 years (except 2005 when migration was delayed by weather). The proportion of the annual calving grounds within the Caribou Protection Area averaged 80% (excluding 2005).

The Caribou Protection Measures and Caribou Protection Areas were relatively effective as far as we could ascertain from the available data. Our analyses also suggest that that satellite telemetry and contemporary GIS techniques could be easily adapted as a set of consistent rules to update the Measures as Mobile Protection Measures. Those rules would include procedures to objectively determine boundaries for calving grounds (Caribou Calving Management Areas). Public concerns about declining caribou numbers indicate the need to integrate protection for caribou calving and post-calving areas relative to human activities.

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Acronyms and definitions used in the report

Annual calving ground	The area occupied by parturient caribou from birth through the initiation of foraging by calves - at about 3 weeks after birth (Russell et al. 2002)
BQCMB	Beverly and Qamanirjuaq Caribou Management Board
CPA	Caribou Protection Area
CPM	Caribou Protection Measures
CWA	Critical Wildlife Area: calving areas listed in draft GN Wildlife regulations - areas of uncertain provenance
DIAND	Department of Indian Affairs and Northern Development
DOE	Department of Environment Government of Nunavut
ENR	Environment and Natural Resources, GNWT
Extent of Calving	The Extent of Calving is the outer perimeter of all known annual calving grounds (Russell et al. 2002)
GNWT	Government of the Northwest Territories
GN	Government of Nunavut
IOL	Inuit Owned Land
KIA	Kivalliq Inuit Association
LUP	Land Use Permit
NIRB	Nunavut Impact Review Board
NPC	Nunavut Planning Commission
NTI	Nunavut Tunngavik Incorporated
NWMB	Nunavut Wildlife Management Board
QIA	Qikiqtani Inuit Association
Peak of calving	When 50% of cows in the herd have calved (Russell et al. 2002)
Traditional Calving Grounds	The total cumulative area used for calving by a particular herd from the 1950s to present (BQCMB 2004).
Traditional water crossing	River or lake crossings identified through traditional knowledge and aerial monitoring and listed by DIAND

INTRODUCTION

In the mid 1970s, people in the arctic community of Baker Lake were worried about possible effects of a boom in uranium exploration on wildlife, especially caribou *Rangifer tarandus groenlandicus*. The Inuit concerns prompted the Department of Indian Affairs and Northern Development (Government of Canada) in 1978 to implement Caribou Protection Measures within designated Caribou Protection Areas (Fig 1.) to protect the calving and post-calving caribou of the Beverly and Qamanirjuaq herds of barren-ground caribou. The Caribou Protection Measures (Appendix A) essentially imposed space between land use activities and the caribou through a series of controls on where and when Land Use Permits were active. In the subsequent 28 years, the Measures themselves and their context have been modified.

During the intervening years between 1978 and 2006, levels of exploration have varied, which is typical of mineral exploration that, in logistically remote areas, proceeds as a series of steps along a cumulative discovery curve (Dewing et al. 2006). As well as changes in the level of exploration, the intervening years since the implementation of the Caribou Protection Measures have been marked by changes in land and wildlife management (settlement of the Nunavut Land Claim and establishment of the Territory of Nunavut). Satellite telemetry and Geographical Information Systems have supplemented the results of aerial surveys in how we describe and analyze caribou distribution. We have also added to our collective knowledge about caribou responses to human activities, which were the original impetus for the Caribou Protection Measures.

In the late 1970s, there was a boom in mining exploration especially uranium and in the last few years there is, again, a trend toward increasing mining exploration activity in the Kivalliq Region of Nunavut. In the late 1970s, caribou numbers were low and a source of concern. The herds then increased and during the early to mid-1990s, the Beverly and Qamanirjuaq herds were stable to increasing. Most recently, there are hints that those two caribou herds may be declining. Concerns about caribou and especially about their calving grounds are increasing.

We note some similarities between the situation now (2007) with the late 1970s including concerns about the effects of mineral exploration and concerns for caribou. Many things have also changed and in this report we will summarize some of those changes since 1978. In the Introduction, we briefly describe the history of and the modifications to the Caribou Protection Measures and the Caribou Protection Areas. In the Discussion, we also briefly describe increases in understanding of how caribou respond to disturbance.

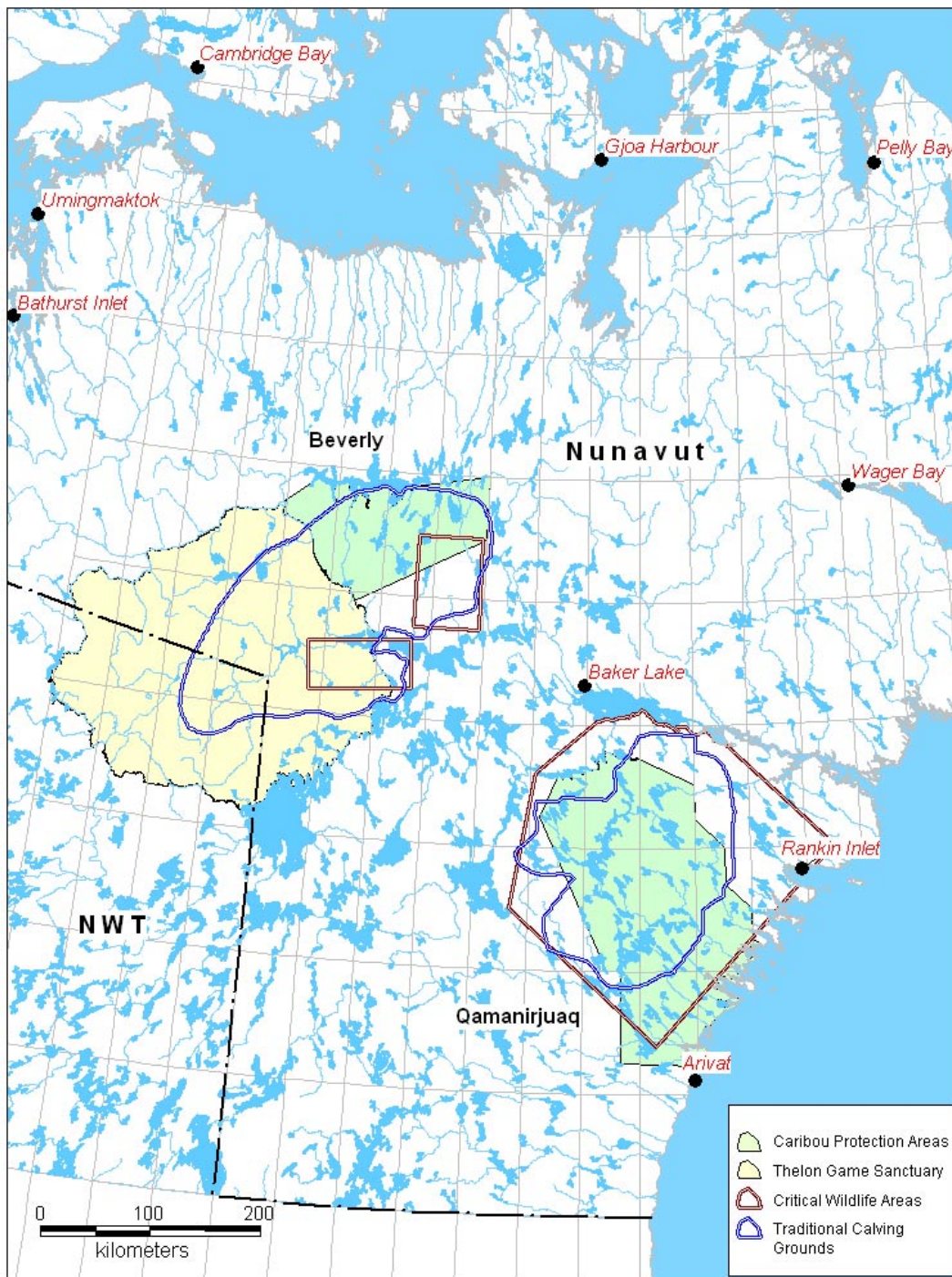


Figure 1. Location of the Beverly and Qamanirjuaq Caribou Protection Areas, Critical Wildlife Areas, and Traditional Calving Grounds, Kivilliq Region, Nunavut.

1.1 Development of the Caribou Protection Measures

In 1977, concerns about exploration for uranium by people from Baker Lake had reached the level where DIAND temporally stopped issuing Land Use Permits in a 78,000-km² area ("the Baker Lake area") from 28 April 1977 to 1 March 1978 (then extended to 14 April 1978)(Mychasiw 1984). During that period when the suspension was in effect, a consulting company, Interdisciplinary Systems Ltd (IDS) (1978), investigated the importance of hunting and trapping for people of Baker Lake and compiled information on the effects of exploration on wildlife. Based on interviews, IDS recommended distances to separate caribou from land use activities (4.8 km; 3 miles) and identified Primary Calving and Post-calving Areas for the Beverly and Qamanirjuaq herds as well as traditional water crossings.

There was disagreement between DIAND and Baker Lake people during the review of the IDS (1978) report. Consequently, on 17 April 1978, the Hamlet of Baker Lake, the Baker Lake Hunters' and Trappers' Association and Inuit Taparistat of Canada sought an injunction against the issuance of Land Use Permits, mineral leases and prospecting permits in the "Baker Lake area" (Court Order T-1628-78). The Plaintiffs' experts included an ecologist (Milton Freeman), a geographer (Peter Usher) and an anthropologist (Robert Williamson). DIAND, as Defendants, had Canadian Wildlife Service biologists Frank Miller and Don Thomas as experts. DIAND did not dispute much of the evidence. Where the Plaintiffs and the Defendant differed most was on the overall effects of mining and exploration. The Plaintiffs argued for their dependence on caribou and that the mining exploration threatened that dependence. The case was, in essence, an aboriginal rights case. The Defendants attributed the decline of the Qamanirjuaq herd to hunting and wolves. Evidently, Judge P. M. Mahoney was unconvinced as he wrote: "The weight of evidence leads to the conclusion that exploration and mining activity is incompatible with the natural use by caribou of their habitat at times and at places where they congregate in large numbers".

On 24 April 1978, Judge Mahoney's logic in finding for an interim injunction was that "The minerals, if there, will remain; the caribou presently there, may not". The interim injunction allowed Land Use Permits to be issued but with conditions attached that were intended to protect caribou. DIAND's evidence had included that the recommendations of the IDS (1978) study would be attached as conditions to Land Use Permits. Those recommendations would disallow issuing permits for within the Primary Calving Areas (during 15 May to 30 June) and Primary Post-Calving Areas (during 1–31 July) and within 4.8 km of major water-crossings. Judge Mahoney agreed that the conditions would afford necessary protection. He also noted "The Plaintiffs are entitled to protection deriving its legal effect from something more substantial than a declaration of policy". His ruling added that the 4.8 km distance should be applied within and around the calving and post-calving areas and should be applied to prospecting permits and

leases. Helicopters and low-flying aircraft should be prohibited over the calving and post-calving areas.

Within a few days of Judge Mahoney's interim injunction, DIAND announced a new set of conditions and management zones – the Caribou Protection Measures. The Measures were essentially an amalgam of the IDS (1978) report and the interim injunction. The conditions to be attached to Land Use Permits (Darby 1978) included the prohibition of activities in the Area of Spring Migration (May 15–June 30) until after the caribou had passed; the Primary Calving Areas (May 15–June 30); the Primary Post Calving Areas (30 June – 31 July) and within 4.8 km of major lake or river crossings. Transport Canada regulations would require aircraft to maintain altitudes of 300 m above the caribou during migration and 600 m above water-crossings, calving grounds and post-calving aggregations. The measures included proposals to the people of Baker Lake to become actively involved in regulating land uses through an Advisory Committee and participation in caribou aerial surveys. The aerial surveys were to monitor herd movements and to better define the boundaries of the management zones.

