

ESTIMATES OF THE NUMBER OF BARREN-
GROUND CARIBOU IN THE CAPE BATHURST
AND BLUENOSE-WEST HERDS DERIVED
USING POST CALVING PHOTOGRAPHY, JULY
2005

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INTRODUCTION

In 1994, as part of the Bluenose barren-ground caribou herd management planning and environmental impact assessment process, distribution data obtained during population and telemetry surveys done between 1966 and 1993 were analyzed using a computer geographic information system (GIS) to define the seasonal ranges of the Bluenose barren-ground caribou herd (Nagy et al. 1999a). That analysis indicated there were three calving and two rutting areas within the range of the 'Bluenose caribou herd'. Caribou management has been based on the herd concept, where herds are identified based on their use of traditional calving grounds (Thomas 1969, Gunn and Miller 1986). Applying this approach, (Nagy et al. 1999b) hypothesized that there were two, and possibly three, herds within the range of the 'Bluenose' caribou herd.

Satellite tracking and genetic studies similar to those done to define polar bear populations (Paetkau et al. 1995, Bethke et al. 1996) were initiated in March 1996 to identify the number of caribou herds within the 'Bluenose' range (Nagy et al. 1999b, Zittlau et al. 2003). Tissue samples were also collected from the well-defined Porcupine (*R. t. granti*) and Bathurst herds (*R. t. groenlandicus*) herds to the west and east of the Bluenose range, respectively, to extract DNA for genetic comparisons. The results of these studies strongly support the hypothesis that there are three herds of barren-ground caribou within the range previously ascribed to the 'Bluenose caribou herd' (Nagy et al. 1999b, Zittlau et al. 2003). These data show that the herds use different seasonal ranges (especially calving) (Nagy et al. 2005) and are genetically different (Nagy et al. 1999b, Zittlau et al. 2003). For convenience we have referred to these herds as the Cape Bathurst, Bluenose-West, and Bluenose-East herds.

The first photo-census surveys of the 'Bluenose' herd were completed in 1986 and 1987 (McLean and Russell 1992). Nagy (in prep. a) reviewed and mapped McLean and Russell's (1992) capture locations and movement data in order to assign the groups photographed in 1986 and 1987 to Cape Bathurst, Bluenose-West, or Bluenose-East herds and to derive the parameters required to generate population estimate using a modified Lincoln-Petersen estimator (Russell et al. 1996). Nagy (in prep. a) was not able to derive the parameter required to derive a modified Lincoln-Petersen estimate for the 1986 survey as the data were not well documented, however, there were 83,460 and 13,476 non-calf caribou counted in the groups photographed within the post-calving ranges of the Bluenose-West and Cape Bathurst herds, respectively (McLean and Russell 1992). Based on Nagy's (in prep. a) re-analysis of the 1987 data, the Bluenose-West herds and Cape Bathurst were estimated at $98,874 \pm 3,145$ and $14,529 \pm 2,542$ non-calf caribou, respectively, in the 1987. A similar re-analysis of the 1992 photo-census data resulted in estimates of $64,705 \pm 9,057$ and $17,521 \pm 5,352$ non-calf caribou in the Bluenose-West and Cape Bathurst herds, respectively (Nagy in prep. a).

Prior to the 1986, 1987, and 1992 photo-census surveys, the majority of the caribou that were radio-collared were captured in the western and central portions of the range of the 'Bluenose' herd (now defined as ranges of the Cape Bathurst and Bluenose-West caribou herds)(Nagy in prep. a). As a result, there were an insufficient number of radio collars deployed in the eastern portion of the 'Bluenose' range (now defined as range of Bluenose-East herd) to derive reliable estimates of the number caribou in this area (Nagy et al. 1999a, Nagy in prep. a).

The first photo-census surveys designed to estimate the size of the Cape Bathurst, Bluenose-West, and Bluenose-East herds were undertaken during summer 2000 (Nagy in prep. a; Patterson et al. 2004). The results of these surveys suggested that the Cape Bathurst herd had declined from 17521 ± 5352 non-calf caribou in 1992 to 10013 ± 1132 non-calf caribou in 2000, however, (Nagy in prep. a) indicated that portions of the herd were poorly aggregated and as a result population size was underestimated. The size of Bluenose-West herd was estimated at 64705 ± 9057 non-calf caribou in 1992 and $74273 \pm 10,591$ non-calf caribou in 2000; these estimates are not significantly different (Nagy in prep. a). The Bluenose-East herd was estimated at 103974 ± 22101 non-calf caribou in 2000 (Patterson et al. 2004)

In 2005, the Department of Environment and Natural Resources, GNWT conducted photo-census surveys of the Cape Bathurst and Bluenose-West to determine the status of these herds. This report presents the results of photo-census surveys completed for the Cape Bathurst and Bluenose-West barren-ground caribou herds completed during July 2005.

METHODS

Pre-radio collar deployment reconnaissance survey

Reconnaissance surveys were flown to document the distribution of caribou on the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds prior to collar deployment. The surveys were flown with fixed-wing aircraft (Pilatus Porter, Helio Courier, or Cessna 185) at an altitude of 110 m agl and air speed of 160 km per hour. Transect lines were spaced at an interval of 20 km. The number of caribou in each group observed and sightings of other wildlife including wolves, muskoxen, and moose were recorded. A GPS was used to record the longitude and latitude coordinates of each sighting and the tracks flown.

VHF and satellite radio collar deployment

During March and early April 2005 barren-ground caribou were captured with a handheld net gun (Ron's Gun Shop, BC) fired from a Bell 206B helicopter and equipped with radio collars (VHF, ARGOS satellite). Capture efforts were

conducted over open tundra and lakes during periods when there was (1) sufficient snow to impede the movement of caribou and cushion their fall after netting, (2) good contrasting light conditions, (3) little or no wind, and (4) temperatures were not severe (warmer than -30°C). Caribou were radio-collared throughout the areas occupied by the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds during the late winter 2005 reconnaissance survey.

Reconnaissance/telemetry surveys

During March 2005 to July 2005 we maintained a database documenting the status of caribou radio-collared during 2005. The frequencies of radio collars for caribou that were harvested, died of natural causes, or that were on fast pulse but the status of the collar or caribou was not verified were censored from the database. We then flew telemetry surveys over the post-calving ranges of the Cape Bathurst and Bluenose-West herds during June and July 2005 to locate and verify the status of the remaining radio-collared caribou, to monitor their movements, and to detect aggregations. We also searched for the frequencies of radio collars that had not been located on the post-calving/early summer ranges of the Bluenose-East herd. Similarly, the field crew conducting the photo-census survey of the Bluenose-East herd also searched for the frequencies of radio collars that had not been located on the ranges of the Cape Bathurst and Bluenose-West herds.

We used a Helio Courier fixed-wing aircraft equipped with two independent tracking systems comprised of an ATS scanner/receiver (Advanced Telemetry Systems Inc., Isanti, MN) and 2 model RA-2AK dual antennae (Telonics Corp. Ltd., Mesa, AZ). One operator scanned the frequencies of the target herd (Cape Bathurst or Bluenose-West) and the other scanned the frequencies of the target herd and those of radio-collared caribou from neighboring herds for which the status had not yet been verified (including Cape Bathurst or Bluenose-West and Bluenose-East). Transect lines were spaced approximately 20-40 km apart, while flight altitude ranged between 440 and 1320 m agl.

We also monitored the movements of ARGOS satellite-collared caribou. We received ARGOS satellite location data periodically via fax from ENR Inuvik and Norman Wells. Data obtained for VHF and satellite collars were then mapped using Arcview (Environmental Systems Research Institute) so that tracking and monitoring efforts could be allocated effectively.

We mapped the distribution of radio-collared Cape Bathurst, Bluenose-West, and Bluenose-East caribou located during the 2005 photo-census relative to the sites where they were captured during 2005. We also mapped the sites where the larger groups were photographed relative to the sites where the radio-collared caribou in these groups were captured.

Aerial photography and image processing

Once suitably aggregated, groups were photographed from a Helio Courier fixed-wing aircraft with a handheld Nikon D70 digital (6.6 megapixel) camera equipped with a Nikon AF 35 mm 1:2 D lens. The aircraft flew between 110 and 330 m above and parallel to each group when the photos were taken. The photographer sat in the rear seat of the aircraft behind the pilot and removed the rear window for each photo session. We attempted to photograph each aggregation in a single pass to minimize movement of caribou between frames and to allow for approximately 20% overlap between successive frames. The group number, longitude and latitude co-ordinates, frequencies of radio collars present, and frame numbers of photos taken for each group photographed were recorded.

