# A REVIEW OF CONCERNS EXPRESSED BY OUTFITTERS BETWEEN 2003 AND 2007 ABOUT THE BATHURST AND AHIAK HERDS

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# ABSTRACT

Abundance of barren-ground caribou *Rangifer tarandus groenlandicus* in the Northwest Territories (NT) is known to fluctuate widely at regular intervals, based on surveys conducted since the 1970s, other scientific studies such as dendrochronology, and elders' traditional knowledge. The last period of major declines was in the 1970s. Most herds in the NWT and Nunavut grew in size in the 1980s, peaked in the 1990s and declined in the early 2000s. Declines in wildlife populations like caribou often bring hardship to the people who depend on them for subsistence or their livelihood. Criticism of the evidence for a decline in wildlife abundance is not unusual. The current decline of the Bathurst barren-ground caribou herd was detected in 2003. Some big-game outfitters did not believe that the Bathurst herd had declined, and questioned other aspects of the Government of the Northwest Territories' (GNWT) barren-ground caribou programs. The outfitters' strongest contention was that the Bathurst herd had not declined but rather that the Department of Environment and Natural Resources (ENR) had divided the Bathurst herd into the Bathurst and "new" Ahiak herds. This report reviews comments from the outfitters made during 2003 – 2007 about the Ahiak and Bathurst herds and details a response to their comments. The report addresses issues specific to these two herds, and reviews studies across the North American range of barren-ground caribou. The Bathurst and Ahiak herds have geographically separate calving grounds based on aerial surveys conducted between 1986 and 2008. Satellite telemetry (1996-2006) of adult cows from the two herds has also confirmed the annual use of separate calving

grounds and separate rutting areas. Over 30 years of surveys and evolving ecological research have supported the definition and management of barren-ground caribou as separate herds defined by individual calving grounds.

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# INTRODUCTION

Declines in wildlife populations often bring hardship to the people who depend on them for subsistence or their livelihood. Given the importance of wildlife, it is not uncommon for controversy to arise and for some stakeholders to question or reject population estimates when the data suggest populations are low or declining (for example: Weeks and Packard, 1997; Freddy *et al.,* 2004).

Based on surveys conducted since the 1970s, other scientific studies such as dendrochronology, and elders' traditional knowledge, the abundance of barren-ground caribou *Rangifer tarandus groenlandicus* in the Northwest Territories (NT) is known to fluctuate widely at regular intervals. The last period of major declines was in the 1970s. Most herds in the NWT and Nunavut grew in size in the 1980s, peaked in the 1990s, and declined in the early 2000s.

The Bathurst herd's annual range crosses jurisdictional boundaries with Nunavut and areas under several different land claim agreements (Figure 1). The herd is relatively accessible to people from ten communities including Yellowknife (Figure 1). Based on counts of breeding females on the calving grounds, the size of the herd was determined to be low in the mid-1970s, increasing in the mid-1980s and stable in the mid 1990s (Case *et al.,* 1996; Gunn *et al.,* 1997). Censuses in 2003 and 2006, supported by other evidence, showed that the herd was declining (Gunn *et al.,* 2005a,b; Nishi *et al.,* 2007). Some big-game outfitters did not believe that the herd had declined and subsequently questioned broader aspects of barren-ground caribou management in the

Northwest Territories, including the methods used to define and count caribou herds.

The administrative and legislative context for caribou management in the NWT is complex and has changed greatly in the last decades. Barren-ground caribou hunting is managed by the Government of the Northwest Territories (GNWT), working in partnership with regional co-management boards and Aboriginal governments. Under land claim agreements (e.g. Sahtu Dene and Métis Comprehensive Land Claim Agreement 1993, Tlicho Agreement 2003) and through case law, priorities for harvest allocation are highest for land claim beneficiaries, second for residents, and last for commercial use. Hunting by licence-holders (residents, big-game outfitting and commercial harvesting) is regulated by the GNWT Department of Environment and Natural Resources (ENR). Regulations passed by the GNWT are subject to change when caribou numbers increase or decrease. The complex nature of caribou management in the NWT may have both enhanced and hindered communication about the caribou decline and subsequent management actions. Ineffective communication may, at the least, contribute to wildlife controversies (Decker and Chase, 2001).

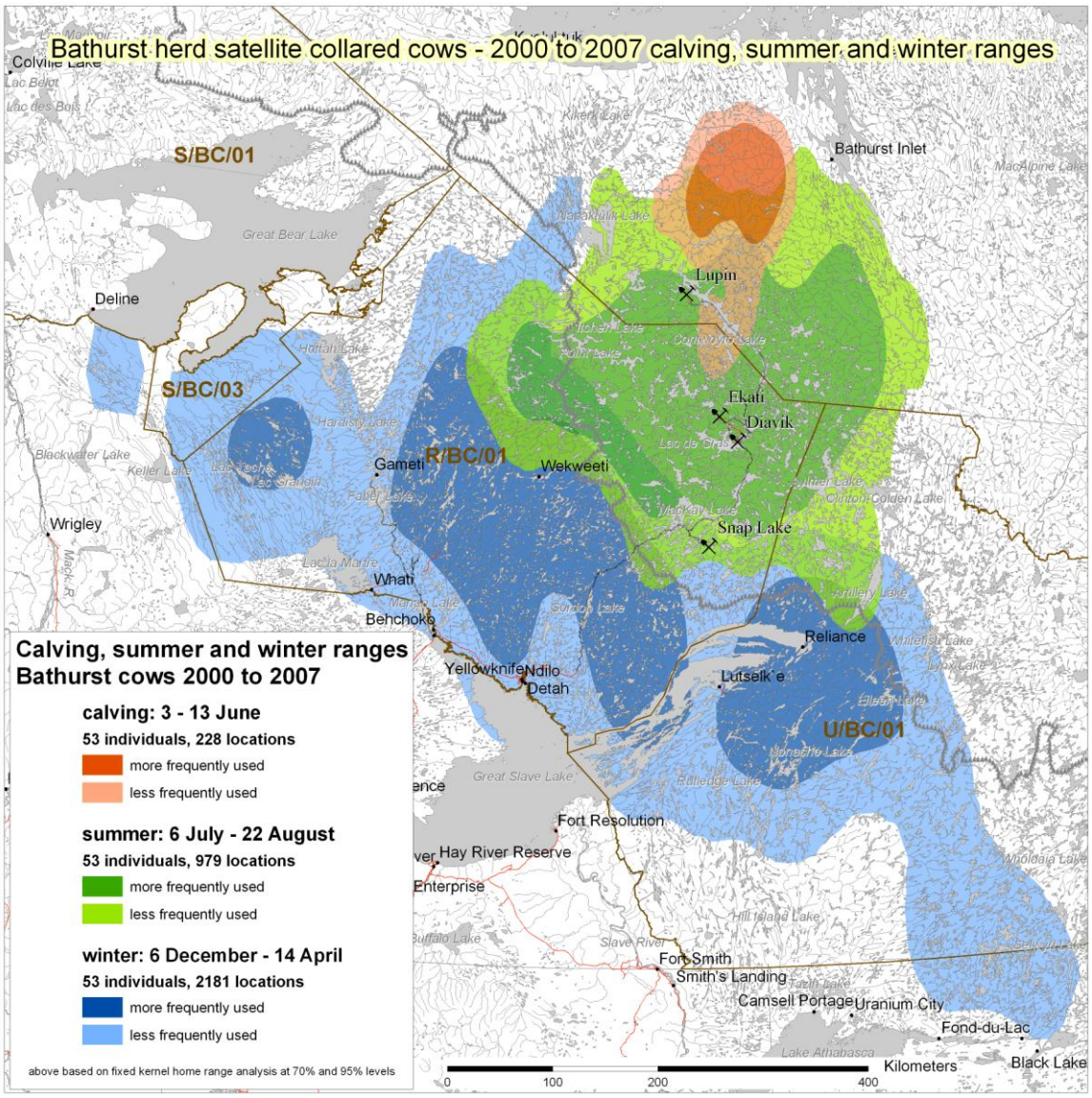


**Figure 1.** Annual range of the Bathurst caribou herd based on satellite telemetry (2000-2007), communities, jurisdictional boundaries and wildlife management zones.

## OBJECTIVES

In this report we summarize ENR responses to critiques expressed during the period 2003-2007 by outfitters who hunt barren-ground caribou in the Bathurst herd's range. Our main objective is to examine the outfitters' comments and concerns and explain the contested information, specifically for the Bathurst

and Ahiak herds. To provide context for comments on the outfitters' concerns, we review relevant background information on barren-ground caribou ecology and management from herds across their North American range. We begin with a brief history of barren-ground caribou outfitting operations in the central Northwest Territories and then provide a point-by-point explanation for the individual points raised by the outfitters. (Table 1; Appendices A – G).

**Table 1.** List of sources for points to be explained and appendices where comments are listed in response.

| Source | Appendices |
|---|---|
| Caribou Information Sheet (Mr. Boyd Warner 14 January 2004) | Appendices A and B. |
| Mr. Boyd Warner's comments on the Bathurst Caribou Management Plan | Appendix C. |
| Mr. John Andre's presentation to and questions at WRRB public hearings (transcripts 13-14 March 2007) | Appendix D. |
| Mr. John Andre's May 18, 2007 Final Submission to the Wek'eezhi Renewable Resources Board | Appendix E. |
| TerraMar Environmental Services Ltd's report 24 May 2007 | Appendix F. |
| Mr. John Andre's PowerPoint Presentation to ENR Minister Miltenberger 6 November 2007 | Appendix G. |

## Overview of outfitted barren-ground caribou hunting (1982 to 2006) and outfitter concerns

Non-residents (Canadian citizens who live outside of the NWT or individuals who live outside Canada) require an outfitter and licenced guide to hunt barren-ground caribou in the NWT. The hunting season for these hunters runs from August 31 to October 31 with most hunts completed by the first week of October. Reporting of harvest is mandatory for outfitters. There is some seasonal overlap in the ranges of barren-ground caribou herds in summer and

early fall, but radio-collar locations of cows indicate that the barren-ground caribou outfitters primarily access the Bathurst herd in August and September (Figure 2).

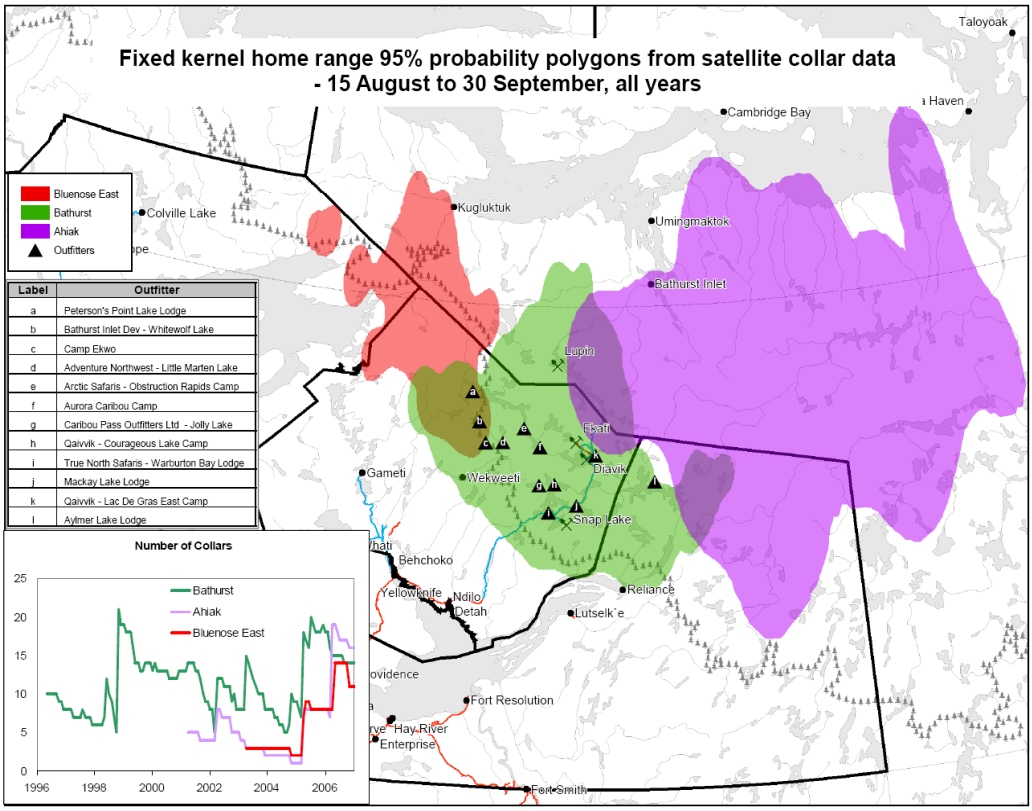


**Figure 2.** Ranges used August 15 to September 30 by the Bluenose-East, Bathurst, and Ahiak herds, based on satellite collar locations from 1996 to 2006. Main camps used by outfitters are shown as triangles.

Outfitted hunting for barren-ground caribou started in 1982 when 80 tags were issued for Wildlife Management Unit R. This was during a period when the Bathurst herd had started to increase (Table 2). The number of annual tags issued increased seven times between 1982 and 2000. Between 1982 and 1996, photographic surveys of the calving grounds and calf recruitment data indicated an increasing or stable trend in the numbers of caribou in the Bathurst

herd (Table 2). The next photo survey of the Bathurst calving ground did not occur until 2003.

**Table 2.** Changes in the number of outfitter tags for Unit R by year and estimated size of the Bathurst herd (data from Case *et al.,* 1996; Gunn *et al*., 1997, 2005b; Nishi *et al.,* 2007; ENR files). All population estimates are from calving-ground photo surveys.

| Year | Outfitter tags available | Estimated herd size (Mean +/- Standard Error) | Management planning |
|---|---|---|---|
| | | | |
| 1982 | 80 | 174,000 | |
| 1984 | 80 | 384,000 | |
| 1985 | 96 | | |
| 1986 | 200 | 472,000+/-72,900 | |
| 1987 | 400 | | |
| 1988 | 800 | | |
| 1990 | 800 | 352,000+/-77,800 | |
| 1991 | 1010 | | |
| 1992 | 1320 | | |
| 1994 | 1320 | | Draft GNWT Bathurst herd management plan and consultation |
| 1996 | 1320 | 349,000+/- 94,900 | |
| 2000 | 1656 | | Bathurst Caribou Management Planning Committee formed and consultations 2000-2004 |
| 2003 | 1656 | 186 000 +/- 40 100[2] | |
| 2004 | 1656 | | Bathurst Caribou Management Planning Committee releases plan |
| 2005 | 1656 | | Wek'èezhìi Renewable Resources Board established |
| 2006 | 1559 | 128,000 +/- 27,300 | NWT Barren-ground Caribou Strategy (2006-2010). |
| 2007 | 750 | | |

[2] Estimated herd size in 2003 and 2006, as in other years, is based on extrapolation from numbers of breeding females counted on the calving grounds (see Gunn *et al.,* 2005). The extrapolation assumes that the proportion of females is 0.602 and the overall proportion of pregnant females is 0.72, based on an average of six herds (Heard 1991 in Gunn *et al.*, 1997).

Outfitter licences are issued either to companies associated with community Hunters and Trappers Associations or to independent companies. Caribou harvested on tags issued for Management Unit R were assumed to be taken from the Bathurst herd (Figure 1, 2). The hunt was directed at large-antlered male caribou and the meat was used in camps, taken home by guides, or distributed to nearby communities.

The demand for outfitted hunts increased rapidly in 1985, when the Boone and Crocket Club created a separate category for central barren-ground caribou. By 2000, the number of tags in Unit R had been increased to 1656, with 396 tags allocated to the three Hunters and Trappers Association (HTA) outfitters, and 1260 tags allocated to seven non-HTA outfitters (departmental files). The number of tags was reduced to 1559 in 2006 and to 750 in 2007 after the 2006 Bathurst population survey showed a continuing decline.

The Department of Resources, Wildlife and Economic Development (RWED[3]) twice cooperated with the outfitter businesses to estimate the total contribution of big game outfitting to the NWT economy: $1.9 million in 1993 (300 non-resident hunters) and $3.26 million in 1999 (595 non-resident hunters) (Ashley, 2002). In 2006, the NWT Barren-ground Caribou Outfitter Association contracted their own report on the economic value of their business (GNWT Industry Tourism and Investment briefing material prepared December 2006). The 2005 contribution by the big game outfitting industry to the NWT economy was $4.01 million, which was about 7% of total receipts from leisure tourists

[3] The department was originally named Renewable Resources, became Resources, Wildlife and Economic Development (RWED) in 1996 and was re-named Environment and Natural Resources (ENR) in 2005.

(GNWT Industry Tourism and Investment briefing material prepared December 2006).

The Barren-ground Caribou Outfitters also cooperated with the Department in 2000 to report on issues facing the outfitting industry (Wordsworth Resources 2000). The report emphasized business and licensing concerns. The outfitters indicated a wish for better communication with RWED on research findings and rationale for management decisions, and for more input into Bathurst herd management planning. The report did not deal with the relationship between the number of tags and the size of the herd.

The Department issued outfitting tags annually with the proviso that the number of tags might change depending on herd size (departmental files). For example, when the number of non-HTA tags was increased to 1260 in May 2000, the Department's letter to the outfitters stated:

> "The increase [of tags] would be on an interim basis only, and subject to change by the Bathurst Caribou Management Board when a Management Plan is implemented, or if surveys indicate that the herd cannot sustain this level of hunting prior to the completion of the Management Plan." (Wordsworth Resources 2000).

The last time the number of outfitter tags was increased was in 2000. Spring composition surveys were reinstated in the 2000s and showed low calf recruitment. Then the June 2003 census results for the Bathurst herd revealed a decline (Gunn *et al.,* 2005b) relative to the previous census in 1996. The

Department presented the 2003 June census results during the Outfitters' Association annual meeting in October 2003.

The June 2003 survey results were not available earlier because of the time needed to count the census photographs and analyze the results. The outfitters were critical of the department's conclusions about the decline of the Bathurst herd. During the meeting, one outfitter, Mr. Boyd Warner (Adventure NW / Bathurst Inlet Developments), questioned RWED about the overlap in winter distribution of neighbouring herds in some years and about the number of herds. Mr. Warner asserted that the distinction between the Bathurst and Ahiak herds was not clear and he offered an alternative interpretation of ENR's information (Appendices A & B).

Similar questions from the outfitters arose during a public meeting on the decline of the Bathurst herd held in Yellowknife, 18 December 2003. These questions were addressed during the meeting. Mr. Warner then circulated his questions to other outfitters and the media as a 'Caribou Information Sheet'. On 19 December 2003, RWED staff met with the outfitters and gave a presentation with a 12-page response to Mr. Warner's questions (Appendices A and B).

In January 2004, RWED released a media advisory describing the December 2003 meeting with the outfitters. The advisory noted that "The Outfitters Association and RWED will continue to work together and with all other harvesters to increase monitoring of central barren-ground caribou and to determine what measures may be required to ensure the barren-ground herds remain healthy and viable."

On 4 November 2004, the Bathurst Caribou Management Planning Committee released a management plan for the Bathurst herd. The Committee had been formed in April 2000 with representation from the Department of Indian and Northern Affairs Canada; RWED, Government of the Northwest Territories; Department of Sustainable Development, Government of Nunavut; Dogrib Treaty 11 Council; Lutsel K'e Dene First Nation; Yellowknives Dene First Nation; the North Slave Métis Alliance; Nunavut Tunngavik Inc.; Kitikmeot Inuit Association; Kitikmeot Hunters and Trappers Association; and Nunavut Wildlife Management Board. The outfitters and resident hunters were represented through RWED-GNWT and were present at some public meetings when the plan was drafted.

The Bathurst Caribou Management Plan identified different actions for the herd depending on whether it was increasing, decreasing or at low numbers. One of the management actions identified for times when the herd was decreasing was a reduction in the number of tags for resident hunters and outfitting. When the herd was at low numbers, the plan recommended there be no tags issued for outfitting. This is consistent with priorities for harvest allocation under several NWT Aboriginal land claim agreements.

In February 2005, Mr. Boyd Warner responded to the Bathurst Caribou Management Plan (Appendix C) listing points similar to those he had previously raised in 2003. He shared his concerns with Members of the Legislature as well as with other outfitters and the local media. His concerns again focused on overlapping ranges and the implications for allocating harvests on a herd basis. He also referred to changes in the calving grounds of the Bathurst herd and the

presence of the Ahiak herd calving in areas traditionally used by the Bathurst herd. He contended that RWED had stated that all herds were increasing except the Bathurst herd.

Email correspondence between Mr. Boyd Warner and RWED continued during 2005, with further questioning of the calving distribution of the Bathurst herd. Mr. Warner also questioned whether the low number of satellite collared cows could be representative of the herd's calving distribution. In addition, Mr. Gary Jaeb (TrueNorth Safaris) questioned the calving distribution of the Bathurst herd and whether the low number of satellite collars was representative of the calving ground distribution. Mr. Jaeb had concluded that RWED's interpretation of the decline of the Bathurst herd was based on one [2003] survey. One outfitter threatened to sue the government if the outfitter quota for the Bathurst herd was cut (18 February 2005, NWT News North). Not all the outfitters shared this view.

During 2005 and 2006, ENR surveyed the Cape Bathurst, Bluenose West and Bluenose East herds using post-calving photography and confirmed a downward trend in the size of those herds compared to 2000. Population estimates for the Porcupine caribou herd based on post-calving photo surveys (from the Porcupine Caribou Management Board web-site: www.taiga.net/pcmb/population.html) indicated that this herd had been declining since about 1990. In June 2006, the Department undertook a photographic census of the calving ground for the Bathurst herd using the same methods used in 2003 and 1996. The results confirmed the downward trend in the Bathurst herd's size (Nishi *et al.,* 2007).

Given the widespread nature of the barren-ground caribou declines, ENR increased consultation with co-management boards and Aboriginal governments to publicize survey results and develop management actions. In February 2006, ENR released the *NWT Barren-ground Caribou Management Strategy (2006-2010)*. The Strategy identified the need for increased monitoring and actions to help the herds recover.

Since the release of the Bathurst Caribou Management Plan in 2004, the Wek'eezhii Renewable Resources Board (WRRB) has been established under the Tlicho Agreement signed in 2003. The WRRB is a co-management board and has the primary responsibility for wildlife management in Wek'eezhii. In December 2006, the Department proposed management recommendations for the Bathurst caribou herd to the WRRB. The proposal caused the WRRB to hold a public meeting to review ENR's proposal, which included a recommendation to reduce the 2006 level of 1559 outfitter tags (1163 non-HTA and 396 HTA outfitters) to a total of 350 tags for 2007. The NWT Barren-ground Caribou Outfitters Association and individual outfitters gave presentations to the WRRB in March 2007 during the public meeting and answered questions from the Board (WRRB transcripts). Mr. John Andre also posted his presentation on the Internet (www.nwtcaribounumbers.com).

Management actions taken around this time for other NWT herds included eliminating resident and commercial hunting opportunities in the Inuvik and Sahtu regions, as well as reducing the annual number of tags available to NWT resident hunters in other areas from 5 to 2.

During 2007, the outfitters again met with the government. Three outfitters filed and later withdrew two legal suits against the government. In May 2007, Mr. John Andre hired a biological consultant (TerraMar Environmental Research Ltd.) who reviewed the government's reports on caribou research. Mr. Boyd Warner and Mr. John Andre asserted that ENR had divided the Bathurst herd into the Bathurst and Ahiak herds, and this had resulted in an apparent population decline in the Bathurst herd. They also questioned the reported trend in numbers for the different herds and the allocation of harvests to individual herds. The outfitters have shared their concerns in the local media l; see, for example, the on-line Hunting Report article number 1792 in Feb. 2007 "Crisis over central barren-ground caribou"

(http://www.huntingreport.com/article_details.cfm?anniconc=Caribou%2C%20Central%20Canada%20Barren%20Ground&artstate=&artcountry=canada&whoconc=&artissu_m=&artissu_y=&arttitl=&artauth=), accessed Aug. 2007.

## EXAMINATION OF SPECIFIC CARIBOU MANAGEMENT ISSUES RAISED BY OUTFITTERS

### 1. NWT Barren-ground caribou management

**Outfitter concerns:**

The outfitters (Mr. Warner and Mr. Andre) questioned the validity of methods used by ENR to monitor and manage caribou populations. The outfitters and their contractor Fraker (2007) expressed reservations about herd designation, estimates of caribou abundance, sex and age ratio sampling, and sample sizes for satellite collars on individual herds.

**ENR comments:**

ENR's management programs for barren-ground caribou are based on premises and techniques similar to those used by other agencies in North

America. Approaches to management have been revised as new information or techniques such as new statistical designs, photographic survey methods and satellite telemetry became available. Additionally, ENR's approach to barren-ground caribou management has been subject to internal and external review (Urquhart, 1989; Caughley, 1991; Heard and Williams, 1990 and 1991; Mowat and Boulanger, 2000). The following text summarizes the basis for NWT caribou management and describes how the Department has refined its approach to improve survey design and adopt new technologies as they became available.

The evolution of caribou research in the 1960s-80s (Urquhart, 1981 and 1989) in the Northwest Territories traces the increase in our understanding of seasonal distribution, herd delineation, and general population trends for the Bluenose, Bathurst, Beverly, and Qamanirjuaq herds. The approach taken for barren-ground caribou herd designation in the NWT has been consistent since the late 1960s, and is consistent with the approach of other agencies, including Alaska. Across northern Canada, barren-ground caribou herds are defined and named based on fidelity of females to calving grounds.

Over the years, ENR has adopted new technologies in its barren-ground caribou program. As examples, individual caribou were first tracked using ear-tags, then by radio-collars, followed by satellite radio-collars, and most recently GPS[4] satellite radio-collars; photographic surveys have replaced visual surveys; and more recently, genetics have been used to investigate relationships between herds. While these evolving techniques have improved our knowledge of

[4] GPS stands for Global Positioning Systems; GPS satellite collars are expensive but provide more precise and frequent collar locations than satellite collars.

individual herd ecology and numbers and our ability to monitor herds, they also have consistently confirmed the herd-based approach that has been used for caribou management since the 1960s. In the 1980s, the Department dealt with the question of whether herds experience mass immigration from other herds (Heard and Stenhouse, 1992; Heard and Williams, 1990 and 1991) and found that inter-herd migration was minimal. Consequent research further confirmed the validity of fidelity to calving grounds as a basis for herd delineation.

In the 1970s, surveys along the route of the proposed Polar Gas pipeline mapped Wager Bay, Lorrilard and South Melville Peninsula calving grounds in what is now Nunavut[5] (references and maps in Gunn and Fournier, 2000). In the early 1980s, the understanding of caribou distribution, especially calving, increased in the northeast Kitikmeot region (now in Nunavut) and on Baffin Island. Also in the 1980s, under the leadership of Mr. Doug Heard, the methods for counting caribou were standardized and modified to deal with accuracy and precision. In particular, Heard developed and published the application of aerial photography to calving ground surveys (Heard, 1985).

In 1990-92, the GNWT approach to barren-ground caribou management and surveys was reviewed within the department by biologists and managers (Heard and Williams, 1990 and 1991). The review explained and justified basing management decisions on tracking the trend in numbers of breeding females and herd size, using photographic censuses on calving grounds or post-calving

[5] Nunavut became a separate territory in 1999. Previously, the Northwest Territories included all of what is now NWT and Nunavut. Several barren-ground caribou herds are shared by the two territories. Radio-collar data have also shown that in some winters, portions of the Bathurst, Ahiak, Qamanirjuaq and Beverly herds have also been found in northern Saskatchewan and Manitoba. The two provinces share management of trans-border herds with the two territories.

aggregations. The review re-affirmed the identification of herds based on annual return of cows to their traditional calving grounds. The sampling approach and logic for estimating calf:cow ratios as an index to recruitment was described.

Heard and Williams (1990, 1991) also reviewed and explained why post-calving photography was not a practical technique for NWT herds other than the Bluenose herd. D. C. Thomas had argued that post-calving photography was a more precise technique than the calving ground photography used in the NWT. He later published his argument (Thomas, 1998). However, the post-calving photographic aggregation technique requires a relatively large number of radio-collared individuals. Heard and Williams (1990, 1991) explained that the lack of community support for putting radio-collars on caribou made calving ground photography the only viable option for the Bathurst herd. Heard and Williams (1990, 1991) also pointed out that post-calving photography is dependent on weather conditions that cause caribou to aggregate and on the biologists' ability to locate all the aggregations. Post-calving photographic surveys have been used for the Porcupine herd, but from 2003 to 2008 annual attempts at counting the herd with this technique have failed, in part because the herd did not form sufficiently dense post-calving groups and in part because of poor weather. In some years, the window of opportunity for post-calving photography was as short as 24-36 hours (S. Arthur, Alaska Fish and Game biologist, pers. comm. 2008). Survey aircraft would have to be able to fly on a few hours' notice, a condition that might be very difficult to meet on the more remote NWT/Nunavut herd ranges.

In 1991, the Department invited Dr. Graeme Caughley, an internationally respected wildlife population ecologist and expert on aerial surveys, to review the department's approach to caribou management and techniques (departmental files). Caughley (1991) concluded that the approach and techniques used by the Department were sound and credible, although he cautioned against relying on calf:cow ratios to predict trends in abundance, in part because these ratios do not measure cow survival. An evaluation of the demography of the declining George River herd (Crete *et al.*, 1996) concluded that low calf recruitment and reduced adult cow survival were both major contributors to the herd's decline in the 1990s in Quebec and Labrador. ENR uses composition surveys, which provide ratios of calves:cows or bulls:cows, as indicators of herd status (e.g.: several years of low calf:cow ratios likely indicate a declining herd), but relies on census-surveys as the primary measure of herd size.