1.2. Caribou Protection Areas

In 1978, when the Caribou Protection Measures were announced, management zones were identified on Caribou Protection Maps, which were based on input by the Canadian Wildlife Service, NWT Fish and Wildlife Service and people from Baker Lake, as well as including the condition in the interim injunction to expand the calving and post-calving areas. The map showed a Primary Calving Area for each of the Beverly and Qamanirjuaq herds.

During the first year of caribou monitoring in 1978, Darby (1978) described the distribution and movements, and compiled information on pre-calving, calving and post-calving movements from earlier surveys from the 1950s to 1978. Darby (1978) concluded that the calving areas were relatively predictable in their location and that pre- and post-calving areas were less predictable. He recommended a modified map for 1979 with a change in names. The 1978 Primary Calving Area became slightly larger and was called the Traditional Calving and Post-calving Area (Area A). The Primary Post Calving area became the Potential Calving and Post-calving Area (Area B). Land use activities would not be permitted in Caribou Protection Area "A" 15 May–31 July although areas could be released if no substantial numbers were expected to use the area. In Caribou Protection Area "B", land use activities could proceed unless a substantial number of caribou occurred, and the activity had to cease. Monitoring in 1979 led Darby (1980) to recommend that suspension of Land Use Permit activity in Area B was unnecessary as long as it did not involve low-level aircraft flights (<300 m agl). In the official DIAND maps for 1980 and in subsequent years, Area B was dropped.

Subsequently, the annual monitoring objectives included flights to map the distribution of calving relative to the Caribou Protection Areas. In years when GNWT was undertaking an aerial census on the calving grounds, the survey information was used to delineate the calving ground boundary (Beverly: 1982, 1984, 1987, 1988; Qamanirjuaq: 1983, 1985, 1988, 1989). The annual monitoring reports led to recommendations to DIAND for minor modifications of the boundaries both adding and deleting areas (Appendix B). After the monitoring program was discontinued in 1991, the Caribou Protection Area boundaries were not modified.

In the 1990s, wildlife and land management agencies were looking at how to manage human activities for calving and post-calving caribou. As part of the information gathering on calving, the Department of Renewable Resources (Government of Northwest Territories) reviewed the aerial survey information on calving distribution for the Bathurst, Beverly and Qamanirjuaq herds in the mid 1990s (Sutherland and Gunn 1996, Gunn and Sutherland 1997). One of the objectives for the Beverly herd report (Gunn and Sutherland 1997) was to determine how frequently the Caribou Protection Area covered the annual calving grounds. GIS analyses were just starting in the Department and the techniques were not available for the project.¹ The Beverly and Qamanirjuaq Caribou Management Board (BQCMB) lists maps for the Beverly and Qamanirjuaq calving surveys (www.arctic-caribou.com/parttwo/a_calv.html).

Besides the Caribou Protection Areas, there are three other designations for the distribution of calving. DIAND includes two of those designations (Traditional Calving Grounds and Critical Wildlife Areas on departmental maps; Fig. 1). The BQCMB uses the Traditional Calving Grounds on their maps. The compilation of the calving ground surveys from 1957 to 1994 (which were mostly at or close to the peak of calving) produced a composite and smoothed calving ground boundary – ‘Traditional Calving Ground’ boundary. The Critical Wildlife Areas were described for NWT Wildlife Regulations although no regulations were actually written to protect the areas. The two rectangles for the Beverly herd (Fig. 1) are plainly outdated as they appear to be based on calving distribution in 1971 and 1974. However, GN adopted those boundaries for their draft Nunavut Wildlife Act and Regulations.

The third and most recent designation for caribou calving is the Extent of Calving (Russell et al. 2002). During a workshop, agreement was reached among the caribou biologists that the annual calving ground is the area occupied by parturient caribou from birth through the initiation of foraging by calves (calves becomes foragers at about 3 weeks after birth). This definition recognizes the

¹ The Qamanirjuaq calving surveys were compiled and mapped but the comparison with the Caribou Protection Area was not completed. As part of the transfer of government assets to the Government of Nunavut, the files were all provided to the Kivalliq Region, Department of Sustainable Development (now Department of Environment).

time when calves are most sensitive to the maternal and environmental conditions that affect their growth and when they are most vulnerable to predation. The Extent of Calving is the outer perimeter of all known annual calving grounds (Russell et al. 2002).

1.3 Operation of the Caribou Protection Measures

In 1978, all Land Use Permit activities were excluded from the Caribou Protection Areas between 15 May and 31 July. Darby (1978) suggested that this was too restrictive. If 'substantial' numbers of caribou were not in the vicinity of the Land Use Permit within the Caribou Protection Areas based on monitoring flight, the Land Use Inspector could release the Caribou Protection Measures conditions attached to the permit. For Land Use Permits outside the Caribou Protection Areas, the activities could proceed unless caribou were in the vicinity. Darby (1978) had defined a 'substantial number of caribou' in the context that if a substantial number of caribou were in an area, then land use activity should cease. Darby (1978) defined 'substantial' as $>1,000$ caribou in an area 500 km^2 or less. If herd size was $<20,000$ caribou then 5% of herd size would be applied.

After 1978, the Caribou Protection Measures were modified to give greater flexibility to Land Use Permit operators. The Land Use Permit operators could request DIAND to release the Caribou Protection Measures from a Land Use Permit within the Caribou Protection Area during 15 May – 31 July (so that Land Use Permits could operate within the Caribou Protection Areas if there were no caribou in the vicinity). Based on advice from the Caribou Monitor, the Land Use Inspector could defer the release until the caribou were no longer in the vicinity. Outside the Caribou Protection Areas, the Land Use Permits could proceed unless caribou were in the vicinity. Then either the camp operator or the Land Use Inspector could suspend the camp's activities until the caribou had moved away. In 1983, the period inside the Caribou Protection Area when land use operations would not require a release was changed from 31 July to 15 July. Mychasiw (1984) justified the change based on known caribou departure dates from the Caribou Protection Areas.

In 1984, Mychasiw (1984) reviewed progress on caribou protection for the 1978–1982 period, and commented on the lack of a direct method to quantify the effectiveness of the Caribou Protection Measures on reducing the effects of disturbance on caribou. In 1978, protection for the caribou was relatively complete as no Land Use Permits were issued for within the Caribou Protection Areas (Mychasiw 1984). However, as we do not know how many companies did not apply for Land Use Permits, the extent of protection is unknown. Mychasiw's (1984) indirect criteria of Caribou Protection Measures success in protecting caribou was the number of instances when DIAND denied land use operators releases from Caribou Protection Measures in the Caribou Protection Areas as the monitor had reported caribou in the vicinity. Subsequently, the annual

monitoring reports (1985–1990) listed instances when the monitor had provided information on caribou movements to the Land Use Inspectors, who had released the Caribou Protection Measures or suspended land use activities. Although, annual reports were written, they were not compiled into an overall summary to assess how well the Caribou Protection Measures were working. In 1990, lack of funds forced the cancellation of the monitoring.

In 1993, land use management in Nunavut changed when the Nunavut Final Agreement was ratified by Parliament. The Agreement established Inuit managed programs for land use on Inuit-owned surface lands. The Kivalliq Inuit Association (KIA) is responsible for issuing access permits for Inuit Owned Lands (about 25% of the Kivalliq Region), the Nunavut Impact Review Board screens activities for environmental impacts, and the Nunavut Planning Commission ensures that the activities conform to the 2000 Keewatin Regional Land Use Plan². The KIA also attaches the Caribou Protection Measures to licenses and lists the Caribou Protection Measures in the Keewatin Regional Land Use Plan as an action (legislative requirement) and a conformity requirement. The Land Use Plan states in Chapter 6 Section 2.6:

“The Development activities shall be prohibited on all public lands and waters within all caribou calving areas during calving season and within caribou water crossings in the Keewatin, in accordance with the terms of DIAND caribou protection measures³ contained in Appendix H. Development activities shall be prohibited on IOL (*Inuit Owned Lands*) within all caribou calving areas during calving season and within caribou water crossings in the Keewatin, in accordance with the KIA caribou protection measures (an example of which is contained in Appendix H). These measures shall be enforced throughout the region by DIAND, KIA and DSD (*Department of Sustainable Development*), to the full extent of their respective jurisdictions”.

Community concerns about a boom in mining exploration in the Kitikmeot led the Nunavut Planning Commission Transition Team (NPCTT) in May 1994 to raise the question of whether Caribou Protection Measures were necessary in the Kitikmeot. The Nunavut Planning Commission Transition Team in August 1995 August hosted a community meeting in Omingmaktok to discuss calving protection options. Conclusions from the meeting included that: “Despite concerns about monitoring and enforcement, Caribou Protection Measures have the advantages of being “portable””.

Meanwhile in the mid- to late 1990s, DIAND worked with Government of Northwest Territories’ Department of Renewable Resources to consult with all

² The Keewatin Regional Land Use Plan is at:

http://www.npc.nunavut.ca/eng/regions/Keewatin/keewatin_screen_complete.pdf

³ We recognize that the 1978 Caribou Protection Measures are now sometimes termed the original Caribou Protection Measures, or the DIAND or Keewatin Caribou Protection Measures. For clarity, we refer to the 1978 Caribou Protection Measures as (Beverly Qamanirjuaq) Caribou Protection Measures.

land and wildlife agencies to explore the most effective approach to protecting caribou on their calving grounds. The Caribou Protection Measures were one of the options discussed along with variations on a protected areas approach. A series of planning meetings and discussion papers (summarized in Gunn In Press) led to DIAND hiring consultants to canvass opinions and views from land and wildlife management agencies in both the Northwest Territories and Nunavut through a series of interviews. The consultants wrote two reports in compiling the interviews and drawing conclusions about managing human activities on caribou calving grounds (Consilium and Usher 2001, Weihs and Usher 2001).

Weihs and Usher (2001:18) reached four conclusions from the interviews on the effectiveness of the Beverly Qamanirjuaq Caribou Protection Measures:

- The associated monitoring program was discontinued, so it is impossible to determine either compliance with or effectiveness of the Measures;
- The Caribou Protection Areas were fixed but became increasingly based on out-dated information when annual surveys to identify changes were discontinued; given the mobility of caribou calving and post-calving areas, there may in fact be little effective protection from disturbance for caribou in most of the areas currently used;
- There has been no assessment of the program for many years;
- The Measures provide protection against disturbance of animals but not habitat, and address exploration rather than development projects.

Weihs and Usher (2001) wrote that “NPC has adopted the use of Mobile Caribou Protection Measures for application in the Keewatin and North Baffin Land Use Plans, and in the draft Kitikmeot Land Use Plan”. These measures are adapted from the Caribou Protection Measures applied by DIAND for the Beverly and Qamanirjuaq herds. They are “mobile” measures in that they “travel with the caribou” in order to protect the animals at critical times in their life cycle (primarily during calving and post-calving periods) and at places where they are physically most vulnerable (water crossings). Draft Mobile Caribou Protection Measures are presented in Appendix 5 of NPC’s Draft West Kitikmeot Regional Land Use Plan⁴.