In the lab we selected the best photo or series of photos taken of each group and printed these on 38.6 X 50 cm paper. For groups that were photographed over a series of photos, we identified the unique portions of each photo and marked the boundaries of these on the paper prints. We used OziExplorer GPS Mapping Software, Version 3.95.4m, D & L Software Pty Ltd. to create a photomap of each digital image. For groups that were photographed over a series of photos, we transferred the boundaries of the unique portions of each image as marked on the paper prints to the corresponding photomaps by creating track lines on the digital image. Once this was completed, the photomaps were visually scanned on a computer screen and a waypoint was created on each caribou. The waypoint count gave the number of caribou present on each photomap. OziExplorer allowed us to easily change the view magnification as required to ensure that all caribou could be accurately identified and counted. We classified caribou as calves, cows (cows, yearlings, young bulls), and bulls whenever possible or as calf or non-calf caribou. We assigned a unique symbol color for each class of caribou. In the OziExplorer Mapping Software each color has a unique number code. Once all caribou were counted, we imported the waypoint files into Microsoft EXCEL and determined the number of caribou counted in each class by doing a frequency count of each color code. This was particularly useful for large groups of caribou.

Population Size

The photo count data provided an estimate of the minimum number of non-calf caribou in the Cape Bathurst and Bluenose-West barren-ground caribou herds. However, because not all collared caribou are associated with aggregations and not all aggregations will always contain a collared caribou, total herd size will always be larger than the minimum count obtained during a photo-census (Russell et al. 1996). We estimated the total population size using a modification of the method presented by Russell et al. (1996) that is based on the Lincoln-Petersen Index as applied to radio-telemetry data by White and Garrott (1990). Not all aggregations photographed contained a radio-collared caribou but they

were typically found in close proximity to aggregations that contained radio-collared caribou. We assumed that these groups formed a general aggregation of caribou that under more favorable conditions would have formed one group. By this method

$$N = (((M+1)(C+1))/(R+1)) - 1$$

Where: N = estimate of population size during the census

M = number of radio-collared caribou present in the herd (including all collars known to be active during the survey)

C = number of caribou in all aggregations observed during the survey

R = number of radio-collared caribou observed in these aggregations during the survey.

The 95% CI for the estimate can then be calculated as $N_i \pm 1.96 \text{ Var}(N)^{0.5}$, where:

$$\text{Var}(N) = ((M+1)(C+1)(M-R)(C-R))/(R+1)^2(R+2)$$

Comparison of Population Estimates

We used Lincoln-Petersen estimators to determine if the relative abundance of caribou (K) in each herd during 2000 and 2005 was significantly different (Williams et al. 2002). We assumed that capture probabilities were different between 2000 and 2005. We estimated K and constructed the appropriate 95% confidence intervals as follows (Williams et al. 2002):

$$K = [((n_{b1}+1)(n_{b2}+1)/(m_{b2}+1)) - 1] / (n_{a1}n_{a2}) / m_{a2}$$

with

$$\text{var}(K) = (m_{a2}n_{b1}^{b1}/m_{b2}^3n_{a1}^3n_{a2}^3)[(((n_{b2}-m_{b2})(n_{b1}-m_{b2})(m_{a2}n_{a1}n_{a2}))+((n_{a2}-m_{a2})(n_{a1}-m_{a2})(m_{b2}n_{b1}n_{b2})))]$$

where n_1 = number of collared animals available for the photo-census, n_2 = number of caribou associated with radio collared caribou located, m_2 = number of collared caribou located during the photo-census, and the subscripts a and b refer to time period 1 and 2 of the comparisons, respectively. We calculated the 95% CI of K as $1.96 \text{ Var}(K)^{0.5}$ (Williams et al. 2002). If K was < 1 and the 95% CI did not include 1, the population estimate for time period 2 was significantly lower than that for time period 1. If K was > 1 and the 95% CI did not include 1, the population estimate for time period 2 was significantly higher than that for time period 1. If the 95% CI around K included 1, the population estimates for time periods 1 and 2 were not significantly different.

Composition of the herds photographed

We classified caribou as calves, cows (cows, yearlings, young bulls), and bulls whenever possible or as calf or non-calf caribou.

Weather Conditions at Paulatuk

Records of air temperature (Celsius), wind speed (knots), wind direction (true north), and precipitation (mm) were obtained from the CARS weather station at Paulatuk for the period mid June to mid July 2005.

RESULTS

Pre-radio collar deployment reconnaissance survey

The distribution of transect lines flown and sightings of caribou on the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds and on the upper Tuktoyaktuk Peninsula are shown on Figure 1.

VHF and satellite radio collar deployment

During March/early April 2005 we captured and equipped 162 barren-ground caribou with radio collars (VHF and ARGOS satellite) on the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds (Table 1) (Figure 2). We captured and radio-collared caribou randomly across the areas occupied by these herds during late winter 2005.

Verification of Status of Radio-Collared Caribou

We flew telemetry surveys daily, during the period 16 June and 11 July 2005, weather permitting, and verified the status of caribou that were radio-collared in 2005. In late June/early July 2005 there were 63 functional radio collars (including VHF and ARGOS) on Bluenose-West caribou and 32 on Cape Bathurst Caribou (Table 2). We the status of all caribou radio-collared on the winter ranges of the Cape Bathurst and Bluenose-West herds (Table 2). This was in part due to the extensive area that was flown during reconnaissance and telemetry surveys (Figure 3 and 4) and that we ran two tracking systems and continually scanned for radio collars.

Distribution of Radio-Collared Caribou Relative to Capture Sites

Figures 5 and 6 show the movements of the radio-collared cow and bull caribou that we tracked during 16 June to 11 July 2006 relative to the sites where they were captured, respectively. Caribou found on the Cape Bathurst calving/post-calving range were captured in the area south and east of Tuktoyaktuk and southeast to Caribou Lakes. Caribou found on the Bluenose-West calving/post calving range were captured in the Colville Lake/Rendezvous Lake/Crossley Lakes area. One cow captured east of Tuktoyaktuk was located on the Bluenose-West calving/post-calving range (Figure 5). The majority of caribou

found on the Bluenose-East calving/post-calving range were captured in the area south and east of Great Bear Lake and northeast to Kugluktuk, NT. One cow and two bulls captured in the Colville Lake area in 2005 were located on the Bluenose-East calving/post-calving range in late June/early July 2005. In general, caribou captured on the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds were found on the calving/post-calving ranges defined for these herds (Nagy et al. 2005).

Distribution of Satellite-Collared Cows by Herd

Figure 7 shows the movements of the satellite collared (ARGOS) Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou cows during the period 1 March 2005 to 17 July 2005. The movements of these satellite collared caribou are consistent with those documented by (Nagy et al. 2005).

Post-calving Photo-census 2006

i. Bluenose-West Herd

The Bluenose-West herd was photographed on 6 July 2005.

The caribou in this herd were sufficiently aggregated for photography on 6 July 2006. The tracks flown and distribution of groups photographed are shown in Figure 9. We photographed 40 groups, 23 of which included radio-collared caribou (Table 3). A total of 54 of the 63 available radio-collared caribou were photographed. We counted 17875 non-calf caribou on the photos taken. Some of the photos were taken at high altitudes and as a result were not able to reliably count calves on the photos. The largest groups include 4913 non-calf caribou and 10 radio-collared caribou. The population estimate generated for this photo session was 20801 ± 2040 non-calf caribou ($CV = 5\%$)(Table 4). This indicates that the Bluenose-West herd declined significantly to approximately 28% of the population size reported for 2000 ($K = 0.28$ range 0.21 and 0.34).

ii. Cape Bathurst Herd

The Cape Bathurst herd was photographed on 9 July 2006. The tracks flown and distribution of groups photographed are shown in Figures 10 and 11.

We photographed 15 groups of caribou; all groups included radio-collared caribou (Table 5). A total of 29 of the 32 available radio-collared caribou were photographed. We counted 2213 non-calf and 346 calf caribou on the photos. The largest group included 492 non-calf and 153 calf caribou and 10 radio-collared caribou. The population estimate generated for this photo session was 2435 ± 257 non-calf caribou ($CV = 5\%$)(Table 4). This indicates that the Cape Bathurst herd declined significantly to approximately 24% of the population size reported for 2000 ($K = 0.24$ range 0.19 and 0.29).

We were able to classify a majority of caribou on the photos taken of the Cape Bathurst herd (Table 5). Approximately 46% of the caribou classified were cows (cows, yearlings, and young bulls) and 41% and 13.5% were bulls and calves, respectively. Bulls represented 47% of the non-calf caribou counted and classified.

Weather Conditions at Paulatuk

Air temperatures, wind speeds, wind directions, and precipitation documented at the CARS weather station at Paulatuk, NT, during 15 June to 10 July 2005 are given in Table 6. Paulatuk is situated on the coast and as a result its weather is strongly influenced by the marine environment, particularly the presences of ice flows or ice pack. Temperature in Paulatuk can be in the +2 to +3 range but maybe significantly higher inland from the coast. However, if winds are calm or relatively calm in Paulatuk, weather conditions inland are usually favorable for the aggregation of caribou.

We photographed the Bluenose-West herd on 6 July 2005. The weather in Paulatuk was warm and relatively calm (maximum temperatures at 13:00 and 23:00 were +7.8 to +14.2 °C range, while wind speed was 8 knots at both times) (Table 6). The Bluenose-West herd was approximately 40 km inland from the coast south of Paulatuk and in the northern portion of Tuktut Nogait National Park. All groups observed were sufficiently aggregated for photography.