In 2000, the Department convened a workshop to examine the census methods for photographic censuses on calving grounds, and especially to examine options for increasing precision. The workshop included external reviewers, a statistician, and a biologist from the Government of Nunavut. The workshop participants concluded that the method was sound and that statistical procedures could be used to improve the precision of the estimates (Mowat and Boulanger, 2000).

The outfitters specifically criticized the sample size of satellite collars on the Ahiak herd and questioned whether their locations were representative of calving ground distribution. Gunn *et al.* (2000) acknowledged the small sample

size and used the collars as indicators of distribution. The collars were not used to map total distribution. When the distribution of caribou is concentrated, as during calving, collars indicate the calving ground's overall location but under-estimate the size of the area as mapped by aerial surveys (Gunn and D'Hont, 2002; Gunn *et al.,* in prep.). This is similar to findings in Alaska (Noel and George, 2003). The number of collars used on the Ahiak herd is limited in part by their expense. In addition, in the NWT and NU, there is sometimes resistance to the use of radio-collars. The degree of resistance to collars varies among communities and thus among caribou herds. Some elders consider putting collars on caribou to be disrespectful to the animals. Biologists working in the Canadian north balance the sample size required for study designs with respect for community concerns.

Technological advancements in telemetry, dendrochronology and genetics have allowed ENR staff to improve monitoring of barren-ground caribou herds and ecology. For example, the use of satellite telemetry started in the mid-1980s and greatly improved the frequency of locations of collared caribou. Satellite telemetry also made it possible to monitor animals in remote locations and under all kinds of weather. Previously, VHF collars[6] required fixed-wing aircraft flights to determine each location. These flights were costly and difficult in remote terrain. Dendrochronology (using annual tree rings to age trees) has been applied to determine the annual frequency of hoof scars in roots exposed on caribou trails as a retroactive technique to reconstruct historic caribou abundance

[6] VHF means Very High Frequency. VHF collars were the first type of radio-collar used in the NWT. They are relatively inexpensive but only transmit at a range of a few km, so must be radio-tracked to obtain locations..

over decades (Boudreau *et al.*, 2003). Zalatan *et al.* (2006) applied the technique to the late summer range of the Bathurst herd. The resulting pattern of highs and lows in abundance of the Bathurst caribou over time was similar to the Dogrib elders' oral history and provided an index of caribou abundance back to the 1800s (Dogrib Treaty 11 Council. 2001).

The application of nuclear DNA analyses to designating conservation and management units for Peary, boreal and mountain woodland caribou, as well as barren-ground caribou, was discussed when the Department convened a workshop in 2003. Geneticists, and biologists from Quebec, Nunavut and BC shared information (McFarlane *et al.,* in press).

The Department uses more than one method to determine trends in barren-ground caribou herd size. Population estimates are, for example, supported by monitoring trends in calf survival (measured from the ratio calves:100 cows), sex ratios (bulls:100 cows), observations by hunters and elders of pregnancy rates and body condition, and indirect indicators such as annual frequency of hoof scars. In the case of the Bathurst herd, decreasing estimates of breeding females in 2003 and 2006 correlated with low calf:cow ratios and low bull:cow ratios. Measuring trends in demographic rates, in addition to trends in census size, is an established practice for caribou management and also a recommended practice in conservation biology (Gerrodette and Gilmartin, 1990). Jenkins and Barten (2005), for example, describe trends in census data and measured demographic rates to describe a decline in an Alaskan caribou herd. Schaefer *et al.* (1999) used trends in demographic rates (calf and adult

survival and sex ratios) as well as trend in census size to describe a declining trend in the Red Wine Mountain herd (Labrador).

## 2. Government reports and peer-reviewed publications

**Outfitter concerns:**

The value of peer review in scientific wildlife management was one of the questions that Mr. Andre asked TerraMar Environmental Research Ltd to address. The specific question was “What is the value of published scientific papers that have been subjected to a critical review by external peers, compared with government reports, such as those prepared by the GNWT wildlife agency?”.

**ENR comments:**

A detailed response to the points raised by TerraMar is given in Appendix F. TerraMar (2007) focused on government reports by Gunn *et al.* (2000) and Gunn and D’Hont (2002) and concluded that technical and editorial deficiencies reinforced the need for external scientific peer review of GNWT reports. TerraMar’s (2007) conclusion was based on questions about the representation of sex and age ratio sampling; their perception that the distribution of the collared cows was non-random compared to the cows on the calving ground; and the small sample size of collared cows. As well TerraMar (2007) used four examples from Gunn *et al.* (2000) which included a typographic error, a misreading by TerraMar (2007), and two instances where, with hind sight, the authors could have included more detail about calculations. Instead, Gunn *et al.* (2000) referenced a peer-reviewed paper which detailed the rationale for the

calculations. Although the NWT departmental report series are reviewed and copy-edited, typographic and minor errors can slip by undetected. This also occasionally occurs in peer-reviewed technical publications.

ENR biologists regularly publish research findings in recognized, peer-reviewed journals. However, technical journals rarely accept results of individual wildlife surveys and, because space on paper is limited, raw data or very detailed methodologies are almost never published. In addition, the peer-review process used by journals often adds a year or more to the time needed for report completion and widespread availability. ENR staff publish their findings in technical journals on a regular basis, but government file and manuscript reports, now widely available via web-page on the internet, fulfill a complementary role in making individual survey and study results widely available.

The emphasis for the ENR reports is to keep the public, co-management boards, and wildlife management professionals informed about NWT wildlife status and studies, and to assist in making management decisions. Typically, reports are written for individual surveys or projects and those reports include detailed methods and raw data. Sometimes a report may be delayed by work-loads or staff turnover. The reports are reviewed within the department by biologists and their supervisors, and occasionally by reviewers external to the department. The reports are often co-authored by two or more biologists, which increases the level of technical review. This emphasis on reporting results through government reports is consistent with the approach of other government wildlife agencies.

One useful consequence of publishing individual survey and project reports that include detailed data is that the conclusions and interpretations in earlier reports can be superseded by information or re-analysis in subsequent reports. Every few years the Alaskan Department of Fish and Game publishes compendiums of annual inventory and survey reports. The advantage is that the previous and updated results and methods are all in the same report. The disadvantage is that the detailed methods and results are not always included.

The argument for undertaking peer-review, which is not limited to journal publications, (Anderson *et al.,* 2003) is to improve scientific credibility (Anderson *et al.,* 2003). The department has approached the need to ensure scientific credibility by inviting external (peer) reviews of approaches and survey design (see Section 1 above) and by providing on-the-job training, education leave and sabbatical leave for ENR staff. The department regularly supports presentations at scientific meetings and in recognized journals. For example, the NWT calving ground photographic census was published as a peer-reviewed publication after a caribou workshop (Heard, 1985) while Couturier *et al.,* (1994) compared results of calving and post-calving photo surveys for the George River herd. Heard and Calef (1986) reviewed the population ecology of the Kaminuriak herd (now the Qamanirjuaq herd) and Gunn and Miller (1986) reviewed fidelity to calving grounds by barren-ground caribou. Caughley and Gunn (1993) compared and evaluated population dynamics of kangaroos and caribou, and Gunn (2003) reviewed the complex relationships between caribou, climatic variation and forage.

### 3. Designation of caribou herds

**Outfitter concerns:**

Mr. Boyd and Mr. Andre's most serious concern is the GNWT's designation and management of barren-ground herds based on calving grounds. For example Mr. Andre wrote:

> "Splitting the Bathurst Herd - The splitting of herds and counting caribou in only one of these herds, and then applying these numbers to previously surveyed "complete" herds is the heart of our argument with the Department of Environmental Resources. For forty years, we had four herds, but now we needed seven." (Slide 37 of 54 slides Part 1 presentation to Mr. Michael Miltenburger 31 October 2007).

TerraMar (2007) criticized the designation of the Ahiak herd based on the absence of genetic differences from the Bathurst herd, the small sample of collared cows (1996-1998), and TerraMar's perception that the distribution of the collared animals was not representative of all breeding cows on the calving ground (see Appendix F for detailed comments on this assertion).

**ENR comments:**

We have organized our response to the outfitters' concerns regarding calving grounds into four sections:

(a) describing the basis for defining herds in the NWT and elsewhere;

(b) defining the logic for using 'herds' as the appropriate unit for management;

(c) summarizing the basis for designating the Bathurst and the Ahiak herds as separate herds; and

(d) reviewing the trends in numbers of caribou in the Bathurst and Ahiak herds.

This section is lengthy, in part because herd designation was the most contentious issue for the outfitters, but also because there is a considerable body of published work supporting the approach used in the NWT and in other jurisdictions.

**(a)** The Definition of 'Herd'

The concept of 'herds' as aggregations which did not associate with each other dates back to Preble (1908 in Urquhart, 1989). In the NWT, aerial surveys of caribou ranges started in 1948. Banfield (1954) organized those initial surveys and identified 19 herds based on winter distribution. However, assigning herd names to sections of the winter range caused confusion as use of the winter range was not annually predictable (Thomas, 1969). More recent information has reinforced Thomas' (1969) comments on winter range use. Periodic shifts in winter range use and partial overlap of neighbouring herds on winter ranges are two characteristics of barren-ground caribou herds (Schmelzer and Otto, 2003).

Based on caribou ear-tagging studies and field observations, Thomas (1969) suggested that the use of calving grounds was more predictable than the use of winter range, as caribou used the same (overlapping) area to calve, year after year. On the central Canadian barrens, Thomas (1969), while surveying

spring migration of caribou in 1968, linked the return of caribou to their calving grounds to the definition of the Bluenose, Bathurst, Beverly and Qamanirjuaq herds. Although calving grounds were previously known, it was Thomas (1969) who named the herds on the basis of their return to the calving grounds and his 1968 pre-calving survey. At about the same time, based on surveys of the Qamanirjuaq herd, Parker (1972) recognized the importance of calving grounds as relatively small and predictably located areas from which to survey caribou numbers. Survey methods since then (calving and post-calving) have taken advantage of the limited size and discreteness of calving grounds and post-calving ranges.

One of the first definitions of 'herd' in caribou biology was Bergerud's (1963), which defined a caribou herd in Newfoundland as "a temporarily discrete population of at least 100 animals composed of individual aggregations distributed within a restricted geographical area". Meanwhile, in the 1960s, in dealing with large herds of migratory tundra caribou in Alaska, both Lent (1964) and Skoog (1968) recognized the annual use of traditional calving grounds and its importance in defining groups of caribou. Skoog (1968) defined a herd as a group of caribou which uses a calving area (center of occupancy), distinct from that of any other group, for a number of years.

A detailed example of the data used to designate a herd comes from northern Alaska. Cameron and Whitten (1979) reported on systematic seasonal aerial surveys done in 1975 to identify seasonal centers of caribou occupancy on the coastal tundra. Historic observations of calving had suggested the presence

of a concentration of calving caribou between the Western Arctic and Porcupine herd ranges. Their 1975 surveys revealed the continued use of calving and post-calving areas distinct from those of the neighbouring Porcupine and Western Arctic herds. On the basis of the regular use of “a relatively fixed calving area, predictable formation and movement of post-calving aggregations, and the synchrony of movement during the annual cycle”, Cameron and Whitten (1979) named these caribou the Central Arctic herd.

In Alaska, by the mid-1970s, studies moved beyond aerial surveys to marking individual caribou to document their movements and use of seasonal ranges. Caribou were marked either with visible collars or radio-collars. Early in the use of marked caribou, overlap on the winter range led to premature conclusions about the extent of inter-herd movements. Whitten and Cameron (1983) marked 127 caribou on the Central Arctic herd’s winter range (1975-78) and found 6% in the three neighbouring herds. This caused the authors to conclude that 6% of the re-sightings were inter-herd movements. Subsequently, Cameron *et al.* (1986) refuted that conclusion as the herd identity of the caribou marked on the winter range had not been initially established. In their subsequent analysis of 1975-82 data, Cameron *et al.* (1986) first established whether the marked caribou were on the Central Arctic herd’s summer range on the coastal tundra and then relocated the caribou in three subsequent summers. They found an overall 91% fidelity to summer range (129 of 142 caribou years of radio-tracking). Only one caribou was a confirmed emigrant to another herd. Cameron *et al.* (1986) concluded that their estimates of summer range fidelity were a

“reasonably accurate reflection of calving ground fidelity” and that “caribou occur as separate subpopulations or herds, each occupying a calving ground and summer range distinct from that of any other.”

In the NWT, in the mid-1980s, the concept of herd designation based on fidelity to calving grounds was tested using the Qamanirjuaq herd. Unexpected census results for the Qamanirjuaq and Bathurst herds led Heard and Stenhouse (1992) to use marked individual caribou (radio-collars) to test one of the possible explanations – mass immigration. The test was only undertaken for the Qamanirjuaq herd as there was no community support for collaring on the Bathurst herd’s range (Heard and Stenhouse, 1992). The issue for the Qamanirjuaq herd was the relationship between the Qamanirjuaq herd and the neighbouring Beverly and northeastern mainland herds (Wager Bay, Lorrilard and Melville Peninsula). Heard and Stenhouse (1992) cautioned that their findings could not be used to retro-actively explain why the Qamanirjuaq herd had increased.

The two research questions they addressed were whether cows would be within a calving ground as defined by standard census surveys, and whether cows returned to the same herd’s calving ground in consecutive years. Based on categorizing fidelity as the return of cows to within 90 km of the previous year’s location during calving, Heard and Stenhouse (1992) found that 5% and 9% of the cows would have been outside the Qamanirjuaq and northeast mainland herds’ calving grounds respectively. Secondly, in the four years of the study, only 4 of the 82 cows located in two consecutive calving seasons switched calving

grounds. One cow was on the Qamanjuaq calving ground for 3 years and 1 year on the Beverly calving ground. Two cows switched between the Wager Bay and Melville Peninsula calving grounds. Heard and Stenhouse (1992) concluded that the Qamanirjuaq herd was discrete and “there is no reason to reject the concept of herd definition based on calving grounds”.

The application of satellite telemetry was a step forward in defining herds as it confirmed that cows found together on a particular calving ground will also be associated during the rut. The implication is that the herd is a breeding unit – at least based on the cows. Gunn and D’Hont (2002) and Nagy *et al.* (2005) have reported on the calving and rutting distributions for the Bathurst, Ahiak, Bluenose-West, Bluenose-East and Cape Bathurst herds. This adds strength to the argument for basing the definition of herds on the return of cows to the calving grounds and for using herds as management units. Satellite telemetry has also shown fidelity to post-calving and summer ranges and in some years, overlapping distribution on winter ranges with neighbouring herds (Gunn and D’Hont 2002; Nagy *et al.,* 2005).

Community reservations about the capture and handling of caribou and the expense of satellite telemetry limit the number of caribou collared in some herds to small sample sizes relative to herd size. Low sample size is fairly typical of telemetry studies for many large mammals. For example, Stewart (2008) defined walrus *Odobenus rosmarus* management units in the eastern Arctic using 18 satellite tags (1994-2003) to define seven stocks. He also used supporting information from survey observations to define management units.

Stewart's (2008) use of supporting data regarding the telemetry data is similar to how biologists use the collared caribou locations with supporting aerial survey data. Satellite collars on female caribou provide useful supporting information for calving ground photographic surveys; collar locations provide independent data on timing and extent of calving, which is complementary to the systematic survey methods used to delineate annual calving grounds.

The next tool to be applied to the definition of caribou herds was nuclear DNA analyses. Studies to date have left some uncertainties about the identification of herds using DNA methods. The use of DNA analyses initially started in relation to conservation questions about population structure in Peary caribou (MacFarlane *et al*., In Press). The DNA analyses showed differences among smaller herds in the mountains and arctic islands, but the results were not as clear-cut for the large barren-ground herds in the NWT and Nunavut (Zittlau, 2004) and northern Quebec and Labrador (Boulet *et al.,* 2005). Early in her analysis, Zittlau (pers. comm. 1999 cited in Gunn *et al.,* 2000) considered there to be differences between the Ahiak and the Bathurst herds. However, with more statistical analyses, the genetic differentiation was not clear-cut. For example, Zittlau (2004: 84) wrote "Pairwise assignments showed that the greatest proportion of assignments were to the sampled population." Two exceptions were noted. First, the Ahiak herd was not different from the Bathurst herd, although the Bathurst herd was differentiated from the Ahiak herd (the lack of symmetry in the relationships is a consequence of the assignment test). Second, the Beverly was

neither different from the Ahiak nor the Qamanirjuaq, although the Qamanirjuaq herd was different from the Beverly herd. Also Zittlau (2004) wrote that,

> "The linkage disequilibrium noted in the Ahiak and Qamanirjuaq herds may be indicative of their more relatively recent establishment. Glacial retreat occurred later on the northeastern mainland, where the herds are presently located, than it did in western regions. Therefore, the Ahiak and Qamanirjuaq herds may have been established only 2000 to 3000 ybp (years before present), as opposed to the establishment of the Porcupine and barren-ground herds in the Northwest Territories and western Nunavut, which likely occurred as long ago as 8 000 to 10 000 ybp."

We recognize that there remain uncertainties about what can be concluded about the genetic distinctiveness of barren-ground caribou herds. Further analyses using more loci and both nuclear and mitochondrial DNA for males and females may clarify relationships among herds (D. Paetkau 2007 pers. comm.). Genetic methods are evolving due to recent advances in laboratory techniques and analytical techniques (Selkoe and Toonen, 2006; Väli *et al.*, 2008). The advances include analyses which can increase the resolution and power of genetic analyses to partition genetic variation between individuals, social units, populations and groupings of populations (Scribner *et al.*, 2005). Although Zittlau (2004) did not find compelling evidence that the herds were not genetically differentiated, further more detailed sampling and analyses will refine our understanding of genetic differentiation between herds.

Using genetic evidence involves different terminology, which can cause confusion. Geneticists define ‘migration’ as the movements of a few genes per generation, through dispersal or simply interbreeding. This would not be at a scale measured demographically. Boulet *et al.* (2005) refer to 5-10 immigrants/generation being sufficient to explain genetic similarities between herds, and satellite radio-telemetry has confirmed a low rate of individual exchange among neighbouring herds. Finding genetic similarities is difficult to interpret as evidence for dispersal between the two populations if effective population size is large. In large populations (more than a few hundred individuals), genetic drift is slow and differences between populations can require many generations to accumulate. Similarities can be the result of a common origin for two populations or dispersal (i.e., gene flow) between the populations.

## ‘Herds’ As The Appropriate Unit For Management

Wildlife management deals with changes in abundance of populations driven by rates of births, deaths, immigration and emigration (Caughley, 1977). ‘Population’ has been variously defined since its introduction in the 1950s. Berryman (2002), in a review, argued that the population is a basic building block of ecology and should be defined as “a group of individuals of the same species that live together in an area of sufficient size to permit normal dispersal and/or migration behaviour and in which numerical changes are largely determined by birth and death processes.”

There are two lines of evidence that support the assertion that caribou herds meet the above definition of “population”, particularly in how changes in abundance are determined by birth and death rates. Firstly, measured herd-specific changes in calf survival and mortality have been sufficient to explain recorded trends in abundance of particular herds (Boulanger and Gunn, 2007; Jenkins and Barten, 2005; Fancy *et al.,* 1994; Davis *et al.,* 1978). Secondly, rates of dispersal (immigration or emigration) are rarely sufficiently high to significantly affect herd size. For years, this has been speculated about, with earlier proponents arguing that at intervals, large-scale dispersal took place (Skoog, 1968; Bergerud, 1980; Haber and Walters, 1980; Bergerud, 1983). However, since the widespread use of telemetry, there has been little evidence from Alaska or NWT to support the supposition of mass emigration. Hinkes *et al.* (2005) argued to the contrary, generalizing from two apparently rare instances for mountain caribou in Alaska (Davis *et al.,* 1986; Hinkes *et al.,* 2005), which we suggest are the exception rather than the rule.

Schaefer *et al.* (1999) suggested that emigration had contributed to the decline in the Red Wine Mountain herd in Labrador. This herd is a small sedentary herd of boreal woodland caribou (151 caribou in 1997; 95% CI = 65-251) whose annual range overlaps in some years with the winter distribution of the much larger migratory George River herd. Schaefer *et al.*‘s (1999) evidence for emigration was limited: 5 of 36 >1-year-old radio-collared females in October or November moved ca. 200 km to where the migratory George River Herd was wintering. One of the five females returned before calving and the other four died

during the winter so it is unknown whether they would have returned. Possibly they would have returned, as Brown *et al.* (1986 in Schaefer *et al.,* 1999) described how female caribou from the Caniapiscau Herd, a sedentary herd at the southern edge of the George River caribou range, returned 200-500 km to their previous year's calving sites after moving north with the George River Herd during winter.

The reasons for managing caribou at the herd scale rather than one large geographic area are two-fold. Firstly, regional ecological conditions such as weather, hunter harvest rates and predator abundance vary across the NWT and Nunavut. Caribou from different herds are responding to variable regional ecological conditions, which is why relative abundance and demographic rates vary between herds. Secondly, the most efficient and effective times to count barren-ground caribou herds are either when they are on the calving grounds or during post-calving aggregations. By contrast, counts on the winter range would have to cover much greater areas and could include caribou from more than one herd.

If, over the timescale of management (typically decades), individual caribou herds undergo changes in abundance and demographic rates independent of neighbouring herds, and demonstrate geographic isolation during at least the breeding season, then the herd is the appropriate unit for management. In Alaska, the Yukon, Northwest Territories, Nunavut, Quebec and Newfoundland and Labrador, the herd, as defined by calving grounds, is the basis for management of barren-ground caribou.

Hinkes *et al.* (2005) recently suggested that our collective experience with caribou is too short to know how caribou will behave during all phases of their population cycles. Increasing knowledge as we collectively monitor over longer periods of time has revealed greater complexity in caribou behaviour. However Hinkes *et al.* (2005) did conclude that the 'herd' as a management unit is still valid, which is the same conclusion reached by Valkenburg *et al.* (2003). Valkenburg *et al.* (2003: 43) stated for Alaskan herds,

> "The last 20 years of data from radio-collaring and radio-tracking caribou indicate that caribou herds can be considered closed populations for the purposes of population management."

This comment indicates that movements of individual caribou between herds occur, but that their scale (relative contribution to population dynamics and probability of occurrence) is insufficient to affect estimated herd sizes. Use of the herd as a management unit is then consistent with the concept that management units must be defined by management objectives and consideration of the risks of failing to detect changes in size (for example, Taylor and Dizon, 1999).

The scale of movements that would affect an estimate of herd size depends on the precision and frequency of population surveys – in other words, the ability to detect changes. An alternate approach is to look at the known scale of calving ground switching by individual cows. Switching between two calving grounds is relatively uncommon and may be environmentally forced (e.g. the Teshekpuk herd in 2004, Carroll 2005) or a result of individual variation. It is likely that the strength of fidelity to a calving ground is an individual trait and likely

to vary with age, experience and even condition (Gunn and Miller, 1986; Davis *et al.,* 1986; Heard and Williams, 1990 and 1991).

Radio-collar telemetry studies have shown that very few individual cows switch calving grounds. For example, in the Bathurst herd, we had 63 pairs of consecutive years of calving locations (1996-2006) and only two cows were located outside the Bathurst calving ground – one was found to be a non-breeder and one cow went to the Bluenose East calving ground (Gunn and Poole, Unpubl. Data). We had one collared cow that returned to the Bathurst calving ground for six consecutive years and six cows that returned to the Bathurst calving grounds for four or five years. The low rate of switching between the Bathurst and neighbouring herds is similar to, for example, the Teshekpuk herd: Person *et al*. (2007) documented an annual apparent emigration rate of 0.07 +/- 0.03 (five cows from 73 caribou years, 1990-2005). We also had 14 pairs of consecutive calving (2000-2006) for the Ahiak herd, including one cow returning to the Ahiak calving grounds for five consecutive years and one cow returning for three years.

The low level of radio-collared individual cows that do switch between calving grounds has been interpreted as evidence of dispersal (for example Boulet *et al.,* 2007). However, recording a cow on a neighbouring herd's calving ground is incomplete evidence of dispersal unless the individual is known to have bred outside its natal population, which requires a comparison of rutting locations and an assessment of breeding. Another difficulty is that some cows have reverse-switched calving grounds (i.e. shifted to a different calving ground and

then returned to the original one; Boulet *et al.,* 2007) and the duration of sampling (sometimes just 2-3 years for each cow) limits our ability to assess longer-term individual movements. Dispersal in mammals is generally most common in juveniles, whose seasonal movements and range fidelity have thus far had limited study in caribou.

The rates of cows switching between neighbouring calving grounds vary between herds. In Alaska, the Mentasta, Nelchina, Chisana and FortyMile herds had overlapping winter ranges in some years. Only one of 175 cows radio-collared between 1981-1990 switched calving grounds between the Mentasta and Nelchina (Lieb *et al.,* 1994). However, rates of switching were higher between the George River and Leaf River herds in northern Quebec and Labrador. Boulet *et al.* (2007) recorded that 14 of 149 satellite-collared cows switched calving grounds (1986-2003). Most of the switches were George River cows moving to the Leaf River for at least one calving season (whether they calved was not recorded). The annual rates of switching calving grounds were 6.6% and 0.9% of the George River and Leaf River collared cows, respectively. Six of 13 cows (one cow had only two calving locations) reversed and returned to their natal calving ground. Two cows spent an equal number of years on either calving ground (six and eight years).

Environmental variation such as unusual regional weather affects caribou movements and distribution, and may occasionally result in unexpected calving locations. Fall conditions can result in long-distance movements to unusual winter ranges (Campbell, 2005; Carroll, 2005). During spring migration, the cows

may not all make it back to their natal calving ground. For example, Person *et al.* (2007: 247) commented that three of five collared Teshekpuk cows, and possibly thousands of other Teshekpuk caribou, may have migrated to the neighbouring Central Arctic herd's range in 2003/2004. However, Carroll (2005) added more explanation than Person *et al.* (2007). Usually the Teshekpuk herd winters on the Alaskan coastal plain. In fall 2003, severe icing conditions may have induced a third of the herd (including five collared cows) to migrate about 400 km to the Alaskan National Wildlife Refuge. During spring migration in May 2004, Carroll (2005) reported that a combination of the Trans Alaska Pipeline, the Dalton Highway and the flooding Savaganirktok River delayed the Teshekpuk migration. Two collared cows eventually continued migration west but calved before they reached the Teshekpuk herd's usual calving ground. The other three collared cows and many uncollared cows calved on the Central Arctic herd's calving ground. Attention must be paid to environmental conditions when interpreting unusual caribou movements, including apparent switching between calving grounds.

The fidelity of caribou to familiar seasonal ranges, especially calving and post-calving ranges, likely confers advantages to individual reproductive fitness. This fidelity would likely not be such a widespread characteristic of migratory tundra caribou if it did not confer evolutionary advantages. The question of the disadvantages of leaving familiar ranges has not been explicitly addressed. However, Carroll (2005) reported for the Teshekpuk herd that annual mortality

was highest (24-25%) in the two winters when icing conditions triggered unusually long distance movements to unfamiliar (rarely used) winter ranges.

Person *et al.* (2007:247) commented on the emigration of three collared Teshekpuk herd cows to the Central Arctic Herd's range in 2003/2004 after icing on the fall range and speculated that the emigration explained some of the variation in population estimates. However, the 2004 post-calving photographic census was unsuccessful because of weather (Carroll, 2005), thus the effect of the emigration on estimated herd size was not documented.

Some instances of extensions of winter ranges (mass movements) have been mistakenly ascribed to emigration between herds. For example, Valkenburg and Davis (1982) refuted two supposed examples of mass emigration/immigration between the Porcupine and Fortymile herds in 1957 and 1964. The examples were based on observations of caribou winter distribution and preceded the use of radio-collars, which have considerably improved our ability to describe herd movements. Difficulties in discriminating between winter range overlap and emigration between herds are now less likely with the general use of individually marked caribou.

There are other instances when biologists have speculated about mass emigration as one of several possible explanations for unexpectedly large increases in herd size. As described earlier, Heard and Stenhouse (1992) placed 112 radio-collars over four years on the Qamanirjuaq and neighbouring herds and reported that four cows (3.6%) switched calving grounds. Heard and Stenhouse (1992) concluded that the data did not support the suggestion that

immigration contributed substantially to the increase in the Qamanirjuaq herd. However, they cautioned that their observations were for 1985 to 1988 and did not eliminate the possibility that large-scale dispersal contributed to changes in the number of animals on the Qamanirjuaq calving ground in past years.

In the Alaskan mountains, there are two examples of smaller mountain caribou herds assimilated by larger barren-ground caribou herds (Valkenburg *et al.,* 2003). The two published examples (Davis *et al.,* 1986; Hinkes *et al.,* 2005) both involved a change in calving behaviour – a switch from dispersed to gregarious calving by a smaller mountain herd, and a shift in calving grounds, with the larger herd absorbing or swamping the smaller herd. In both examples, the larger herd had expanded and shifted its calving ground. And, in the mountains, the nearest neighbouring herd was geographically close (Text boxes 1 and 2). Between 1979 and 1987, the calving grounds of the smaller Yanert herd (500-1000 caribou) and the larger Delta herd (4000-8000 caribou) were only 10 – 50 km apart after the Delta herd's calving ground had shifted. In the second example, the smaller Kilbuck herd's (ca. 4000) traditional calving ground was within 25 km of the larger Mulchatna's (ca. 200,000) shifted calving ground in 1994 (Hinkes *et al.,* 2005) and the herds combined. The smaller mountain herds (Yanert and Kilbuck) had different calving strategies (scattered rather than gregarious) than the larger herds. The larger herds with gregarious calving expanded their winter and summer ranges and each overlapped a small neighbouring herd.