In late 2006, DIAND requested that we assess whether Mobile Caribou Protection Measures could be effective in providing protection for caribou, and could be successfully implemented and enforced. Firstly, we assessed whether the Beverly Qamanirjuaq Caribou Protection Measures were effective in protecting caribou. The information that we had available for the assessment was the annual monitoring reports (1980-1990), DIAND’s database for Land Use Permits, the Qamanirjuaq satellite-telemetry database from Department of Environment, Government of Nunavut (1993-2006), the Beverly satellite-telemetry database

⁴ Available at: http://www.npc.nunavut.ca/eng/regions/westkit/getplan/WKRLUP_ENG_SC_ALL.pdf

from Department of Environment and Natural Resources, Government of the Northwest Territories (2006), and previously compiled maps of calving distribution (BQCMB web site; Gunn and Sutherland 1997).

The second part of our assessment was to examine the effectiveness of the Caribou Protection Areas in representing the distribution of calving and early post-calving caribou. Some if not much of the criticism of the Beverly Qamanirjuaq Caribou Protection Measures have been on the assumption of the mobility of caribou calving and post-calving areas. For example Weihs and Usher (2001:18) wrote "given the mobility of caribou calving and post-calving areas, there may in fact be little effective protection from disturbance for caribou in most of the areas currently used".

The third part of our assessment was to offer DIAND those points from our assessment of the 1978 Caribou Protection Measures that would contribute to an improved design and operation, including application of current technologies and techniques.

METHODS

2.1. Assessing the Beverly Qamanirjuaq Caribou Protection Measures

To determine effectiveness of the Beverly Qamanirjuaq Caribou Protection Measures, we identified three conditions that index 'effectiveness'.

2.1.a) Hypothetically, if there were no Caribou Protection Measures, then we described the level of activity that the caribou would have been exposed to by totalling the number of Land Use Permits active while the caribou were on the calving and post-calving areas (15 May–31 July) both inside and outside of the Caribou Protection Areas.

2.1.b) Caribou Protection Measures with no aerial monitoring: inside the Caribou Protection Areas, caribou would be protected but as there were no releases, therefore, flexibility was reduced for land use operations. Outside Caribou Protection Areas, caribou would not be protected when in the vicinity of land use operations (unless they voluntarily shut down or were suspended by a Land Use Inspector).

2.1.c) Caribou Protection Measures with aerial monitoring (1978–1990) or telemetry (surrogate monitoring: 1993–2005 Qamanirjuaq herd) – Within the Caribou Protection Areas, a refined measure of the protective effect for caribou was indexed from the number of Land Use Permit operations that did not request releases or had the releases were deferred because there were caribou in the vicinity. A measure of the flexibility for land use operators is the number of active permits within the Caribou Protection Areas that requested and received releases. Outside the Caribou Protection Areas, the level of protection is the numbers of Land Use Permits suspended because caribou were in the vicinity.

Our assessment of the Caribou Protection Measures is for two time periods (1978–1990 and 1993–2005). We summarized information for 1978–1990 from the individual annual monitoring reports (*in litt*), which described the caribou distribution relative to the Land Use Permits. After the monitoring program was discontinued in 1991, DIAND did not have the information on which to base releases and the Land Use Permits within the Caribou Protection Areas during 15 May to 15 July would have been inactive. There was also no basis to suspend Land Use Permit activity outside the Caribou Protection Areas between 15 May and 15 July except for the Land Use Inspector's inspection flights.

However, starting in 1993, we applied a surrogate and retrospective form of monitoring caribou distribution relative to land use activity for at least the Qamanirjuaq herd. We examined caribou movements using satellite telemetry of cows. Within the Caribou Protection Areas, we can examine annually and overall whether permits could have been released because caribou were not using that

part of the Caribou Protection Area. Conversely, the locations of the collared cows can reveal if any permits outside the Caribou Protection Area should have been suspended as caribou were in the vicinity. Given the comparatively few number of collared caribou and mean daily travel distances (see below), we buffered all Land Use Permits by 50 km (approximately five times the maximum daily travel rate in early July), and determined when caribou were within this buffer distance for each Land Use Permit inside and outside the Caribou Protection Area. No assessment was made for 1997 as only 2 caribou were collared. We also assessed the proximity of Land Use Permits to designated water crossings.

2.2 Effectiveness of the Caribou Protection Areas

Between 1978 and 1990, the annual monitoring included mapping calving distribution relative to the Caribou Protection Area boundaries. After 1993, the only years when calving distribution relative to the Caribou Protection Area boundaries was mapped during aerial surveys was in 1993 and 1994 for the Beverly and 1994 for the Qamanirjuaq herd.

Otherwise the only information to assess the Caribou Protection Areas was the satellite telemetry data for the Qamanirjuaq herd. We used two approaches with the telemetry data. Firstly, we evaluated the degree of overlap of the annual distribution of the Extent of Calving with the Caribou Protection Area. We determined the proportion each annual calving ground was within the Caribou Protection Area each year to see how well the distribution of caribou was captured.

Secondly, we calculated the centroid (midpoint) and compactness of each annual calving ground. The compactness (in effect, the complexity of the shape) was calculated as a ratio computed by comparing the area of a polygon to that of a circle having the same perimeter as the polygon. The formula is:

$$C = \text{SQRT}(A_p/A_c)$$

where C is the compactness ratio, SQRT is the square root function, A_p is the area of the polygon being calculated, and A_c is the area of a circle having the same perimeter as that of the polygon being calculated. This ratio provides an indication how spread out the collared caribou were during the time on each annual calving ground. We also show the location of the centroids relative to the boundary of the Caribou Protection Area.

We determined the peak of calving by plotting sequential locations of each caribou each year. Calving was assumed to have occurred when the distance between sequential locations decreased markedly during the range of normal calving periods (early to mid-June; Fig. 2). Because of the time between

locations (generally 4–5 days most years), this assessment is a crude estimate of the peak of calving each year. The annual calving grounds were determined using 90% fixed kernel estimates of occurrence from the distribution of satellite-collared caribou using the Animal Movement extension for ArcView (Hooge and Eichenlaub 2000). The technique essentially encloses the satellite-collared locations within a polygon, which we mapped. We used the annual caribou locations to map the annual calving grounds and then compiled all years to map the Extent of Calving probability polygon. Given points on the landscape (e.g., Land Use Permits) can then be assigned a frequency (probability) of being used by calving Qamanirjuaq caribou. Annual calving ground kernels of Qamanirjuaq caribou distribution were amalgamated into the Extent of Calving for 1993 to 2005.

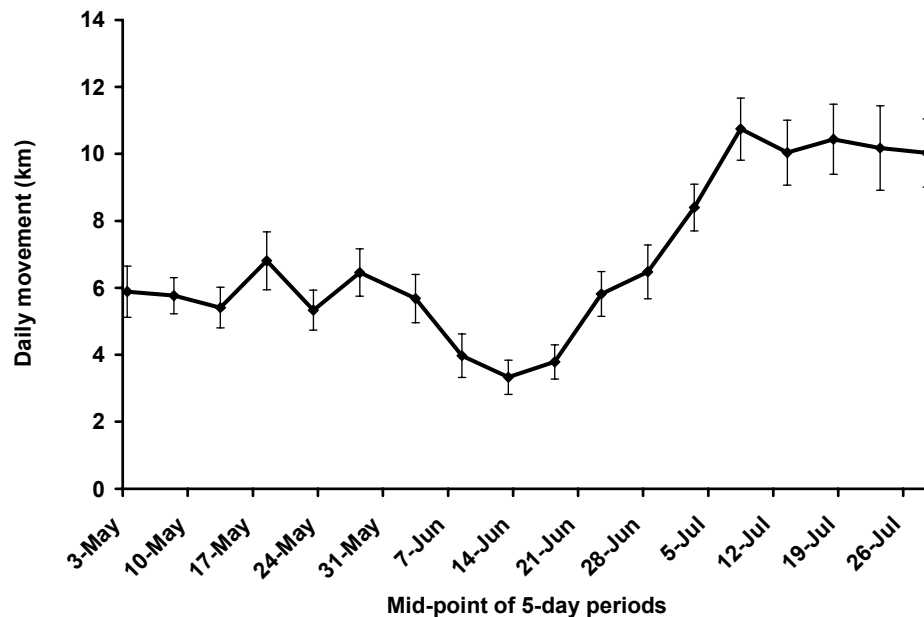


Figure 2. Average daily movement rates (mean \pm 95% confidence interval) by satellite-collared Qamanirjuaq cow caribou during May to July, 1993–2005. Movement distances were assigned to 5-day period based on the majority of the inter-location interval falling within a particular 5-day period ($n = 2,719$ distances). Two percent of distances were deleted from this analysis because they either equally split 2 5-day periods (i.e., 3 days in each), were >8 days between locations, or were >150 km between successive locations (generally satellite location errors or initial collar deployment).

Caribou approach into and out of areas

Using ArcView, we determined the annual dates of entry into and exit out of the Caribou Protection Area and the Extent of Calving. For the Beverly herd we were only able to summarize data from 6 collared cows from 2006. For the Qamanirjuaq herd we determined the median and range of dates for each parameter each year to look at variation in timing among years, and the length of time caribou were within each area. Data from the Qamanirjuaq herd were graphed to facilitate interpretation.

2.3 Interviews

We compiled comments gained through discussions⁵ of existing Caribou Protection Measures with DIAND Land Use Inspectors and industry (who were not interviewed by Weihs and Usher 2001) to gain their views on whether the current Caribou Protection Measures and Mobile Caribou Protection Measures may be effective in minimizing human disturbance impacts to caribou. We sought comments on the application, implementation and enforcement while encouraging respondents to be as specific as possible.

⁵ Discussions were conducted through phone interviews and email follow-up.

RESULTS

3.1 Data available for the assessment

Land use permits: For the period 1980–1990, we used the annual monitoring reports (see literature cited). For after 1991, we were provided DIAND's open and closed Land Use Permit files which contained point location latitude and longitudes, which we portrayed on a GIS map to examine location of Land Use Permits relative to various boundaries and caribou locations.

There were 48 open Land Use Permits for the Kivalliq Region (1991–2006). Those permits were 5 roads, 1 quarry, 16 mining exploration, 4 fuel storage, 15 campsite and 7 miscellaneous. There were also 46 closed Land Use Permits for the Kivalliq Region (1991–2006). Those permits were 15 roads, 2 quarries, 14 mining exploration, 2 fuel storage, 11 campsite, and 2 miscellaneous. No dates of activity were provided for the closed permits; thus we assume each permit was valid for 3 years from year of issue (S. Dewar, DIAND, Iqaluit, pers. comm. 2007).

Between 1991 and 2006, two open Land Use Permits and 10 closed Land Use Permits were within Qamanirjuaq herd's Caribou Protection Area. One open permit was a winter road (N2003E0032) and the other was an exploration camp (N2006J0017). Of the 10 closed Land Use Permits, there were 4 roads, 2 mining exploration, 3 campsites, and 1 miscellaneous. For the Beverly herd, there no open or closed Land Use Permits in the Caribou Protection Area.

Qamanirjuaq and Beverly telemetry data: Satellite collar data were obtained for the Qamanirjuaq herd for April to October of 1993 to 2006 (M. Campbell, GN DoE, Arviat, NU, data for 2006 to 27 May), and for the Beverly herd for 1 May to 31 August 2006 (D. Johnson, GNWT ENR, Ft. Smith, NT).