We photographed the Cape Bathurst herd on 9 July 2006. Weather data were not available at the CARS station for this day. However, weather data were available for the 8 and 10 July 2006. The weather on these days in Paulatuk was warm and relatively calm (maximum temperatures at 13:00 and 23:00 were in the +6 to +13 °C range, while wind speed generally ranged from 2 to 5 knots). All groups observed in these herds during this period were sufficiently aggregated for photography.

DISCUSSION

Comparisons of population estimates derived in 2000 and 2005 for the Cape Bathurst and Bluenose-West herds indicated significant declines in these herds (Nagy in prep. a). We believe that conditions were favorable for the successful completion of photo-census surveys of these herds during 2005. (Russell et al. 1996) discussed 4 assumptions on which an accurate estimate of population size using post-calving photography and the Lincoln-Petersen estimator is dependent. The degree to which each of these assumptions was met during our photo-census is discussed below:

Assumption 1: The population is closed. Satellite tracking and genetic data indicate that the Cape Bathurst, Bluenose-West, and Bluenose-East herds are distinct from each other and adjacent herds (Porcupine and Bathurst herds)

(Nagy et al. 2005; Nagy et al. 1999b; Zittlau et al. 2003). Range overlap occurs in some seasons, particularly during the winter (Nagy et al. 2005) but some overlap occurs between the Bluenose-West and Bluenose-East herds during the post-calving period in some years (Patterson et al. 2004). We found some evidence of mixing of herds on winter ranges, including:

- one radio-collared cow and two bulls that were found on the Bluenose-East post-calving range were captured on the Bluenose-West winter range in 2005,
- one radio-collared cow found on the Bluenose-West post-calving range was captured on the Cape Bathurst winter range in 2005

Mixing of caribou may be more prevalent among large herds whose seasonal ranges are in close proximity. Our data indicates that the cows and bulls of the Cape Bathurst, Bluenose-West, and Bluenose-East herds were distributed within their respective post-calving ranges and as a result the assumption of closure was met during the survey.

Assumption 2: All highly aggregated groups contain at least one radio-collared caribou and thus can be located. We had a high ratio of collars per caribou in each herd including:

- 1 per 330 caribou in the Bluenose-West herd, and
- 1 per 76 caribou in the Cape Bathurst herd.

As a result we believe that we located all significant aggregations of caribou on these post-calving ranges. Aggregations were clustered non-randomly across the landscape. Not all aggregations photographed contained a radio-collared caribou but they were typically found in close proximity to aggregations that contained radio-collared caribou. We assumed that these groups were part of a general aggregation that under more favorable conditions would have formed one group, as a result, these caribou were considered to be part of nearby groups that contained radio-collared animals and were included in the analyses. Although we did not strictly meet the conditions for this assumption, we believe that this violation had little influence on our population estimates.

Assumption 3: Radio-collared animals are randomly distributed throughout the herd. We designed and conducted a survey in late February/early March 2005 to define the distribution of caribou on the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East caribou herds prior to collar deployment in March 2005. We captured and radio-collared caribou randomly across the areas occupied by these herds during late winter 2005. Radio-collared caribou found within the largest groups photographed on the post-calving ranges of the Bluenose-West herd on 6 July 2005 (Figures 12, 13, and 14) and the Cape Bathurst herd on 9 July 2005 (Figures 15 and 16) were captured over a wide geographic area suggesting that the radio-collared caribou were randomly distributed within these herds.

Assumption 4: No significant movement of individual caribou among photographed groups used in the estimate occurred during the photo-census. We photographed the Bluenose-West herd on one day on 6 July 2005. Similarly, we photographed the Cape Bathurst herd in one day on 9 July 2005. We did not detect any movement of collared animals among groups when we photographed these herds. As a result, we believe that this assumption was fully met.

In summary, radio-collars were distributed randomly among caribou in these herds during late winter 2005, and the status of the majority of these was verified prior to and during the photo-census. The largest majority of caribou were found in each area because there was a high ratio of radio-collars deployed per caribou in each herd. Weather conditions during the days when we photographed the herds were favorable for aggregation. We met the basic assumptions on which an accurate estimate of population size using post-calving photography and the Lincoln-Petersen estimator is dependent. As a result, we believe that the population estimates generated for caribou on the post-calving ranges of the Cape Bathurst and Bluenose-West barren-ground caribou herds are precise and accurate.

MANAGEMENT IMPLICATIONS

The numbers of caribou in the Cape Bathurst and Bluenose-West barren-ground caribou herds were significantly lower than in 2000; both of these herds have declined significantly to levels that are less than 30% of those in 2000 estimates.

The small number of calves observed in the Cape Bathurst herd in early July 2005 indicates that few yearlings will be recruited to this herd in spring 2006. This suggests that a further decline of the Cape Bathurst herd can be anticipated. The high proportion of bulls in the Cape Bathurst herd is of concern. Approximately 47% of the non-calf caribou in this herd were bulls. However, if yearlings and young bulls were removed from the “cow” component, the proportion of bulls in the herd would be much higher. Typically approximately 30-40% of a caribou herd is comprised of bulls (Don Russell pers. Comm.). The imbalance in the sex ratio in the Cape Bathurst herd is likely a result of hunters selectively harvesting cows. Recruitment should be maximized to facilitate recovery of the Cape Bathurst herd.

The Bluenose-West herd appears to be in better shape, but recruitment to this herd need to be maximized during the next few years to facilitate its recovery.

A photo-census of these herds should be undertaken in summer 2006 to determine if the decline in these two herds has stabilized.

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The capture and radio-collaring program was completed by John Nagy (ENR Inuvik), Ian Ellsworth (ENR Inuvik), Boyan Tracz (ENR, Norman Wells), Brad Culling (Diversified Environmental Services, Fort St. John), and Diane Culling (Diversified Environmental Services, Fort St. John). Ole Vaage (Highland Helicopters, Inuvik) and Benedict ?? (Canadian Helicopters) piloted helicopters used to complete the capture program.

John Nagy (ENR Inuvik) and Deborah Johnson (ENR Fort Smith) completed the photo-census. Wendy Wright (ENR Inuvik) and James Auld (ENR Norman Wells) provided GIS support. Perry Linton (North-Wright Airways Ltd., Norman Wells) piloted the fixed-wing aircraft used to complete this survey.

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Table 1. Number of radio-collars deployed on caribou in the winter ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East herds during March and early April 2005.

			Collar Type (Telonics)		Total
			ARGOS	VHF	
Bluenose-East	2005	female	12	26	38
		male		10	10
		subtotal	12	36	48
Bluenose-West	2005	female	10	44	54
		male		16	16
		subtotal	10	60	70
Cape Bathurst	2005	female	11	23	34
		male		10	10
		subtotal	11	33	44
Total			33	129	162

Table 2. Number of active radio-collars in the Cape Bathurst and Bluenose-West barren-ground caribou herds during late June and early July 2005.

Herd	Year of Capture	No. of radio-collared caribou not located			No. of radio-collared caribou located		
		Female	Male	Total	Female	Male	Total
Bluenose-West	2005	0	0	0	48	15	63
Cape Bathurst	2005	0	0	0	22	10	32
subtotal					70	25	95

Table 3. Non-calf caribou counted on photographs taken of the Bluenose-West caribou herd on 6 July 2005. We did not count calves because they were difficult to discern on most of the photos.

Date	Group	No. of radio collars	Number of non-calf caribou	
			All groups observed	Groups with radio-collars only
06-Jul-06	1	1	203	203
06-Jul-06	2	1	360	360
06-Jul-06	3	0	282	
06-Jul-06	4	1	338	338
06-Jul-06	5	0	185	
06-Jul-06	6	1	619	619
06-Jul-06	7	0	33	
06-Jul-06	8	6	1750	1750
06-Jul-06	9	7	1321	1321
06-Jul-06	10	3	1256	1256
06-Jul-06	11	2	571	571
06-Jul-06	12	1	12	12
06-Jul-06	13	3	591	591
06-Jul-06	14	1	7	7
06-Jul-06	15	0	1	
06-Jul-06	16	0	1	
06-Jul-06	17	4	470	470
06-Jul-06	18	1	556	556
06-Jul-06	19	2	1678	1678
06-Jul-06	20	1	1	1
06-Jul-06	21	10	4913	4913
06-Jul-06	22	2	857	857
06-Jul-06	23	1	826	826
06-Jul-06	24	0	1	
06-Jul-06	25	1	91	91
06-Jul-06	26	0	1	
06-Jul-06	27	0	3	
06-Jul-06	28	0	1	
06-Jul-06	29	0	44	
06-Jul-06	30	0	3	
06-Jul-06	31	0	1	
06-Jul-06	32	1	83	83
06-Jul-06	33	0	116	
06-Jul-06	34	2	308	308
06-Jul-06	35	1	11	11
06-Jul-06	36	0	170	
06-Jul-06	37	0	71	
06-Jul-06	38	0	135	
06-Jul-06	39	1	2	2
06-Jul-06	40	0	3	
Total		54	17875	16824

Table 4. Non-calf population estimates for the Cape Bathurst and Bluenose-West caribou herds in 1986, 1987, 1992, 2000, and 2005.