About half of Alaska's herds are small (<1000 caribou) and the mountainous terrain lends itself to the maintaining of two calving strategies: gregarious, or dispersed, such as along ridge tops. The two calving behaviours are different responses to predation (Bergerud, 1996). Hinkes *et al.* (2005) argue that the Mulchatna's assimilation of the Kilbuck herd was an example of "significant interchange" and "mass immigration" (though they defined neither term). Hinkes *et al.* (2005) also implied that interchange could occur between other herds based, apparently, on genetic data (Cronin *et al.,* 1998). As previously described in this report, the basis for genetic immigration/emigration is very different from demographic mass immigration. Additionally, Zittlau (2005) noted that the lack of genetic difference between the Alaskan herds (Cronin *et al.,* 2003) was based on microsatellite markers with low levels of variability. Some of the microsatellite loci were linked on the same chromosome or potentially linked to functional genes. This raises the possibility that selection pressures could alter the genetic diversity rather than the relationship between the herds.

Given that the above information pertains to herds in the Alaskan mountains and coastal plains, how relevant is it to the barren-ground herds in NWT and Nunavut? Firstly, the balance of evidence is that the concept of defining herds as populations based on their return to traditional calving grounds is a robust and pragmatic model. Switching between herds based on fidelity to calving grounds appears to normally occur at very low rates. Given that most herds, especially Alaskan herds, have radio-collared caribou that

are annually tracked, the evidence for mass immigration is very rare. The two documented cases both involved a large migratory herd “swamping” a much smaller mountain herd, which may not be representative of neighbouring large migratory Canadian barren-ground herds. Secondly, the Alaskan mountainous terrain is likely a factor in facilitating alternative strategies such as dispersed calving along mountain ridges, which likely plays a role in maintaining small herds.

Both Hinkes *et al.* (2005) and Boulet *et al.* (2005) agreed that herd identity based on calving ground fidelity is appropriate for short-term management. Valkenburg *et al.* (2003) did not mention a timeframe when affirming that the herd concept based on fidelity to calving grounds is a valid model. Hinkes *et al.* (2005) and Boulet *et al.* (2005) suggested that a metapopulation approach may be appropriate over a longer-time scale, but offered no details as to the timescale and conceptual framework for dispersal strategies. Defining a time and spatial scale for management is essential (for example, Clapham *et al.*, 2008). Applying the metapopulations concept to caribou would be premature without more precise terminology and analyses. Originally, Levins (1969) introduced “metapopulation” as a term for any population composed of local populations established through immigration and emigration. The application of ‘metapopulation’ has mostly been for insects and small mammals rather than large mammals which would have to meet specific conditions (Elmhagen and Angerbjörn, 2001). Furthermore, Berryman (2002) in his review commented that

the term metapopulation has not brought any clarity to either defining populations or metapopulations.

The balance of evidence supports the approach of defining barren-ground caribou herd identity based on calving fidelity over the past 40 years. We acknowledge that we are unlikely to have sampled the full range of caribou evolutionary strategies and, over longer time periods, more knowledge about caribou ecology and herd identity may accrue. Bergerud (1974) and Davis *et al.* (1986), for example, have emphasized that the caribou's use of space is adaptive.

**Text Box 1. A summary of the Delta and Yanert caribou herds, Alaska, 1979-89.**
In the Alaskan mountains south of Fairbanks, between 1979 and 1985, the Yanert herd numbered 500-1000 caribou and the Delta herd 4000-8000 caribou. Their calving grounds were some 50 km apart across a watershed (Davis *et al.,* 1986). The Yanert cows calved at scattered locations at higher elevations, in contrast to the more gregarious calving of the Delta herd at lower elevations. Although the two herds had separate calving grounds, their other seasonal ranges overlapped. Tracking radio-collared caribou in the two herds revealed that, after calving on the Yanert calving ground, one of the 60 collared cows switched to the Delta calving ground for three years. Also, 10 of 49 Delta radio-collared cows switched to the Yanert calving ground in 1984 and then returned to the Delta herd calving ground in 1985. By 1986, Davis *et al.,* (1988) described an expansion of the Delta herd's calving range, which brought the Delta and Yanert calving grounds to within some 10 km of each other. Although strong fidelity to the Delta calving grounds was documented during the eight-year study period, there were four radio-collared Delta cows in 1983, seven of 36 cows in 1984 and 10 of 19 cows in 1987 that were on the Yanert's calving grounds. In the intervening years, those cows calved on the Delta calving ground. Snow conditions varied considerably, with late snow melt in 1982 and 1983 when Delta caribou calved 'outside' the major calving area. In 1987, snowmelt was early and caribou apparently calved at higher elevations, closer to the retreating snowline. Valkenburg *et al.* (1988) commented that the 1984 and 1987 shift in the Delta's herd calving might have occurred previously but was been missed because of the infrequency of surveys. In 1988, the Delta herd's calving distribution continued to shift to the area used by the Yanert herd (the upper Wood River).

Intriguingly, Valkenburg *et al.* (2002) commented that, in contrast to calving, the use of post-calving and summer range did not shift during the period (1987-90) when the calving had shifted west. However, Davis *et al.* (1991) noted that in 1986-89 in early July, the post-calving aggregations from the two herds were in the same area and so the herd size estimates were a combined total. The net effect was that the Yanert herd was no longer treated as a separate herd although the rut distribution of the collared caribou in the two herds was not described in detail. However Davis *et al.* (1991) mentioned that during fall 1987, radio-collared caribou from both herds overlapped and in 1988 and 1989, no radio-collared Yanert caribou were found on the traditional Yanert herd rut area. All collared cows were with the Delta radio-collared caribou.

**Text Box 2. A summary of the Mulchatna and Kilbuck herds, Alaska, 1981-2000.**
An example of one caribou herd absorbing another occurred when the Mulchatna herd was increasing in abundance from 20,000 in 1981 to a peak at 200,000 in 1996, and expanding fall and winter ranges as herd size increased. The Mulchatna herd absorbed the much smaller Kilbuck herd (estimated to number 4220 in 1994). The mechanism appeared to be both a shift in fall movements and a shift in the calving ground (Woolington, 2005), although the report lacks maps or detailed analysis.

In August 1994, 10,000-40,000 Muchatna caribou moved onto the Kilbuck herd's range and stayed there until April 1995, traveling through the Kilbuck's traditional calving grounds. The Kilbuck caribou calving was dispersed along mountain ridges within about 25 km of the Mulchatna herd's calving ground. In June 1995, 11 of 13 collared Kilbuck cows were on the Mulchatna calving ground and two remained on the Kilbuck traditional calving area (Hinkes *et al.,* 2005). However, Valkenburg *et al.* (2003:137) reported that in early June 2000, after the Mulchatna herd had moved to its calving area, there were <50 adult female caribou with newborn calves in the Kilbuck Mountains. This led the authors to suggest that the "[Kilbuck] calving tradition is still being maintained by a small number of caribou, and the KCH could re-emerge".

### **(c)** The Basis For Designating The Bathurst And Ahiak Herds

There is no formal, generally accepted standard for how many years of aerial surveys, or how many marked individuals over how many years, are required to justify naming a herd based on the return of cows to a calving ground. Conventionally, the initial description is based on more than one annual aerial survey to demonstrate the return of cows to calve in a definable area (Gunn and Miller, 1986).

Both in Canada and Alaska, the number of known herds has increased as our collective knowledge of caribou seasonal distribution, gained from aerial surveys and telemetry, has deepened. In Alaska, Skoog (1968) listed 12 herds; by 1977, 22 herds were listed as more became known about calving distribution (Davis 1978). By 1998, Valkenburg (1998) listed 32 herds in Alaska. Half were small herds (<1000 caribou estimated) and three herds were listed with less than 100 caribou. Most of these herds have radio-collared individuals and their

location is monitored during calving. Some of the smaller herds have annual ranges within the seasonal ranges of larger herds (Hinkes *et al.,* 2005). At this stage we cannot state whether or not that is a consequence of mountainous terrain favouring the isolation of smaller herds.

In 1968, Thomas (1969) listed four herds (Bluenose, Bathurst, Beverly and Qamanirjuaq) for the Canadian NWT and NU mainland[7]. By 2007, the number of mainland herds in NWT and NU was at least 11 (Porcupine, Bluenose West, Bluenose East, Cape Bathurst, Bathurst, Ahiak, Beverly, Lorrilard, Wager Bay, South Melville Peninsula, and Qamanirjuaq). The increase occurred as more mainland areas were surveyed and more radio-collars were used, leading to greater understanding of caribou calving distribution and herd identity.

Gunn and Fournier (2000) summarized available information on NWT calving grounds (excluding the Bluenose, Bathurst, Beverly and Qamanirjuaq herds, and Banks and Baffin Islands as they had been covered in other reports). The report listed the information available to describe calving grounds. Four mainland areas had only one year's survey data or scattered observations (Arrowsmith Lowlands, King William Island, Keith Bay, and Northern Melville Peninsula). Boothia Peninsula East, Simpson Peninsula Lake, and Keith Bay had more than one year's information but calving ground boundaries were not mapped. These locations may represent small herds that are not yet designated.

[7] Before 1999, the Northwest Territories included all of the lands now included in Nunavut and present-day Northwest Territories. Nunavut became a separate territory in 1999. Several of the Canadian barren-ground herds range across the NWT/NU border and in some winters into northern Saskatchewan and Manitoba.

Like other biologists, government staff in NWT and Nunavut must operate within assigned budgets; field work in these remote regions remains costly.

Thomas (1969) named the Bathurst herd on the basis of mapping the distribution of caribou during the May 1968 spring migration and noting that the trails and caribou were heading to Bathurst Inlet. Calving at Bathurst Inlet had been previously observed both east and west of the Inlet (Kelsall, 1968; Thorpe *et al.*, 2001). The Bathurst calving grounds were surveyed at frequent although irregular intervals from 1965 to 1996 (reviewed in Sutherland and Gunn, 1996), in 2003, in 2006, 2007 and in 2008 (Gunn *et al.,* 2005b; Nishi *et al.,* 2007; Gunn *et al.,* In Prep., ENR unpublished data). In 2007 and 2008, the Bathurst calving ground was surveyed along with those of the Cape Bathurst, Bluenose West, Bluenose East, Qamanirjuaq, Ahiak, and Beverly herds (ENR unpublished data; Qamanirjuaq: Government of Nunavut unpublished data). Further descriptions of Bathurst calving distribution and analyses of the calving grounds using satellite telemetry from 1996 to 2005 were reported (Gunn *et al.,* 2001; Gunn *et al.,* In Prep.). The satellite telemetry revealed that the cows that were on the Bathurst calving ground were also associated during the rut (Gunn and D'Hont, 2002).

There were observations of a caribou calving ground to the east of the Bathurst herd's in the 1970s (Gunn *et al.,* 2000), including observations of scattered calving south of Adelaide Peninsula with a concentration of cows and calves east of the Kaleet River in early June 1975 (Fischer *et al.,* 1976; mapped in Gunn and Fournier, 2000). The edge of the systematically placed transects was the Kaleet River. A pre-calving survey in May 1983 (Heard *et al.*, 1987)

indicated that there was likely a calving ground in the eastern Queen Maud Gulf area. Gunn *et al.* (2000) compiled Inuit observations and historic evidence of caribou calving along the eastern Queen Maud Gulf coast. An aerial survey was flown in June 1986 to follow up on Inuit observations and the May 1983 survey to determine if there was a calving ground geographically separate from the Bathurst calving ground.

The basis for inferring in 1986 that the Bathurst and Queen Maud Gulf calving grounds[8] were geographically separate is documented in the maps included in Gunn and Fournier (2000), and Sutherland and Gunn (1996). In 1986, the survey lines delimited the western boundary of the Ahiak calving ground near the Simpson River. The Simpson River is about 160 km east of the Ellice River where Heard and Williams (1991 in Gunn *et al.,* 1997) recorded a low density of caribou in Stratum 8 during the 1986 Bathurst herd census. Stratum 8 was the eastern-most stratum flown. The high and moderate Bathurst calving densities were along the west and east coasts of Bathurst Inlet in June 1986 (Sutherland and Gunn, 1996).

Priorities elsewhere meant that the Ahiak (Queen Maud Gulf) herd's calving ground was not mapped again until 1995 when a distribution survey east and west of Bathurst Inlet was undertaken. In June 1995, an aerial survey to map calving distribution was undertaken in a year when snow cover was unusually deep and spring migration may have been late (Gunn, 1996). The systematic reconnaissance was east and west of Bathurst Inlet. Cows and calves were

[8] Caribou calving in the Queen Maud Gulf area were renamed the Ahiak herd in 2000, at the request of the Kitikmeot Hunters and Trappers Association.

distributed across the survey area (Figure 5 in Gunn, 1996). Densities around Bathurst Inlet were low with areas of concentration west and east of Bathurst Inlet (Figure 4 in Gunn, 1996). Caribou east of Bathurst Inlet were moving east. Gunn (1996) suggested that either an eastward extension to the Bathurst herd had been missed or the cows and calves were from the Queen Maud Gulf/Ahiak herd. This survey and questions about the caribou calving east of Bathurst Inlet led to the 1996-98 application of satellite collars in this region.

Five cows were collared northeast of Bathurst Inlet in April 1996 (Gunn *et al.*, 2000). In May-June 1996, the five cows moved east along the coast of Queen Maud Gulf. Meanwhile the 10 cows collared that year north of Yellowknife migrated to the Hood River area west of Bathurst Inlet. The systematic reconnaissance survey to estimate the number of breeding females in the Bathurst herd included transects east and west of Bathurst Inlet (Gunn *et al.*, 1997). The survey lines showed that the Ahiak herd's calving ground was elongated along an east-west axis, reached the coast of Chantry Inlet to the east, and spread west to the Ellice River and Brichta Lake. The Bathurst herd's calving was concentrated west of Bathurst Inlet in the vicinity of the Hood River with an area of low density extending to the west coast of Bathurst Inlet. However, the caribou in that low density stratum were moving south and west (Gunn *et al.,* 1997).

The 1996 survey along the coast of the Queen Maud Gulf confirmed that caribou calving overlapped the calving ground mapped in 1986. In that year, the Bathurst calving ground was also surveyed and shown to be geographically

distinct from the caribou calving near the Queen Maud Gulf. Further support came in 1996-98 when the five cows collared north-east of Bathurst Inlet in April 1996 calved within or close to the boundaries of the Queen Maud Gulf calving ground mapped by aerial survey in 1996 (Gunn *et al.*, 2000). The report acknowledged that the number of collars was small but also noted consecutive use between years for annual calving locations. In addition to using a separate calving ground from the Bathurst herd, the Ahiak collared cows did not overlap with the Bathurst collared cows during the rut in 1996 or 1997.

In summary, the identification of the Ahiak herd was based on historic sightings of calving, the 1986 and 1996 aerial surveys of calving grounds, and the 1996-98 telemetry. Subsequent information on calving and rutting distribution is consistent with the designation of the Ahiak herd. Collaring in 2001 and 2002 (Gunn and D'Hont, 2002) added a total of eight satellite collared cows. During calving in 2001 and 2002, the collared cows were east of Bathurst Inlet overlapping the area used in 1996. During the rut, the cows were geographically separate from the collared cows that had calved west of Bathurst Inlet (Figure 3). Since 2002, more evidence has accrued to support the original designation. A further 7 cows were collared in March 2005 (Gunn *et al.*, In Prep.) and 12 more in March 2006. Surveys of the Ahiak calving grounds in 2006 (D. Johnson unpublished data) 2007 (ENR unpublished data, Figure 4) and 2008 (ENR unpublished data) revealed a distribution similar to that recorded in 1996.

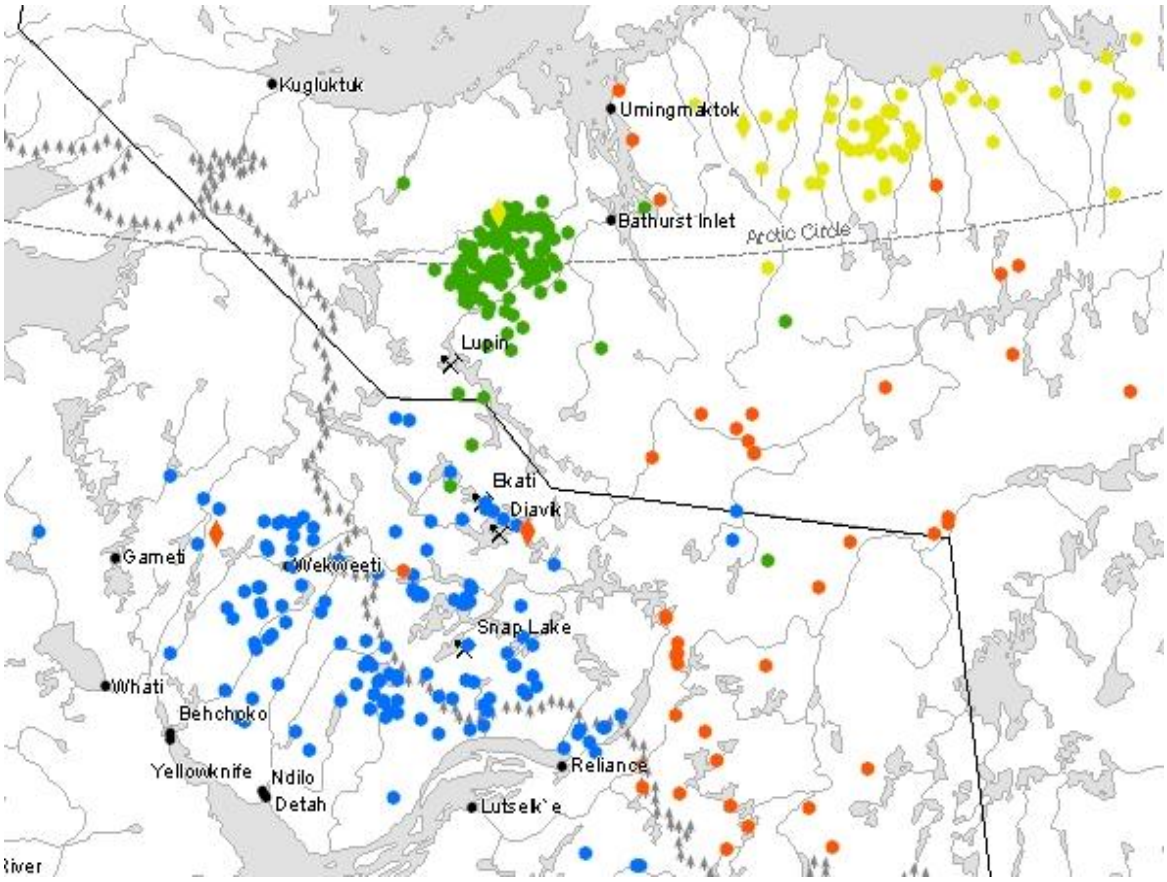


**Figure 3**. Satellite locations for cows on 15 June (Bathurst green dots, Ahiak yellow dots) and 15 October (Bathurst blue dots, Ahiak red dots), 2000 to 2006.

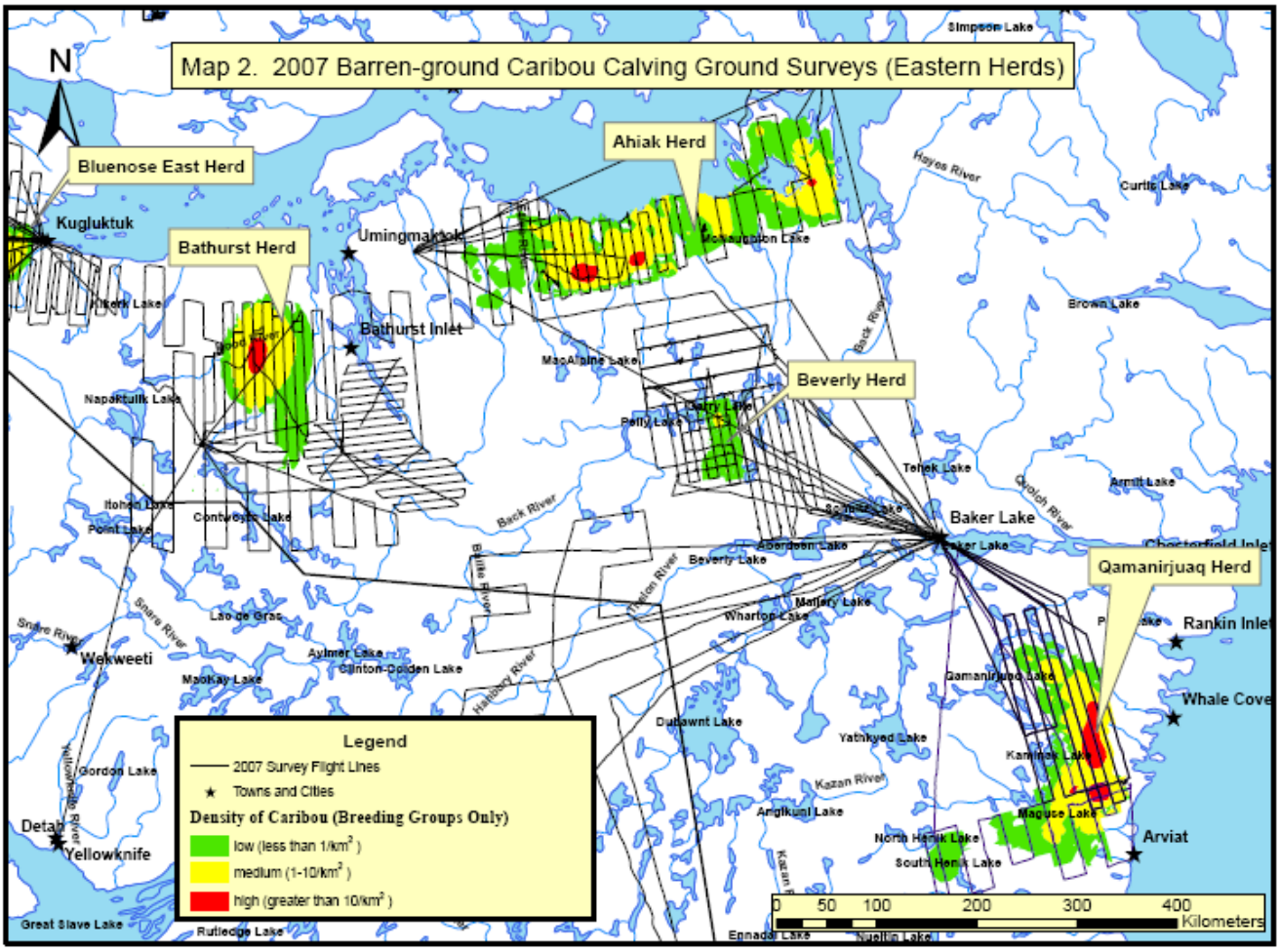


**Figure 4.** Flightlines and locations of calving grounds in the eastern Northwest Territories and Nunavut in June 2007 (ENR unpublished data).

Fidelity to a calving ground does not mean an immutable fidelity to a geographic point. Instead, a consistent pattern for the calving grounds of migratory tundra caribou is for a high degree of annual overlap between consecutive years. Over decades, the calving grounds continue to overlap around a central point (non-directional shift). This is the pattern described for herds in Canada and Alaska (Wolfe, 2000; Kelleyhouse, 2001; Griffith *et al.,* 2002; Sutherland and Gunn, 1996; Gunn and Sutherland, 1997; Valkenburg and Davis 1986; Gunn *et al,.* In Prep.). The amount of overlap for the annual calving

areas varied and was non-directional for the Teshekpuk (1994-2000), Western Arctic herd (1987 -2000) and Porcupine herd (1983-2001) along the Alaskan coastal Plain (Kelleyhouse, 2001; Griffith *et al.,* 2002) based on locations of radio-collared cows. There were no consistent directional shifts for these calving grounds, which were relatively predictable in location.

Periods of non-directional shifts in consecutive calving grounds have also been punctuated by periods of directional shifts for some herds. An early example of a directional shift and return is described by Valkenburg and Davis (1986) for the Fortymile herd based on observations and annual aerial surveys since the 1950s. Their maps suggested a progressive geographic shift about 70 km to the southeast of the Steese Highway. By 1973, the caribou were calving at Birch Creek; although they abandoned the area after 1976, they did return to calve there in 1984. Valkenburg and Davis (1986) discussed possible roles of trends in herd size, weather and predation as influencing calving ground locations without reaching any firm conclusions. Subsequently, based on inventory reports, calving in the 1990s appeared to occur in areas overlapping with the areas used in the early 1980s, although lack of maps and analyses hinder generalizations.

The George and Leaf River herds in northern Quebec and Labrador have shown pronounced directional shifts in calving distribution over decades (Bergerud *et al.,* 2008). Both herds shifted from calving at or near the treeline to calving further north. In the case of the Leaf River herd, the directional shift was 400 km north over 17 years (1974-1991). The Leaf River herd's northward shift

brought the calving close to where it was reported in the 1870s. The George River herd shifted about 250 km between two apparent clusters between 1973-1985. Bergerud *et al.* (2008) interpreted the shift north as a response to reduce the risk of predation as the herds increased in size. However, to date the directional shift of the George and Leaf River herds has not been analyzed in detail.

The Bathurst herd's calving grounds have shifted from west to east and back to west of Bathurst Inlet (Kelsall, 1968; Urquhart, 1981; Fleck and Gunn, 1982; Sutherland and Gunn, 1996; Thorpe *et al.*, 2001; Gunn *et al.,* In Prep.). Gunn *et al.* (in prep.) mapped 24 calving grounds over a 42-year period (1966-2007) based on aerial surveys and satellite telemetry. From the analyses, Gunn *et al.* (in prep.) report that calving ground location for the Bathurst herd at the peak of calving is predictable based on a 38% (range 4-78%) average overlap between successive calving distributions. The shift between the centroids of calving distribution (centres weighted by caribou density) averaged 17 km and was non-directional except during 1984 to 1996, when it was consistently westward. The net effect of the direction of the shift was two periods when peak calving ground overlap was high and one period when the overlap was low, which was when the calving ground shifted from east to west of Bathurst Inlet (1986-1996).

Despite the periods of directional and non-directional shifts for the Bathurst herd and the elongation of the Ahiak herd's calving grounds in an east and west direction between 1986 and 1996, the two calving grounds have

remained geographically separate. In 1996 and 2003, the Bathurst calving ground's eastern boundary was some 50-60 km west of Bathurst Inlet. The eastern edge of the Bathurst's calving ground was also about 100 km from the eastern edge of Bathurst Inlet in 2006 (Nishi *et al.,* 2007). In 1996 and 2006, the western edge of the Ahiak herd's calving ground was about 100 km from the east coast of Bathurst Inlet (Gunn *et al.,* 2000; D. Johnson pers. comm.). In 2007, the aerial surveys for the Ahiak, Bathurst, and Beverly calving grounds revealed clear geographic separation between the three calving grounds (Figure 4).

In the Alaskan mountain herds, calving ground shifts for the Delta and Mulchatna herds have been mentioned in the previous section (Hinkes *et al.,* 2005; Woolington, 2005; Davis *et al.,* 1988). The shifts in the Muchatna herd's calving distribution were changes in the drainages used. Between 1989 and 1993 the shifts were over a straight-line distance of about 100 km (Hinkes *et al.,* 2005). Those directional shifts did lead to overlap in calving distribution of two herds.

Shifts in calving ground locations, even directional shifts are not a problem for mapping calving caribou distribution unless there are long intervals when the distribution has not been monitored. The shifts do not detract from the concept of fidelity to traditional calving grounds (sensu Skoog's 1968 centre of occupancy), but rather emphasize the dynamic and adaptive use of space by caribou over long time intervals. In selecting calving grounds and calving sites within the calving grounds, caribou may be responding to both short-term (annual) environmental variation such as snow loss and the timing and rate of plant green-up (see Griffith *et al.,* 2001; Griffith *et al.,* 2002) as well as longer-term trends.

We need to look at the evolutionary advantages and disadvantages of gregarious calving and learned behaviour to determine why calving grounds shift, and return to previous areas, over the longer term. The Bathurst herd has shown two periods of non-directional shift separated by a period when the shift was directional. Based on four systematic calving ground surveys (1986-2007), the Ahiak herd's calving ground has expanded both west and east between 1986 and 1996, but subsequently has remained relatively consistent in location. The herd was increasing in abundance through this period, and there is no strong linear relationship between calving ground area and herd size (Sutherland and Gunn, 2006*).* To date the Ahiak and Bathurst calving grounds are geographically separate by distances of about 50 km from the west and east coast of Bathurst Inlet (100 km total) and are separated by the Inlet itself. By 1996, the western part of the Ahiak herd's calving ground overlapped with the previously used traditional calving ground of the Bathurst herd.

**(d)** Trend In Numbers Of Caribou In The Bathurst Herd And Ahiak Herds

In the preceding section, we provided evidence that the Bathurst and Ahiak herds have had separate calving grounds through the 20-some years of surveys and satellite-collar data. We summarize in this section the information on herd size and trend in these two herds.