Qamanirjuaq caribou

The number of cow caribou collared annually during the calving period ranged from 2–13 animals (Table 1). Peak of calving was not determined for 1997 because of small sample size. As determined from caribou movements, the timing of peak of calving varied little among years, although we acknowledge that this assessment is very rough.

Beverly caribou

Six cows were collared from the Beverly herd in April 2006; satellite locations were obtained daily. The median date of the peak of calving was approximately 7 June. The Extent of Calving in 2006 appeared to occur primarily in the western portion of the Caribou Protection Area (Fig. 3). Median dates of entry into and out of the Caribou Protection Area were 23 May and 28 June 2006, respectively.

Table 1. Number of collared adult female Qamanirjuaq caribou and number of satellite locations used to delineate the annual calving ground, June 1993 to 2005.

Year	No. of caribou	No. of locations	Peak of calving	Location interval (d)
1993	5	30	9 June	4
1994	4	24	8 June	4
1995	4	71	11 June	5/1 (after 11 Jun)
1996	7	85	11 June	5/1 (after 10 Jun)
1997	2	12	Not calculated	4/5
1998	8	38	9 June	4/5
1999	7	32	8 June	4/5
2000	6	26	9 June	4/5
2001	10	41	8 June	5
2002	6	29	11 June	5
2003	6	22	9 June	5
2004	13	152	10 June	5/1
2005	6	76	8 June	5/1

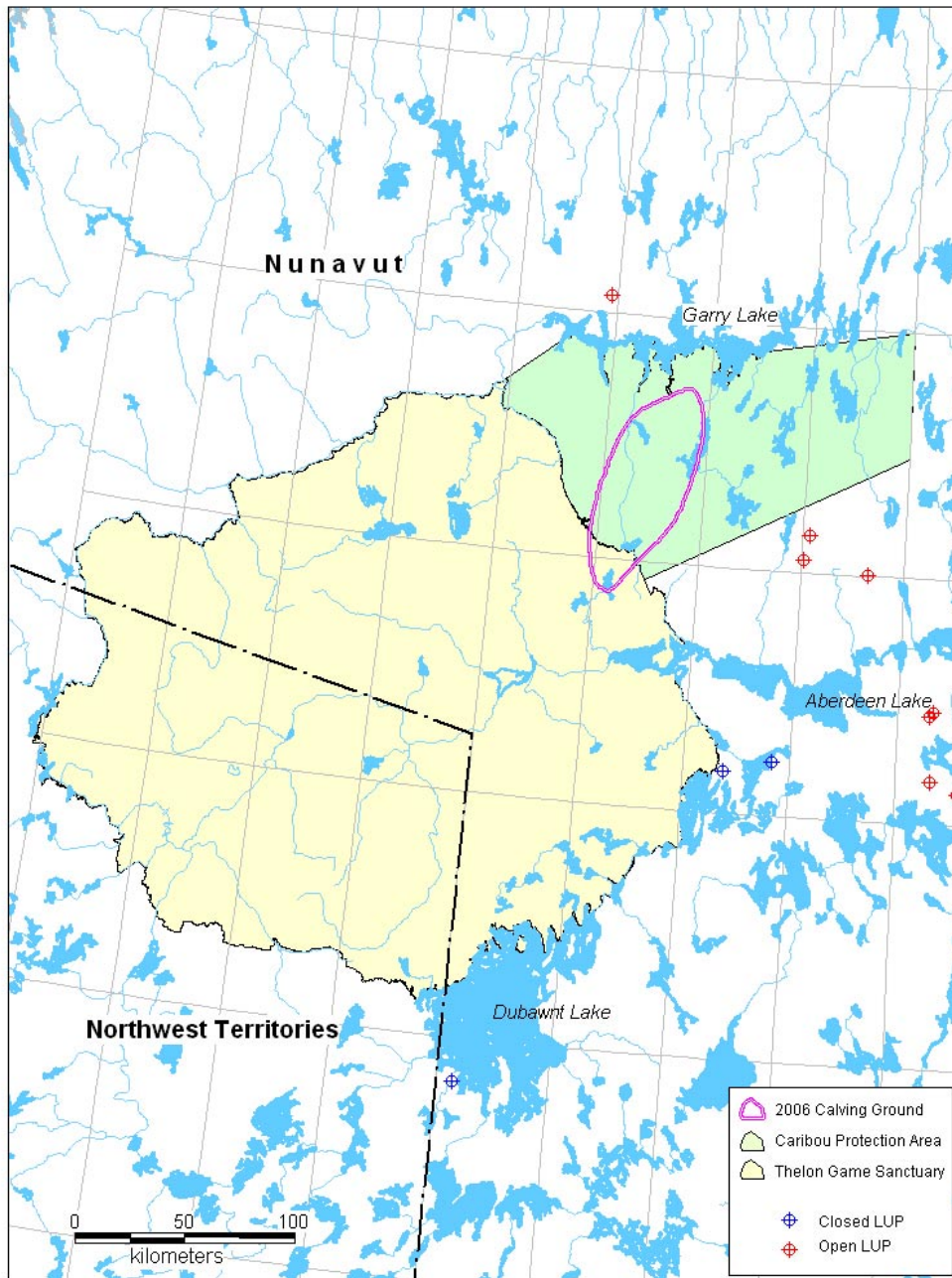


Figure 3. Annual calving ground for the Beverly caribou herd, 2006, based on data from collared caribou ($n = 6$), in relation to the Beverly Caribou Protection Area. Locations of open and closed Land Use Permits (LUP) also shown.

3.2 Effectiveness of the Caribou Protection Measures

In the Kivalliq Region (and south of Wager Bay and east of the Thelon Game Sanctuary the number of Land Use Permits totalled 268 from 1980–2006. Almost a third of those permits were in the Caribou Protection Areas. In the early 1980s, the number of Land Use Permits was relatively high with a peak of 33 permits in 1981 (Fig. 4). Numbers dropped with a brief resurgence of interest 1988–1990 and again 1998–2000. After 1990, there was no monitoring.

3.2.a) If there were no Caribou Protection Measures: For the 1980–1990 period, calving and early post-calving caribou (15 May–15 July) could have been exposed to 43% of the 150 Land Use Permits in the Kivalliq Region (Fig. 4). For the subsequent period, 1993–2006, it was 16% of the 118 Land Use Permits (Fig. 4).

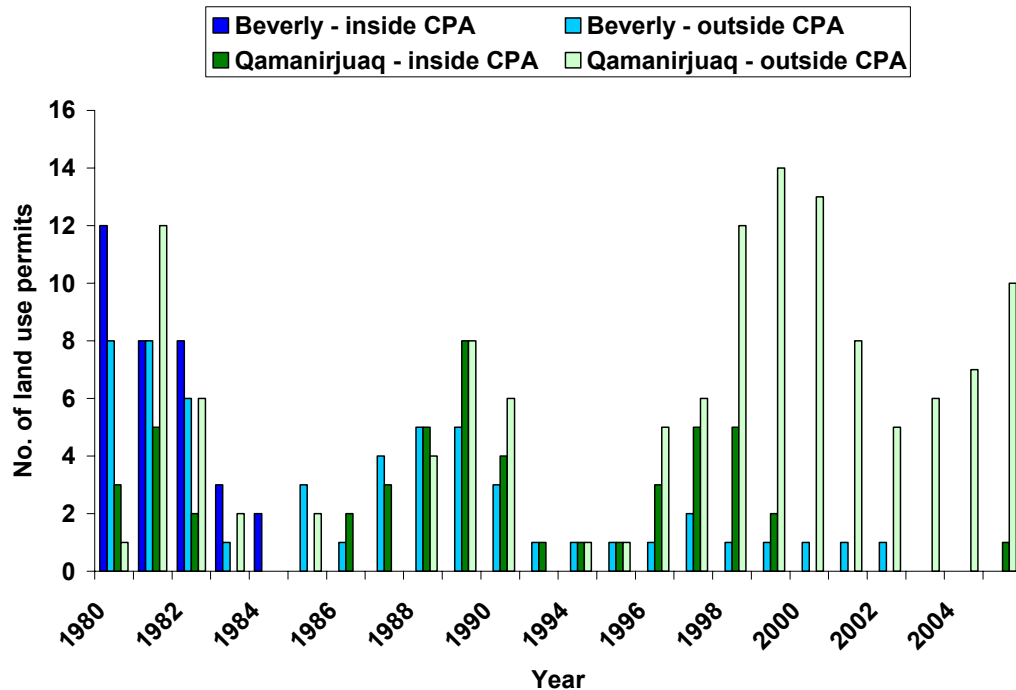


Figure 4. Number of Land Use Activities (based on Land Use Permits) that Beverly and Qamanirjuaq caribou were potentially exposed to Land Use Permits inside and outside the Caribou Protection Areas (CPA) during the period 15 May–15 July 1980–1990 (based on annual monitoring reports) and 1993–2005 (based on satellite collar data and proximity to the Caribou Protection Area) if there were no Caribou Protection Measures. Closed Land Use Permits were assumed active for 3 years since the issue year.

3.2.b) Conversely, with the Caribou Protection Measures (and no monitoring, so no releases within the Caribou Protection Areas) between 1980–2006, caribou would not have exposed to 65 Land Use Permits in the Caribou Protection Areas (assuming caribou were evenly dispersed across the entire Caribou Protection Areas and assuming that all the Land Use Permits were active 15 May–31 July) (Fig. 4).

However, outside the Caribou Protection Areas, caribou were less protected if they were in the vicinity of Land Use operations (unless the operation shut down voluntarily or was suspended by a Land Use Inspector). For the period 1980–1990, there were only two instances with Land Use Permit activities outside the Qamanirjuaq Caribou Protection Areas, when monitoring provided the information for the Land Use Inspector to suspend activities (Table 2).

For after 1993, we assessed the location of caribou based on satellite collar data relative to Land Use Permits within and outside of the Qamanirjuaq Caribou Protection Area. Within the Caribou Protection Area, two Land Use Permits (14%) had no collared caribou come within 50 km during the calving period (Table 3). Outside of the Caribou Protection Area, 14 permits (17%) had caribou within 50 km during 15 May to 31 July (Table 3).

Table 2. Summary of releases requested and deferred for Land Use Permits (LUPs) based on monitoring caribou distribution inside and outside Caribou Protection Areas (CPA) relative to the Beverly (B) and Qamanirjuaq (Q) areas, 1980–1990.

	LUPs within CPA						LUPs outside CPA			
	No. LUPs		No. releases requested		No. releases deferred		No. LUPs		No. suspended	
	B	Q	B	Q	B	Q	B	Q	B	Q
1980	12	3	21 ⁶		10	0	8	1	0	0
1981	8	5	8	0	5	0	8	12	0	0
1982	8	2	17	2	2	0	6	6	0	0
1983	3	0	3	0	0	0	1	2	0	0
1984	2	0	2	0	0	0	0	0	0	0
1985	0	0	0	0	0	0	3	2	0	0
1986	0	2	0	2	0	1	1	0	0	1
1987	0	3	0	3 ⁷	0	0	4	0	0	0
1988	0	5	0	4	0	3	5	4	0	1
1989	0	8	0	6	0	2	5	8	0	0
1990	0	4	0	0	0	0	3	6	0	0

⁶ Several camps were included under a single Land Use Permit

⁷ Camp voluntarily suspended activity

No open or closed Land Use Permits were <20 km from a designated water crossing.