Herd	Year	M	C	R	N	Number Counted on Photos	Coefficient of Variation (%)
Bluenose-West							
	1986 ¹	?	83460	33	83460	83460	
	1987 ¹	43	96626	42	98874 ± 3145	101067	2
	1992 ²	31	48528	23	64705 ± 9057	72049	10
	2000 ³	50	48058	32	74273 ± 10591	52508	10
	2005 ⁴	63	17875	54	20801 ± 2040	17875	5
Cape Bathurst							
	1986 ¹	?	13476	3	13476	13476	
	1987 ¹	7	12712	6	14529 ± 2542	14173	12
	1992 ²	6	12514	4	17521 ± 5352	15670	22
	2000 ³	17	8899	15	10013 ± 1132	9857	8
	2005 ⁴	32	2213	29	2435 ± 257	2213	5

The estimate of population size for each census was calculated as

$N = (((M+1)(C+1))/(R+1)) - 1$; where:

N = estimate of population size during the census

M = number of radio-collared caribou present in the herd (including all collars known to be active during the survey)

C = number of caribou observed in aggregations containing at least one radio-collared caribou during the survey

R = number of radio-collared caribou observed in these aggregations during the survey.

The 95% CI for the estimate was calculated as $N_i = 1.96 \text{ Var}(N)^{0.5}$, where:

$\text{Var}(N) = ((M+1)(C+1)(M-R)(C-R))/(R+1)^2(R+2)$

¹Parameters used to derive population estimates for 1987 were obtained from field and published data (McLean and Russell (1992). There was not sufficient information documented to derive population estimates for 1986; the estimates provided here are the number of caribou counted on photos taken (McLean and Russell 1992).

²Parameters used to derive population estimates were obtained from field and unpublished data (Nagy in prep. a).

³Parameters used to derive population estimates were obtained from field and unpublished data (Nagy in prep. a)

Table 5. Cow, calf, and bull caribou counted on photographs taken of the Cape Bathurst caribou herd on 9 July 2005.

Date	Group	No. of Radio Collars	No. Counted					Percent Calves
			Cows	Calves	Bulls	Non-Calf	Calves	
09-Jul-06	1	2	7	2		7	2	22.2
09-Jul-06	2	1	22	9		22	9	29
09-Jul-06	3	1	9	4		9	4	30.8
09-Jul-06	4	1	73	24		73	24	24.7
09-Jul-06	5	1			1	1	0	0
09-Jul-06	6	10	455	153	37	492	153	23.7
09-Jul-06	7	1	133	38	40	173	38	18
09-Jul-06	8	2	211	47	17	228	47	17.1
09-Jul-06	9	2	138	67	0	138	67	32.7
09-Jul-06	10	1	0	0	6	6	0	0
09-Jul-06	11	1	0	0	421	421	0	0
09-Jul-06	12	1	110	1	343	453	1	0.2
09-Jul-06	13	1	15	1	0	15	1	6.3
09-Jul-06	14	1	1	0	0	1	0	0
09-Jul-06	15	3	0	0	174	174	0	0
Total		29	1174	346	1039	2213	346	13.5

Table 6. Air temperatures, wind direction, wind speed, and precipitation documented at the CARS weather station at Paulatuk, NT, 15 June 2006 to 10 July 2005.

Date	Temperature by Time (UTC)				Wind Direction by Time (UTC)		Wind Speed by Time UTC		Precipitation by Time UTC	
	13:00		23:00		13:00	23:00	13:00	23:00	13:00	23:00
	Minimum	Maximum	Minimum	Maximum	True	True	Knots	Knots	mm	mm
15-Jun-05	-2.2	4.6	-1.3	4.0	31	33	2	5	trace	0.0
16-Jun-05	-0.2	4.4	0.0	6.0	34	1	3	12	0.0	0.0
17-Jun-05	0.0	6.2	1.4	4.7	0	2	0	20	0.0	0.0
18-Jun-05	0.6	6.0	0.5	3.8	30	33	9	5	0.0	trace
19-Jun-05	0.8	3.4	0.8	1.7	22	27	5	10	0.0	trace
20-Jun-05	-0.3	6.8	0.0	2.7	32	32	3	7	0.0	0.0
21-Jun-05	-0.5	4.2	0.3	6.5	30	10	8	3	3.2	trace
22-Jun-05	1.3	7.6	1.5	5.2	4	2	5	14	0.0	trace
23-Jun-05	0.6	3.7	0.9	3.4	31	27	13	3	8.0	trace
24-Jun-05	-0.5	2.7	-0.6	4.7	28	33	15	10	0.4	trace
25-Jun-05	0.7	4.2	1.0	5.1	26	27	3	6	0.6	trace
26-Jun-05	-0.1	5.6	0.0	1.1	29	33	3	4	0.0	0.0
27-Jun-05	0.7	7.2	0.6	7.0	30	8	4	7	0.0	trace
28-Jun-05	0.5	7.2	0.6	0.9	9	3	4	10	0.0	trace
29-Jun-05	4.2	13.5	7.2	14.5	22	33	8	2	0.0	0.4
30-Jun-05	1.8	15.1	1.1	5.4	26	29	2	6	trace	0.2
01-Jul-05	0.9	5.0	1.0	5.0	30	31	5	3	0.2	0.0
02-Jul-05	0.8	5.2	6.0	7.6	4	33	3	4	0.0	0.0
03-Jul-05	3.0	9.3	3.7	7.8	0	0	0	0	0.0	trace
04-Jul-05	2.0	11.4	2.0	6.1	30	31	11	8	0.4	trace
05-Jul-05	2.0	5.7	2.2	7.2	28	5	3	8	trace	0.0
06-Jul-05	3.5	7.8	4.4	14.2	26	8	8	8	1.2	0.0
07-Jul-05	5.8	20.2	4.4	6.4	27	35	18	6	0.4	0.2
08-Jul-05	1.5	6.7	1.9	4.0	3	0	2	0	0.0	5.6
09-Jul-05					na	na				
10-Jul-05	3.9	13.1	6.5	11.6	25	9	5	4	7.0	0.4

Figure 1. Transect lines flown during late February and March 2005 to document the distribution of caribou on the winter ranges of the Cape Bathurst, Bluenose-West, Bluenose-East, and Bathurst barren-ground caribou herds.

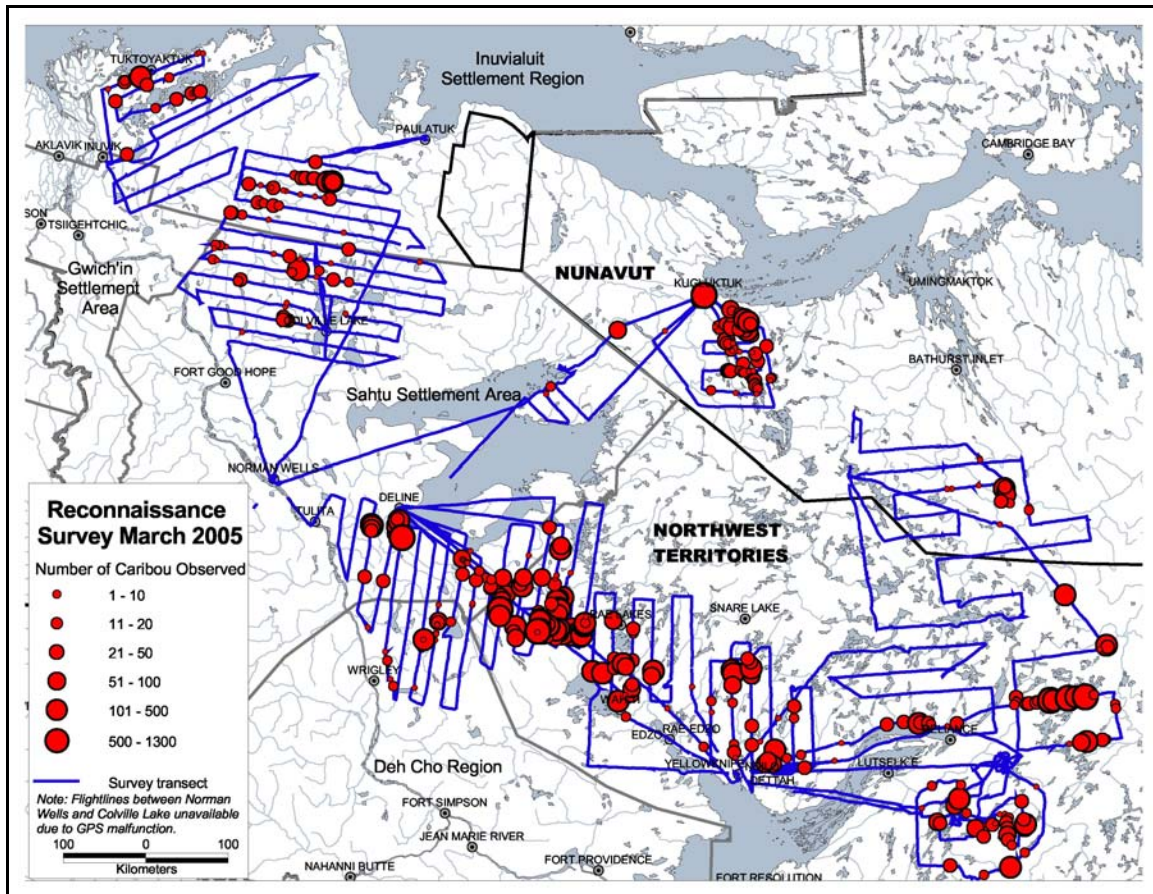


Figure 2. Distribution of capture sites for Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou radio-collared during March and early April 2005.