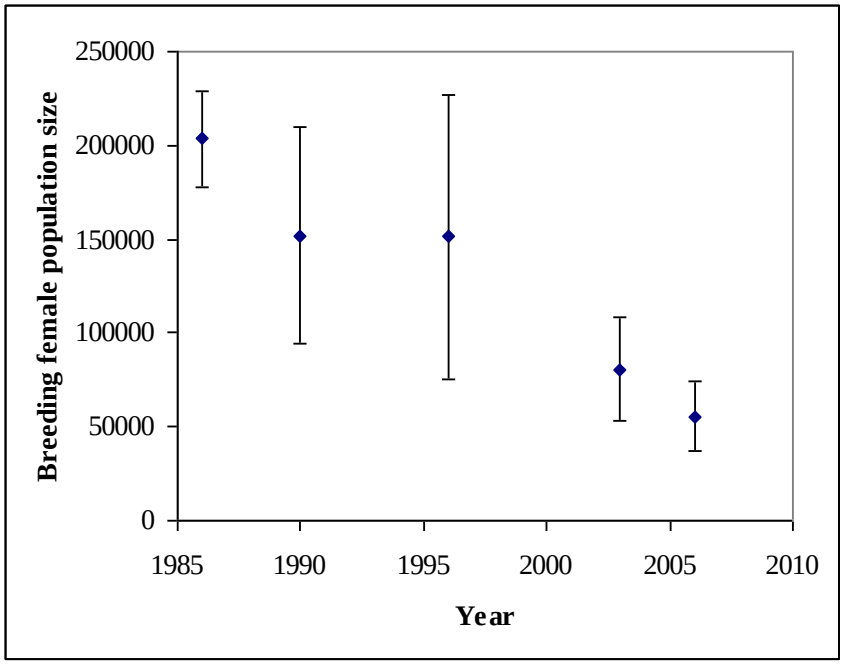


**Figure 5.** The trend in numbers of breeding females in the Bathurst herd, 1986-2006 (Boulanger and Gunn, 2007).

Estimates of the Bathurst herd size (Table 2) were based on photographic surveys of the calving grounds, which measured the trend in the number of breeding females (Figure 5). Emphasis on measuring a trend rather than absolute estimates increases the statistical power to detect changes in abundance (Taylor et al., 2007).

The calving ground survey technique takes advantage of the evolutionary drive of the cows to reach their calving ground. The motivation for breeding and non-breeding cows to reach and congregate on the calving ground is very strong. This considerably reduces variation in ensuring that the survey area is adequate (that calving cows are not missed). The sequential reconnaissance surveys prior to the photographic survey are extensive and the timing is such that snowcover reveals caribou trails. These reconnaissance surveys and the application of

repeatable criteria to end transect lines increase the confidence that the survey area for the photographic and visual survey strata include the calving cows and are repeatable between surveys. Survey accuracy is optimized by timing the census for the peak of calving when cows are the most stationary in their individual movements during the peak of calving.

The trend between 1996 and 2006 shows a significant decline. Nishi *et al.* (2007) provide a detailed explanation of the relationship between the precision of surveys and the ability to detect changes between estimates. They also discuss the relative risks of failing to detect a decline compared to missing the detection of a decline. Biologists with ENR have collected supporting data that provide evidence of the decline of the Bathurst herd.

The decline in calf survival (Figure 6), a sex ratio biased towards females, contraction of the southern boundary of the winter range, and views of Aboriginal elders all provide supporting evidence of a declining population (Boulanger and Gunn, 2007; Gunn *et al., 2005a;* Gunn *et al.,2005*b; Gunn *et al.,* In Prep.).

The trend in breeding females measured on the calving ground is supported by demographic modeling using estimates of calf survival and adult survival to estimate the finite rate of increase (lambda) (Boulanger and Gunn, 2007). The model is an independent, credible cross-validation of trend estimates because it simulates population trend without being constrained by data input from the calving ground surveys. A Monte Carlo simulation approach was used to estimate trend in breeding females by randomly selecting values from the statistical distribution of respective survey estimates, and estimating the

distribution of lambda values for herd trend. The resulting distribution of trend estimates were less than 1 and indicated a declining population. This trend analysis showed that there was no valid statistical approach to construct a linear slope from the series of estimates that would show a stable population. Alternatively, it may be argued that the 1990's estimates imply stability in that time period, but certainly the data from the 2000's estimates indicate a declining population.

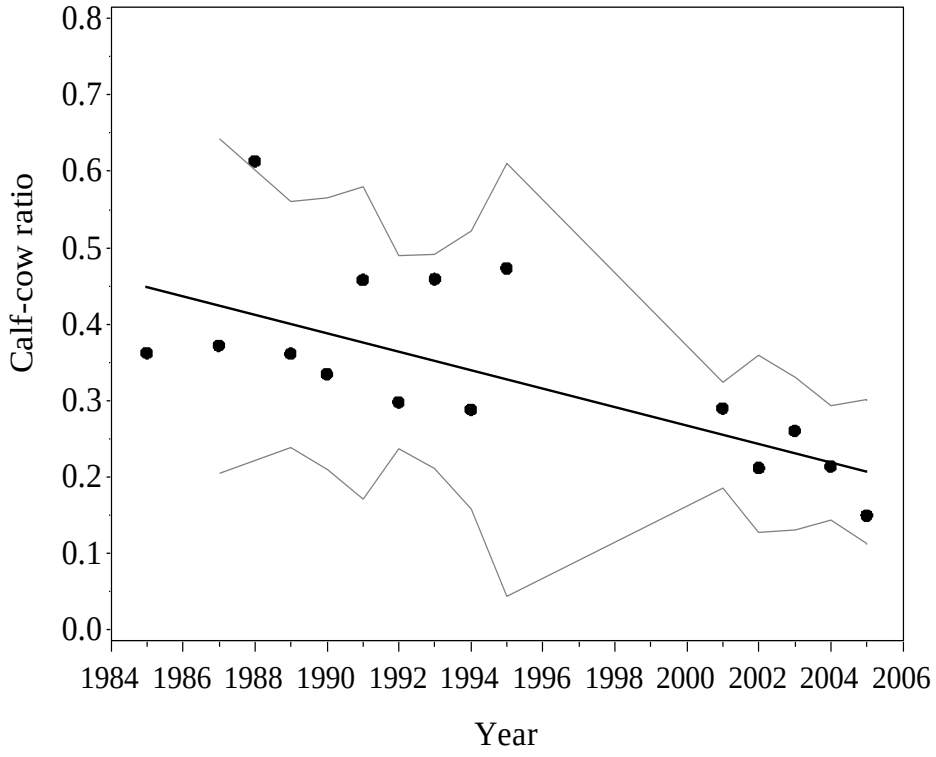


**Figure 6.** Calf-cow ratios and their confidence intervals regressed against year for the Bathurst herd 1985-2005 (Boulanger and Gunn, 2007).

Information on the Ahiak herd's size and trend is less complete than for the Bathurst herd. This is, in part, due to its remoteness, but also in part because it is hunted by few communities, hence the herd's management was seen as a lower priority. The high levels of mining exploration and development

on the Bathurst herd's annual range in the 1990s also increased the level of interest in the Bathurst herd.

Population surveys of the Ahiak herd have not been carried out to date. The 1986 and 1996 calving distribution surveys reported by Gunn *et al.* (2000) were carried out primarily to map the calving grounds and to establish their separation from other herds' calving ranges. Nevertheless, the number of caribou seen on transect in 1996, with lower coverage of the calving grounds than in 1986 (Table 3), suggests that the Ahiak herd had increased substantially over that period. The large Ahiak calving ground mapped in 2007 (Figure 4; data from D. Johnson) suggests that the Ahiak's population trend has not paralleled the declines seen in the Bathurst, Bluenose-West, Bluenose-East, Cape Bathurst, and Porcupine herds in the 1990s and 2000s and that the Ahiak herd was among the larger herds in the Canadian north in 2007. In 2007 and 2008, ENR and GNU biologists evaluated the feasibility of a calving ground photo-survey for the Ahiak herd. The area is remote, has no landing strips nearby for aircraft, and cloud cover is chronically low. In addition the calving ground is exceptionally large in extent. Current methods may need to be modified.

**Table 3**. Numbers of caribou seen on transect in 1986 and 1996 during calving distribution surveys over the Ahiak calving grounds (Gunn *et al.,* 2000).

| Year | Number of Transects | % coverage on calving ground | Number of caribou counted on transect |
|---|---|---|---|
| | | | |
| 1986 | 32[9] | 23.2 | 2,998 |
| 1996 | 6 | 5.2 | 4,453 |

[9] The 1986 survey included higher and lower density strata.

Overall, the information from calving distribution surveys suggests that the Ahiak herd has increased during a period when the overall trend in the neighbouring Bathurst herd to the west was a decline. A comparable example where one herd has declined while a neighbouring herd has increased is seen in the George and Leaf River herds in Quebec and Labrador (Boulet *et al.,* 2007; Couturier *et al.,* in press). The variable and at times opposing population trends in the two herds were attributed to differing rates of births and deaths, rather than mass immigration or emigration (Boulet *et al.* 2007; Couturier *et al.*, in press)

# SUMMARY

NWT barren-ground caribou outfitter concerns were first voiced when a decline in the estimated size of the Bathurst herd was detected in 2003, based on the trend in the number of breeding females estimated during aerial photographic surveys on the calving grounds (1986-2006). Other evidence, including reduced calf survival, supports a statistically significant decline in the number of Bathurst breeding females. The Bathurst decline also mirrors the trend in other NWT herds such as the Bluenose-East, Bluenose-West, Cape Bathurst, and Porcupine. The outfitters contended that the Bathurst herd had not declined and that GNWT biologists had effectively created the Ahiak herd with the missing Bathurst caribou. However, the evidence from calving ground surveys and radio-collars has consistently shown that the Bathurst and Ahiak herds have been separate herds with distinct calving grounds through at least the last 22 years. The less-studied Ahiak herd has not had a photographic population survey, but calving distribution surveys in 1986, 1996, 2006, 2007 and 2008 suggest that it has increased over a period when most other NWT herds have decreased.

In this report, we have summarized the basis for designating barren-ground caribou herds across their range. Barren-ground caribou herds in Alaska and northern Canada have been defined and named since the late 1960s based on fidelity of females to distinct calving grounds. During winter, overlap of caribou from neighbouring herds is not uncommon, but in June cow caribou annually return to well-defined separate calving grounds. At calving, females

from one herd are most clearly separated spatially from other herds, and they are also most concentrated spatially. Given this separation and spatial concentration, photographic population surveys are carried out either on the calving grounds or during post-calving aggregations. Satellite collar data also indicate strong herd separation during the breeding season. In both Alaska and Canada, the numbers of herds, the knowledge of their ecology, and methods used to study them have evolved and improved, but satellite radio-collars and photo-surveys have confirmed the designation of herds based on calving grounds. Location data from individual cows have shown that cows occasionally switch to other calving grounds, but these events are generally rare.

This report also summarizes the evidence for the designation of the Ahiak herd, whose calving grounds were first mapped in 1986. This herd was initially called the Queen Maud Gulf herd. In 2000 it was re-named the Ahiak herd based on a request from the Kitikmeot Hunters and Trappers Association. The Bathurst herd's calving ground was also mapped during aerial surveys in 1986 when the herd was estimated to have peaked in size. The Bathurst and Ahiak herd calving grounds were concurrently mapped in 1996, 2006, 2007 and 2008 and were, in each case, separate. Between 1996 and 2006, satellite telemetry supported the designation of the two herds with discrete calving and rutting areas. Although the information available for individual herds varies, the designation of caribou herds based on the return of the cows to traditional calving grounds remains the standard circumpolar approach for migratory tundra caribou.

# ACKNOWLEDGEMENTS

Over the years, many staff from the Department of Environment and Natural Resources has been involved in projects for the Bathurst and Ahiak herds. The nature of wildlife work is that we build and depend on the efforts of others and so we thank David Abernethy, John Boulanger, Laurie Buckland, Ray Case, Dean Cluff, Bruno Croft, Adrian D'Hont, Susan Fleck, Bonnie Fournier, Ron Graf, Doug Heard, Deborah Johnson, Kevin Lloyd, Mika Sutherland, Judy Williams, and Mark Williams. Kim Ullyot helped us with this report by efficiently tracking down reports. We also thank Susan Fleck and Bruno Croft who took the time and trouble to review this report.

# APPENDIX A.

**Caribou Information Sheet emailed to Ray Case 14 January 2004 (written and circulated by Boyd Warner)**

Northerners have always thought there were four main herds of caribou occupying the mainland of central Canada in the area that stretches from the Mackenzie River in the west to the coast of Hudson Bay in the east.

THESE HERDS WERE CALLED:

THE BLUENOSE, BATHURST, BEVERLY, QAMANIRJUAQ.

NOW THE GNWT AND NUVAUT GOVERNMENTS RECOGNIZE THAT THERE ARE EIGHT HERDS THAT OCCUPY THE SAME LAND AREA.

THESE NEW HERDS ARE CALLED:

BLUENOSE EAST, DAUPHIN UNION STRAIGHT, AHIAK AND NORTHEASTERN MAINLAND.

DID YOU KNOW THAT:

- Hunters from Kugluktuk, Bathurst Inlet and Umingmuktuk likely never kill a Bathurst Caribou.
- Hunters from the Dogrib communities hunting the winter months to the northwest of Rae Lakes are more then likely harvesting caribou from the Bluenose East Herd and NOT the Bathurst, although at times both herds are together.
- Hunters going north from Yellowknife on the winter road would likely be harvesting Bluenose East, Bathurst or Ahiak Caribou (or if you shot more then one then it is even possible you shot one from each herd even though they are all together on the same lake and may be standing side by side), yet it is still a possibility that it was a Dauphin or Beverly Caribou.
- Hunters from Lutseke are likely to harvest from the Bathurst, Beverly, Ahiak and sometimes the Qamanirjuaq Caribou herds.
- There is only Caribou Management boards for the Bathurst, Beverly and Qamanirjuaq herds. Who manages the rest?
- To the best of our knowledge the commercial and domestic harvest figures used for management reasons DOES NOT take into account harvest from specific herds, all the historic data gathered refers to the harvest being Bathurst or perhaps Beverly Caribou.
- Without DNA sample from every Caribou Killed it would be impossible to identify harvests from which herds an animal was harvested.
- The area commonly thought of as Bathurst Caribou Range is now shared by four herds (Bluenose East, Bathurst, Dauphin and Ahiak Caribou).
- Current “estimates” are that the Bluenose East herd has 100,000 animals, Dauphin herd 75,000, Ahiak 250,000 and Bathurst at 187,000. That equals a conservative 612,000 animals living on in the Central Canadian Arctic. It does not include figures for the Beverly, Qamanirjuaq Northeastern mainland herds.
- Six Caribou Cows were satellite collared north of Indin Lk in the winter of 2003. Four of them calved west of Bathurst Inlet and are now referred to

as Bathurst Cows. Two went and calved east of Kugluktuk and are now considered Bluenose Cows. There is no prior information on these caribou or DNA to support the fact they are from different herds. The only evidence is that they calved in different areas. What will we call them if they calve somewhere else next year?

- Outfitters take less then 1000 animals / year and there is now evidence to suggest it is not all from the Bathurst Herd.
- Resident hunters harvest has been declining and last year was less then 500 animals from the Yellowknife Region. This harvest is likely spread over many herds but without sending a sample in for DNA testing you will never know.
- At a public meeting held in Yellowknife recently it was stated that 50 years ago the average family living on or near the barrenlands would use 300 caribou a year to support themselves and there dogs. There were hundreds of families depending on Caribou, both Dene and Inuit on the Central Mainland.
- Today the total harvest by none-Aboriginal hunters is less then what six families would have needed 50 years ago.

ARE YOU CONFUSED YET? HOW DO WE STOP THE CONFUSION?

CREATING NEW HERDS MAY BE GOOD FOR SCIENTIFIC REASON AND OR FOR BIOLOGIST, BUT IT IS CONFUSING THE HECK OUT OF THE AVERAGE PERSON. WE WANT TO KNOW HOW THE “CARIBOU” ARE DOING NOT JUST ONES FROM A SPECIFIC AREA.

THE SOLUTION IS SIMPLE, RECOGNIZE THAT WE HAVE HUNDREDS OF THOUSANDS OF CARIBOU ON THE MAINLAND IN CENTRAL CANADA AND THAT MANY DIFFERENT CALVING GROUNDS ARE USED.

CALL THE HERD THE CENTRAL CANADIAN BARRENGROUND CARIBOU HERD.

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# APPENDIX B.

**Explanations and comments on Mr. Boyd Warner's Caribou Information Sheet (Ray Case and Anne Gunn 17 February 2004 - Email response to Mr. Boyd Warner).**

The map that Boyd provides highlights the four major barren-ground herds in the NWT that migrate between the tundra and the boreal forest, Bluenose, Bathurst, Beverly and Qamanirjuaq. The map is from the RWED web site. The only change to our understanding of those four herds today is that the Bluenose herd is actually three herds – Cape Bathurst, Bluenose West and Bluenose East. Wildlife and Fisheries have, since the 1980s, used contemporary techniques (especially satellite telemetry) as well as aerial surveys and traditional knowledge to describe the ranges of the other mostly smaller caribou herds. Those herds have been known for a long time but only more recently have their ranges been mapped. RWED has published reports and papers describing the herd ranges.

RWED has published reports with maps showing the smaller barren-ground caribou herds that are resident on the tundra year round. These herds only rarely migrated south of tree line. These herds were thought to calve mainly on the Northeast mainland of the NWT (These are collectively shown as the Northeast Mainland in the figure from the RWED web site). The map on the RWED web site refers to barren-ground caribou and thus does not include the Dolphin and Union herd which summers on Victoria Island and winters on the mainland and is not a barren-ground caribou herd as it is more similar to Peary caribou.

Surveys and satellite telemetry data collected since the early 1980s have provided additional information on the winter movements of the northeast mainland herds. One of the herds was renamed from the Queen Maud Gulf herd to the Ahiak herd as a result of a request from the Kitikmeot Hunters and Trappers Association. The Ahiak herd typically stays on the barrens in winter and thus access to this herd is limited compared to the Bathurst herd; in more recent years Ahiak satellite collars indicate increasing use of areas below treeline.

Many of Mr. Warner's points arise from, perhaps, not fully appreciating the consequences of two characteristics of barren-ground caribou. Firstly, cows that calve together also rut together – this is based on satellite telemetry and supported by genetic analyses. Thus defining herds based on the return of cows to their traditional calving grounds is well-founded and is supported by contemporary data. Secondly, it is a characteristic of the barren-ground caribou herds that their annual use of winter ranges varies and it is quite common for neighbouring herds to overlap part of the winter ranges in some years. In contrast to the use of winter ranges, caribou herds have high fidelity to the calving and summer ranges and we have not documented overlap between herds in the use of those areas.

The specific answers to questions raised by Boyd Warner (Table 1) were as follows:

**1.** Hunters from Kugluktuk, Bathurst Inlet and Umingmuktuk likely never kill a Bathurst Caribou.

*Comment: As the Bathurst herd moves south of treeline in winter, hunters from Kugluktuk, Bathurst Inlet and Umingmuktuk have only had access to Bathurst Caribou during calving and post calving. In recent years there has been very little harvesting taking place during this period, thus few Bathurst caribou are likely harvested by Kitikmeot communities. However, elders have contributed a significant amount of knowledge about the Bathurst herd, suggesting the importance of the herd to the people.*

**2.** Hunters from the Dogrib communities hunting the winter months to the northwest of Rae Lakes are more than likely harvesting caribou from the Bluenose East Herd and NOT the Bathurst, although at times both herds are together.

*Comment: The major barren-ground caribou herds overlap on their winter ranges – south of treeline. This has been known for a long time. However, it is not a generalized random mixing and does not occur every year. The likelihood that a hunter is harvesting a Bluenose caribou increases as he gets closer to the western edge of the Bathurst Range and closer to the center of the Bluenose east range. Thus a hunter on the Gameti-Wekweti winter road could harvest either a Bluenose East or Bathurst herd in some years. Our information from the satellite collars suggests that in most years, it is more likely to be Bathurst than Bluenose caribou*.

**3.** Hunters going north from Yellowknife on the winter road would likely be harvesting Bluenose East, Bathurst or Ahiak Caribou (or if you shot more then

one then it is even possible you shot one from each herd even though they are all together on the same lake and may be standing side by side), yet it is still a possibility that it was a Dauphin or Beverly Caribou.

*Comment: A hunter on the Lupin iceroad could harvest caribou from the Ahiak or Bathurst herd, again, in some years. The likelihood that a hunter is harvesting an Ahiak caribou increases as he travels further to the northeast of the Bathurst herd's range onto the barrenlands in winter. We have no information to suggest that caribou from the Dolphin and Union herd move as far south as the winter road. A hunter would have no difficulty in recognizing a caribou from the Dolphin and Union herd as they have a very different appearance (and size) than barren-ground caribou.*

**4.** Comment: Hunters from Lutseke are likely to harvest from the Bathurst, Beverly, Ahiak and sometimes the Qamanirjuaq Caribou herds.

*Comment: This is mostly correct –Lutsel K'e hunters have access to Ahiak, Bathurst and Beverly caribou. Between 1993 and 2004, the satellite collars suggested that the Qamanirjuaq herd was distant from Lutsel K'e . [note added 2007: In winters 2005/2006, 2006/2007, one collared cow was within 150 km of Lutsel K'e].*

**5.** There is only Caribou Management boards for the Bathurst, Beverly and Qamanirjuaq herds. Who manages the rest?

*Comment: There is a Management Board for the Beverly and Qamanirjuaq caribou herds and that board is advisory to the territorial, provincial*

*and federal governments. There is no management board for the Bathurst herd, although there is a draft management plan from a management committee. The Northwest Territories Government is the responsible authority for wildlife management, working in cooperation with legislated co-management boards and Aboriginal governments and with neighbouring territories and provinces.*

**6.** To the best of our knowledge the commercial and domestic harvest figures used for management reasons DOES NOT take into account harvest from specific herds, all the historic data gathered refers to the harvest being Bathurst or perhaps Beverly Caribou.

*Comment: The commercial (ie outfitter harvest) from the NWT outfitters is all applied to the Bathurst herd based on summer distribution of the Bathurst herd and neighbouring Bluenose East and Ahiak herds. The only published figures for Aboriginal harvest levels are the* ***maximum*** *number of caribou the community has reported harvesting in any given year in the 1980s and early 1990s. This is used to indicate demand, not harvest levels.*

**7.** Without DNA sample from every Caribou Killed it would be impossible to identify harvests from which herds an animal was harvested.

*Comment: Expense and logistics indicates that it would not be practical to analyze the DNA from each caribou and it is not necessary.*

**8.** The area commonly thought of as Bathurst Caribou Range is now shared by four herds (Bluenose East, Bathurst, Dauphin and Ahiak Caribou).

*Comment: In the 1960s, 1970s and 1980s, winter range overlap was assumed to occur between the Bathurst, Beverly and Bluenose herds based initially on ear-tag returns and distribution surveys. In the 1990s RWED was able to confirm the overlap in the winter distribution between the Bluenose East, Bathurst, Beverly and Ahiak herds in some, not all, winters. The Ahiak and Dolphin and Union herd (not Dauphin as Mr. Warner calls the herd) have overlapping range in some winters. It would be relatively straightforward to estimate the probability of a given animal harvested on a known date in a known location from being from one herd or another. It is not necessary to know with 100% certainty. The ability to do this will also improve over time with increased information from satellite telemetry and will be refined with some DNA analysis.*

**9.** Current “estimates” are that the Bluenose East herd has 100,000 animals, Dauphin herd 75,000, Ahiak 250,000 and Bathurst at 187,000. That equals a conservative 612,000 animals living on in the Central Canadian Arctic. It does not include figures for the Beverly, Qamanirjuaq Northeastern mainland herds.

*Comment: The Dolphin and Union herd was estimated to number 27 000 in 1997 (not 75 000). The Ahiak herd has not been rigorously counted and the figure is a guesstimate. The status of barren-ground caribou in Canada remains not at risk. However, the path to changing the status begins with the mis-management of even one herd. A well-supported maxim in conservation is that it is not the size of the starting population but the rate of decline that determines persistence or extinction.*

**10.** Six Caribou Cows were satellite collared north of Indin Lk in the winter of 2003. Four of them calved west of Bathurst Inlet and are now referred to as Bathurst Cows. Two went and calved east of Kugluktuk and are now considered Bluenose Cows. There is no prior information on these caribou or DNA to support the fact they are from different herds. The only evidence is that they calved in different areas. What will we call them if they calve somewhere else next year?

*Comment: In the winter of 2003 the Bluenose and Bathurst caribou herds overlapped in the area between Wekwati and Gameti. This causes problems for collaring at that time of year. March/April are the best months for collar deployment as the capture operations can be done on lakes with snow and weather is relatively predictable. However, we are moving to collar in the fall to ensure we can deploy the collars on the appropriate herds. The three caribou collared in April 2003 that migrated to the Bluenose East calving ground also rutted together in an area separate from the Bathurst herd in October. Thus we have no reason to call them anything other than Bluenose East caribou. Caribou collared in winter are not assigned to a herd until calving location is known. Caribou show strong fidelity to calving areas so it is unlikely that the females will calve somewhere else next year.*

**11.** Outfitters take less then 1000 animals / year and there is now evidence to suggest it is not all from the Bathurst Herd.

*Comment: Evidence suggests that almost all, if not all, the outfitter harvest comes from the Bathurst herd.*

**12.** Resident hunters harvest has been declining and last year was less then 500 animals from the Yellowknife Region. This harvest is likely spread over many herds but without sending a sample in for DNA testing you will never know.

*Comment: The resident harvest comes in two peaks. Fall harvest just north of treeline can be safely allocated to the Bathurst herd. Late winter harvest along the ice roads can be allocated proportionately based on winter distribution of the satellite collared caribou from neighbouring herds.*

**13.** At a public meeting held in Yellowknife recently it was stated that 50 years ago the average family living on or near the barrenlands would use 300 caribou a year to support themselves and there dogs. There were hundreds of families depending on Caribou, both Dene and Inuit on the Central Mainland.

*Please see comment for question 14.*

**14.** Today the total harvest by none-Aboriginal hunters is less then what six families would have needed 50 years ago.

*Comment: The per capita Aboriginal harvest is undoubtedly much lower across the NWT than it was when dog teams were the primary mode of transportation and caribou were the primary source of meat and clothing.*

*The only "new" herds resulted from the division of the Bluenose herd. We must continue to monitor and refine our understanding of how and why these herds move. Barren-ground caribou show fidelity to calving grounds for a reason – undoubtedly a result of thousands of years of evolutionary pressure. The risk to the viability of any one herd must be managed.*

*We do not know for certain the implications of eliminating one herd. However, we can look to hundreds of examples from around the world where failure to manage at a breeding population level has resulted in local extirpation. Boreal caribou are now listed is threatened in Canada and are extirpated in some areas such as the Maritimes, as a result of not managing the species and their habitat at a population level.*

# APPENDIX C.

**Mr. Boyd Warner comments on the Bathurst Caribou Management Plan emailed to David Abernethy (Bathurst Management Planning Committee) 16 February 2005**

Bathurst Caribou Management Plan Notes

While in itself a useful tool it is USELESS until.

1) Management plans are in place for the Bluenose East, Dauphin Union Straight and Ahiak Herds.
2) Harvest levels are known for ALL four Herds that have overlapping ranges.
3) Aboriginal, Resident, Commercial Meat and Sport Hunt quotas are established for each Herd and a system in place insure that all groups of harvesters know which animals they are harvesting at different times of the year.
4) The figures used currently in the report as “harvest figures” are assuming ALL caribou killed from the communities are Bathurst Caribou. Until we know the answer to #3 a effective Management Plan cannot be in place.
5) RWED biologist have admitted in public meetings that Outfitters and other harvesters could be harvesting from different herds or even from two herds on the same lake on the same day!!!!!!
6) The same biologist have confirmed that the communities of Kugluktuk, Bathurst Inlet, Umimgmuktuk, Cambridge Bay likely NEVER harvest caribou from what is now called the “Bathurst Herd”, but instead harvest from the Bluenose East, Dauphin Union and Ahiak Herds.
7) All the Dogribs communities likely harvest from at least two herds, Bluenose East and Bathurst.
8) Lutsel K harvests from Bathurst, Ahiak and Beverly Herds.
9) All other hunters depending on what ice road is used hunt from different herds.
10) RWED’s own maps of overlapping boundaries PROOF that you cannot tell from which herd you may be harvesting.
11) You CANNOT come up with a management plan for one group of animals that lives in the Center of 4 other groups.

**WHAT IS NEEDED IS A MANAGEMENT PLAN FOR ALL THE CENTRAL CARIBOU.**

The Barrenground Outfitters have REPEATEDLY tried to get this message across to the GNWT. To date all it has been is “token” listening.

It is now clear that there is a plan to mislead the people into believing we have a Crisis in our Caribou population when in fact the opposite is likely true and we

have MORE Caribou living and breeding on the Central Mainland now then for the last 50 years.

The Barrenground Caribou Outfitters are 100% behind management of our Caribou. We are also 100% opposed to any plans that are impossible to implement and do not take into account all the facts.