Table 3. Number of Land Use Permits inside the Qamanirjuaq Caribou Protection Area (CPA) and those where no collared caribou were present (within 50 km), and the number of Land Use Permits outside where collared caribou were <50 km away, 1993–2005.

Year	Inside CPA		Outside CPA	
	No. LUPs	No. where no caribou present	No. LUPs	No. LUPs with caribou <50 km
1993	1	0	0	0
1994	1	0	1	0
1995	1	0	1	0
1996	3	1	5	1
1998	5	1	12	2
1999	2	0	14	2
2000	0	0	13	1
2001	0	0	8	1
2002	0	0	5	0
2003	0	0	6	1
2004	0	0	7	1
2005	1	0	10	5

3.3 Effectiveness of the Caribou Protection Areas

The annual calving ground for the Qamanirjuaq herd, as determined from satellite collars, varied in size among years (Table 4), and was concentrated in the northern portion of the Caribou Protection Area (Figs. 5, 6). The Extent of Calving from 1993–2005 encompassed 61,800 km². In general, the annual calving grounds were largest and least compact in years when it was not located in the northern portion of the Caribou Protection Area (Table 4, Fig. 6). The annual calving grounds were centred within the Caribou Protection Area 1993–2004 and only 2005 was outside the Caribou Protection Area.

In most years, most calving occurred in the northern sections of the Caribou Protection Area (Fig. 5), with an apparent slow shift in location of annual calving grounds west or southwest over time. The annual calving grounds in 2000 and 2002 occurred within and beyond the southwestern portion of the Caribou Protection Area, consistent with observations of calving outside of the “traditional

calving grounds” in those years by Campbell (2005). In 2005, following a winter characterized by severe icing in fall 2004, calving appeared to be split between the northern portion of the Caribou Protection Area and areas well to the southwest.

Successive overlap of annual calving grounds between years varied and became less pronounced in the past 6 years (Fig. 5). When the frequency of cumulative distribution of annual calving grounds was plotted (in effect, areas were weighted by the number of years they were used for calving), the northern portion of the Caribou Protection Area was used to the greatest extent, and the southern and southeastern portions of the Caribou Protection Area were used to the least extent (Fig. 7). Overlap frequency from 2000–2006 suggest the annual calving grounds have shifted slightly away from the northern area in a southwesterly direction. These polygons can be used to build probabilities of use of areas within the Extent of Calving.

We compared the location of the annual calving grounds with the Caribou Protection Area, and found that on average, 68% ($\pm 19.4\%$ (SD)) of the annual calving grounds were within the Caribou Protection Area (Table 4).

Table 4. Annual calving grounds for the Qamanirjuaq caribou herd based on movements of satellite-collared caribou, 1993–2005) and proportion of the annual calving grounds within the Caribou Protection Area (CPA). The compactness ratio (C ratio) is the, an indication of complexity of the distribution of the Extent of Calving (higher ratios indicate less complex shape with greater central tendency)

Year	Area (km ²)	% in CPA	C ratio
1993	7,163	83	0.51
1994	13,063	69	0.77
1995	5,504	82	0.72
1996	7,024	69	0.59
1998	21,564	66	0.52
1999	13,526	84	0.60
2000	20,085	56	0.64
2001	7,283	77	0.51
2002	19,710	54	0.57
2003	18,046	49	0.63
2004	4,794	100	0.62
2005	30,405	27	0.46
Average	14,014	68	0.59

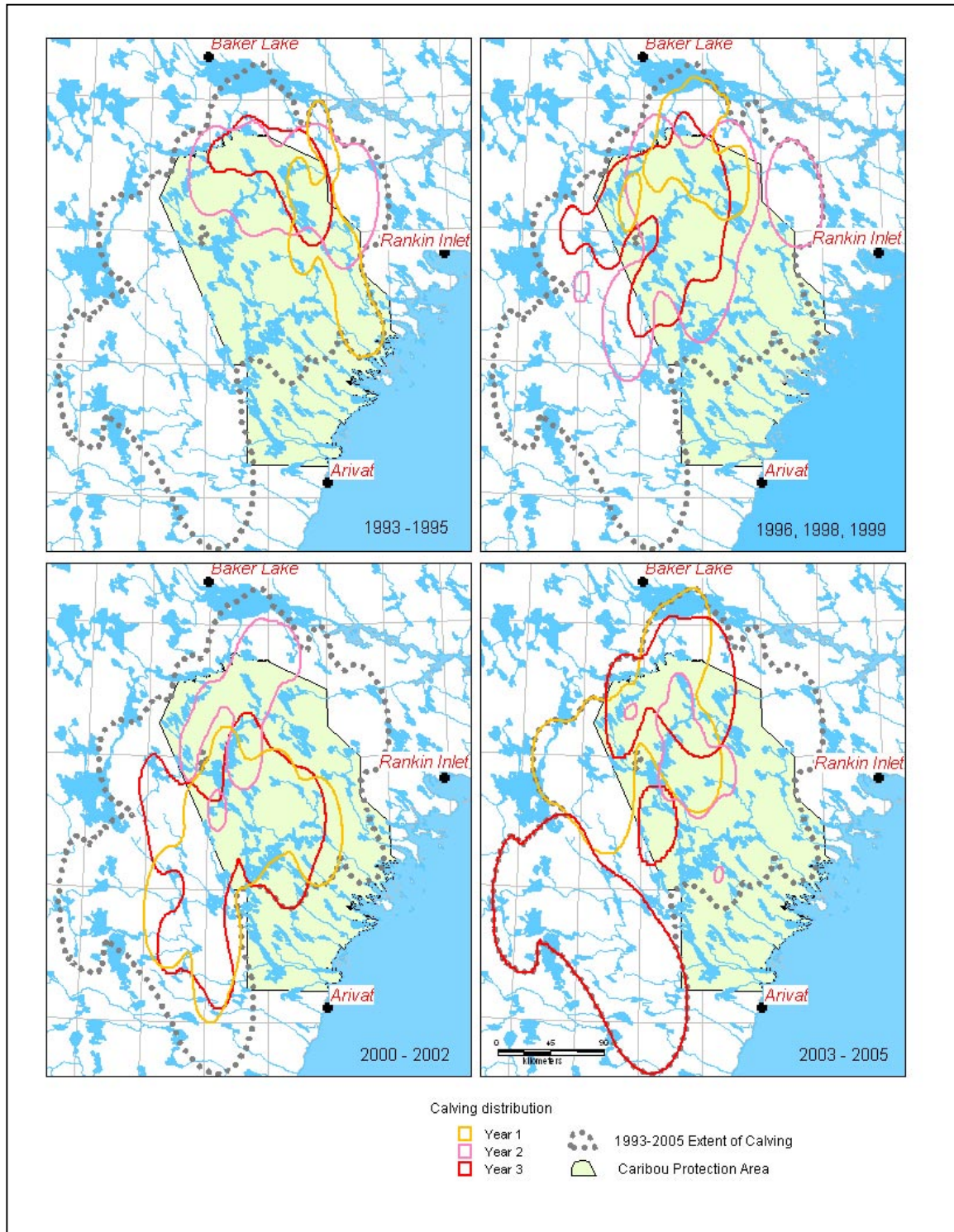


Figure 5. Distribution of annual calving grounds by Qamanirjuaq caribou, 1993–2005, based on satellite collar locations (Table 1).

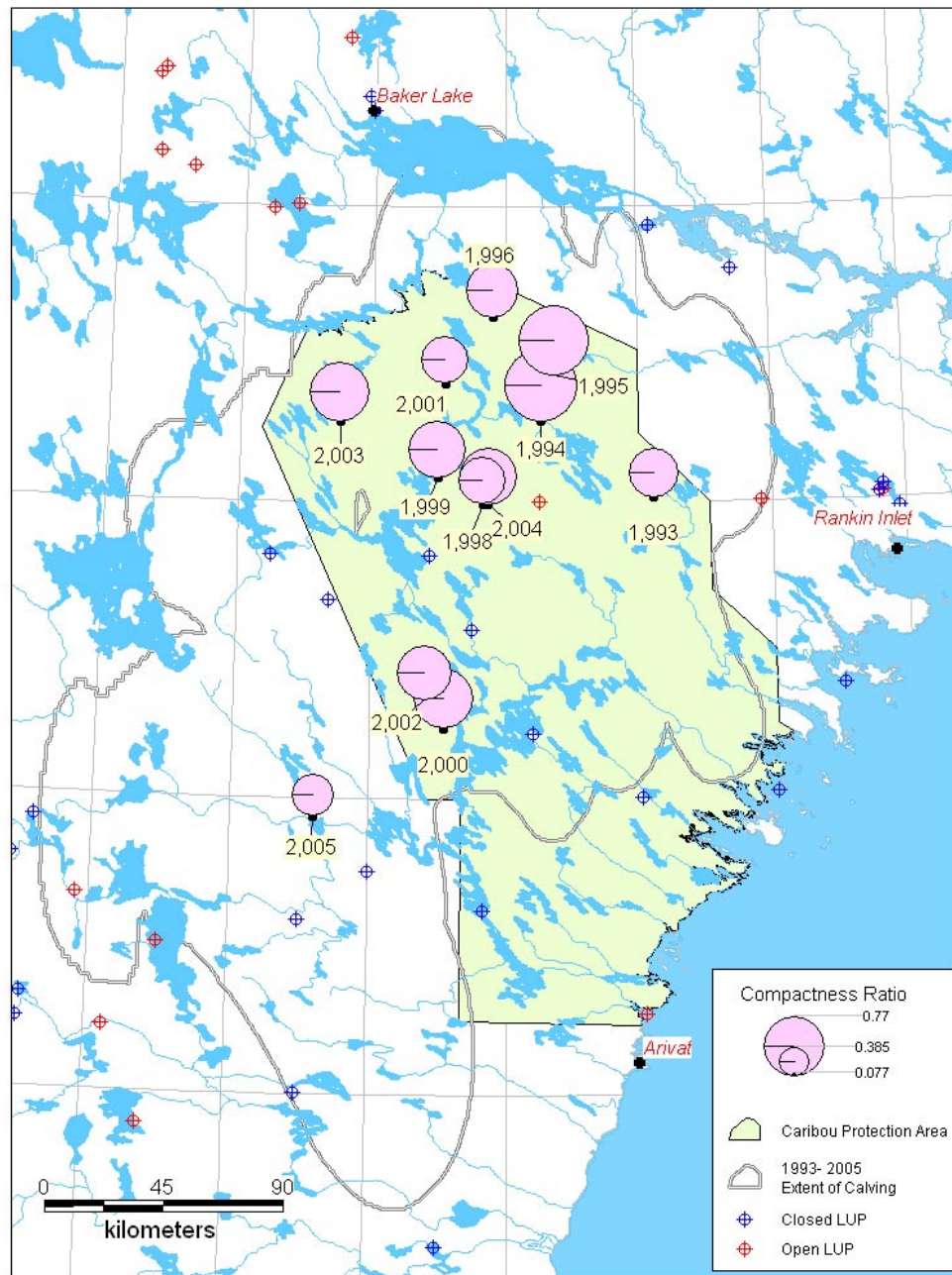


Figure 6. The distribution of annual calving grounds as shown by the centroids (dark dots) and the compactness ratio, Qamanirjuaq caribou herd, 1993–2005. Higher compactness ratios indicate less complex shape with greater central tendency. Locations of open and closed Land Use Permits (LUP) shown. Sample sizes of collared caribou to determine annual calving grounds ranged from 4–13 animals.