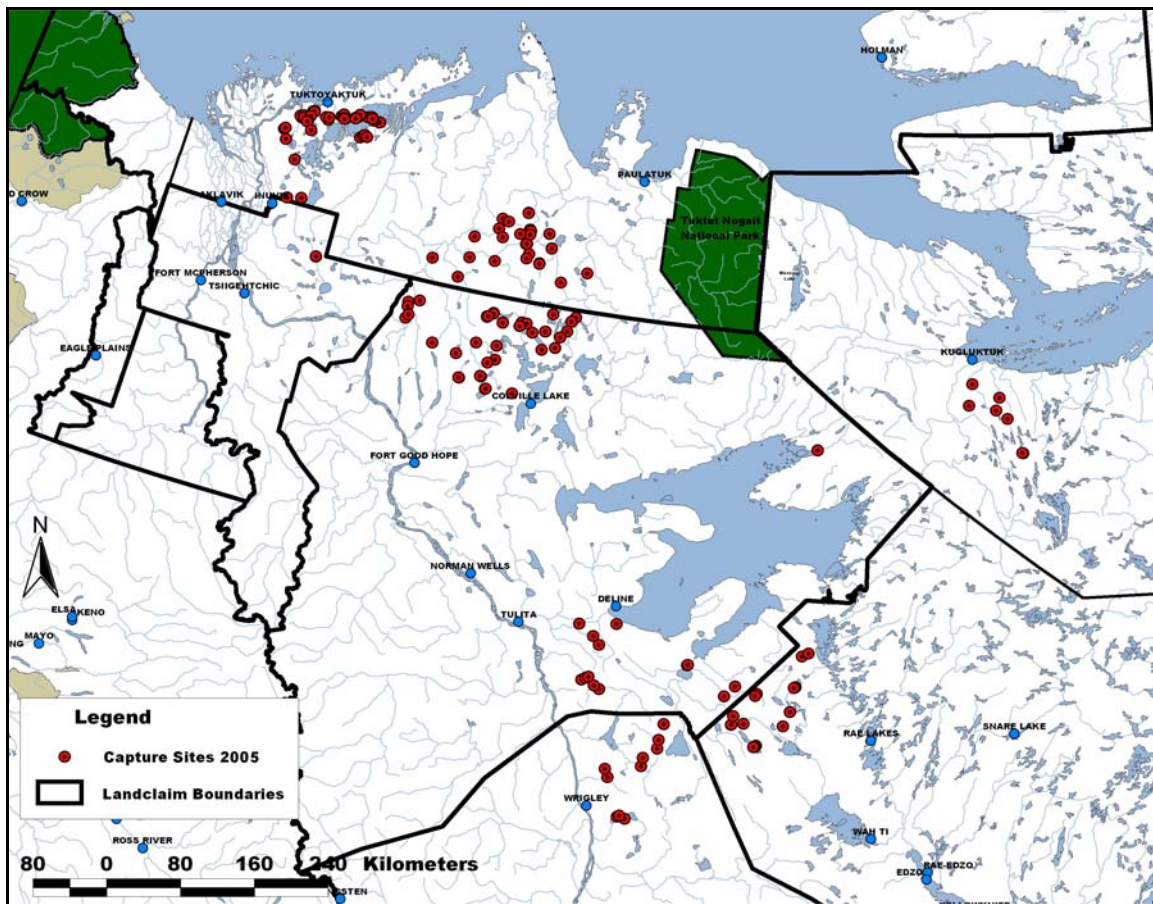
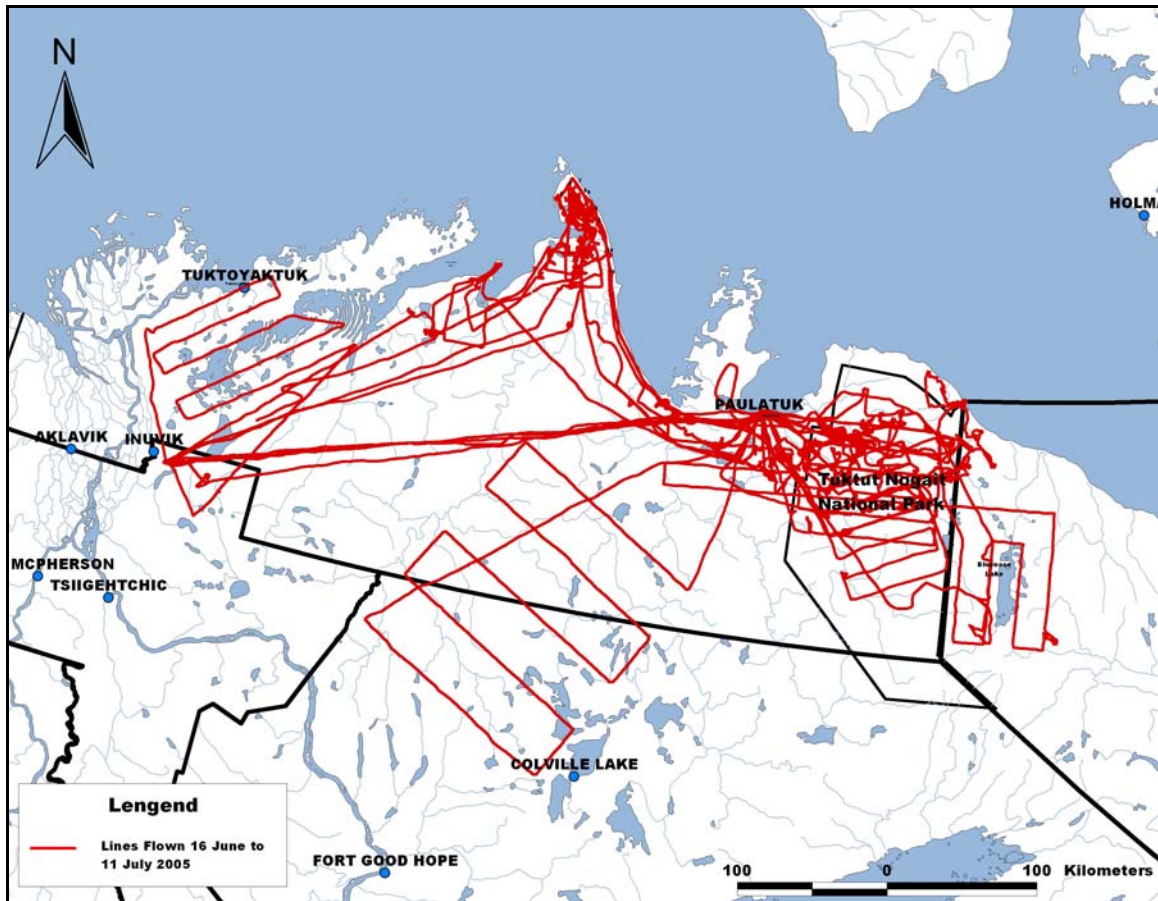


Figure 3. Lines flown during reconnaissance and telemetry flights conducted to verify the status and monitor the movements of radio-collared Cape Bathurst and Bluenose-West caribou between 16 June and 11 July 2005.



[illegible]

Figure 5. Distribution of radio-collared Cape Bathurst, Bluenose-West, and Bluenose-East cows located during the 2005 photo-census relative to where they were captured during March and early April 2005.