Some interesting facts:

1) There are now at least 4 recognized Caribou calving grounds in the area that was traditionally thought of as “Bathurst Range”
2) The “Bathurst Caribou” are now said to be calving on the West side of Bathurst Inlet. Traditionally they have always calved on the East side. This Calving ground on the East side still has Caribou Calving there, but they are now called Ahiak Caribou and that calving ground is said to run continuously from Bathurst Inlet to Chantry Inlet (a distance almost equal to that of Yellowknife to Bathurst Inlet, or some 300 + miles).
3) The new range maps for the new “Bathurst Herd” is at least 20% smaller then old maps.
4) RWED has indicated that EVERY OTHER HERD on the mainland is increasing in population while the Bathurst Herd is declining?????
5) There are NO harvest levels for the “other Herds” and EVERY Caribou killed between Great Slave Lake and the Arctic Coast is presumed to be a “Bathurst Caribou”
6) The “management steps” called for in this plan could NOT be implemented as it is impossible for ANYONE to know what Caribou are being killed when. Until this is know

CONCLUSION:

The Bathurst Caribou Management plan has to be shelved until either:

1) A management plan is in place for all groups of Caribou sharing the same areas (like the Beverly / Kamaniarak Plan does).
2) This plan be expanded to include the other herds.

# APPENDIX D.

**Response by the authors (AG, JA and JN) to comments by Mr. John Andre during the Wek'eezhii Renewable Resource Board (WRRB) public hearings – March 13-14, 2007**

March 13 2007 Transcript Extracts From The WRRB Public Hearings

The following quotes are questions and comments from Mr. John Andre to Susan Fleck and Bruno Croft (Wildlife Division, Environment and Natural Resources). Text preceded by the word 'comment' are the authors' responses to questions that were either not answered or incompletely answered, provided subsequent to the public hearing. For ease of identification, these responses are italicized. Additional comments on Mr. Andre's presentation are listed in Appendix E.

**John Andre question to Susan Fleck** - p. 35: "Okay. I'd -- I'd like to just read a statement that Ms. Gunn made. In 2001 she said -- she's speaking of the caribou in the Northwest Territories:

> "The reality of further declines in the early 1980s was controversial and by the 1990s it became obvious that the herds of barren ground caribou had increased in size up to five (5) fold. Currently on the mainland tundra, the four (4) largest herds of barren ground caribou -- Bathurst, Beverly, Quamanirjuag and Queen Maud Gulf totalled 1.4 million caribou in the mid-1990s and are probably stable or increasing."

Now this book was written in 2001. Why would she say that about a herd that had been declining, according to your statements, 5 percent every year since 1986?"

***Comment:*** *The book chapter that is the source of Mr. Andre's quote is based on a 1999 symposium (Gunn 2001). The material was written in 1999-2000 and published in 2001. The Bathurst herd decline was not recognized until the 2003 census. The basis for the comment on the other herds was based on information available prior to and up to 1999: the Qaminirjuaq herd had high calf survival; the 1986 and 1996 surveys for the Queen Maud Gulf (Ahiak) herd indicated an increase; and the Beverly herd had increased up to 1994 (the most recent estimate at that point).*

**John Andre question to Susan Fleck** - p. 37: "In 1986, the survey you were just speaking about, you just said that Anne Gunn was over there looking at the Ahiak Herd. Well, the Ahiak Herd was not delineated until the year 2000. How could she have possibly been over there looking at the Ahiak Herd?"

***Comment:*** *The confusion arose because, at the request of the Kitikmeot Hunter's and Trapper's Association, the herd's name was changed from Queen Maud Gulf herd to Ahiak herd in 2000. The Ahiak herd's calving ground was delineated in 1986 and 1996 but at that time was called the Queen Maud Gulf herd. There is limited survey information for the Ahiak herd back to 1986.*

**John Andre to Bruno Croft** - p. 38: "In your 2001 to 2004 calf survival and adult sex ratio in the Bathurst herd of barren ground caribou, in the -- in the abstract you talk about the proportion of bulls in the Bathurst herd in the fall of 2004 was low and then it says 37 percent. Now, is that -- when you say 37 percent, do you actually mean a bull-to-cow ratio of thirty-seven (37) bulls per hundred (100)

cows? It's interchanged here a little bit and it's not -- it's not accurate".

***Comment:*** *Mr. Andre was correct – the confusion was caused by a typographical error in the abstract – the correct information was in the Results and Discussion (Gunn et al 2005a).*

**John Andre to Bruno Croft** - p. 40: "Okay. In 1996 Ray Case said the annual -- the estimated annual cow mortality rate was 8 percent. He also cited Tom Bergerud's work where the overall mortality rate for herds -- for ten (10) herds in North America -- was 10 percent. Now in a document of calf survival and adult sex ratio in a Bathurst herd of barren ground caribou 2001/2004, this is the document where you -- the Government creates the theory that this herd has fallen 5 percent every year since 1986. It uses a cow mortality rate of 21 percent per year".

***Comment:*** *Bergerud (1980) proposed using population size, hunting and recruitment to calculate mortality and came up with the average 10% figure in 1980. A similar approach was used in the early 1990s to derive the 8% that Ray Case referred to in 1996 (Case et al. 1996). Bergerud's (1980) approach proved to be difficult as it required sufficiently accurate estimates of abundance and harvest (Martell and Russell 1983, Davis and Valkenburg 1985). Instead, Martell and Russell (1983), after noting problems with a life-table analysis, advocated the use of radio-collars to estimate average annual death rates. The rate of 21% for adult cows for the Bathurst herd is based on satellite collars 1996-2003 (Boulanger et al. 2004). Survival of adult caribou cows typically varies around*

*0.82 (18% annual mortality) to 0.90 (10% mortality), the latter being more typical of increasing herds (see also notes below).*

**John Andre to Bruno Croft** - p. 42: "Since 1997 to 2003, we had an average of ten (10) collared caribou. In 2003/2004, we had eight (8) collared caribou. The -- the proper cert -- sample size for a herd this size is ninety-six (96). . . . . How -- with the surv -- with the sample size that small, how can you come up with data like that?

Do you honestly believe that we are losing 20 percent -- one (1) out of five (5) of our cows every year, our adult cows? Is -- is that what you believe for the last twenty (20) years? And if that's the case, how did the herd go from three hundred and fifty four thousand (354,000) in 1980 to one million five hundred and thirty-four thousand (1,534,000) today?"

***Comment:*** *Boulanger et al. (2004) acknowledged the small sample size for collars. The measured survival rate is summed for the period 1996-2004. The sensitivity of population trend to the survival rates of adult females is common in large herbivores (Gaillard et al. 2000). The survival rates are similar to those estimated from radio-telemetry in other large herds of caribou. For example, in the George River herd (Quebec and Labrador), annual survival rates for adult females varied: in 1984-85, survival was 0.895-1.00 (95% CI) and 0.846-0.971 in 1986-87 during a period when the herd was starting to decline in size (Hearn et al. 1990). Annual survival of Porcupine caribou herd adult females was about 84% between 1982 and 1988 (Fancy et al. 1994, Walsh et al. 1995) during a*

*period when the herd was increasing in size. In other Alaskan herds, for example the Nelchina, annual survival for radio-collared adult cows was 82% (1999-2000) during a period when the herd was declining (Alaska Department of Fish and Game 2001). In the Western Arctic herd, during the period when the herd was increasing (1984-1990), annual survival for adult females averaged 87% compared to 85% when the herd was stable to slowly declining 1990-2000.*

*The comment that the Bathurst herd went from 354,000 in 1980 to 1,534,000 by 2007 is based on Mr. Andre's misunderstanding of herd identity. The Bathurst herd has never been estimated at this great size. It is possible to draw misleading conclusions about numbers of caribou in different herds if the estimates are drawn from different periods. Caribou herds can grow or decline rapidly. Rapid increases were shown the early 1980s when the Qamanirjuaq and Beverly herds expanded rapidly, and rapid declines have been documented more recently by the Cape Bathurst and Bluenose-West herds in the 2000s. Comparisons should only be made on a herd-by-herd basis, or for estimates made in the same year or a short span of years while following the same herds.*

March 14 Transcript Extracts From The WRRB Public Hearings

**John Andre presentation** - p 35: " . . . The splitting of herds in counting caribou in only of these herds and then applying these numbers to previous surveyed complete herds is the heart of our argument with the Department of Environmental Resources. Why all of the sudden did they find this herd in 2000? It's simply the splitting of the Bathurst herd, it is not a new herd that was suddenly found. Anne

Gunn said this on the Queen Maud Gulf herd: "Unlike Bathurst, Beverly, Qamanirjuag caribou herds, which occupy most of the central and eastern mainland, caribou on a northeast mainland do not migrate between calving areas on the tundra and winter ranges within the boreal forest."

Well if these caribou that are the Queen Maud Gulf caribou don't migrate, how can they be going all the way from the Arctic Ocean down to the Alberta border? That -- that simply doesn't make sense. Obviously these migrating caribou are the eastern portion of the Bathurst caribou."

***Comment:*** *The quote is from Buckland et al. (2000). Initial data for the Queen Maud Gulf/Ahiak herd indicated that the herd wintered on the tundra during the winter of 1996/97, but by the winter of 1997/98, satellite collared cows were wintering along the treeline. In late winter 2001-2004, satellite-collared cows from the Queen Maud Gulf/Ahiak herd wintered mostly in the boreal forest but also on the tundra. The most recent radio-collar data (2007 – 2008) indicate that portions of the Ahiak herd winter well below the treeline.*

**John Andre presentation** - p. 36: "This is the justification for the creation of the Ahiak herd and this is what Anne Gunn said in 2002.

> "Relatively little has been reported about the Ahiak herd, but the justification for identifying it as a separate herd from the Bathurst herd was based on 1996 to 1998 satellite telemetry and that caribou from the Ahiak herd are genetically distinct from both the Beverly and the Bathurst herd based on nuclear DNA."

. . .Zitlau eventually concluded that because the continental herds are so large, some herds have not yet developed features that are distinct from their neighbours."

***Comment:*** *Biologists do not 'create' herds – biologists recognize herds from data on caribou behaviour and calving and rut distribution. When the 2002 report was written, Keri Zittlau had done some analyses but later concluded that the pair-differences between the Ahiak and Bathurst were not statistically significant (Zittlau 2004). However, Zittlau (2004) did write that "the linkage disequilibrium noted in the Ahiak and Qamanirjuaq herds may be indicative of their more relatively recent establishment. Glacial retreat occurred later on the northeastern mainland, where the herds are presently located, than it did in western regions. Therefore, the Ahiak and Qamanirjuaq herds may have been established only 2 000 to 3 000 ybp (years before present), as opposed to the establishment of the Porcupine and barren-ground herds in the Northwest Territories and western Nunavut, which likely occurred as long ago as 8 000 to 10 000 ybp."*

**John Andre presentation** - p. 38: "Here's what Dr. Ray Case said of the ENR in 1996, about that 1986 survey:

> "The very large increase of 280 percent in Bathurst herd size observed between 1982, when it was a hundred and seventy-four thousand (174,000) and in 1986 when it was four hundred and eighty-six thousand (486,000), was likely due to a combination of increased recruitment and immigration. It is possible that caribou from the Queen Maud Gulf herd, where caribou inhabit the tundra year round, may have been included in

the Bathurst calving ground survey."

So basically what Ray is saying there is the two (2) herds got together and they had a bad survey; that happens frequently. In 1993 they surveyed the Beverly herd at eighty-seven thousand (87,000) caribou. They re-surveyed it in 1994, had two hundred and sixty-seven (267,000) caribou. So the -- problems with these surveys is not unusual."

***Comment:*** *The increase in the Bathurst herd was not impossible given the confidence intervals for the two estimates. The most likely explanation is a combination of survey error and high recruitment to the herd, as calf survival was high. The maximum likely increase due to recruitment would be a doubling in herd size – so the herd could have been 348,000 in 1986 based on recruitment alone. The 1982 survey was the first survey using photographic techniques and there are other reasons to query the estimate. The systematic survey was flown before the peak of calving and there was a gap of 4 days between the systematic reconnaissance and the photographic survey. Movements of cows could have occurred. There was no report written so the more detailed information was not available to Dr. Case. Sutherland and Gunn (1996) extracted and reported on the 1982 survey information from files.*

*Subsequent to the early 1990s when Case et al. (1996) wrote the report, the use of satellite telemetry across North American caribou herds has revealed the rarity of immigration/emigration between herds. The suggestion of immigration into the Bathurst herd was speculation with no examination for evidence in support for or against it. It is typical of 'scientists' to list possible*

*alternative explanations; further evidence may later be used to confirm or refute such explanations.*

*There have been at least 35 calving ground censuses of the major herds in NWT/Nunavut since 1977. Depending on criteria, about four of those surveys (11%) had problems that raised questions about the reliability of the resulting estimates. The 1993 Beverly herd estimate was most likely the result of survey error (possibly caribou were delayed in reaching the calving ground at the time of the survey) as it was unexpected, and there was no supporting evidence for a decline. That was why the Beverly herd was re-surveyed the following year.*

**John Andre presentation** - p.39: "Likewise, the 2003 survey versus the 2006 survey is statistically insignificant. When you're doing a survey, this not a census. There are statistics used when you survey a small portion of the herd and then you extrapolate those numbers out to the entire herd. This is the reason that many jurisdictions, particularly Alaska, have gone to post-calving ground censuses which is an actual count as opposed to the pep -- calving ground survey which uses statistics and creates a lot of issues."

***Comment:*** *As noted in the main text, post-calving photo surveys require a relatively large number of radio-collars and the right weather to produce dense aggregations during the insect season. The timing window for these surveys may be very short (24-36 hours). In the Porcupine herd's range, annual attempts at these surveys from 2003 to 2008 failed because the caribou did not form sufficiently dense aggregations (a weather effect). Post-calving photo surveys*

*are not a realistic option for all NWT herds, in part because of community resistance to radio-collars, and in part because the right combination of weather, dense caribou aggregations during post-calving, and immediate access to the photo-plane may not be met.*

*Calving ground surveys do not require as many collars and caribou cows at calving are reliably found on spatially limited calving grounds. Relying on the estimated number of breeding females in a herd has proved to be a reliable measure of population trend in several NWT herds. An extrapolation to overall herd size is needed to account for males and cows not on the calving grounds, but the statistics and methods of these surveys have been reviewed more than once by qualified statisticians.*

**John Andre presentation** – p 40: "In the year 2003, as you can see, there were 43 percent of the collared cows that were not on the Bathurst Inlet. That would help explain why the survey only came up with a hundred and eighty-six thousand (186,000) caribou. As you can see we've got caribou over here and scattered all through here as well as down here and here.

Now understand that -- as you can see these are all Bathurst caribou, 43 percent of them were not on the calving ground. This is the peak of calving in 2005. Only four (4) of the collared cows are on the Bathurst calving ground."

***Comments:*** *Both slides and Mr. Andre's interpretations relate to maps showing distribution of collared cows pre-calving, when the cows were still migrating to the calving ground.*

*One Powerpoint slide showed a map from the ENR website for 6 June 2003. In 2003, the peak of calving occurred between June 8 – 11. On 6 June 2003, when the map referred to by Mr. Andre was compiled, the collared cows had not all reached the calving ground for 2003. The peak of calving (Figure 13 in the survey report, Gunn et al. 2005b) showed that 11 of 12 collared cows were within the survey blocks photographed 14-15 June 2003. In addition, in his calculations, Mr. Andre is including the Ahiak collared cows (which are on the Ahiak calving ground) and Bluenose East cows as Bathurst cows.*

*The second Powerpoint slide showed a map from the ENR website for 6 June 2005, which was also before the peak of calving. In 2005, the cows were late in reaching the calving ground, possibly because they were in poor body condition and pregnancy rates were lower than average (Gunn, In Prep.). The peak of calving was late (based on rate of movements and by mid-June, the calving distribution had contracted). There was no population survey in 2005.*

**John Andre presentation** – p.41: - “Anne Gunn recognized that -- that she -- she did know that when she said the latter calving area, when she's talking about the Bathurst Peninsula which was reported to have been permanently abandoned. So they knew that this herd was going to crash because it is not a separate calving ground.”

***Comment:*** *The paper Mr. Andre refers to in this comment was published in 1986 (Gunn and Miller, 1986). Considerably more data has been collected since then on the location of the Bathurst calving ground, and satellite collars allow the*

*herd's overall location to be monitored seasonally. The amount of aerial reconnaissance in 1978 and 1979 might not have been sufficient, and there were no radio-collars on the herd.*

**John Andre presentation** - p. 45: "Anne Gunn said, the overall trend since 1990 is stable. In 2000, the Government gave us a hundred and thirty-two (132) to a hundred and eighty (180) tags. Why would they do that if the herd was crashing? We -- we can skip some of this.

This is what Anne Gunn said in 2003, "Judging by what we've heard from hunters they seem to be in okay condition, said Gunn. We certainly haven't heard any reports of animals in poor shape."

***Comment:*** *This is likely a quote from 3 February 2003 Northern News Services and listed in http://www.tundrawolves.org/media.htm. This was 4 months before the June 2003 census which revealed the decline in the estimated number of breeding females.*

**John Andre answer to Andy McMullen** – p.55: "I believe that we are simply collateral damage and that environmentalists, since this Department was split with the ITI, have pushed forward an agenda to create protected calving grounds up on the -- if you look where the -- where the herds are created, I believe up on the Mackenzie Delta, and all through those calving grounds, I believe that's what's going on here. They're trying to stop development by protecting calving grounds.

In 2002, Anne Gunn increased the -- or changed the definition of calving grounds, and increased the definition so that the size of a single calving ground went up by 762 percent. For two (2) calving grounds alone, it created a larger protected area the size of Massachusetts and Connecticut combined."

***Comment:*** *The Canadian Wildlife Service hosted a workshop in November 2001 on caribou calving grounds (Russell et al., 2002). The workshop concluded that it is more appropriate to define the extent of calving ground based on the area used by the cows for three weeks after the peak of calving, which reflects the time needed until the calves are independently foraging. Very few North American barren-ground caribou calving grounds have any formal protection, although the Beverly and Qamanirjuaq Caribou Management Board and others have called for calving grounds to be protected. For biologists in Alaska and Canada, mapping calving grounds is a normal part of management programs for barren-ground caribou and the 2001 workshop was convened, in part, to standardize the definition of calving grounds.*

*Gunn and D'Hont (2003) applied the definition from the workshop and pointed out that "At any 5 day–interval during June 2002, the Bathurst herd occupied a minimum of 5% to a maximum of 58% of the annual calving ground (4% to 77% for the Ahiak herd)".*

**John Andre** - p. 71: The Ahiak Herd was first created as the Ahiak Herd, not mentioned as the Queen Maud Gulf now, in 2000. In that year or possi -- between 2000 and 2002 Anne Gunn went back to information that she apparently

had in 1996 when she was doing the -- the Bathurst Management or the Bathurst Survey.

On that survey, she counted four thousand, four hundred and fifty-three (4,453) cari -- Ahiak caribou. By using statistics she upped that number to two hundred thousand (200,000) caribou. Now that would make the Bathurst caribou five hundred and fifty thousand (550,000) in 1996, okay? At the time, the Ahiak caribou herd had not been identified. Why she says there was two hundred thousand (200,000) caribou and didn't include them in the Bathurst Survey, I'm not a hundred percent sure.

***Comment:*** *In the 2000 report (Gunn et al., 2000), we explained why we called the herd the Queen Maud Gulf herd. The report described 1996-98 collaring, 1986 and 1996 June surveys, early history, and the evidence to consider the Queen Maud Gulf as a separate herd from the Bathurst herd. The report stated "The two surveys in 1986 and 1996 were primarily to describe calving distribution but we have also used them to estimate the numbers of caribou, mostly cows and calves, in the areas. However, to extrapolate those estimates to population estimates are only a rough approximation." The name change Queen Maud Gulf to Ahiak was at the request of the Kitikmeot Hunters and Trappers Association in 2000.*

**John Andre comment to Ernie Campbell** - p 73: "Between 1997 and 2003 there was an average of ten point five (10.5) collars on the Bathurst caribou at any one time. Now when these cows are collared, they are often times collared

one (1), two (2), three (3) at a time, and so those cows may -- they may actually be sisters, I don't know, but they have a -- a tendency to stay together".

***Comment:*** *During the collaring, we tried to disperse collars as much as possible and, although the cows are together during calving, they are more dispersed during the winter. Ernie Campbell had asked Mr. Andre why none of the collared cows had moved east [of Bathurst Inlet] as evidence for mass migration. Mr. Andre's response was that "the sample size of collars that you have here versus other jurisdictions simply is not a high enough number to -- to draw some of the conclusions that we're drawing". 20 collars were used because that was the agreement made in 1996 (10) and 1998 (20) with Tlicho elders (Gunn et al., 2001). The question of whether the number of collars is representative is discussed in reports including Gunn and D'Hont (2003).*

# APPENDIX E.

**The authors' (AG, JA, and JN) comments on Mr. John Andre's May 18, 2007 Final Submission to the Wek'eezhi Renewable Resources Board**

The numbered text was extracted from Mr. Andre's PowerPoint presentation. Text preceded by the word 'comment' is from the report authors (AG, JA and JN). For ease of identification, the authors' comments are italicized.

Ahiak Herd

**1.** How can Anne Gunn, ENR biologist, cite genetic evidence for the creation of the Ahiak herd, separate from the Bathurst herd, in the year 2000, when the researcher she cites, Keri Zittlau, didn't complete her work till 2003?

***Comment:*** *Keri Zittlau started her research in the May 1998 and published her thesis in 2004. Anne Gunn was in periodic contact with K. Zittlau throughout her thesis studies.*

**2.** Keri Zittlau concluded that these herds were not genetically different. Without genetic evidence, and the following of only two collared cows, how can Anne Gunn declare this a separate herd for management purposes?

***Comment:*** *In the 2000 report, Gunn et al. used historic evidence, Inuit reports of calving, the confirmation of the calving grounds in 1986 and 1996, as well as the calving of 4 satellite-collared cows in 1996 and 1997 to reach their conclusions. As noted in the main text of this report, genetic studies to date have not provided clear evidence for distinguishing barren-ground herds. Zittlau suggested that*

*some of the more eastern herds may not have separated as long ago as more western herds.*

**3.** The ENR freely states the Ahiak herd mixes with the Bathurst and other herds on the rutting ground. How could sixth grade students, let alone trained wildlife biologists, expect them to be genetically distinct?

***Comment:*** *It is not clear what this information is based on. Satellite collar data have shown partial overlap on winter ranges of a number of herds, but have indicated distinct calving and rutting ranges for the Bathurst and Ahiak herds (see Figure 3).*

**4.** Doug Heard, in 1983, counted 33,000 caribou (+-5100) in the Queen Maud Gulf area. He stated that they could be part of the Bathurst herd, or, perhaps, a separate herd. If they migrated south, they would be Bathurst caribou. If they didn't migrate south, they would be an additional (non-migrating) Northeast Mainland herd (along with the Wager Bay, Melville Hills, and Lorillard herds.) Since collared caribou show they migrate all the way to Saskatchewan, they must be Bathurst caribou. Why does the ENR ignore this evidence?

***Comment:*** *Subsequent information published later (Heard et al. 1987) updates what Heard (1983) wrote – he was simply offering possible explanations, not conclusions. Satellite telemetry has revealed that the Ahiak herd expanded its winter range (1996-2006) and changed from wintering on the barrens to wintering further south (even into Saskatchewan) partially on the barrens and partially*

*below treeline. Expansion of winter range is typical of an increasing herd of migratory tundra caribou. The Wager Bay, Melville and Lorrilard herds are all migratory herds that winter on the tundra, although being smaller herds, their winter ranges are not as large.*

**5.** The ENR reports the 1986 Queen Maud Gulf (renamed Ahiak) herd at 10,000 animals. How can the Ahiak herd grow from 10,000 in 1986 to 200,000 in 1996, unless those extra 190,000 caribou are actually carved out of the Bathurst herd?

***Comment:*** *The 10,000 was the estimate from the calving ground which was extrapolated to an approximation of 30,000 for herd size. The 1996 estimate of 200,000 was, in the same report, described as an approximation (Gunn et al. 2000). The rate of increase is biologically possible and within the range seen elsewhere; for example, the Alaska Mulchatna herd increased from 20,000 (1981) to 200,000 (1996). As noted in the main text of this report, the George River herd has declined while the neighbouring Leaf River herd increased; herds may show coordinated population trends over time, but exceptions in neighbouring herds do occur.*

**6.** What has the ENR identified about the Ahiak herd that would allow it to grow 2000.00% in 10 years, while the neighbouring Bathurst herd was falling 5% every year for twenty years, according to the ENR?

***Comment:*** *The two herds have different histories in terms of their harvesting, ecology and current range conditions that likely contribute to their different trends in abundance.*

**7.** In 1995, Laurie Buckland counted 31,556 caribou in the Ahiak Herd area. In 1996, looking at 6% of the area, Anne Gunn counted 4453 caribou and now says there were 200,000 caribou there. How did this herd grow by over 6X in just one year? What is the government's motivation for claiming such a high number, a number that this herd must now live up to, or be called "crashing'???

***Comment:*** *Buckland et al.'s 1995 count was based on a late spring (May) aerial survey and was not during calving. The survey only covered the east end of the Queen Maud Gulf area. The 1996 count of 4453 was based on an aerial survey of the calving ground in June and was extrapolated to an approximate estimate (Gunn et al. 2000) as an index of likely relative size of the herd.*

**8.** If the Ahiak herd is the third largest herd in the NWT (according to your numbers given to the CCWHC in 2005), a herd that, according to ENRs map, covers the largest geographic area in the NWT, what is the reason it has taken the GNWT 40 years to find it?

***Comment:*** *The emphasis for caribou management and monitoring in the NWT and Nunavut has generally been on the herds where there were the most management concerns and the greatest community use (Qamanirjuaq, Beverly, Bathurst and the Bluenose). Surveys and radio-collar programs are costly and*

*time-consuming, so it is not practical to study all herds at the same time. By the 1980s, attention was being paid to more remote caribou herds such as the Ahiak herd, which was increasing in abundance and the size of its annual range. There has been a similar pattern of study and surveys in Alaska from the 1960s to the present – initial emphasis on studying the larger herds of greatest management importance, with more recent study of smaller or more remote herds. Readers should also bear in mind that the GNWT shares responsibility for several cross-border herds of barren-ground caribou with Nunavut and to a lesser extent with Saskatchewan and Manitoba. After Nunavut became a separate territory in 1999, GNWT priorities for funding and research were focused most on the herds of greatest importance to NWT communities and hunters, and less on herds with most of their range outside the NWT.*

The Bathurst Caribou Herd

**1.** How can the ENR compare the Bathurst Herd in the 1980s and 1990s, to the Bathurst Herd in 2006, when the definition of the herd has changed?

***Comment:*** *The definition of herd has not changed and is based on the return of cows to their traditional calving ground. The calving ground of the Bathurst herd has been known since the 1960s and 1970s. Although it has shifted location periodically, it has remained a distinct calving ground, hence a distinct herd, from the earliest studies onwards.*

**2.** If, according to Aboriginal Knowledge and former ENR biologists, the Bathurst herd calving ground has shifted east and west of the Bathurst Inlet since the

1950s (and probably for centuries), why does the ENR now insist that caribou calving on the east side of the inlet must be Ahiak caribou?

***Comment:*** *Aerial surveys in 1986, 1995, 1996, 2002, 2006, 2007and 2008 east and west of Bathurst Inlet have delineated two calving grounds, geographically separated by at least 100 km. See, for example, Figure 4 for the clear separation between the Bathurst and Ahiak calving grounds. Results for 2008 have not yet been mapped but were similar. Satellite collar data since 1996 from the Bathurst and Ahiak ranges have confirmed this separation.*

**3.** Traditionally, caribou calving on both sides of the Bathurst Inlet have migrated south and been harvested in Wek'heezhi. Now, the ENR says no caribou (none, zero, zip, nada) that calved on the east side of the Bathurst Inlet (Ahiak Caribou), despite mixing freely with Bathurst and Beverly caribou, are being harvested. How is that possible?

***Comment:*** *ENR made this comment specifically in relation to whether Ahiak caribou bulls were being harvested in Unit R by outfitters (see Figure 2). Satellite collar data show that it is unlikely for Ahiak caribou to be hunted from the camps used by the outfitters at this time of year.*

**4.** Outfitters and residents harvest only bulls. What is the definition of a Bathurst or an Ahiak or a Bluenose East bull? (The reality is, there is no such definition, which is why the Wildlife Act only says "Barren ground caribou.")

***Comment:*** *The outfitter quotas are assigned to wildlife management zones, not herds in the regulations. ENR uses satellite collar information to apportion likely hunter harvest to herds where a management zone or land claim settlement area includes multiple herd ranges. The Bluenose West is harvested in the Sahtu, Gwich'in, and Inuvialuit Settlement Areas, so the harvest is managed in all three regions.*

**5.** If the Bathurst herd was dropping 5% every year for the past twenty years, what took the government twenty years to figure this out?

***Comment:*** *The decline was detected in 2003 when the trend had become a statistically significant decline between 1986 and 2003; between 1996 and 1986, the trend was that the herd was statistically stable. Based on the estimates, 1986 was the peak in herd size so the decline likely started then. Calving ground photo-surveys like those on the Bathurst range are time-consuming and now cost in excess of $300,000. As a result, they are undertaken when needed, more often when herd numbers are low or declining, and less often when the herds are at high numbers or growing rapidly. Small changes in herd size are difficult to detect.*

**6.** Anne Gunn, in her 2007 "Possible Reasons for the Decline of the Bathust Herd Using Demographic Modeling" doesn't talk about Range Condition, Wolves, Predation, Grizzly Bears, Disease, Weather, or Nutritional Issues. She only talks about hunting as the probable reason for the caribou decline. (Please bear in

mind that the Bathurst herd is the least hunted major herd of caribou in North America, and harvest levels have dropped by nearly 70% in the last decade.) Is statistics how the ENR now plans to manage wildlife in the Northwest Territories? Is this the sort of misinformation it will be giving the WRRB, when it begins managing wildlife in Wek'eezhi?