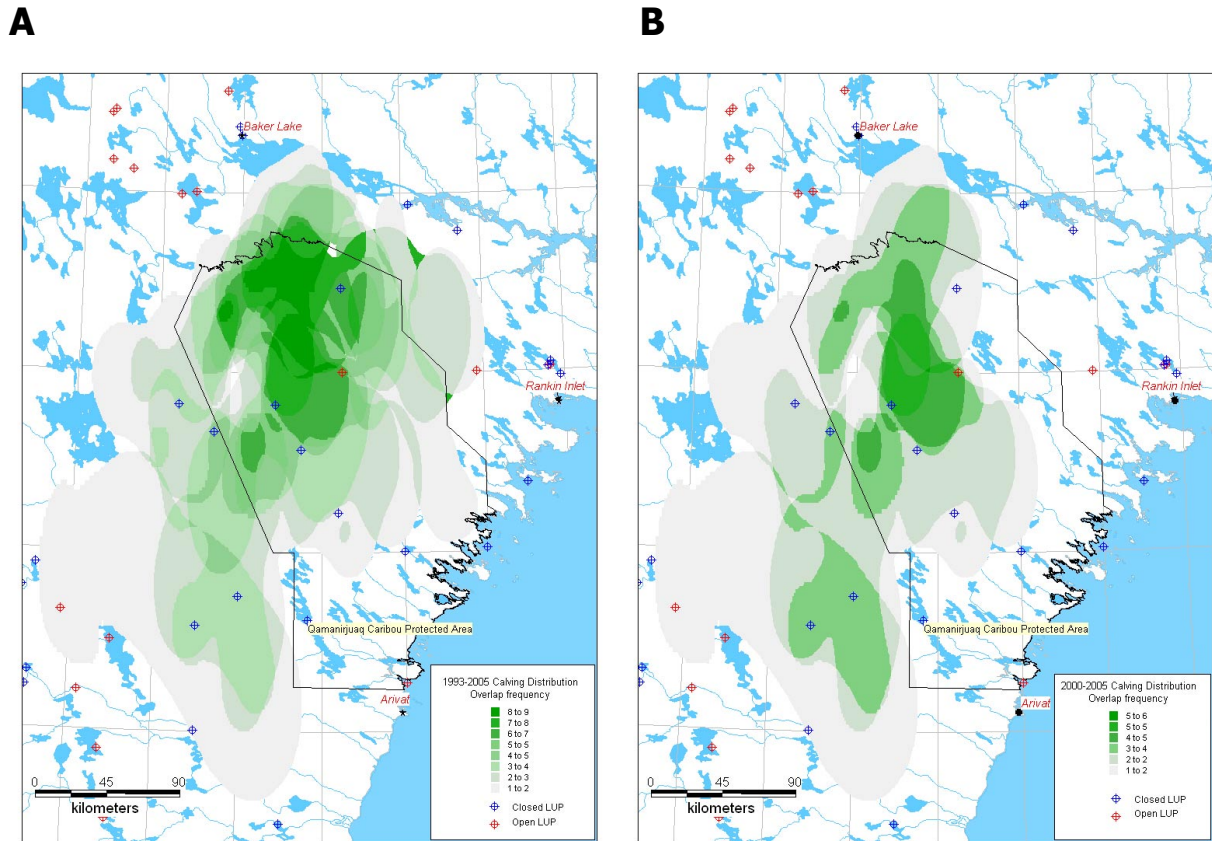


Figure 7. Cumulative frequency of annual calving grounds for the Qamanirjuaq caribou herd as determined from satellite collars (Table 1), A) 1993–2005, and B) 2000–2005. The darker shading depicts areas with greater frequency of use during calving. Locations of open and closed Land Use Permits (LUP) also shown.

When we plotted the annual median date of entry (Fig. 8) and exit (Fig. 9) of Qamanirjuaq caribou in relation to the Caribou Protection Area and the Extent of Calving, we observed two main patterns. First, the timing of entry, and to a slightly lesser degree exit, from the areas bounces around on a 2–3 year pattern, such that earlier entry into the areas in one year is generally followed by later entry in the following year. Second, the trend over time strongly suggests that caribou are approaching and leaving the Caribou Protection Area later each year. Regression lines on median dates of entry into the Caribou Protection Area indicate a 14-day change in the date of entry into the Caribou Protection Area, and one-month change in dates if 2006 data are removed (Fig. 8). In 2006, caribou were clustered along the coast (and inside the edge of the Caribou Protection Area) for a long period of time prior to calving. The trend in dates of exit from the Caribou Protection Area suggests a 21-day shift (Fig. 9).

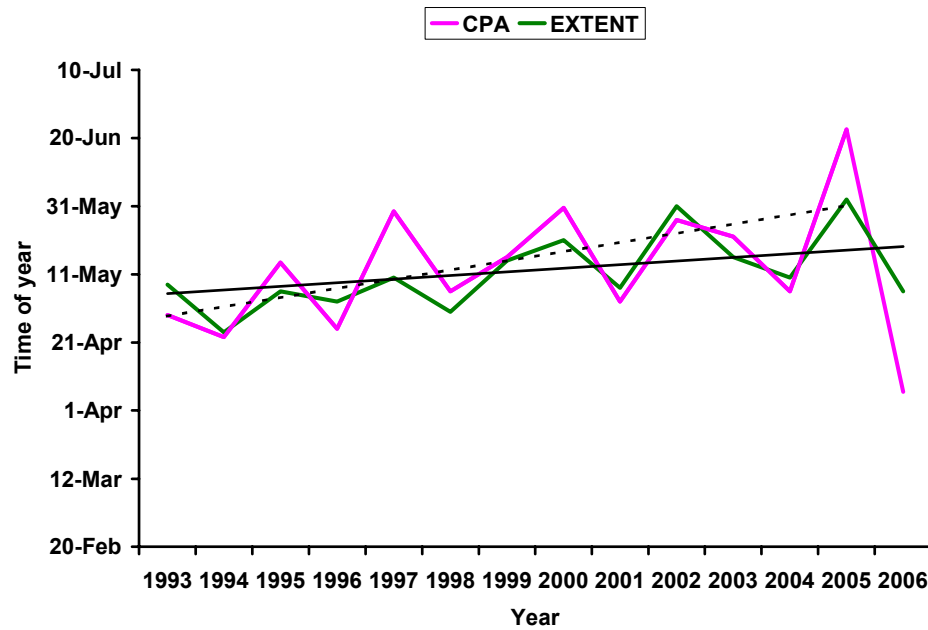


Figure 8. Median dates of Qamanirjuaq caribou entry into the Caribou Protection Area (CPA) and the Extent of Calving (EXTENT). Linear regression lines for Caribou Protection Area for all years (solid line), and for data with 2005 removed (dotted line).

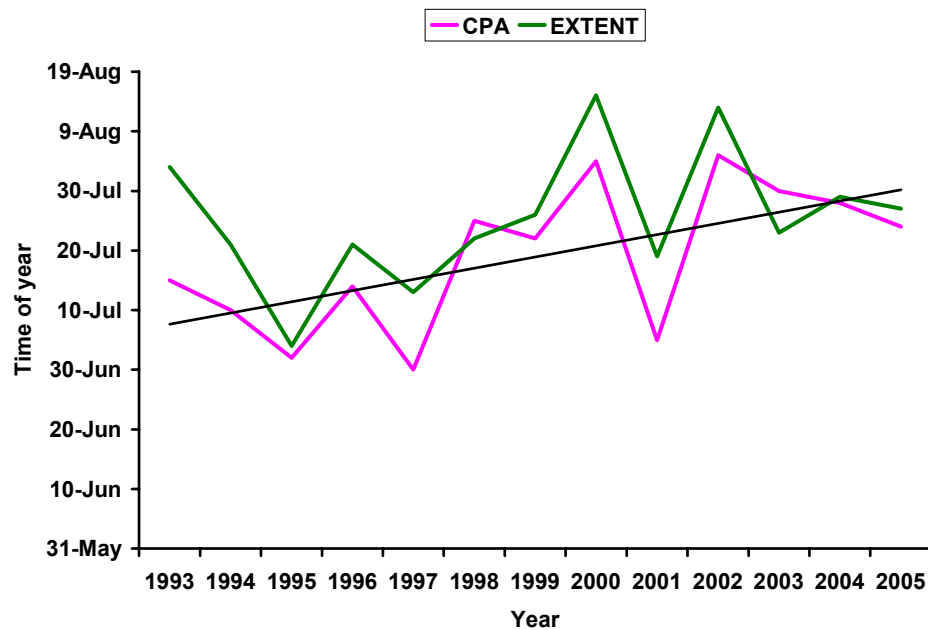


Figure 9. Median dates of Qamanirjuaq caribou exit from the Caribou Protection Area (CPA) and the Extent of Calving (EXTENT). Linear regression lines for Caribou Protection Area for all years (solid line).

3.4 Interviews

We interviewed people by phone from three mining companies currently active in the area of the Beverly and Qamanirjuaq calving grounds, and one DIAND Land Use Inspector (delays in beginning the contract limited the time available to conduct further interviews). Common to the interviews was concern for caribou and a wish to see more use of satellite-collared caribou to aid monitoring, as the interviews identified a relationship between the effectiveness of the Caribou Protection Measures and ongoing monitoring of caribou distribution.

DISCUSSION

We structured our assessment of DIAND's Beverly and Qamanirjuaq Caribou Protection Measures in response to Weihs and Usher's (2001) compilation of comments and answers about managing human activities on caribou calving grounds. Our assessment does not fully support Weihs and Usher's (2001) first point about the Caribou Protection Measures: "The associated monitoring program was discontinued, so it is impossible to determine either compliance with or effectiveness of the measures". Our analysis of DIAND's Land Use Permit database coupled with GIS mapping and analysis of the satellite telemetry data indicate that we can index the effectiveness of the Caribou Protection Measures in separating calving and early post-calving from Land Use Permit operations. Without annual monitoring (either aerial surveys or use of satellite-telemetry) the Measures are most effective within the Caribou Protection Areas and least effective outside, as there is no basis for the suspension of activities when caribou are approaching or in the vicinity of a Land Use Permit. Within the Qamanirjuaq Caribou Protection Area the Caribou Protection Measures provided protection for all permits, including two that apparently had no caribou in their vicinity during the calving period. Outside of the Qamanirjuaq Caribou Protection Area, upward of 17% of permits may have had caribou in the area and suspension of activities should have been considered.

We have no independent data on compliance – the rate of inspection is low for open permits (47%) and although higher for closed permits, it was because the inspections were more to do with closure than operation (80%). We suggest that a reporting requirement could be effective. That is to say, Land Use Permit operators should have to report annually to DIAND their dates of operation in the field and any caribou observations in the vicinity of their camps. Those dates and information should be included in the Land Use Permit database. Given the ease of updates such as DIAND provides on mining activities, an annual report on the Caribou Protection Measures (web-based) might ease some concerns and criticisms. We also caution that sample size restricted our analyses. The number of Land Use Permits we were aware of during 1993–2005 totalled 117 and the number of satellite-collared caribou was low (Table 1).

Our assessment of the effectiveness of the Caribou Protection Areas also does not support Weihs and Usher's (2001) second point: "The Caribou Protection Areas were fixed but became increasingly based on out-dated information when annual surveys to identify changes were discontinued; given the mobility of caribou calving and post-calving areas, there may in fact be little effective protection from disturbance for caribou in most of the areas currently used". Several respondents in Weihs and Usher's (2001) commented on the mobility of calving grounds, which suggested it is a relatively entrenched view.