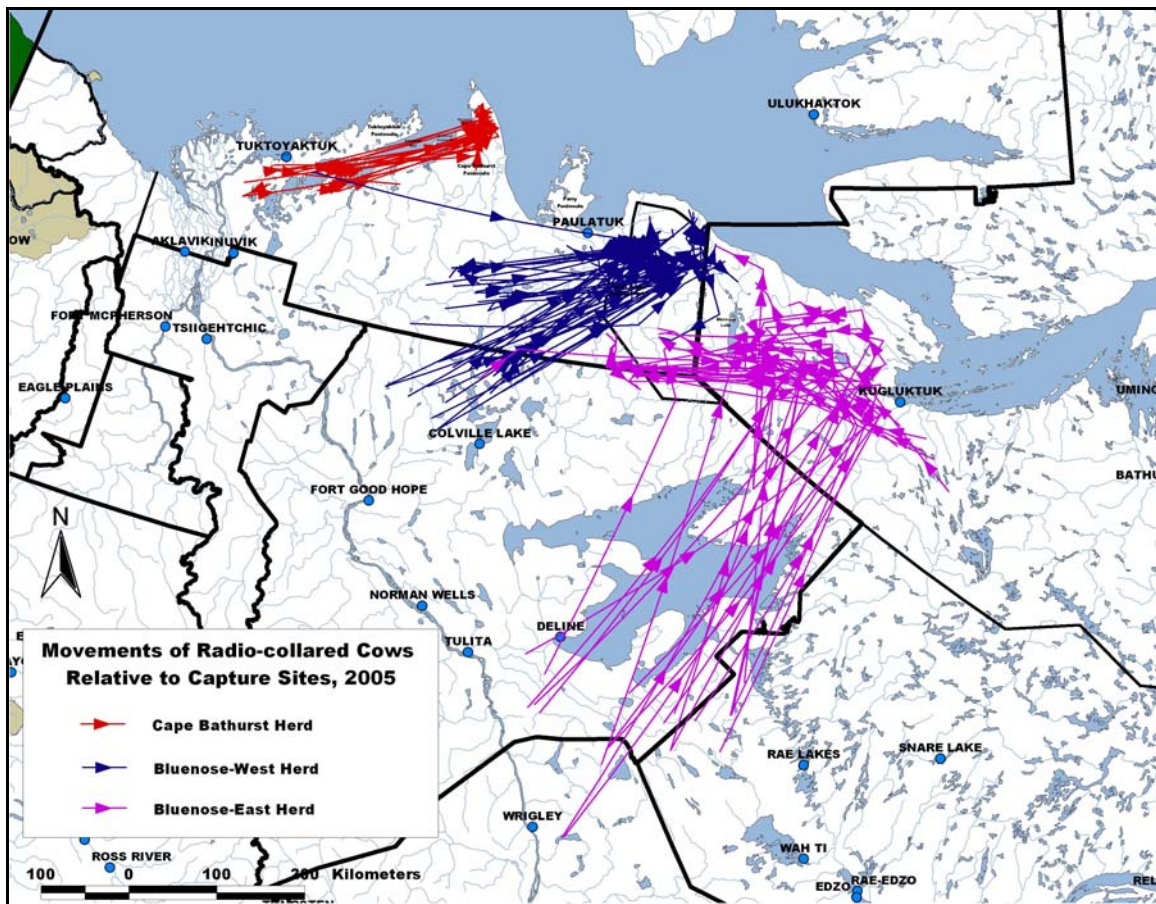


Figure 6. Distribution of radio-collared Cape Bathurst, Bluenose-West, and Bluenose-East bulls located during the 2005 photo-census relative to where they were captured during March and early April 2005.

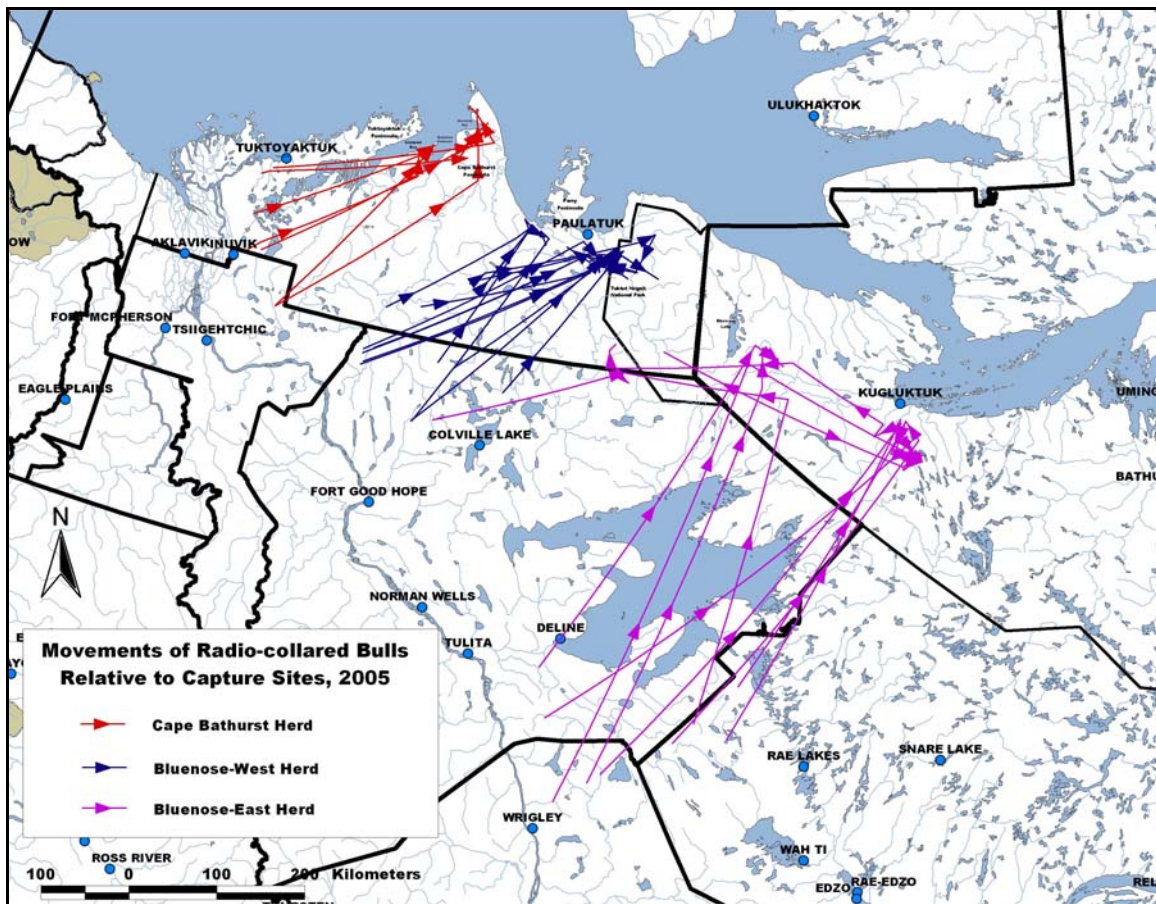


Figure 7. Distribution of satellite-collared Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou cows, 1 March 2005 to 17 July 2005.

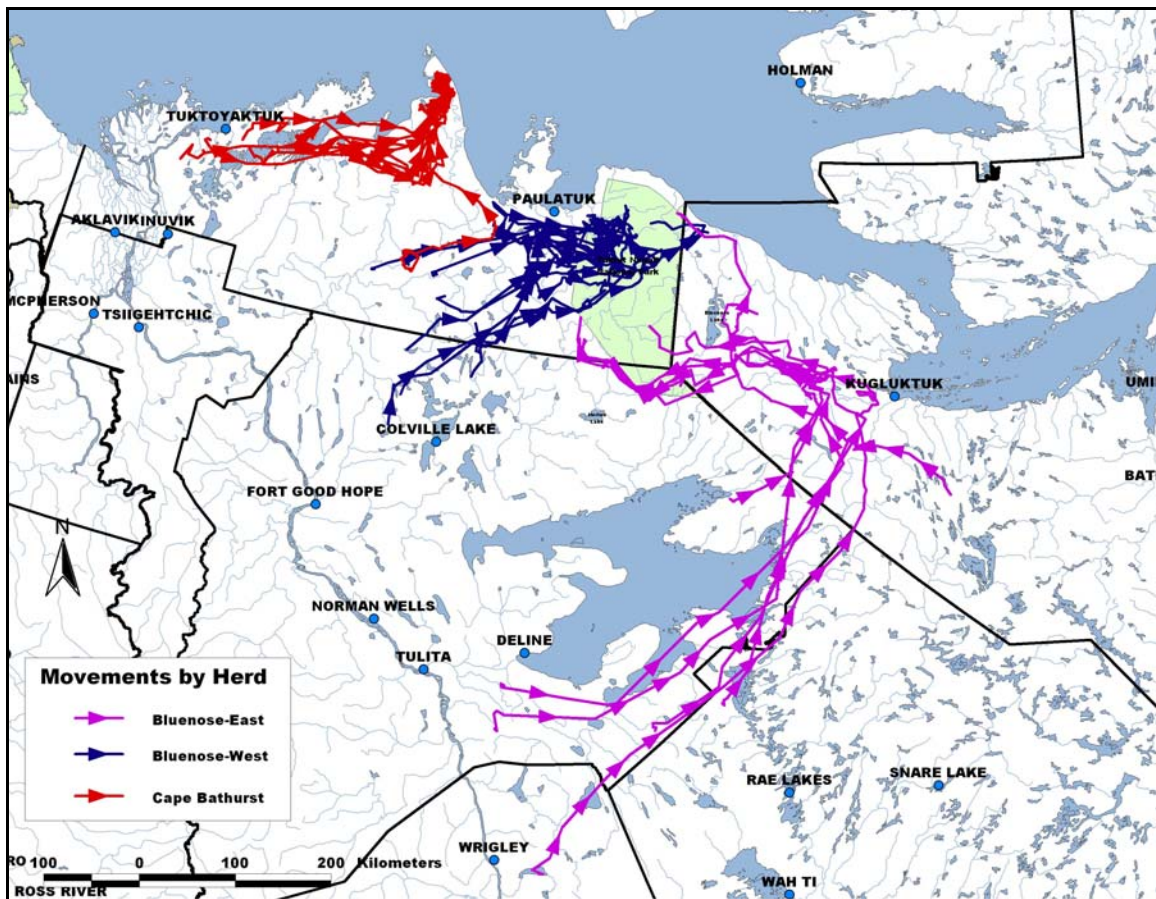


Figure 8. Track flown and distribution of groups of Bluenose-West caribou photographed on 6 July 2005.