***Comment:*** *The report specifies that the model was built to explore how demographic rates were interacting and how harvest (as an estimated factor) could affect recovery. ENR is well aware that various other factors influence caribou herd size; however, study emphasis has been on demographic parameters such as adult survival, calf recruitment, and population trend, as factors such as weather, predation and disease will translate into measurable demographic indicators like survival rates.*

**7.** In the ENRs 2001-2004 bull to cow ratio counts, it states: "We did not classify yearlings as we suspect that classification errors between 22 and 34 month old caribou are likely." In Alaska, these "young bulls" (one to three year olds), make up 55% of the total bull counts. If the government is not classifying these bulls, it is skipping over half of the bulls (assuming the same age distribution as Alaskan caribou) . This would give the Bathurst herd a bull to cow ratio of over 74/100. Why does the ENR refuse to acknowledge mistakes of this nature, and why does every mistake they make always point in the same downward direction?

***Comment:*** *We classified male yearlings as young bulls rather than identify them as a cohort. The difficulty is in distinguishing between yearlings and 2-year-olds.*

*In other words, male yearlings were classified as males and included with the young bull category. No animals are omitted from surveys.*

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**8.** In the government's 2003 spring calf survival count, it didn't have the fuel cache to reach the collared caribou, so instead it counted the calves where it had 13 collared wolves, plus additional uncollared wolves. What did the government think these wolves had been eating all winter? What kind of representative sample did they think they would get? What caribou cow, with a calf in tow, in its right mind, would hang around where there are dozens of wolves?

***Comment:*** *Caribou space themselves at a smaller scale (lakes) from the wolves so using the collared wolves to check to see if there were caribou in the vicinity is practical. An effort is made during all composition surveys to distribute the sample over a representative range.*

**9.** In the 2001-2004 Calf Survival study, where the government first determines the Bathurst herd has dropped 5% for 20 years, it bases this on a 100 bull per 100 cow ratio. Nowhere in the history of any major caribou herd, has there ever been such a ratio. How can caribou "experts make this kind of error?

***Comment:*** *The sex ratio at birth in caribou is usually close to 50:50 (or 100:100) but thereafter male mortality, even in the first 6 months, is consistently higher than female mortality. Adult sex ratios in caribou vary usually from about 30:100 (decreasing herds) to 60-70:100 (increasing herds). The 100:100 ratio noted could only have come from an estimated ratio at birth.*

**10.** In the same document, the government bases its calculations on an annual cow mortality rate of 21% a year. In 1996 Ray Case puts this mortality rate at 8%. What has the government identified to explain this incredibly high mortality rate, a rate it says has existed for 20 years?

***Comment:*** *The estimate of 8% was based on estimating herd trend, recruitment and harvest in 1980, with increasing herds. With more information it has been recognized that this method of estimated mortality frequently results In an under-estimate. With the introduction of radio-telemetry, estimates of adult mortality are now mostly based on individual-based models. Adult mortality varies annually and between herds, depending whether herds are increasing or decreasing.*

*The 21% estimate of cow mortality is not high compared to other decreasing herds. The survival rates are similar to those estimated from radio-telemetry in other large herds of caribou seasonally migrating between the tundra and taiga. In the George River herd (Quebec and Labrador), survival rates for adult females in 1984-85 were 0.895-1.00 (95% CI) compared to 0.846-0.971 in 1986-87 (Crete et al. 1996). Annual survival of Porcupine caribou herd adult females was about 84% between 1982 and 1988 (Fancy et al. 1994, Walsh et al. 1995) during a period when the herd was increasing in size. In other Alaska herds, for example the Nelchina, annual survival for radio-collared adult cows was 82% (1999-2000) during a period when the herd was declining (Alaska Department of Fish and Game 2001). In the Western Arctic herd, survival for adult females during the period when the herd was increasing (1984-1990)*

*averaged 87% compared to 85% when the herd was stable to slowly declining (1990-2000). Adult cow survival from the declining Bathurst herd is slightly lower than these estimates, but similar.*

**11.** At the Wek'eezhi Board meeting on March 13, 2007, Susan Fleck testified **"In '86 they (Bathurst Caribou) used either side of Bathurst Inlet."** How come now they only count caribou on the west side of the inlet?

***Comment:*** *The aerial surveys were flown east and west of Bathurst Inlet. In 1986, calving was along the coast on both sides of the Inlet, and study of the Ahiak (QMG) herd was in the initial exploratory stages . See also figure 4 for 2007 calving grounds of the Bathurst and Ahiak herds, well separated on either side of Bathurst Inlet.*

General Questions

**1.** How can the government report 354,000 caribou in 1980, and 1,534,000 in 2005, and say the herds are rapidly declining?

***Comment:*** *As noted earlier, it is possible to draw misleading conclusions about numbers of caribou in different herds if the estimates are drawn from different periods. Comparisons should only be made on a herd-by-herd basis, or for estimates made in the same year or a short span of years, including the same herds. Between 1980 and 2005, knowledge of barren-ground herds in Canada and Alaska increased and some previously remote and little-known herds have been studied and surveyed. On a herd-by herd basis, the declines of the*

*Bathurst, Porcupine, and Blunenose herds in the late 1990s and early 2000s are well documented.*

**2.** Why does Anne Gunn, in 2001, say the herds have increased “fivefold”, when now she says they had been dropping 5% a year for 20 years?

***Comment:*** *The quote is from a book chapter written in 1999, using data from 1996 or earlier, and published in 2001 before the declines were detected. The ability of barren-ground caribou herds to increase rapidly (for example the Qamanirjuaq and Beverly herds in the 1980s) or decrease rapidly (for example the Bluenose-West and Cape Bathurst herds in the 2000s) within a five-year period is now well established.*

**3.** How can 4 caribou herds be divided into 7 herds, and the government compare one herd definition with an earlier definition?

***Comment:*** *The definition has not changed and is still based on the annual return to a traditional calving ground. Closer evaluation of the Bluenose herd and calving range in the 1990s showed that there were in fact 3 distinct calving grounds. As a result, the herd was divided into 3 herds named the Bluenose-East, Bluenose-West, and Cape Bathurst. No caribou were added or lost in the process.*

**4.** Where does the 4% allowable harvest number come from? In 1996, using the precautionary principle, the number was 5.7%. Why has this changed?

***Comment:*** *The level of allowable harvesting depends on the objectives for the herd. By definition, there is no sustainable harvest from a declining population, but wildlife managers may still permit a limited harvest for a short period. Specifically, ENR recommended that the hunter harvest from the Bathurst herd not exceed 4%, considering previous harvest rates (the 2005-06 harvest) and recommendations from co-management boards for other declining herds in the NWT. For example, the Sahtu Renewable Resources Board recommended a harvest limited to 4% of the declining Bluenose West herd in late 2007, with a bias towards bulls, and re-evaluation of the harvest rate when more information (such as a new survey) was available.*

[some non-technical questions omitted]

**11.** Susan Fleck at the Wek'eezhi Board meeting testified "when we see less than 30 calves per hundred cows, this can mean a declining herd." On the government's website, Doug Heard, former ENR biologist, says the Bathurst herd, in 1984 had 22 calves per 100 cows (File Report 83). This is similar to that observed in 2001-2004. Heard estimates the herd growing at 14%, which it did, according to the next survey. Why does the government now say there is an emergency?

***Comment:*** *Calf survival does vary from one year to the next, which is why Gunn et al. (2005a) compared average calf survival 1985-1995 and 2001-2004. Trends are usually more informative than single annual estimates. Calf:cow ratios of less*

*than 30 are a signal for caution about what might be happening. Modeling of caribou demographics has consistently shown that adult cow survival varies much less than calf survival (and is more difficult to measure) but small changes in adult cow survival affect the herd much more than small changes in calf survival. Consistently low calf:cow ratios tend to reflect a declining herd, but one year's calf:cow ratio must be used with caution.*

**13.** If the management goal for the bull to cow ratio in Alaska is 30-40, why is this same number identified by the ENR as a reason for closing down the outfitting industry in the Northwest Territories?

***Comment:*** *The proposed change to the outfitters' tag quota is a result of the decline in the size of the herd, not the bull:cow ratio. However, fall bull:cow ratios for the Bathurst herd in the 2000s indicate declining values, so that a harvest that targets only prime bulls must be managed with caution.*

**18.** On several occasions the ENR has cited "climate change" as a possible reason for the theoretical decline in the caribou. Although this may be trendy and win them an audience when Al Gore visits, has the government done any actual studies to verify this claim?

***Comment:*** *Studies of the Porcupine herd's calving grounds and timing of green-up have shown that weather at this time can affect the location of calving and summer calf survival. ENR is pursuing a similar evaluation for other NWT caribou calving grounds. There are also graduate studies of the winter range, insect harassment, and fire ecology on the Bathurst winter range underway. It is*

*important to keep in mind that annual variation in weather, with potential effects on caribou, has been a factor in their ecology for a long time. Global warming is a related phenomenon, although its effects need to be considered as additional to existing weather variation at various temporal and spatial scales.*

**19.** If the Ahiak herd has grown 20 fold in the past twenty years on the east side of the Bathurst Inlet, and the Bathurst herd has declined 5% for twenty years on the west side of the inlet, is the weather east of the Bathurst Inlet substantially different than the weather west of the Bathurst Inlet? And is this warmer weather, with shorter winters, earlier spring greenup, better feed for lactating cows, killing caribou? And if so, why doesn't warmer weather kill caribou in Newfoundland, British Columbia, even as far south as Idaho, in the U.S.? If range conditions are in issue, will the range recover faster in warmer weather or colder weather?

***Comment:*** *Weather east of Bathurst Inlet tends to be cooler and drier. Plant green-up in June is later east of the Inlet. Relationships between weather, spring or summer foraging conditions, and caribou population trend are not simple. In Quebec/Labrador, the George River and Leaf River herds have had opposing population trends in the 1990s and 2000s. ENR has studied these kinds of questions in the past. See for example, Griffith et al 2001 for a study of spring-time food habits, vegetation green-up and annual variation on Bathurst caribou calving grounds .*

**20.** Anne Gunn, ENR biologist, told a Canadian Arctic Resources Committee meeting that caribou are cutting their feet on mining roads, walking in mining dust, getting a higher incidence of foot rot, and then have trouble escaping predators. Is this the reason for the Bathurst Caribou decline? In 2004, she saw two lame caribou out of 12,444 caribou. Where is the study for the basis of such ridiculous statements?

***Comment:*** *The comment referred to observations by Aboriginal elders. We also suggest that in years with severe insect harassment, especially dry summers, conditions may be conducive to foot rot. In 2001, because we had reports of lame caribou, we surveyed in November to record the prevalence of lame caribou: 17/6122 caribou (0.3%) compared to 0.0% in 2000 and 0.0002% in 2004. Information such as this should be used in the context originally intended (Gunn et al 2005a).*

**21.** Slides with Quotes from Thomas 1995's publication (post-calving photo surveys vs. calving ground photo surveys).

***Comment:*** *Dr. Thomas's comments are well known and were considered during a workshop held by ENR in 2000 to re-examine the techniques for counting caribou. The workshop included ENR staff, as well as outside statisticians and biologists.*

*Improvements have been made to calving ground photo surveys to improve reliability of estimates:*

- *We made changes to our statistical design to improve precision.*

- *We began using trend analyses rather than simple paired census comparisons.*
- *The Coefficients of Variation for estimates of breeding females have been within the acceptable range-1986 6%; 1990 17%; 1996-23%; 2003-16%; 2006- 16%.*

*To have a chance of success for post-calving photography, many radio-collars are needed, which has not had community support in portions of the NWT and Nunavut. In Alaska where post-calving photography is the standard technique, they have had problems of missing caribou and missed surveys when the caribou do not aggregate adequately. As we noted earlier, post-calving photo surveys of the Porcupine herd in the 2000s failed for 6 years consecutively due to weather and a lack of adequate caribou aggregation.*

# APPENDIX F.

**Comments on Terramar Environmental Services Ltd's report, contracted by Mr. John Andre to review ENR's caribou data (24 May 2007). Mark Fraker assisted by Dr. R. K. Page was the author of the review.**

TerraMar Environmental Services Ltd was asked to review the biological basis for the proposed reduction in the outfitter quota. TerraMar was asked to address five specific questions. Mr. Fraker lists the question, then his response (**MF**). Text preceded by the word "Comment" and italicized is from the authors (AG, JA, and JN).

Question 1: The Effects Of Harvesting Bull Caribou By Non-resident Hunters

**Question** – "What would be the effect of the removal of bull caribou by non-resident hunters on the trend in abundance of the Bathurst Caribou Herd?"

**MF Response:** Practically none. Members of the deer family, including caribou, are highly polygynous, meaning that a single male is capable of inseminating a large number of females. In fact, in many population-modeling exercises, only the female component of the population is considered because it is assumed that the number of males present will always be adequate to breed the females. Ten or fewer males / 100 females are required to obtain a high pregnancy rate in reindeer (the same species as caribou). Assuming the 2003 estimate of 80,756 cows on the Bathurst calving grounds, and the fall 2004 bull:cow ratio of 0.37, there would be about 29,869 bulls. In practical terms, removing fewer than 1000 bull caribou from a herd as large as the Bathurst herd will have no impact on

pregnancy rates or the trajectory of herd abundance. The impact of non-resident hunters can be summarized as follows:

| **Regulatory Year** | **No. Bull Caribou Harvested** | **Total No. Bull Caribou** | **Percent Bull Caribou Harvested** |
|---|---|---|---|
| 2005-2006 | 891 | 29,869 | 3.0 |
| 2006-2007 | 727 | 29,869 | 2.4 |

***Comment:*** *The Department's concern was the decline of the herd and whether the total harvest contributed to the decline in abundance and could affect herd recovery. The Department felt that the harvest was too high, which triggered an order of priority for harvest reductions. It was the herd's decline and the need for harvest reduction that triggered the reduction in the outfitter quota, rather than the effect of the prime bull harvest on the herd's trend in abundance. It is worth remembering that a sustainable harvest from a declining game population is, by definition, non-existent; a continued harvest may accelerate a decline or slow a recovery.*

*It is unclear why Mr. Fraker used the 2003 and not the 2006 estimate as he uses the 2005-07 harvest years. Assuming the 2006 estimate of 55,593 cows on the Bathurst calving grounds (ENR unpublished[10]), and based on the fall 2004 bull:cow ratio of 0.37, there would be about 20,570 bulls and about half those*

[10] Although unpublished, TerraMAr's covering letter refers to the report with this estimate

*bulls are prime bulls (Gunn et al., 2005a). Bulls are categorized as prime based on the height of their rack relative to shoulder height. The outfitters' clients are selecting from within the prime category for a trophy bull so their harvest is focused on a few year classes of bulls. If there were 10,300 prime bulls, the outfitters were annually removing between 7 and 9% of them, not 2.4-3% as suggested below by Mr. Fraker (AG, JA & JN changes - bold italic entries to table).*

| **Interpretation (M. Fraker or A. Gunn)** | **Regulatory Year** | **No. Bull Caribou Harvested** | **Total No. Bull Caribou** | **Percent Bull Caribou Harvested** |
|---|---|---|---|---|
| M. Fraker | 2005-2006 | 891 | 29,869 | 3.0 |
| ***AG, JA & JN*** | ***Prime bulls*** | | ***10,285*** | ***9*** |
| M. Fraker | 2006-2007 | 727 | 29,869 | 2.4 |
| ***AG, JA, & JN*** | ***Prime bulls*** | | ***10,285*** | ***7*** |

**Comments On Question 1's Discussion From TerraMar's Environmental Research Report**

**MF Discussion:** Using the most recent population estimate available for the breeding cow component of the Bathurst Herd (80,756; Gunn *et al.*, 2005b) and the most recent cow:bull ratio (0.37 in 2004; Gunn *et al.*, 2005a), we can calculate the approximate number of bulls in the Bathurst Herd: 29,869. The harvest by non-resident hunters was <3.0 % annually for the past two years. [This analysis assumes a "worst case", in that

1) the 2003 calving ground estimate may have been low owing to the lateness of the survey (Gunn *et al.*, 2005b),

***Comment:*** *The cited report did not conclude that the estimate was low because the photography occurred a few days after the peak of calving. The report gives the reasons (additional aerial verification for movements) why the survey biologists did not conclude that the delay resulted in an under-estimate.*

**MF Discussion Paragraph Cont.:**

2) the cow:bull ratio may be low given the variability in the ratios obtained on different parts of the fall distribution and in different years (Gunn *et al*., 2005a),

***Comment:*** *There is no reason to believe that the 2004 sex ratio was not representative of the Bathurst herd in 2004. The ratio varied between sampling sites, which is why an average was used. The different sampling locations were representative of the herd's distribution. This was discussed by Gunn et al. (2005a). In the other two years, the ratio was higher but the sampling was not considered representative of the herd's distribution, as explained in Gunn et al. (2005a). In 2000, the cited report noted that the sampling did not adequately cover the range and in 2001 the sampling was late as it was focused on documenting the proportion of lame bulls.*

**MF Discussion Paragraph Cont. :**

3) it is not certain that the Bathurst and Ahiak herds are, in fact, separate.]

***Comment****: Mr. Fraker's speculation is commented on in the next section (Question 2).*

**MF Discussion:** The presence of 37 bulls:100 cows is entirely adequate to inseminate the fertile females. Holand *et al.* (2003) found no effect of different bull:cow ratios on calving rates in their experimental reindeer populations, which ranged from 8.7 – 37 bulls:100 cows. One dominant bull in their study was observed to have bred 20 females during the main rut.

***Comment:*** *Mr. Fraker may have misunderstood the concern about the sex ratio and effect of outfitter harvesting, which is that with a relatively low sex ratio, more younger bulls may be breeding the cows. Mr. Fraker selectively cites results from Holand et al. (2003) who used an experimental approach to investigate the consequences of skewed sex ratios and a skewed ratio of young to older bulls (8-14 bulls:100 cows) in two groups of about 45 females over 2 years. Calving occurred later with the skewed ratio and younger bulls. Synchrony of births and calf birth weight increased with the higher sex ratio. As Mr. Fraker notes, there was no effect on calving rate. However, Holand et al. (2003) also wrote that caution is needed when extrapolating from enclosure experiments and "In*

*Norway, populations of both semidomestic and wild reindeer populations have a female biased sex ratio and a young male-biased age structure. Managers should consider that such a population structure might delay calving."*

**MF Discussion:** Skjenneberg and Slagsvold [(1968); cited by Holand *et al.* (2003)] indicate that a single mature *domestic* reindeer bull can service 50 cows in a *managed* herd *[AG italics]*. Roed *et al.* (2005), using genetic techniques, found that two-thirds of the reindeer bulls, not just a small group of dominant males, sired calves in their wild population. They stated that their findings challenge "… the traditional assumption that most reindeer calves were fathered by a small group of highly successful males, suggesting that alternative mating strategies may play a more prominent role … than previously expected."

**Comment:** *The point about alternate breeding strategies is also suggested in Gunn et al. (2005a) although it has not been demonstrated. Mr. Fraker did not include the note of caution offered by Røed et al. (2005) about generalizing from their results: "The variance in male breeding success over one breeding season should be interpreted with caution because it has been reported to vary inter-annually with cohort-specific and demographic factors (Clutton-Brock et al., 1982; Rose et al., 1998)."*

*Mr. Fraker also does not refer to Røed 's closing comment :*

> *"Within a sustainable management program where natural sexual selection should occur, we suggest the importance of maintaining*

*reasonable proportions of both young and adult males in the population."*

*Mr. Fraker did not discuss the importance of the age structure of the bulls which becomes more important as sex ratio declines (Mysterud et al., 2003). The most parsimonious conclusion is that we do not completely understand the consequences of male selective harvesting in barren-ground caribou and the published literature reinforces the need for a conservative approach.*

**MF Discussion:** The situation that obtains with barren-ground caribou during the rut, where large numbers of bulls and cows aggregate during migration, would favour the participation of a large proportion of bulls. Bergerud (1978) states that a harvest of 10-15 % of males can be allowed, even in the presence of moderate wolf numbers. However, a harvest of only 5 % can be allowed if both sexes are taken. In a harvested caribou herd in Newfoundland, Bergerud (1971) reported that the herd grew from 5000 to 6192 over an 8-year period, even though the average annual harvest of males amounted to 11 % of the herd – females were not harvested. The number of bulls / 100 cows ranged from 27 to 47 and the percent of cows that gave birth ranged from 81.4 to 91.7 during that time. The proportion of females giving birth was unrelated to bull:cow ratio.

***Comment**: Mr. Fraker does not point out that Holand et al.'s (2003) results are similar to Bergerud (1978) in that the observed sex ratios did not affect birthrate.*

*However, in an earlier paper Bergerud (1974) argued that a sex ratio of 1:12 or more might mean that not all cows were bred during their first heat and calves conceived during a second heat would have lower survival, being born a few days before the onset of mosquito harassment.*

*Bergerud (1974) concluded that for at least Newfoundland caribou a sex ratio of 1:2 was a Rangifer species characteristic and Davis et al. (1978) argued this was the optimum ratio and a management goal. Davis et al. (1978:19) also concluded that based on a comparison of Alaskan herds "a ratio as low as 30 bulls (older than yearling):100 cows (older than yearling) is ample to ensure breeding of most, if not all, cows during the first estrus".*

*In the 1980s, there were few concerns about adult caribou sex ratio. However, as experience and knowledge grew, so did the realization that there may well be unexpected consequences of biasing the ratio strongly toward females. Specifically for herds in decline, males die at greater rates than females, regardless of harvesting. The Department's concern about the sex ratio for the Bathurst herd was based on recent caribou management in Alaska as well as the ungulate scientific literature. For example, the management objective for the Nelchina herd in the late 1990s was to keep the ratio at 40 bulls:100 cows. When the ratio fell to 21:100 cows, bull harvesting was progressively restricted and within 3 years, the ratio was 31:100 cows (2004) as reported by Tobey (2001). The management objective for the Mulchatna herd is a minimum 35 bulls:100 cows; Forty-Mile herd 35 bulls:100 cows; Central Arctic Herd 40 bulls:100 cows (Brown ed. 2004).*

*Secondly, the Department's concern about female based sex ratios was from the published literature on other ungulates. Ginsberg and Milner-Gulland (1994) commented on the lack of theoretical or empirical information on the effects of extreme sex-selective harvesting. They investigated the effects in impala Aepyceros melampus and found that as hunting intensity increased past 8% population size, there is a non-linear effect of increased male selectivity. In a review, Mysterud et al. (2002) commented that "In general, even in harvested populations with highly skewed sex ratios, males are usually able to fertilize all females, though detailed studies document a lower proportion of younger females breeding when sex ratios are heavily female biased. It is well documented that the presence of males can induce oestrus in females, and that male age may be a factor. In populations with both a skewed sex ratio and a young male age structure, calving is delayed and less synchronous." The authors concluded,*

> *"We argue that the effects of males on population dynamics of ungulates are likely to be non-trivial, and that their potential effects should not be ignored. The mechanisms we discuss may be important – though much more research is required before we can demonstrate they are."*

## Question 2: Herd Identity

**Question:** Are the Bathurst and Ahiak caribou herds really a single population?

**MF Response:** Yes. It is possible that what was identified as the Bathurst Caribou Herd in the past is now comprised of 2 components, one, recognized as the Bathurst herd, currently calves to the west of Bathurst Inlet and the second, the putative Ahiak herd, calves to the east. The Bathurst herd was estimated to contain 200,000 animals in 1986. Today, the Bathurst (186,400 in 2003) and Ahiak (200,000 in 1996) herds combined exceed 300,000, indicating an increase in the number of caribou in the region, not a decrease, and a merging of the two herds. [Although these estimates of herd abundance are contained in GNWT reports, they are likely to be inaccurate. See response to Question 3.]

***Comment****: This is obviously a key point for Mr. Andre and as such is dealt with more fully in the body of this report. As we have noted previously, surveys of calving grounds and satellite radio-collar data have shown clear separation of the Bathurst and Ahiak calving grounds since surveys of the Ahiak herd began in 1986. The Bathurst herd was estimated at 472,000 +/- 72,900 in 1986, 349,000 +/- 94,900 in 1996, and 128,000 +/- 27,300 in 2006 (see Table 2; Mr. Fraker's numbers are not correct). Although there have not been population photo-surveys of the Ahiak herds, the calving distribution surveys in 1986, 1999, 2007, and 2008 suggest that the Ahiak herd has increased since 1986 and is, in 2008, one of the larger herds in the NWT. Opposing population trends in neighbouring herds (e.g. George River and Leaf River herds in Quebec/Labrador) have been documented elsewhere.*

**Comments On Question 2's Discussion From TerraMar's Environmental Research Report**

ARE CARIBOU HERDS READILY SEPARABLE?

**MF Discussion:** Herds of barren-ground caribou are aggregations of animals that naturally shift location and frequently exchange individuals with nearby herds (Ferguson and Messier 2000, and others).

***Comment:*** *Conditions on Baffin Island are not likely to be representative of migratory barren-ground herds in Alaska and mainland Canada. As we explained earlier, documented cases of herds shifting en masse are rare, and fidelity to calving grounds of collared cows is typically very high.*

**MF Discussion:** Changes in the abundance of any one herd may be due to changes in natural mortality, increases due to immigration or decreases due to emigration (Hinkes *et al.*, 2005). This work questions how useful or accurate the traditional concept of a herd is for management of caribou at all, or whether a collection of herds (known as a metapopulation) is a more useful division for management (see Hinkes *et al.* (2005) for an extensive discussion).

***Comment:*** *Mr. Fraker does not acknowledge that fidelity to calving grounds is a long-standing tenet of barren-ground caribou management, which the application of more recent techniques has largely supported. Hinkes et al. (2005:1158) comment, "The current herd definition may be appropriate for short-term management; however, over long time frames and large spatial scales, the herd may not be the most effective conservation unit (Courturier, 2001)." The authors*

*do not offer a definition for what a long time scale is. Mr. Fraker also does not consider that Hinkes et al. (2005) describe one of two known exceptions recorded among Alaskan Mountain caribou. There are many other papers and publications documenting the large amount of data on fidelity to calving grounds of barren ground herds and the applicability of the definition of "herd" based on annual return to calving grounds.*

**MF Discussion:** The primary evidence for redefinition of the Bathurst herd and the creation of a new herd, known as the Ahiak, comes from a handful of female caribou with satellite collars (Gunn and D'Hont, 2002), and surveys that have shown calving aggregations east and west of Bathurst Inlet (Gunn *et al.*, 2000). Less than 0.001% of the herd is collared at any time. These females were used to identify and separate the calving grounds of the herds.

***Comment:*** *Mr. Fraker did not use more recent Departmental information (unpublished but available on request) on aerial surveys of the Ahiak calving ground in 2006 and the movements of satellite-collared cows 2002-2008. Also, Mr. Fraker makes no mention of the fact that the satellite-collared cows that were together on one calving ground were also separate during the rut from the cows that calved on another calving ground. This point was made in Gunn et al. (2000) and Gunn and D'Hont (2002), and is described more fully in the main text. In April 2008, ENR biologists collared another 24 Ahiak caribou cows, bringing the total of ENR collars on this herd to 36. Their movements once again confirm the separate nature of the Bathurst and Ahiak herds.*

**MF Discussion:** It has also been suggested, that the herds are genetically distinct. However, Littau (2004), *[Zittlau]* who conducted the only extensive examination of the genetics of barren-ground caribou, found no unique genetic differences among the barren-ground caribou herds in the NWT. In fact, when members of the putative Ahiak Herd were compared with other herds using a genetic assignment test, they were most often recognized by the test as Bathurst animals (Fig. 1).

***Comment**: Mr. Fraker does not acknowledge that Zittlau's (2004) analyses are somewhat ambiguous about the level of herd differentiation. For example, Zittlau (2004:84) wrote "Pairwise assignments showed that the greatest proportion of assignments were to the sampled population. Two exceptions are noted: Ahiak was not different from Bathurst, although the Bathurst herd was differentiated from the Ahiak herd, and Beverly was neither different from Ahiak nor Qamanirjuaq, although the Qamanirjuaq herd was different from the Beverly herd. Also Zittlau (2004) wrote that "the linkage disequilibrium noted in the Ahiak and Qamanirjuaq herds may be indicative of their more relatively recent establishment. Glacial retreat occurred later on the northeastern mainland, where the herds are presently located, than it did in western regions. Therefore, the Ahiak and Qamanirjuaq herds may have been established only 2 000 to 3 000 ybp, as opposed to the establishment of the Porcupine and barren-ground herds in the Northwest Territories and western Nunavut, which likely occurred as long ago as 8 000 to 10 000 ybp."*

*Mr. Fraker also does not deal with the question of whether there have been sufficient generations for the herds to become strongly differentiated, given the time since glaciations, and the effective size of the herds. Nor does he refer to the different scale of genetic immigration relative to demographic immigration. It takes just a few individuals per generation for genetic immigration. At best we can say that at the present time, genetic studies have not allowed clear separation of neighbouring barren-ground herds, but finer-scale studies may provide greater insight.*

WHY DID THE BATHURST CALVING GROUND SHIFT?