We did not find evidence to support the suggestion of the mobility of the Qamanirjuaq calving grounds. Instead the evidence attests to strong geographic fidelity of the cows to their calving grounds. In the context of this report we have not undertaken a critical review of fidelity of calving barren-ground caribou cows to their traditional calving grounds (Gunn and Miller 1986). However, as caribou herds are defined on the basis on their return to their calving grounds, we note that there is a lot of information available. However, much of it predates GIS analyses and so has not been fully analyzed to describe the scales of spatial and temporal variation that different herds may display. Those analyses will be essential to design updated Caribou Protection Measures.

For the Beverly herd, Gunn and Sutherland (1997) had previously reviewed calving distribution relative to the Caribou Protection Area during 1978–1994, and found that the annual calving grounds were located entirely within Caribou Protection Area boundaries (and the adjacent Thelon Game Sanctuary which is closed to mining activity) in 8 out of 15 years. For the 7 years with most but not all calving within the Caribou Protection Area, the amount outside the Caribou Protection Area was relatively low, except in 1978 (when the boundaries were first adjusted) and 1979. In 1979, Darby (1980) wrote that colder temperatures delayed migration and the migrating caribou were dispersed over a wide front. The 1979 aerial census revealed that although the high density calving was within the Caribou Protection Area, about half the calving caribou extended into the Thelon Game Sanctuary (Darby 1980).

Gunn and Sutherland (1997) wrote that: “The degree to which the annual calving grounds were located outside the boundaries varied from 50% in 1978, the first year that the Caribou Protection Measures were implemented, to less than 5% in 1979, 1980, 1981 and 1987”. The Caribou Protection Area boundary was terminated at the Thelon Game Sanctuary (no mining activity) so the Caribou Protection Area boundary adjunct to the Sanctuary is relatively artificial rather than based on calving as with the other boundaries. If the years when calving occurred across the boundary within the Thelon Game Sanctuary are included in the Caribou Protection Areas, then calving was within the protected areas for 13 of 15 years. For the 2 years (1984 and 1987), the extension of calving outside the Caribou Protection Areas was partial and within 10–20 km of the boundary.

Although the maps summarising the calving distribution for the Qamanirjuaq herd during 1978–1994 relative to the Caribou Protection Area were completed, the analyses were not done. The comparison of calving mapped during annual monitoring indicated that calving was within the Caribou Protection Area from 1978–1990 for 12 of 13 years. In 1982, a small area was outside the Caribou Protection Area.

The 1993–2005 satellite telemetry for the Qamanirjuaq herd also supports strong geographic fidelity for calving. The comparison of Extent of Calving based on satellite telemetry relative to the Caribou Protection Area boundaries is a more realistic comparison in the context of the Caribou Protection Measures (because it includes 3 weeks early post-calving). The caribou occupy a larger area during 3 weeks than during the peak of calving. The geographic centres of the annual calving grounds (Fig. 6) were within the Caribou Protection Area 12 of 13 years (2005 was the exception).

The proportion of the annual calving grounds within the Caribou Protection Area averaged 80% (excluding 2005). In 3 years (2000, 2002, 2003) a lower proportion of the annual calving ground (49–56%) was within the Caribou Protection Area (Fig. 5). In at least 2001, spring migration was delayed by a severe winter (Campbell in Russell et al. 2002). The 2004–2005 winter was unusual with severe icing in the fall, which influenced caribou distribution, and caribou mostly calved outside the Caribou Protection Area, although after calving they did cross into the Caribou Protection Area by early July. The annual calving grounds were centred within the Caribou Protection Area during 1993–2004 (Fig. 6).

While we are saying that there is a strong geographical fidelity to the annual calving ground, we are not claiming that they are completely fixed geographic entities. The data indicate a trend for the annual calving grounds to shift southwest (2000–2002) before rotating back toward the north within the Caribou Protection Area (2003 and 2004) (Figs. 5, 7). However, the evidence clearly does not support the suggestion of a level of mobility that would render the Caribou Protection Areas ineffective. More frequent reviews of the Caribou Protection Areas (perhaps every 5 years) using satellite telemetry and supported by aerial censuses could improve the efficiency of the Caribou Protection Areas in two ways. Adjustment of boundaries could ensure the boundaries are responsive to any spatial trends in the annual calving grounds and also allow the release of Land Use Permits in areas less likely to be used. Community information could also be used to trigger reviews if unusual winter or migration conditions are reported.

Weihs and Usher's (2001) raised two other points besides questioning the effectiveness of the Caribou Protection Measures and Areas. Their third point was that "there has been no assessment of the program for many years". Their fourth point was that "the measures provide protection against disturbance of animals but not habitat, and address exploration rather than development projects". This later point, however, is outside the scope of Caribou Protection Measures, which were designed to be attached to Land Use Permits. However, it does raise a highly relevant question, which is also one of the Beverly Qamanirjuaq Caribou Management Board's concerns with the Caribou Protection

Measures (BQCMB 2004). Weihs and Usher (2001) provided guidance as to answer the question of addressing habitat changes and development through the application of land-use planning. Their recommendations were also clear in identifying that one of the tools to manage human activities on caribou calving grounds should be Mobile Caribou Protection Measures.

The Beverly Qamanirjuaq Caribou Management Board (2004) has also suggested several options to improve protecting caribou and their habitat. The options include land-use planning, protected areas and improved caribou protection measures. The recommendations for improved Caribou Protection Measures are the use of updated information (including on caribou distribution), annual monitoring and an increase in compliance activities.

Weihs and Usher (2001) wrote that “NPC (*Nunavut Planning Commission*) has adopted the use of Mobile Caribou Protection Measures for application in the Keewatin and North Baffin Land Use Plans, and in the draft Kitikmeot Land Use Plan”. These measures are adapted from the Caribou Protection Measures applied by DIAND for the Beverly and Qamanirjuaq herds. They are “mobile” measures in that they “travel with the caribou” in order to protect the animals at critical times in their life cycle (primarily during calving and post-calving periods) and at places where they are physically most vulnerable (water crossings). The first mention of the “mobile” was as “portable” measures in 1994 (unpublished notes, Nunavut Planning Commission Transition Team 1994). Draft Mobile Caribou Protection Measures are presented in Appendix 5 of NPC’s 2005 Draft West Kitikmeot Land Use Plan. The draft plan lists Interim Caribou Protection Measures (as a conformity requirement), which require that between 15 May and 15 July activities be suspended if calving or post-calving caribou are present in or near the area of work or activity. The draft plan also lists as an action an inter-agency effort to reform the original Keewatin Caribou Protection Measures. The Protection Measures are intended to be supplemented by Action 3.2, which describes the need for mitigation measures relative to habitat protection for caribou calving habitat.

In the draft 1997 and then the final 2000 North Baffin Land Use Plan, the application of Caribou Protection Measures was recommended. Section 3.3.7 states that “development activities shall be prohibited within all caribou calving areas during calving season, as well as caribou water crossings in the North Baffin region. The Qikiqtani Inuit Association and DIAND shall implement caribou protection measures on Inuit Owned and Crown lands respectively..., and should follow the proposed measures found in Appendix I. While these measures may not solve the problem of what to do about long-term development, they do offer flexible interim protection” (p.39). In both the 2000 North Baffin and 2000 Keewatin Regional Land Use Plan the recommended protection measures were

DIAND's rather than any reference to "mobile" and include reference to a map of a Caribou Protection Area.

In their recommendations, Weihs and Usher (2001), suggest the need for mobility of the measures in that they can be applied to wherever the caribou calve. We suspect that this will be essential for the caribou calving grounds that are either not well-described and or do not have satellite-collared cows. Weihs and Usher (2001) also imply that if the calving grounds are well enough mapped, then their boundaries can be used to assist developers in knowing the likelihood of activities being suspended.

Our analyses of annual calving grounds and the Extent of Calving for the Qamanirjuaq herd suggests that satellite telemetry and contemporary GIS techniques such as describing the centre, shape and degree of overlap of annual calving grounds could be easily adapted as a set of consistent rules to objectively determine boundaries for calving grounds (Caribou Calving Management Areas) and which would be included as part of Mobile Caribou Protection Measures. The rules have to be developed through consultation but could, for example, include boundaries determined from the distribution of the annual calving grounds for the 5 previous years based on 95% probabilities.

The satellite telemetry provides an efficient means to describe caribou movements with no restrictions of weather. It is also efficient in providing early warning of delayed migrations, which can result in caribou calving outside the Caribou Protection Areas. Across the Northwest Territories and Nunavut, there are seven herds of barren-ground caribou with satellite-collared cows and those rules could be devised and tested to describe calving management areas. Part of the testing is necessary to add credibility for using a few collared caribou to describe the movements of 10s of 1000s of caribou. For the Bathurst herd, the representation of the satellite-collared cows is high on annual calving grounds (Gunn et al. In Press).

We offer the term 'Caribou Calving Management Areas' to separate the rule-based areas from the original Caribou Protection Areas. The term also avoids any possible confusion with the Protected Areas Strategy. Within the Caribou Calving Management Areas, the attachment of the Mobile Protection Measures to the Land Use Permit would postpone operational activities between 15 May and 15 July⁸. Releases would only be possible based on a set of rules devised to use satellite telemetry data to ensure with a reasonable safety margin that the calving caribou would not be likely to be in the vicinity of the Land Use Permit. Likewise, outside the Caribou Calving Management Areas (including water-crossings), a set of rule-based conditions using the satellite-telemetry data could cause suspension of Land Use Permit operations.

⁸ Respondents to Weihs and Usher (2001) did not apparently question the dates.

Our experience with satellite telemetry and inter-agency cooperation makes us aware of the requirement to sort out agreements, arrangements and details about sharing data on caribou movements. A robust and simple system independent of government agency workloads will need to be devised if it is to be practical. An advantage of the satellite telemetry is that the information on caribou distribution is available within hours but this is only true with an efficient way to collect and distribute the information.

The Caribou Protection Measures were intended to impose separation between the Land Use Permit activities (machinery, people, aircraft, etc.) and caribou. The original distance in 1978 (IDS 1978) for protection was nominated to be 5 km. Since then there have been many studies that have advanced our understanding of how and why wildlife responds to human activities (Wolfe et al. 2000). Most studies to describe how wildlife responds to human activities have assumed that wildlife such as caribou respond to human activity as though the human activity is an approaching predator. It is a useful parallel as it does explain the trade-offs between countering predation risk without risking other behaviours, such as having enough to eat or not wasting energy by fleeing unnecessarily (Frid and Dill 2002).

Treating responses to human activities as predation risk also helps explain some of the variation seen in how caribou respond to human activities. There is for example a clear difference between how a cow with a young calf responds compared to a mature bull. Caribou also respond differently to aerial predators such as eagles than ground predators. The variation in caribou responses has sometimes caused doubt about the need to protect especially calving caribou. However, research on the Beverly calving ground (Gunn 1984) and elsewhere (for example, Murphy and Curatolo 1987, Maier et al. 1998, Nellemann and Cameron 1998, Aastrup 2000, Nellemann et al. 2000, Nellemann et al. 2001, Vistnes and Nellemann 2001, Mahoney and Schaefer 2002, Joly et al. 2006) indicates that caribou respond and distance themselves some 5–10 km from human activity, and cows especially with calves are the most responsive.