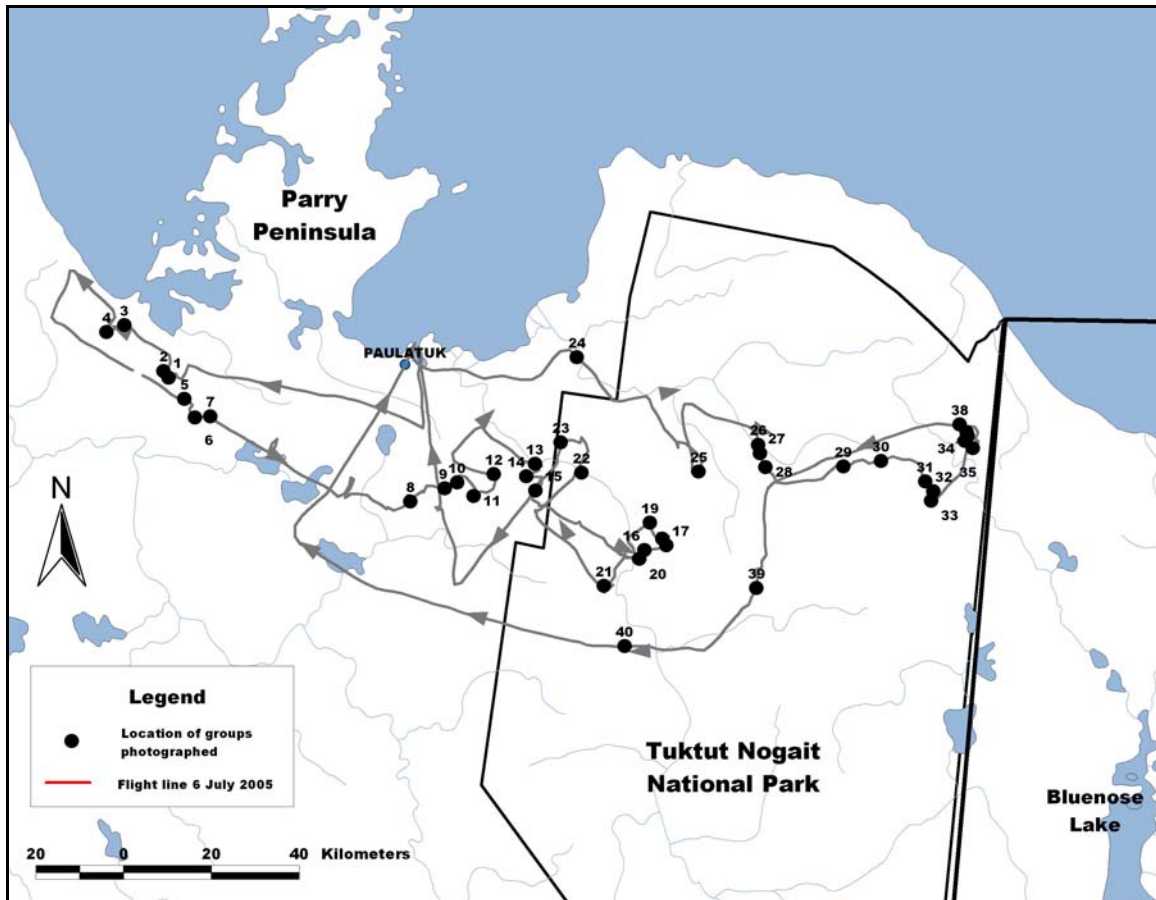


Figure 9. Tracks flown and distribution of groups of Cape Bathurst caribou photographed on 9 July 2005.

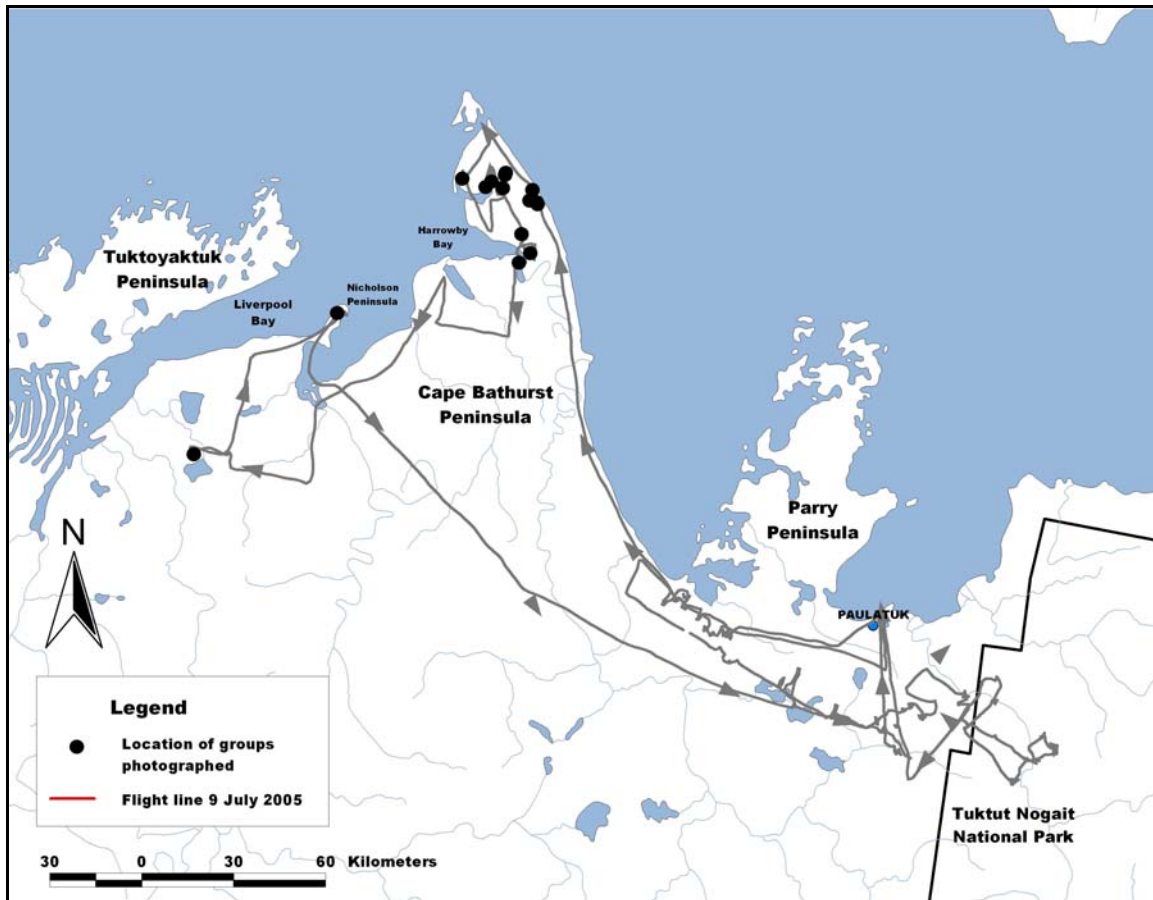


Figure 10. Tracks flown and distribution of groups of Cape Bathurst caribou photographed on 9 July 2005 (close-up).