**MF Discussion:** In the specific case of the Bathurst herd, both the range and abundance of the herd have been redefined since the 1990s. Herds are defined by the areas that females occupy during calving and a dramatic shift in this area is unlikely:

> "… caribou are adaptable in their evolutionary strategies, including their use of space (e.g., Bergerud, 1996; Ferguson and Messier, 2000), it would require an extremely severe and prolonged environmental stimulus to cause several thousand caribou to completely abandon their calving areas and summer ranges" Gunn *et al.* (2006)."

***Comment:*** *Mr. Fraker is citing a paper on Peary caribou (Gunn et al. 2006) and the context was different from the Bathurst and Ahiak herds. The Peary caribou had disappeared from their two-island range whereas the calving grounds for the Ahiak and Bathurst herds still exist today. Although there have been shifts over*

*decades, consecutive annual calving grounds overlap for each individual herd (Ahiak and Bathurst) but there is no overlap between them.*

**Figure 1. *[not included in this Appendix*] -** Results of genetic assignment tests for continental caribou.

**MF Discussion:** No reports have identified the "extremely severe and prolonged environmental stimulus" that could account for the shift in calving areas of the Bathurst herd. Without such an explanation, the Bathurst and Ahiak herds should continue to be regarded as a single population with the calving grounds separated in some years by Bathurst Inlet. In the past, and presumably again in the future, the calving grounds were contiguous as they would be today if the barrier of Bathurst Inlet did not exist.

***Comment:*** *It is normal for the calving grounds of barren ground caribou herds to shift over time – although consecutive annual calving grounds overlap over time. The overlap may be in a particular direction or the shifting may be non-directional. Sutherland and Gunn (1996) described the known shifts in calving of the Bathurst herd. At no point have the known calving grounds of the Bathurst and Ahiak herds been contiguous. In 1986, when the Bathurst herd calved along the east coast of Bathurst Inlet, the Ahiak herd's calving ground was separate and some 200 km east of the Bahturst herd's calving ground. Essentially simultaneous surveys of NWT and Nunavut barren ground caribou calving*

*grounds in June 2007 and 2008 once again confirmed the separate nature of the Bathurst, Ahiak, Beverly and Qamanirjuaq herds.*

**MF Discussion:** A likely explanation for expansion of the Bathurst-Ahiak population to the west is an increase in the size of the herd. In both Alaska (Hinkes *et al.,* 2005) and Quebec (Bergerud pers. comm., Messier *et al.,* 1988) an increase in the numbers of caribou resulted in a dramatic increase in the range of the herd and expansion into previously unoccupied areas. What was once called the Queen Maud herd may also have been incorporated into what is now called the Ahiak herd, but the surveys are too infrequent (often separated by a decade) for definitive conclusions. The putative Ahiak herd has been surveyed only twice, once in 1986 and again in 1996 (Table 1). The understanding of herd movements, expansions, and range overlaps in Alaska and in Quebec and Labrador was possible only because of frequent surveys and extensive data collection. This level of effort has not been afforded these herds in the NWT. The Ahiak herd was identified and named as a new herd just recently. In describing this herd, the NWT biologists agree that it has no unique range and overlaps other herds.

> "Their traditional calving grounds overlap with the Bathurst herd's traditional (but not current) calving grounds, their southern wintering ranges overlap with the ranges of the Beverly and Bathurst herds, and their northern winter ranges overlap with the Dolphin and Union herd's mainland winter ranges."

***Comment:*** *Mr. Fraker's quote, although not identified, is from the abstract of Gunn et al. (2000). Mr. Fraker has confused overlap on the winter range with neighbouring herds in some years as meaning the Ahiak herd does not have a "unique" range. This is untrue as telemetry and surveys of calving grounds have shown that the current calving, post-calving, summer and rut ranges do not overlap with areas used by other herds. It is correct to say that the Ahiak herd's current calving ground overlaps with an area once used by the Bathurst herd, but at no point have the two herds had contiguous calving grounds.*

*Experience with most tundra migratory herds is that trends in herd size and location of calving grounds are not related. Typically, it is the location of winter ranges that changes with herd size. The shift of the Bathurst calving ground to west of the Inlet is unlikely to be related to herd size.*

*Mr. Fraker may not have understood that the Kitikmeot Hunters' and Trappers' Association requested the name Queen Maud Gulf be changed to Ahiak – two names for the same herd (Gunn and D'Hont, 2002). Mr. Fraker is also unaware of 2006, 2007 and 2008 surveys of the Ahiak calving ground and satellite telemetry 2002-08 which further support the use of the Ahiak calving ground. We have 4 aerial calving ground surveys and 8 years of satellite telemetry that are consistent with separate calving grounds and rutting locations for the Ahiak and Bathurst herds. There is also traditional knowledge for calving along the eastern Queen Maud Gulf coast, and historic observations.*

**Table 1. *[not included in this Appendix*]**

**MF Discussion:** If the herds are not easily separable and the evidence is weak, it is more appropriate to manage the contiguous caribou as a single population. Hinkes et *al.* (2005) concluded for the herds in southwestern Alaska that "metapopulations may better describe caribou ecology and be more useful in long-term caribou conservation."

***Comment:*** *The herds in question (Bathurst and Ahiak) are easily separable based on calving, post-calving, summer and rut distribution. Mr. Fraker is selectively quoting Hinkes et al. (2005). Hinkes et al.'s (2005) preceding sentence was "The current herd definition may be appropriate for short-term management; however, over long time frames and large spatial scales, the herd may not be the most effective conservation unit (Courturier 2001)."*

**MF Discussion:** They [Hinkes *et al.*] also concluded that because "adjacent herds seldom underwent concurrent censuses, there may be no way to identify such shifts in range." Management of the NWT herds has also suffered from infrequent surveys that do not include adjacent herds in the same year – making it very difficult to eliminate large-scale movements as an explanation for apparent changes in herd abundance. It would be more parsimonious to consider the Bathurst and Ahiak herds a single population for management. In that case, there is no evidence of a dramatic population decline.

***Comment:*** *We agree that in the past, concurrent censuses were uncommon, but when there have been concurrent surveys (1986, 1996, 2006, 2007 and 2008) they reveal calving ground fidelity and separation for the Bathurst and Ahiak herds (see Figure 4). Satellite telemetry has also shown separate post-calving summer and rut distributions, and no evidence for large-scale movements beyond normal migration and variation often associated with weather. This evidence, although imperfect, indicates that it is parsimonious to consider the Ahiak and Bathurst as separate herds.*

SMALL SAMPLE SIZES OF SATELLITE-COLLARED FEMALES

**MF Discussion:** The recent re-definitions of herds have been based on data from a very small number of satellite-collared females, which cannot possibly capture the full range of behaviour of the entire herd.

***Comment:*** *The question of whether the low number of collared cows is representative of the overall distribution of the herd is addressed in Gunn et al. (2001) and in Gunn and D'Hont (2002). The distribution of the collared cows is most representative of females in a herd during calving. The recognition of the low number of collared individuals is why aerial surveys are used to describe distribution, with the collars being used as supporting and supplementary information. The value of the collars is that they represent marked individuals so that attributes such as survival, calving and rutting associations can be determined. In the event of unusual weather in June, the locations of the collared*

*cows provide a sense of whether movement to the calving grounds, or calving itself, is occurring in unusual locations.*

*Unfortunately Mr. Fraker did not use all the information reported in Gunn and D'Hont (2002) or all the figures, specifically Figures 10 and 11. The text reads, "The movements for 10 of the 11 collared cows between 4-15 June took them to within the polygon enclosing the distribution of cows with calves based on the aerial survey 9–11 June. The 11th cow, Cow 662, had moved to 5 km north of the polygon enclosing the distribution of cows with calves by 14 June.". East of Bathurst Inlet, five of the 6 collared cows were within the polygon enclosing the distribution of cows with calves in the eastern survey block by 14 June (Figure 11). The sixth cow (Cow 77) was within 1 km of the eastern boundary. "*

**MF Discussion:** From Figure 2 (Figure 7 of Gunn and D'Hont, 2002) it is clear that the few females with collars are a biased sample and do not well represent the full range of herd movements. During the calving ground survey from 9-11 June 2002, 6 of 11 collared caribou in the western block and 5 of 6 collared caribou in the eastern block carrying were not within the western surveyed polygon. This occurred even though the surveyors used the VHF radio signals to attempt to locate collared caribou. Compared to the relatively large area that calving caribou occupied, the clumped distribution of the collared females indicates clearly that the animals selected for collaring are also a biased segment of the entire population (Figure 2). They were not randomly distributed among the other calving female caribou. The western collars were disproportionately north of the surveyed caribou and the eastern caribou were south of the surveyed

caribou. In all likelihood, the collared cows were related matrilineal lines that calved close to each other and apparently were wintering close to each other when they were captured and collared.

***Comment**: Without an analysis, whether the collared cows are randomly distributed and at which geographic scale is unknown; random does not mean even dispersal. Valkenburg (1985) evaluated the distribution of collars in 3 Alaskan herds during post-calving and was unable to reject the hypothesis that they were randomly distributed in the herd; in other words, the collared cows were well distributed within the herd, not clumped. Larger groups had more collars, smaller groups had fewer, about as expected. Caribou captured for collaring are always taken from groups well separated. It does not appear that Mr. Fraker carefully analyzed the capture locations and the distance between the cows at calving, as described in Gunn and D'Hont (2002).*

**MF Discussion - Figure 2.:** Extent of calving based on caribou calves observed during the aerial survey 9–12 June 2002 and routes travelled by satellite–collared cows 4–15 June 2002 west and east of Bathurst Inlet, Nunavut. (From Gunn and D'Hont, 2002). The clumped distribution of collared cows may also mean that the survey did not capture the true calving distribution of the herds and there are actually more caribou in the herd than were accounted for in the survey. The tiny number of collared cows do not act independently and, from a statistical point of view, are an effective sample of just 2 or 3. In other words, these animals move and act together, not independently, and clearly do not represent the range of

movements that are typical of the herd as a whole. Similarly, a survey of 10 people in downtown Vancouver alone would be unlikely to reflect the opinions of all Vancouver-area residents, much less all Canadians. The views of one person in that sample would be much more likely to be similar to the views of other people in Vancouver.

***Comment:*** *It is unclear what Mr. Fraker means by the collared cows did not act independently. The term 'random' does not mean evenly dispersed. During systematic surveys such as photographic censuses of the Bathurst herd in 1996, 2003 and 2006, the locations of the satellite collared cows were predictive of calving ground location and the locations of the satellite-collared cows were within high to medium density strata. Most of the collars were where most of the caribou cows were. Mr. Fraker ignores the objectives of the 2002 survey when he suggests that the survey under-estimated the distribution and the number of caribou. The 2002 survey was not designed to answer those questions. In calving photo-surveys, the locations of the collared cows serve as a general guide to the herd's main aggregations, but extensive reconnaissance flying is used to define that year's calving grounds.*

HAS THE WORK UNDERGONE PEER REVIEW?

**MF Discussion:** It is a basic tenet of good science, that all publications should be peer reviewed to validate the data collection, methods, and conclusions. The assignment of caribou to various herds appears to have escaped scientific rigour. Under proper peer review, the small sample sizes and non-random distribution of

the collared animals relative to other females in the herd, would have been thoroughly considered and properly addressed.

The same criticism can be made of much of the data collection for sex and age ratios, which do not appear to sample the entire geographic range of the herds and therefore may be biased.

***Comment:*** *The methods used to study caribou (calving photographic census, use of satellite telemetry to describe calving grounds, sex and age ratios) have been published in peer-reviewed journals for other herds. The government reports are technically reviewed within the Department. The data have not all been published in journals as journals tend not to be interested in publishing 'routine' management studies and individual surveys. It is unclear how Mr. Fraker concluded that the sex-age ratios do not sample the range of the herd as this question is explicitly addressed in the report.*

CAN THE BATHURST AND AHIAK HERDS BE SEPARATED GENETICALLY?

**MF Discussion**: Although it has been suggested that the PhD research of Zittlau (2004) provides genetic evidence for the validity of herd designations in the NWT, this is a misapprehension of her results. She observed differences in the gene *frequencies [MF italics]* between all of the herds, and it is a misinterpretation of the data to suggest that these differences define unique, genetically isolated populations. In fact, Zittlau (p. 85, 2004) herself says, "*Given that these caribou occur as geographic populations, it might be expected that these herds would be significantly genetically differentiated from each other.*

*However, limited genetic differentiation was detected*." *[MF italics].* This statement was referring to a comparison of herds from *Alaska* to *Nunavat [MF italics]* – not just within the NWT itself. Using genetic assignment techniques (Manel *et al.,* 2005), the animals from the Bathurst and Ahiak herds are actually assigned to other herds based on genetic analysis more often than they are assigned to the herds from which the genetic samples were taken, and the genetic composition of the Bathurst and Ahiak herds are virtually identical with no significant differences in gene frequencies between the herds (Figure 1, Zittlau 2004, Chapter 4). Genetically, Bathurst and putative Ahiak herd members appear very similar to one another and cannot be discriminated with even 50 % of the time. In addition, there is a strong genetic influence of all the other mainland herds, reflecting a high rate of genetic exchange among herds. The situation with caribou in the herds of northern Alaska appears to present a situation similar to that seen in the mainland Canadian arctic. The genetic evidence of Cronin *et al.* (2003) suggests that previous field observations of Arctic Alaskan caribou (Western Arctic, Central Arctic, and Porcupine River herds) are correct in considering the herds to be a single breeding population. Certainly the genetic evidence of Zittlau (2004) is even stronger that the Ahiak and Bathurst herds constitute a single breeding population. In southwestern Alaska, Hinkes *et al.* (2005) observed large shifts in range, with smaller herds being swamped by larger ones and concluded that "metapopulations may better describe caribou ecology and be more useful in long-term caribou conservation". They also

concluded that because “adjacent herds seldom underwent concurrent censuses, there may be no way to identify such shifts in range.”

***Comment:*** *The statement in Gunn and D’Hont (2002) is cited as Keri Zittlau pers. comm., as Keri had not completed all her analyses. The initial results indicated differences. Keri began work in May 1998 on migratory barren-ground caribou genetics. The analyses do not support genetic differentiation at the scale measured and there are still uncertainties (see previous quotes for Zittlau 2004).*

*Mr. Fraker is incorrect in asserting that Zittlau (2004) concluded that the Ahiak and Bathurst herd were a single breeding population. What Zittlau (2004:88) reported is:*

> *“The genetic homogeneity across the continental tundra populations is likely the outcome of common post-glacial ancestry and large population sizes, rather than current gene flow. The maximum likelihood and STRUCTURE assignment test results suggest that high rates of recent gene flow have occurred among most of the herds, regardless of the geographic distance among them (Table 4-4). However, the assignment test results may be distorted due to the large effective population sizes of the herds. Also, evidence that geographically neighbouring herds are not necessarily more closely related genetically than distant herds (Table 4-3) suggests that the lack of differentiation is due to a historic relationship, rather than current gene flow. Although tundra caribou are capable of traveling vast distances, such movements are related to seasonal migrations, rather than dispersal events.”*

Question 3: Validity Of Status Assessments Of The Bathurst Caribou Herd

**Question** – In his examination of the status of the Bathurst caribou herd, Mr Andre has raised issues concerning methodology used by NWT biologists. Are there valid concerns about the data collection and analysis procedures that have been used?

**MF Response** – Yes. Concerns are of at least four types: 1) counting caribou on the calving grounds, 2) population reconstruction techniques, which rely on estimates of adult female fecundity and mortality, 3) monitoring of bull:cow ratios, 4) assessment of calf survival using calf:cow ratios.

**Comments on Question 3's Discussion from TerraMar's Environmental Research Report**

COUNTING CARIBOU ON THE CALVING GROUNDS

**MF Discussion:** Systematic aerial surveys and more recently, aerial photography have been used to estimate the size of caribou populations. However, there are serious questions about the validity and utility of making population estimates – at all. Thomas (1998), who has more than four decades of experience with aerial surveys of caribou populations, carefully reviewed the reliability of surveys of the Beverly and Qamanirjuaq herds. He reported strip surveys on calving grounds were inaccurate by 136-374%. Although photographic techniques are better, the level of inaccuracy is such that few survey results are able to detect a change of 50% in population size determined by another, similar survey. Thomas (1998) concluded that much more effort

should be expended on understanding basic biology and vital statistics of the herds than on very expensive and unreliable aerial surveys.

***Comment:*** *The Department is well aware of the views of Thomas (1998). The Department has been consistently working to refine the procedures used for estimating caribou numbers. As described in the main text, barren-ground caribou (breeding cows) are most clearly separated and concentrated during calving; counting at other times of year would be much more difficult. Calving ground photo surveys have been used reliably for more than 25 years in the NWT. Population estimates from calving photo surveys do require extrapolation to account for males and non-breeding cows. Post-calving photo-surveys offer the advantage of counting nearly all the herd in a number of large groups. However, the appropriate weather conditions may not occur, the timing window for photography may be very short, and the method requires large numbers of radio-collars, which some communities in the NWT and Nunavut object to. Neither survey is perfect, but ENR has consistently looked for ways to improve survey methods and precision. ENR also uses vital statistics such as calf:cow ratios, fall bull:cow ratios, condition and pregnancy studies, and hunter observations to monitor herd status and condition. However, calf:cow ratios are best used as indicators, not fine-scale measures of population trend, and they need to be summed over a number of years. Population surveys are expensive and undertaken more often when trend is thought to be negative or the herd is at low numbers, and less often when the herd is increasing or at high numbers.*

**MF Discussion:** The comments that follow pertain to the surveys of the Bathurst and putative Ahiak herds. To estimate the number of caribou on the calving grounds, this area has to be defined. In 2002, biologists used satellite-collared cows to guide them to the calving grounds of the Bathurst and Ahiak herds and to determine whether these cows were generally representative of the distribution of the breeding female component (Gunn and D'Hont, 2002). They found that instead of being distributed more-or-less evenly or randomly throughout the calving grounds, the collared caribou were clumped in particular locations. Two of six collared cows had only 0-2 cow caribou near them, while two others had more than 10,000 each (Gunn and D'Hont, 2002; Table 2). [There are several inconsistencies in the data presented in this report.] In the case of the putative Ahiak herd, aerial surveys were conducted only in 1986 and 1996 (Gunn *et al.*, 2000). The surveyors counted 2855 caribou in 1986 and estimated 10,576 on the calving ground, of which they assumed 0.64 (~6800) to be breeding females (no citation). They then multiplied 6800 by 2 to correct for animals missed by the aerial observers (no citation). Then they extrapolated to the entire area that they believed constituted the calving grounds, which yielded an estimate of 32,000 members of the Ahiak herd. Ten years later, covering only 6% (actually 5.2 %) of the calving ground, as they defined it, they counted 4453 caribou, which they extrapolated to 83,134 animals on the calving ground. (There was an arithmetic error; number should have been 85,249.) They further assumed, without specifying details, that this represented a total population of about 200,000 in the Ahiak herd.

Although Gunn *et al.* (2000) acknowledge *some [MF italics]* of the weaknesses in their 1996 number, the limitations of the estimate of 200,000 for the putative Ahiak herd are rarely, if ever, mentioned, and the figure of 200,000 is commonly presented with the same apparent level of confidence as are the figures arrived at under more rigorous conditions, using aerial photography and a higher density of survey effort. There are a number of arithmetic errors, inconsistencies, and questions about the data and analyses of Gunn *et al.* (2000), and the 1996 estimate of 200,000 is almost certainly grossly in error. Thus, a minimal amount of data collection and analysis, undocumented assumptions, and no apparent rigorous review, has led to the designation of the fourth largest barren-ground caribou herd in Canada.

***Comment**: The extrapolated Ahiak herd estimates were clearly described in the report by Gunn et al. as "rough approximations" to give a general sense of this herd's likely size and to rationalize further studies. The authors were well aware of the limitations of these extrapolations. The report explained exactly how the figures were derived. Mr. Fraker is mistaken that these approximations are used as equivalent to more precise estimates as population estimates are presented as means with either Standard Error or with Confidence Limits.*

**MF Discussion:** One critical aspect of counting caribou on the calving grounds is timing with respect to the arrival and departure of the calving cows, and the 1986 survey of the Ahiak calving grounds is illustrative in this regard. On 6-8 June, Gunn *et al.* (2000) surveyed the area and estimated just 689 caribou. In one of

the few times that surveys have been replicated, Gunn *et al.* (2000) resurveyed about two-thirds of the earlier area on 11-12 June and arrived at an estimate of 10,576 caribou – a 15-fold increase over the estimate of just a few days earlier. Although the ability to time surveys when most of the calving caribou are present may have improved by following the movement of satellite-collared females to the calving grounds, the issue of survey timing may still be important. For example, in 2003, despite the information from satellite-collared females, the survey of the Bathurst calving grounds was delayed several days, owing to poor weather (Gunn *et al.,* 2005b).

***Comment:*** *Mr. Fraker is mistaken about the effect of timing on the estimates, as detailed in Gunn et al. (2000) – both text and figures. The first survey was a systematic reconnaissance over a relatively large area, much of which had no caribou so the overall density was low. The second survey a few days later was a re-survey of the area that had nearly all the concentrations of cows and calves on the first survey. When cows are arriving on the calving grounds, a few days can make a considerable difference as to how many cows have arrived. An effort is made on these calving distribution surveys to time them close to the peak of calving (50% of cows with new-born calves at heel). Before this peak, cows that have not yet calved may still be away from the main calving ground. Thus the results of the first and second surveys, in this case, cannot be directly compared.*

POPULATION RECONSTRUCTION TECHNIQUES

**MF Discussion:** The surveys of calving grounds are often intended to arrive at an estimate of the breeding female component of the population. From this number, an estimate of the number of calves born and an overall estimate of the size of the population is determined. A critical assumption is that female survival and pregnancy rates are "relatively constant" (Gunn *et al.,* 2005a). These authors have consistently assumed fecundity rates of 0.76 and adult female survival rates of 0.79 (mortality rate = 0.21), although they did not reveal the source of these values. However, female survival rates are *not [MF italics]* constant over time, and the value of 0.79 is unusually low; any herd with an adult female survival rate of 0.79 would have to decline, even when first-year calf survival was high (Gunn *et al.,* 2005a, Fig. 20). For example, in the Porcupine Caribou Herd from 1982-91, adult female survival rates ranged from 0.75-0.93 (Walsh *et al.,* 1995). It is unrealistic to assume a constant mortality rate of 0.21 for adult females in the Bathurst Herd for over 20 years, and such a high rate is certainly incorrect.

***Comment:*** *The reports indicate that the method of extrapolation is from Heard 1985. The demographic modeling for the herd did not assume constant mortality rates – the extrapolation from breeding females has assumed constant rates for the proportion of pregnancy and adult sex ratio, as explained by Heard (1985).*

MONITORING BULL:COW RATIOS

**MF Discussion:** The ratio of bulls to cows is used as an indicator of herd status and as the basis for extrapolating the estimate of breeding females to an

estimate of the size of the entire herd. However, it is difficult to accurately determine bull:cow ratios because members of different age and sex classes tend to segregate, and during the period 1985-2000 this parameter was not measured at all. The bull:cow ratio is reported differently throughout the reports. Gunn et al. (2005a) report both 0.37 (i.e., 37 bulls:100 cows = 37/137 = 27 %) and 37 % for the same data. They focus on low values (0.37), while dismissing larger values (0.53 and 0.63) as unreliable.

***Comment**: Caribou biologists have long known that caribou segregate extensively through much of the year. The rut is the only period during which a representative cross-section of the herd can be measured, and it requires a well-timed well-dispersed sampling to derive a credible bull:cow ratio. Gunn et al. (2005a) considered these issues in recognizing the 2004 fall composition survey as having good overall representation, while the higher bull:cow ratios from other years were evaluated as likely being unrepresentative of the herd's distribution.*

### MONITORING CALF:COW RATIOS

**MF Discussion:** The number of calves that survive their first winter to be alive at 11 months of age is critical. Once they reach about one year of age, they have survival rates that are essentially those of adults. The figures for spring counts during 1985-1995 were generally high, 29-61 calves:100 cows (Gunn *et al.*, 2005a, and well above the 25:100 normally required for stability of numbers (Bergerud, 1980). Unless there was extraordinarily high cow mortality during this period, herd growth should have been positive. During 2001-2004, calf:cow ratios

ranged between 21-29, which suggests that there could have been negative growth in some years. (No spring calf counts were conducted during 1996-1999.) [See comments above about cow survival rates.]

***Comment*****:** *The Bathurst census in 1996 indicated that the Bathurst herd was statistically stable between 1986, 1990 and 1996. Gunn et al.( 2005a) stated that "mean calf survival rate for 2001-2004 was 0.203 (SE 0.011) compared to 0.395 (SE 0.048) for 1985-1996". The average calf survival 1985-95 was (as Mr. Fraker noted) above the rule of thumb of 25-30 calves:100 cows, but lower than this value during the period of decline. The limitations of relying on calf:cow ratios as indicators of herd trend can be seen in the modeling of demographics of the George River herd by Crete et al. (1996): at adult cow survival of 0.80 for that herd, herd stability would require 52 calves:100 cows in the fall, while the corresponding value at adult cow survival of 0.85 was 39 calves:100 cows. Calf:cow ratios are useful but are best replicated over a number of years, and they may not reveal small changes in herd population size.*

<u>Question 4: Wolf Predation On Caribou And The Effects Of Wolf Hunting By Non-resident Hunters.</u>

**Question** – Mr. Andre has suggested that a single wolf might eat 25-35 caribou/year and that the wolves that are killed by non-resident hunters would have consumed a large number of caribou. He further suggests that the number of caribou that the harvested wolves would have killed would mitigate, to a large extent, the number of caribou killed by non-resident hunters. Is this conclusion reasonable?

***Comment:*** *Mr. Fraker agrees with Mr. Andre and presents 8 pages of information about wolf kill rates of caribou and moose, with 45 references. On p. 12 of his report he states, "Over the course of a year, a wolf might well kill 25-35 caribou of different age and gender classes", and he provides the number of caribou killed by non-resident hunters (891 and 727 in 2005-2006 and 2006-2007, respectively), wolves killed by non-resident hunters in those years (26 and 27,) and caribou that would have potentially been killed by those wolves (650-910 and 675-945).*

*The response from Mr. Fraker is an example of selective use of technical references, as it does not address the key question of how the removal of 26 and 27 wolves in successive years from the late-summer range of the Bathurst caribou herd is likely to have affected the wolf population and its prey. Studies of wolf control programs suggest that a heavy, sustained wolf hunt removing half or more of individual packs is needed to produce a measurable response in prey populations like moose or woodland caribou. A review of wolf control programs in Alaska and Canada (National Research Council 1997) concluded that in most cases, the effect of wolf control was not evaluated rigorously enough to draw clear conclusions about how the wolf kill affected prey populations. However, the review concluded (p. 184) the following:*

> *"Our review of past attempts at wolf control indicates that it is likely to be successful when air-assisted wolf reduction is used over an area of at least 10,000 km$^2$; wolves are reduced to at least 55% of their pre-control numbers for at least 4 years; and the weather is favourable for ungulate*

*survival. Under these conditions, moose and caribou may increase – at least during the years of control and perhaps longer. If the above conditions are not met, reducing the number of wolves is unlikely to increase ungulate populations."*

*In one of the few studies of wolf control where prey and predator populations were adequately studied (Hayes et al., 2003), the number of wolves in the range of the Aishihik woodland caribou herd in southwest Yukon was reduced annually by 69-83% for 5 years, which resulted in increased calf caribou and moose survival. No significant increase in adult caribou survival was detected. In their discussion, Hayes et al. (2003) concluded that wolf populations were stable when annual wolf reductions were less than 30%, and agreed with the earlier National Research Council (1997) conclusion that prey populations increase when wolves are greatly reduced over a large area for at least 4 years. This reflects the high reproductive capability of wolves (maximum annual finite rate of increase of 2.6, about double that of caribou (1.35) – see Hayes et al. (2003)), and the rapid dispersal capacity of wolves. In addition, the per-capita wolf kill rate of smaller packs is higher than that of larger packs (as noted by Mr. Fraker) and highest in pairs (Hayes et al. 2000, 2003). This is in large part because large packs consume more of the moose or caribou killed, while smaller packs lose more of it to scavengers. Similar to Hayes et al. (2003), the National Research Council (1997) noted (p. 187) that "wolves have high reproductive potential and disperse widely such that their populations often can withstand annual harvest rates as high as 35% and keep their numbers stable".*

*Wolves that hunt migratory barren-ground caribou have a somewhat different ecology than wolves that hunt moose and woodland caribou below tree-line. Walton et al. (2001) studied movement patterns of 23 individual wolves from 19 packs in an area of 30,000 km$^2$ in the Bathurst herd's range in 1997 and 1998. These wolves were territorial in summer, with home ranges of 1,100-2000 km$^2$ but in winter were not territorial and moved large distances. The summer range of the Bathurst herd in recent years has averaged ca. 105,000 km$^2$ and the entire annual range ca. 350,000 km$^2$ (see Figure 1). If the wolf packs studied by Walton et al. (2001) were typical of the Bathurst summer range, then the summer range at that time might have supported 66 packs of 8-10 wolves/pack, or about 528-660 wolves. The National Research Council review (1997) and Hayes et al. (2003) indicated that wolves can sustain annual removal of nearly a third of their numbers in an area, without an overall decrease in numbers, due to rapid replacement by pups or dispersing wolves. Even with a wolf population reduced in response to the declining Bathurst herd (Frame et al., 2008), it seems doubtful that 26 or 27 wolves killed in one year represent more than a small fraction of the wolves found on the present-day (2008) Bathurst herd's summer range. It is unlikely that removal of this low number of wolves would have had any measurable effect on caribou survival rates.*

Question 5: Value Of Peer-review In Scientific Wildlife Management

**Question** – What is the value of published scientific papers that have been subjected to a critical review by external peers, compared with government reports, such as those prepared by the GNWT wildlife agency?