Most research has been to describe behavioural responses, but other changes including reduced calf survival have been documented (Harrington and Veitch 2001). Of interest in the context of maintaining a protective distance between calving caribou and people is Phillips and Alldredge's (2000) experimental study of people disturbing elk (*Cervus elephus*) during calving, which showed calf survival declined even at the frequency of 10 disturbances per calving season.

It is not just the demonstrated greater responsiveness of cows on the calving grounds that warrant protection. It is also because all the cows of any one herd

are gathered together and densities can be high. For example, we recorded 110 caribou/km² in 1996 on the Bathurst herd's calving ground (Gunn et al. 1997).

The responses of caribou to disturbances over the geographic scale of a few kilometres are consistent with a behavioural response to a predator. However, recent analyses suggest that behavioural responses also occur at greater geographic scales. Boulanger et al. (2004) documented a shift in caribou distribution in both aerial survey observations and for satellite-collared cows at distances of 20–25 km from a large open-pit mine on post-calving and summer ranges of the Bathurst herd. Those findings should inject a note of caution that we do not fully understand the effects of human activity on barren-ground caribou.

The Caribou Protection Measures are attached to Land Use Permits only. However, prospecting permits, quarry permits or leases, mineral claims and surface land leases are also potential sources of human activity on calving and post-calving ranges. Mineral leases give rights to minerals and on their own do not have any associated land use or activity. The extent of what this means within the caribou calving and post-calving ranges in terms of people, camps and air and ground transport is seemingly unrecorded, although the same issues were raised in 1978. Recent scientific publications such as Phillips and Alldredge's (2000) research suggest that the cumulative effects of relatively small-scale disturbances should not be assumed to be harmless. Additionally, the findings of some of the original research on calving grounds associated with the development of the Caribou Protection Measures (Gunn et al. 1983) described that cows and calves were responsive to helicopter landings and people on the ground.

The current levels indicate that mining industry is expressing high levels of interest in both the Beverly and Qamanirjuaq calving, post-calving and summer ranges. As of September 2006, DIAND had issued 37 prospecting permits, 417 mineral claims and 10 mineral leases for the Beverly and Qamanirjuaq calving grounds⁹. At this stage, it is unknown how those translate into activities on the ground. The only protection for caribou is if any of the activity reaches the stage of application for a Land Use Permit. Integration of all stages of mineral exploration and development relative to caribou protection could re-assure the public and provide predictability and flexibility to developers. A logical corollary of an integrated system of caribou protection is to ensure that information on caribou and the rationale for their protection relative to activities on calving and post-calving is provided at the preliminary stages, such as attached to Prospector Permits.

⁹ <http://www.arctic-caribou.com/mining.html>

At the same time, concerns about the health and abundance of barren-ground caribou are widespread. The Government of the Northwest Territories in January 2007 organized a caribou summit with 180 representatives from aboriginal governments, caribou management boards, renewable resource and co-management boards, outfitters, environmental organizations, the oil and gas and mining industries who worked together to identify priorities for action. Delegates emphasised the importance of protecting calving and post calving grounds (it was the top-scoring action). The delegates were aware that most calving grounds are in Nunavut, and also knew about the mineral potential and the territories' need for employment (S. Fleck, pers. comm. 2007).

Critique of methods

Our assessment of the Caribou Protection Measures and Areas was based on data available to us during this contract. While we are confident the analyses and methodologies are sound, issues regarding databases may have resulted in introduction of unknown biases. For example, the Land Use Permit datasets contained errors in location (latitude/longitude) that we detected and with DIAND's help corrected; other errors may exist. The closed Land Use Permit file did not provide commencement and expiry dates, thus we had to make assumptions about the length of time and the timing that these permits were active. Twenty (21%) of the Land Use Permits were roads, yet we were unable to obtain linear coverage for two-thirds of these Permits; thus, our spatial analyses were largely based on point locations for activities that often spanned 10s or 100s of kilometres (we were provided with linear coverage for seven road permits active between 1993 and 1999 (Shawn Larocque, DIAND, Yellowknife)).

The KIA also attaches the Caribou Protection Measures to Land Use Permits. Unfortunately, we were unable to obtain data on KIA Land Use Permits to assess this component of land use within the region.

We also suggest the timeline available to conduct this analysis was tight. Everyone we dealt with was really busy and thus delays obtaining responses to queries about databases, coupled with a lengthy delay in obtaining the Qamanirjuaq caribou dataset, meant that our assessment was slightly rushed, with little time to fully explore the data available to us, or contact other sources for relevant information and opinions.

RECOMMENDATIONS

Our first three recommendations relate to Mobile Caribou Protection Measures. As we have read reports and listened to people while doing this assessment of the Caribou Protection Measures, we realize that they cannot be considered in isolation. Thus we also offer three more general recommendations to secure the

context for the Caribou Protection Measures and which would increase their effectiveness.

1. The Beverly Qamanirjuaq Caribou Protection Measures should be updated to be rules-based Mobile Caribou Protection Measures to optimize protection for caribou and flexibility for industry.
2. The current Beverly Qamanirjuaq Caribou Protection Areas should be updated and renamed Caribou Calving Management Areas to emphasise their role in an integrated system of managing human activities on calving and post-calving areas. The Caribou Calving Management Areas should be established using rules-based criteria from satellite telemetry and aerial surveys.
3. The attachment of the Mobile Caribou Protection Measures to the Land Use Permit would eliminate operational activities between 15 May and 15 July. Releases would be possible based on a set of rules devised to use satellite telemetry or aerial survey data to ensure with a reasonable safety margin that the calving caribou would not be likely to be in the vicinity of the Land Use Permit. Likewise, outside the Caribou Calving Management Areas (including water-crossings), a set of rule-based conditions using the satellite-telemetry data could cause suspension of Land Use Permit operations.
4. A sense of urgency is needed to address these issues given the boom in mineral exploration and the concerns for protecting caribou calving as articulated, for example, in the 2007 Caribou Summit in Inuvik.
5. An integrated system including Prospector Permits, mineral claims, mineral leases, as well as Land Use Permits, would protect caribou, re-assure the public, and provide predictability and flexibility to developers.
6. To build on grassroots support for protecting calving and post-calving caribou, information on the caribou and the range of management options for spacing caribou and human activities needs to be disseminated and readily accessible.

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APPENDIX A. DIAND CARIBOU PROTECTION MEASURES

1. (a) The Permittee shall not, without approval, conduct any activity between May 15 and July 15 within the Caribou Protection Areas depicted on the map certified by the Engineer as the "Caribou Protection Map" and annexed to this Land Use Permit.
(b) A Permittee may, upon approval by the Land Use Inspector, operate within the said Caribou Protection Areas beyond the May 15 deadline set out in 1(a), provided that, when monitoring information indicates that caribou cows are approaching the area of operation, the Permittee will implement 1(c).
(c) On cessation of activities pursuant to 1(a) or 1(b), the Permittee will remove from the zone all personnel who are not required for the maintenance and protection of the camp facilities and equipment, unless otherwise directed by the Land Use Inspector.
(d) The Permittee may commence or resume activities prior to July 15 within those parts of the Caribou Protection Areas released by the Land Use Inspector for the reason that caribou cows are not expected to use those parts for calving or post-calving (note 1).
2. (a) In the event that caribou cows calve outside of the Caribou Protection Areas, the Permittee shall suspend operations within the area(s) occupied by cows and/or calves between May 15 and July 15. (b) In the event that caribou cows and calves are present, the permittee shall suspend: (i) blasting; (ii) overflights by aircraft at any altitude of less than 300 meters above ground level; and (iii) the use of snowmobiles and ATVs (all-terrain vehicles) outside the immediate vicinity of the camp.
 1. The Land Use Inspector's decision will be based on the existing caribou information.
 2. Concentrations of caribou should be avoided by low-level aircraft at all times.
3. (a) During migration of caribou, the Permittee shall not locate any operation so as to block or cause substantial diversion to migration.
(b) The Permittee shall cease activities that may interfere with migration, such as airborne geophysics surveys or movement of equipment, until the migrating caribou have passed.
4. (a) The Permittee shall not, between May 15 and September 1, construct any camp, cache any fuel, or conduct any blasting within 10 kilometres of any "Designated Crossing" as outlined on the map certified by the Engineer as the "Caribou Protection Map" and annexed to this Land Use Permit.
(b) The Permittee shall not, between May 15 and September 1, conduct any diamond drilling operation within 5 kilometres of any "Designated Crossing" as outlined on the map certified by the Engineer as the "Caribou Protection Map" and annexed to this Land Use Permit.

APPENDIX B. A SUMMARY OF THE MONITORING FLIGHTS DESCRIBING THE DISTRIBUTION OF CALVING AND EARLY POST-CALVING CARIBOU RELATIVE TO THE BOUNDARIES OF THE BEVERLY AND QAMANIRJUAQ CARIBOU PROTECTION AREAS

Beverly

The annual monitoring reports described that the annual peak of calving distribution was mostly within the boundaries of the Beverly and Qamanirjuaq Caribou Protection Areas 1980–1990. The Beverly Caribou Protection Area was terminated at the boundary of the Thelon Game Sanctuary (rather than being based on the then known calving distribution), as full protection of caribou and their habitat was assumed to occur within the Sanctuary. In 1979, 1980, 1982, 1987, and 1988, low-density calving cows extended about 20 km to within the Thelon Game Sanctuary (Cooper 1980, Darby 1980, Clement 1983, Ogilvie 1987). In 1979, an exceptionally late spring, moderate calving densities extended into the Thelon Game Sanctuary.

Bradley (1985) describes in 1984, when by 19 June calving cows of the Beverly herd extended 5–10 km to the south of Gary Lakes at the peak of calving whereas the Beverly Caribou Protection Areas northern boundary was a straight east-west line intersecting the southern extremities of some bays. Also in 1984, Bradley (1984) notes that the calving distribution extended some 10 km south of the Beverly Caribou Protection Area. This southward extension of about 5 km was also recorded in 1987 (Ogilvie 1987). In 1987, DIAND accepted Ogilvie's (1987) recommendations to extend the southern boundaries of the Beverly Caribou Protection Area. In 1990, Gauthier and Mulders (1990) on the basis of reviewing the Beverly calving distribution for the previous 5 years recommended that the eastern edge of the Beverly Protection Area (east of Deep Rose Lake) be dropped reducing the overall area by 16% (2,160 km²). No other changes to the Beverly Caribou Protection Area have been made since 1991.

Qamanirjuaq

The comparison of calving mapped during annual monitoring indicated that it was within the Caribou Protection Area 1978–1990. In 1982, the mapped calving distribution was west of Kaminuriak Lake and a small part was up to 15 km outside the western Qamanirjuaq Caribou Protection Area (Clement 1983). Post-calving movements were more variable in time when the caribou crossed the Caribou Protection Area boundaries. In 1986, Liepins (1986) recommended a southern extension of the Qamanirjuaq Caribou Protection Area boundary to accommodate post-calving movements observed 15 July 1986. DIAND amended the map for 1987, which extended the southern boundary to include Maguse Lake and Maguse River. And again, DIAND accepted Ogilvie's (1987) recommendation a further extension of the southeastern boundary of the Qamanirjuaq Caribou Protection Area to the coast. Further recommendations

were made in 1989 (Chalmers 1989) and 1990 (Gauthier and Mulders 1990) to extend the northeastern boundary to the coast at Pistol Bay (a 1% increase in the Caribou Protection Areas size). The authors also recommended deleting an eastern and western sliver from the northern Caribou Protection Area as caribou had not used the areas for 5 years. As with the Beverly Caribou Protection Area, no further changes were made subsequent to 1991.