**MF Response:** Peer-review is a fundamental process in science, which ensures that papers meet certain minimum standards with respect to the appropriateness of methods, data presentation and analysis, and interpretation (Day 1983). For example, for describing methods the accepted standard is that the methods should not only be appropriate, but must be described in sufficient detail that a reader can understand how the work was carried out and would even be able to repeat the study. Data should be presented in sufficient detail that a reader could do an independent analysis and interpretation. Where an hypothesis is being tested, that hypothesis should be stated in a way in which it can be tested (i.e., disproved). And, of course, the interpretation must be reasonable and supported by the data. The reports prepared by biologists of the Government of the NWT often do not meet usual standards, and certainly would benefit from an external review by peers.

***Comments:*** *The GNWT file and manuscript reports provide the raw data that an independent analysis could be applied to; journal publications almost never publish the raw data provided in government reports. Journals do not publish the results of individual population surveys unless they are of a truly exceptional nature. The survey methods used for the Bathurst and Ahiak herds are standard*

*methods originally described in peer-reviewed publications. Individual surveys using established methods are suitable for government reports, but not for technical journals.*

**MF Response:** The following examples from Gunn *et al.* (2000) will illustrate the consequences of lack of independent peer review in some of the GNWT wildlife reports:

- Gunn *et al.* (2000, Table 6, p. 19) reported on aerial surveys of the Ahiak calving ground conducted in 1986 and 1996. In 1986, two surveys were flown: one survey was conducted 6-8 June; subsequently, part of the first area was *resurveyed [MF italics]* on 11-12 June. Population estimates were derived for both surveys, and the results were *summed [MF italics]* (Gunn *et al.*, 2000, Abstract). Summing the results from two surveys of the same area should not have been done because it resulted in *double counting [MF italics]*.
- Gunn *et al.* (2000, Table 6, p. 19) also calculated a calving ground population estimate in June 1996. Because of arithmetic errors, the authors stated that they had surveys 6% of the area, while the actual number was 5.2%; they calculated an estimate of the number of caribou as 83,134, while the actual number should have been 85,249.

***Comment:*** *Mr. Fraker has assumed the two surveys were summed. This is not the case. The 1986 extrapolation is not based on summing the two surveys and it was not an example of double-counting. There is an arithmetic error in the*

*report for the 1996 survey, but it is fairly small in relation to the likely caribou numbers.*

**MF Response Paragraph Cont.:**

- Gunn *et al.* (2000, p. 33) used the calving ground survey results to arrive at a total population size. First, they assumed that 64 % of the caribou on the calving ground were breeding females, as they had determined for the Bathurst Herd in 1996. Second, *without explaining the basis, they doubled the number of caribou actually counted [MF italics]* to allow for animals missed by aerial observers. Third, they used assumptions about the gender and age composition of caribou on and off the calving grounds, derived from other herds, to arrive at a total population estimate of 32,000 for 1986 and 200,000 in 1996. Thus, on a very flimsy basis and with little analysis, the fourth largest caribou herd in the Canadian Arctic was created, and the 1996 population estimate of 200,000, which is undoubtedly grossly in error, is widely cited.

***Comment:*** *Gunn et al. (2000:33) stated that the bias correction was based on aerial photography compared to visual surveys. The extrapolation methods were referenced to Heard's (1985) peer-reviewed publication. As noted earlier, the extrapolations were noted as approximations of herd size, not population estimates.*

**MF Response Paragraph Cont.:**

- Inexplicably, Gunn *et al.* (2000) note, without comment, that another survey of the region had been conducted the previous year, in May 1995, with a resulting estimate of only 31,556 caribou (Buckland et al. 1995). This should have prompted some discussion, and perhaps even skepticism, about the 200,000 number.

***Comment**: Mr. Fraker is partially correct. With hindsight, Gunn et al. (2000) would have been prudent to explain the problems with Buckland et al's (1995) estimate. The pre-calving May 1995 survey was a low coverage survey intended to replicate the area and coverage of the 1983 pre-calving survey. Only the eastern part of the Queen Maud area was covered and the authors realized that their coverage of the Ahiak herd's pre-calving distribution was incomplete and the estimate was an under-estimate. A large proportion of the herd's cows would likely not have reached the coastal calving grounds in May.*

# APPENDIX G.

**Comments by the authors on Mr. John Andre's October 31, 2007 presentation to Mr. Michael Miltenberger, Minister, Department of Environment and Natural Resources**

The numbered text was extracted from Mr. Andre's slides. Text preceded by the word 'comment' is from the authors (AG, JA, and JN) and the comments are italicized. Slides that had been included in Mr. Andre's website or the presentation to WRRB have not been repeated as they were commented on in Appendices D and E.

**Slide 31 of 54 slides Part 1:** "The very large increase (280%) in Bathurst herd size observed between 1982 (174,000) and 1986 (486,000) was likely due to a combination of increased recruitment and immigration. It is possible that caribou from the Queen Maud Gulf area (northeast Mainland Herd), where caribou inhabit the tundra year-round, may have been included in the Bathurst calving ground survey. Such changes may represent real growth to an individual herd, however managers and resource users must recognize that the immigration of animals from one herd will result in the reduction of the size of an adjacent herd."

> The Status and Management of the Bathurst Caribou Herd, Northwest Territories, Canada, Ray Case, Laurie Buckland, Mark Williams, RWED, GNWT, 1996

**Slide 35 of 54 slides Part 1**: From 1977 to 1982, the Bathurst Herd was surveyed 5 times in 6 years. The numbers ranged from 110,000 to 174,000, with an average of 142,200. A solid number, based on five surveys in six years. A

number that would help average out the problems with aerial calving ground surveys, such as poor weather, caribou failing to aggregate on the calving grounds, observer bias, etc.* A number with which most scientists could agree would be a solid starting point for comparison purposes.

But there was a problem with using the above number.

It didn't fit the agenda.

*See Surveys of the Beverly Caribou Calving Grounds 1957-1994, pages 18-23 , Ann Gunn, 1997 for more details on caribou calving ground survey problems.

***Comment:*** *The surveys from 1977 to 1982 were carried out during the time when the Department was working to improve survey design. Four surveys were visual and the 1982 survey was the first photographic estimate (Table 1, Case et al., 1996. Mr. Andre had this information available). The difference in survey techniques is one reason not to average the five surveys 1977-1982. If however, the four visual surveys are averaged and the average is doubled (the average accuracy correction factor from photographs compared to visual estimates) then the estimate could have been 270,000 caribou in 1980. The herd would have only had to increase by an annual 10% to reach the estimated size in 1986. In other words there is another plausible explanation for the increase in the Bathurst herd, and one which does not require mass immigration as an explanation.*

**Slide 42 of 54 slides Part 1:** "If Anne Gunn saw 200,000 caribou east of the Bathurst Inlet in 1996, and the Ahiak herd was not yet identified, why didn't she include these caribou in the 1996 Bathurst Caribou Survey? That would have put the Bathurst Herd at 550,000. How could she simply ignore 200,000 caribou on the traditional Bathurst calving ground, when that is what she was there to

survey? The fact is, the caribou weren't there in 1996. It's a lie. She "created" them, using statistics, in the year 2000."

***Comment:*** *The 200,000 caribou that Mr. Andre refers to was an approximation – an extrapolation from the caribou numbers estimated on the Ahiak herd's calving ground in 1996. In June 1996, 4,453 caribou were actually seen and counted. Gunn et al.'s (2000) report explains that the 4,453 caribou counted were extrapolated to 83,134 caribou based on sampling 5.2% of the survey area. The 83,134 was adjusted assuming that 64 % of the caribou on the calving ground were breeding females, similar to what was measured for the Bathurst herd in 1996. Then the extrapolation was doubled as that is the mean bias correction based on the comparison of photographic and visual surveys (Heard, 1985). At that time the Ahiak herd was called the Queen Maud Gulf herd; it was re-named in 2000, when the Kitikmeot Hunters' and Trappers' requested that the Queen Maud Gulf herd be renamed the Ahiak herd. As noted earlier in a number of places, these approximations were intended as approximations of herd size in the absence of a population survey, not as true estimates of herd size.*

**Slide 45 of 54 slides Part 1**: In our meeting on March 2, 2007, with the ENR, Ms. Fleck and Ray Case argued that the Ahiak herd was not the splitting of the Bathurst herd, and that it had always existed, but was formerly the Queen Maud Gulf herd. That simply is not what the science says. Following is the historical calving grounds of the Bathurst caribou, which has been on both sides of the Bathurst Inlet. Now the ENR is calling caribou calving on the east side Ahiak

Caribou. You can call them whatever you want, but if you are going to compare one survey with another, you have to use consistent definitions. This is not rocket science.

***Comment:*** *Mr. Andre's next slide shows the Bathurst herd's calving ground 1966-97 which shows the shift across Bathurst Inlet. The Ahiak herd's calving ground was first mapped by ENR in 1986, as reported in Gunn et al. (2000) and Gunn and D'Hont (2002). In 1986 and in all further calving distribution surveys, the Bathurst and Ahiak calving grounds were well separated and distinct, and separated by Bathurst Inlet. Calving grounds are mapped using a standardized systematic aerial survey which allows them to be compared (see Figure 4).*

**Slide 52 of 54 slides Part 1:** What is clear, is the biologists followed a herd of 200,000 caribou, with a sample size of only five collars (three of which were dead by May of 1998) , for only two years, and declared it a separate herd, a "herd" that was calving in the exact same area the Bathurst herd had calved in all through the 60s and 70s.

***Comment:*** *Gunn et al. (2000) provided traditional knowledge and historic information as well as the results of the 1986 and 1996 aerial surveys, which were combined with the satellite collared cow data to substantiate the Ahiak herd as a distinct population with a distinct calving ground. More recent surveys and increased numbers of radio-collars have further confirmed the earlier results.*

**Slide 53 of Part 1**: “Experience with the Bathurst herd’s calving ground over four decades also reveals a shift in the location of annual calving grounds. The traditional calving grounds comprise the areas known to be used for calving over many years and 23 surveys during four decades may not be an adequate sample.”*

***Comment:*** *Mr. Andre misunderstood the context of this comment. The quote is from Sutherland and Gunn’s 1996 report on the location of the Bathurst herd’s calving ground. The context was shifts in the calving ground over decades, not whether a calving ground existed.*

**Slide 54 of 54 slides Part 1:** And yet, all of a sudden, as soon as diamond mines, and gas and oil pipelines, and a deep water port at Bathurst Inlet, and new roads, become a reality, we’ve magically create the Ahiak herd. And it is based on the following of two collared cows, for two years and on genetic evidence that the scientist who did the work, says doesn’t exist.

What the heck is going on here???????

***Comment:*** *The existence of calving caribou in the Queen Maud Gulf area was known in the early 1980s, and the Queen Maud Gulf/Ahiak calving ground was first mapped in 1986, long before any proposals for roads to Bathurst Inlet or diamond mines in the Bathurst range. Zittlau (2004) has not said that the genetic evidence for herd distinctiveness for eastern Canadian barren-ground herds does not exist – what is reported in her thesis is that the genetics are not unequivocal*

*and paired assignment tests were not statistically significant. She suggested that the Ahiak and Qamanirjuaq herds may be more recent – 2000-3000 years before present, which might help explain the lack of clear genetic separation.*

**Slide 10 of 27 Part 2**: Canadian Arctic Resources Committee (Kevin O'Reilly, Research Director), July 2003:

> "The focus of the trip was to gather information about a proposal to build a deep-sea port in the calving grounds of the Bathurst Caribou herd, and an all-weather road connecting the port to some of the most mineral-rich territory in the North."

RWED Biologist Ann Gunn gave us an excellent presentation on caribou, demonstrating both her vast experience and her passion for her work. Aerial photography of the Bathurst caribou herd had just been completed. The photos now need to be analysed to give a rough count of the size of the herd. RWED caribou biologist, Ann Gunn advised that her impression is that she saw nothing to indicate that the herd's numbers are increasing.

The question is: Why didn't she tell them that the herds have been dropping 5% for the past 17 years??

***Comment:*** *The presentation in July 2003 was made before the June survey photographs were counted and the data analyzed. The June 2003 census produced the first estimate since 1996 and it was significantly lower than 1996, 1990 and 1986.*

**Slide 12 of 27 Part 2:** "She described how the existing mining roads, near the Ekati and Diavik mines, are affecting the caribou. Built up on piles of large rock, the roads present an unusual challenge for the migrating herd. Caribou are being found with cut, swollen and infected feet and broken legs in the vicinity of the mines. It is also thought that they are more vulnerable to predation by wolves and hunters when in the vicinity of road crossings. Caribou cows show signs of feeding less near the mine sites, which may be affecting their ability to conceive and to nourish calves."*

There is no research to support the above statement. Here is what her 2004 observations said:

> "October 2004. "We saw 2 lame caribou among 12,444 caribou observed."** (That's .00016)

*http://www.carc.org/sustainable_dev/bathurst_inlet_study_tour_trip_diary.php
**Calf Survival and Adult Sex Ratio in the Bathurst Herd of Barren-Ground Caribou 2001-2004. Ann Gunn, John Boulanger, and Judy Williams. 2005

***Comment:*** *The evidence for caribou with broken legs and reduced foraging is from BHP's Annual wildlife monitoring reports. This is an example of selective quoting as Mr. Andre cites the rate of lame caribou for 2004 but not the higher level reported in the same report for November 2001 (0.3% 17 of 6122 caribou).*

**Slide 14 of 27 Part 2:** Anne Gunn, working for Miningwatch Canada, fighting Mines in British Columbia

***Comment:*** *Mr. Andre mistakenly assumed from the source (Miningwatch Canada: Re: Comments on the Proposed Tulsequah Chief Mine Project in*

*Northwestern British Columbia, FEAI 36077) that I was working for Miningwatch. I was advising the Taku River Tlingit First Nation with support and permission from the Department of Resources, Wildlife and Economic Development.*

**Slide 17 of 27 Part 2:** Anne Gunn, 2000, creating calving grounds.

> "We compiled information for 20 geographic area where caribou calving had been recorded or inferred for at least 1 year. We excluded the major barren-ground caribou herds (Bluenose, Bathurst, Beverly, and Qamanirjuaq)…..We defined 14 of those 20 areas as calving grounds."

Note: Of the 20 areas listed, the Cape Bathurst and Bluenose (east or west) herds are not mentioned.

***Comment:*** *Gunn and Fournier (2000) compiled all available survey information to map recorded calving distributions. The report states that the four major herds were excluded because their calving distributions were reported elsewhere. The report was published in 2000 and the data were compiled in 1998, which preceded the satellite telemetry analyses for the Cape Bathurst, Bluenose West and Bluenose East herds. The satellite telemetry substantiated the recognition that the Bluenose was actually three herds. As Mr. Andre quotes, the Bluenose herd was not included in that report, which is why the Gunn and Fournier 2000 report did not discuss the three calving grounds.*

**Slide 19 of 27 Part 2:** Unilaterally Enlarging the Calving Ground Definition to Stop More Development.

> "Describing the location of calving grounds also depends on how calving grounds are defined. Previous maps of calving grounds for the Bathurst and Ahiak herds were based on aerial surveys close to or within days of the peak of calving (Sutherland and Gunn 1996, Gunn *et al.*, 2000). However, Russell et al (2002) recommended mapping the extent of calving as the area used up until 3 weeks past the peak of calving. The median peak of calving for the Bathurst herd is 5 – 9 June, but has been recorded as late as 11 – 15 June (1969 and 1986). For the Bathurst herd, the extent of calving will be the area occupied until 5 July." *

*Anne Gunn, 2002 "Extent of Calving for the Ahiak & Bathurst Herd."

***Comment:*** *Russell et al. (2002) was a Canadian Wildlife Service report of a workshop of caribou biologists from Canada and Alaska, to discuss barren-ground caribou calving grounds. The rationale for mapping the extent of calving is that for the first 3 weeks of life the calf is completely dependent on the cow for nutrition. This definition of "extent of calving" was a recognition of more detailed understanding of cow-calf behavior and physiology, and not related to land use issues.*

**Slide 20 of 27 Part 2:** Calving Ground Size Increase-2002. This had nothing to do with counting caribou, and everything to do with preventing oil and mineral exploration.

***Comment:*** *Mr. Andre shows a histogram comparing the size of the calving ground based on aerial surveys (1-2 days) and the extent of calving – the area*

*used by the satellite collared cows from the peak of calving for 3 weeks. Not surprisingly the area used for 3 weeks is larger than the area used for 1 or 2 days. Mr Andre extracted this from Gunn and D'Hont's (2002:23) report. However, Mr. Andre did not include what the report also stated:*

> *"Including the movements of caribou cows and their calves up to 3 weeks past the peak of calving increases the size of the area mapped as the extent of annual calving (compared to the area mapped at about the peak of calving). However, at any one time, the cows and calves are only occupying a portion of the calving ground (Table 4, Figure 13). At any 5 day–interval during June 2002, the Bathurst herd occupied a minimum of 5% to a maximum of 58% of the annual calving ground (4% to 77% for the Ahiak herd)."*

*Since the 2002 workshop on calving grounds described earlier, we have attempted to use a consistent terminology in describing calving grounds and their use.*

**Slide 21 of 27 Part 2**: 32,120 square kilometers of new calving grounds, an area ¾ of the size of Newfoundland, an area, bigger than the states of Massachusetts and Connecticut combined, now potentially closed to mining, or pipelines, or hunting camps, or fishing camps, or whatever.

Did any of the MLAs get to vote on that???

***Comment:*** *We have used definitions of calving grounds and their spatial delineation following standard methods and terminology, based on Russell et al. (2002), a workshop described earlier. Similar methods are used in Alaska and elsewhere in northern Canada.*

**Slide 6 of 68 Part 3:** There is a problem with the above formula, which uses 200,000 in the Ahiak herd, which Anne Gunn says were there in 1996. (She apparently didn't tell anybody till 2000.) The fact is, she only counted 4,453 caribou. The rest she created using statistics, which have no basis in fact. In my opinion, she was setting the Ahiak herd up to crash, much as John Nagy was setting up the Bluenose herds to crash (more on that later.) If there were 350,000 in the Bathurst herd that year, and 200,000 in the Ahiak herd, there would be 550,000 caribou in the total Bathurst herd. Certainly, the Ahiak herd, which Laurie Buckland said had 35,000 in it the year before, did not grow from 35,000 to 200,000. That is a biological impossibility. The 550,000 total caribou is a number the herd could not live up to. And yet that 200,000 number is the number the ENR is still using. I pointed this out to Susan Fleck and Ray Case in March of 2007. Ray Case asked me about it at the Wek'eezhi Board meeting. I told him exactly what I thought; that the Ahiak herd was set up to crash. What happened though, is that the Bathurst herd started moving east again, to the east side of the Bathurst Inlet. What they didn't know, of course, is that now they would be called Ahiak caribou.

***Comment:*** *The report cited was not published until 2000, but the 1996 survey results had been presented to the communities in 1996. The number 4,453 is the number of caribou counted on 5.2% the calving ground and is extrapolated to 83,134 caribou. As explained in the Gunn et al. (2000) report, we assume that 64% of the caribou on the calving grounds are breeding females (similar to the Bathurst herd in 1996) resulting in an estimate of 53,120 breeding females. The visibility bias is known to be at least two-fold (Heard, 1985) which gives an estimate of 106,240 breeding females. Heard (1985) also explains the standard calculations to estimate herd size from the number of breeding females. The estimate was rounded to 200,000 to be conservative. Neither a Standard Error nor a Confidence Interval was attached to the 200,000 because it was described in the report as an approximation.*

*Gunn et al. (2000:33) stated that the bias correction was based on aerial photography compared to visual surveys. The extrapolation methods were referenced to Heard's (1985) peer-reviewed publication. As noted earlier, the extrapolations were reported as approximations of herd size, not population estimates. In a subsequent document (letter from M. Fraker to Department of Environment and Natural Resources, titled "Summary of Critical Assessment of the Population Estimates in File Report 126, Abundance and Distribution of the Queen Maud Gulf Caribou Herd, 1986-1998" 24 March 2008), Fraker outlined inconsistencies in reporting the 1986 and 1996 surveys.*

*Since the objectives of the 1986 and 1996 surveys were to map the location of the QMG (Ahiak) calving grounds and establish whether the calving ground*

*was separate from the known Bathurst caribou calving ground, the surveys were not designed to precisely estimate caribou abundance on a calving ground. Indeed, the 1986 survey was designed as a reconnaissance survey. Factors affecting bias such as transect width differed between the surveys, but this bias does not negate the observed increase in caribou density and increased spatial extent of the QMG (Ahiak) calving ground from 1986 to 1996. The extrapolations to herd size were illustrative and were reported as extrapolations to indicate the relative and approximate size of the QMG (Ahiak) herd. Mr. Fraker (2008) did not question the relative densities and increasing trend of caribou on the calving grounds in 1986 and 1996. Recent work by ENR biologist D. Johnson (unpub. data) on the Ahiak calving ground in 2006, 2007 and 2008 further substantiates an increase in herd size. In summary, the main conclusions of Gunn et al. 2000 are relevant and defensible:*

*1) The QMG (Ahiak) and Bathurst calving grounds are separate entities and therefore separate herds of barren-ground caribou according to our current definition and understanding of herd fidelity to calving grounds. This assertion is reinforced by the fact that the 1986 and 1996 Bathurst calving ground surveys were done concomitantly with the QMG (Ahiak) surveys, and by ongoing radio-telemetry studies and calving ground surveys by the GNWT.*

*2) The increase in spatial extent and caribou densities on the QMG (Ahiak) calving ground establishes trend, and warrants that the QMG (Ahiak) herd is recognized as a distinct herd of barren-ground caribou for wildlife managers in the NWT and Nunavut.*

*The Buckland et al. (2000) report does not claim that the entire pre-calving range was flown. The estimate of 35,000 was likely an under-estimate due to incomplete survey coverage. The area covered 24-26 June 1995 was north of Garry Lakes and west to within 20km of the east coast of MacAlpine Lake and north to the coast. This is approximately half the area used for calving in 1996. The current calving distribution east and west of Bathurst Inlet is not contiguous – neither calving distribution reaches the east or west side of Bathurst Inlet. In other words there were two separate, distinct calving grounds - Ahiak and Bathurst – in 1986 and in all more recent surveys (see Figure 4 for 2007 results).*

**Slide 7 of 68 Part 3**: The slide shows a map from Gunn and D'Hont (2002) for 2001 which Mr. Andre titled as the Bathurst herd starts to split.

***Comment:*** *The map shows locations where the caribou were collared and their pathway to either the existing Bathurst or Ahiak calving grounds. Overlap of neighbouring herds during the winter is not uncommon, as we have described elsewhere. As of Fall 2008, 36 GPS-satellite collars on Ahiak caribou have re-affirmed the seasonal movements and calving ground fidelity established 22 years earlier.*

**Slides 8-11 of 68 Part 3:** The slides were maps that Mr Andre selected to show the distribution of collared cows – Mr Andre's point was that they had all not reached the Bathurst calving ground.

***Comment:*** *Mr. Andre is combining locations of the Ahiak, Bluenose-East and Bathurst herds. At calving, cows from each of the three herds would be well separated, with the exception of a known low rate of switches of collared cows among calving grounds.*

**Slides 12-14 of 68 Part 3:** The slides deal with the lack of statistically significant differences between paired surveys for the Bathurst herd.

***Comment:*** *In Gunn et al., (2005a) the logic for measuring trends rather than paired estimates is explained in detail. We acknowledge that counting caribou is not a simple task, and there remains a substantial variance associated with the herd estimates. However, wise management of caribou requires that we use trend and indicator information about the herds' status as well as population estimates.*

Slides 16-44 deal with the Blue Nose East, Bluenose West and Cape Bathurst herds.

**Slide 45 of 68 Part 3:** Governmental biologist Ann Gunn states: "While aerial surveys are currently the only practical way to estimate the density of caribou populations, they suffer from severe limitations. A visibility bias is present often of unknown size; it not only is a bias but causes loss of repeatability. This bias is then affected, also in unknown ways, by several factors including aircraft speed, altitude, strip width, observer ability, weather and habitat type. Caughley *et al.* (1976) believed that refinement of techniques would probably never completely

eliminate visibility bias….accuracy has been reported to range from 30 to 80 percent (Caughley 1974, LeResche and Rausch 1974.)*

***Comment:*** *This was written in 1981 and does not clearly distinguish between bias (accuracy) and precision. We have improved survey design since then and can design surveys to reduce bias and increase precision. As described earlier, ENR uses additional information – calf:cow ratios, bull:cow ratios, assessments of pregnancy rate and body condition (sometimes by hunters) – to monitor the herds' well-being and trend. None of these indicators, however, is sufficiently reliable and precise to replace periodic population surveys. Awareness of the limitations of the survey methods we use is simply good science.*

**Slide 46 of 68 Part 3 Bullet 2:**

2. In 1997, Ann Gunn, in her "Surveys of the Beverly Caribou Calving Grounds" said "The confidence with which we have mapped the Beverly's herd calving grounds is also influenced by two quite separate sources of uncertainty-technical and environmental. Listed here are five technical uncertainties: changes in survey design, changes in timing, weather, adequacy of coverage, and missing data." Ms. Gunn goes on to discuss in detail how the survey design has changed over the years, so <u>one survey may not be comparable to another survey</u>. Ms. Gunn also goes on to detail all of the problems with the five technical uncertainties.

***Comment:*** *The context of this report is mapping distribution and the problems with comparing maps from surveys already done under a variety of conditions.*

*Many of the same points that limit retroactive comparisons are accommodated in designing future surveys. Population and composition surveys have been used with consistent methodology in the NWT since the 1980s.*

**Slide 47 of 68 Part 3:** In 1993, biologists surveyed the Beverly Caribou Herd, using the same caribou calving ground method and found 87,000 caribou. The next year, they surveyed the Beverly Caribou Herd and found 267,000 caribou, three times as many in one year.

**87,000 to 267,000 in One Year!!!**

**How Reliable Can These Surveys Be???**

The government's explanation of this "bad" survey, was that the caribou didn't "aggregate" well on the calving ground. "If the caribou must trudge through deep, wet, or crusted snow during spring migration, some cows may be delayed in reaching the calving ground" Ann Gunn, 1997* In other words, the caribou had their babies in the taxi, instead of the hospital.

***Comment:*** *The quote was a general comment not an explanation for the 1993 result. During surveys, biologists monitor conditions, and late migration is one of the contingencies that are included in the design. Note, for example, that the Porcupine herd calved in 2001 far from its normal coastal habitat, an anomaly brought on by a very late spring. Because there have been radio-collars on the Porcupine herd for 20-plus years, these exceptional conditions and the locations*

*of most of the calving cows were known annually. The lack of radio-collars on the Beverly herd in the 1980s (a reflection of community resistance to collars) made it more difficult to follow the herd's movements. It is also worth noting that the 1993 Beverly survey was recognized as having survey problems because there was no supporting evidence of a decline – hence the follow-up survey in 1994.*

**Slide 48 of 68 Part 3:** This is what Ann Gunn said about the 1995 Bathurst Caribou Survey: "Our mapped distribution was neither comparable in methodology nor results to previous surveys (Sutherland and Gunn, In Press). Our methods differed because of the 7 day interruption. The first survey on 7 and 8 of June was incomplete when the pilot left and the second part was incomplete because we had essentially to start over again and then were short of available flying hours….The eastern boundary was similar to some other surveys but the apparent departure was that cows and calves were still moving east. Either these were not Bathurst herd cows or an eastern extension to the calving grounds had been missed in previous years." *

***Comment:*** *The report also stated that the objectives were to map the distribution of calving caribou in June 1995, not to estimate abundance, which is why the methods were different. The delay imposed late timing which was a further difference. Without evidence, it is prudent to offer all possible explanations. Caribou surveys, to this day, are vulnerable to weather events, despite the best planning and methods. The weather in the eastern Canadian arctic is notoriously*

*poor and the region is remote, and surveys are difficult despite the best designs and improved technologies.*

**Slide 49 of 68 Part 3 Bullet 6:**

6. In the 2003 Bathurst Caribou Survey, the weather variability issue was clearly in play. “Poor weather from 8-12 June (low cloud ceilings, snow and blowing snow) delayed the photographic survey”.*

So the photographic team loses five consecutive days of flying, at the peak of calving, the most critical time to get an accurate count, according to all the science we have found. (After three or four days, the caribou start to move, possibly because of fecal pellet buildup on the calving ground, and become uncountable.) So how good is this survey, the survey where the herd starts to theoretically decline?

Human nature and common sense tells us that the scientists are not going to come home from a survey and say “We had bad weather, we got a lousy count, we just spent half a million dollars of the taxpayers money, too bad.”

*2003 Bathurst Caribou Calving Ground Survey, Ann Gunn, RWED 2004

***Comment:*** *Mr. Andre chose not to quote from the report the detailed description of why the surveyors were confident that the cows had not started moving. Gunn et al. (2005a) explain how the periphery of the survey blocks was reflown to verify any movements and adjust the stratum boundaries accordingly. Additionally, on p. 48 the question of the delay is further addressed and Figure 13 shows that 11 of the 12*

*satellite collared cows were within the survey strata. Considerable effort is made in these surveys to verify that no significant numbers of caribou have been missed.*

***The slides in Part 4 have been either addressed in Appendices D and E or are covered in the body of the text of this report.***

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