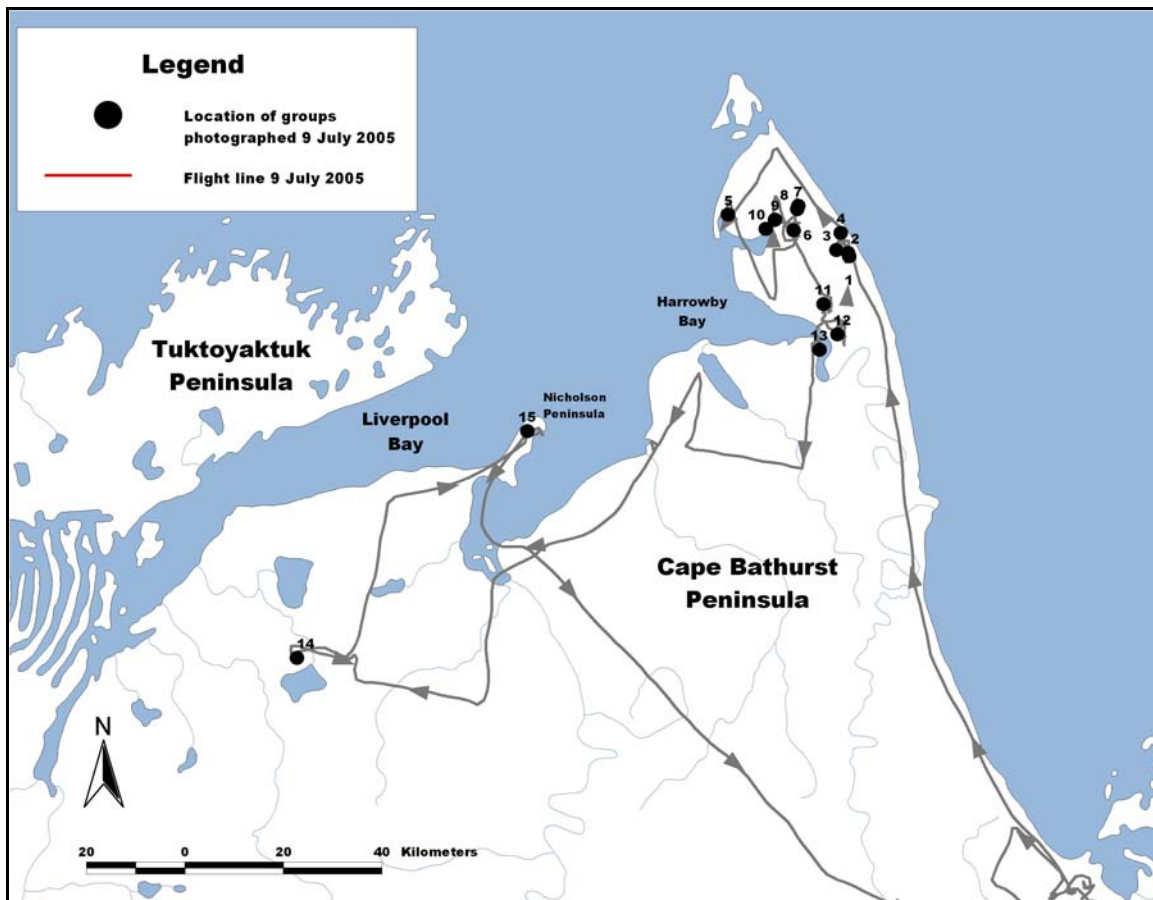


Figure 11. Site where Bluenose-West herd group 8 was photographed on 6 July 2005 relative to the sites where the radio-collared caribou in the group were captured.

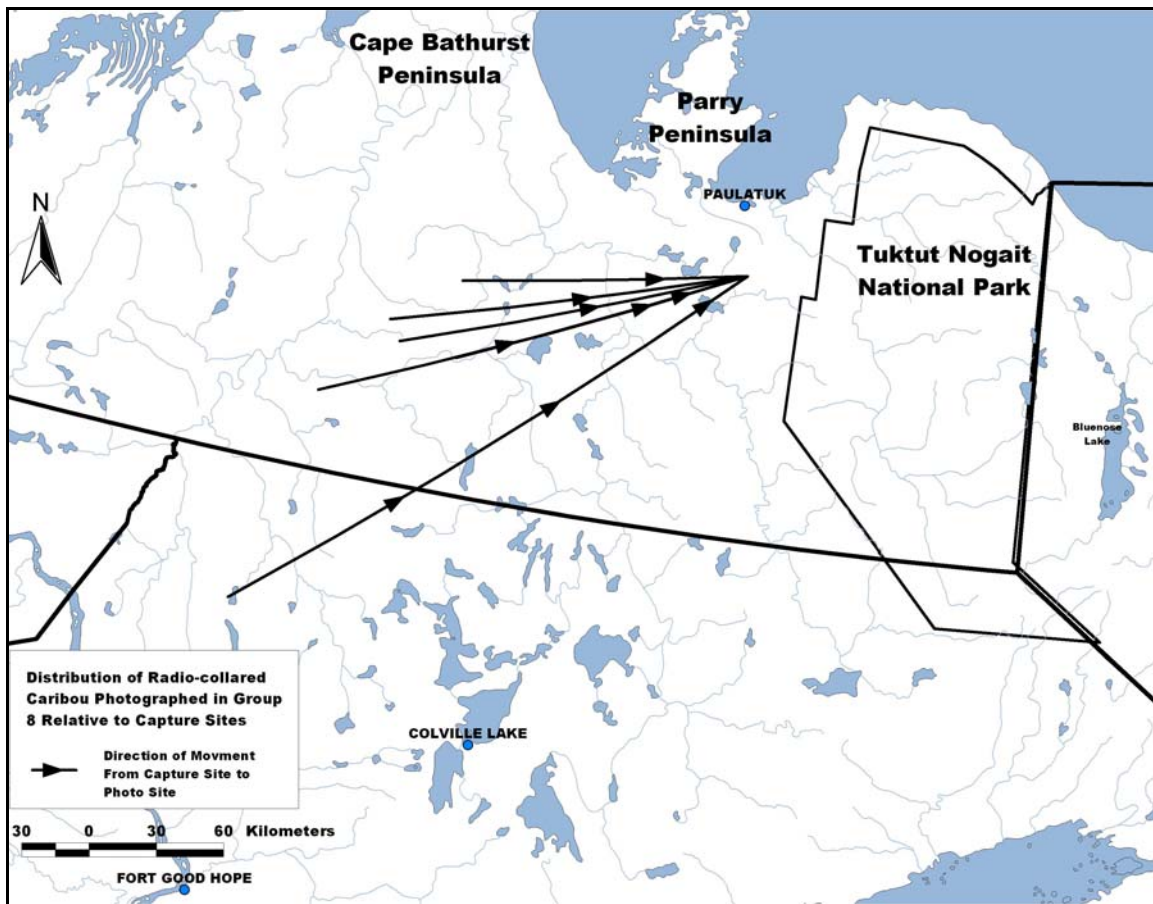


Figure 12. Site where Bluenose-West herd group 9 was photographed on 6 July 2005 relative to the sites where radio-collared caribou in the group were captured.

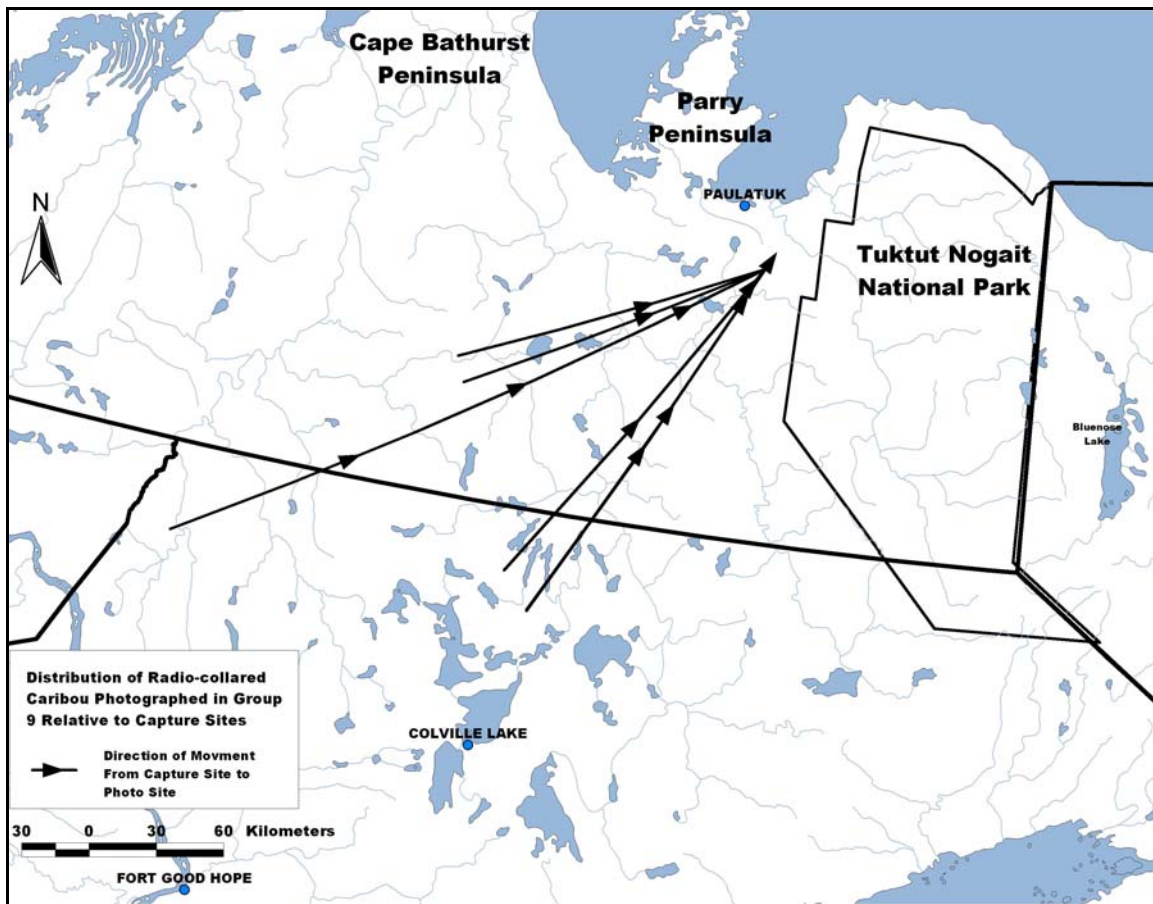


Figure 13. Site where Bluenose-West herd group 21 was photographed on 6 July 2005 relative to the sites where the radio-collared caribou in the group were captured.

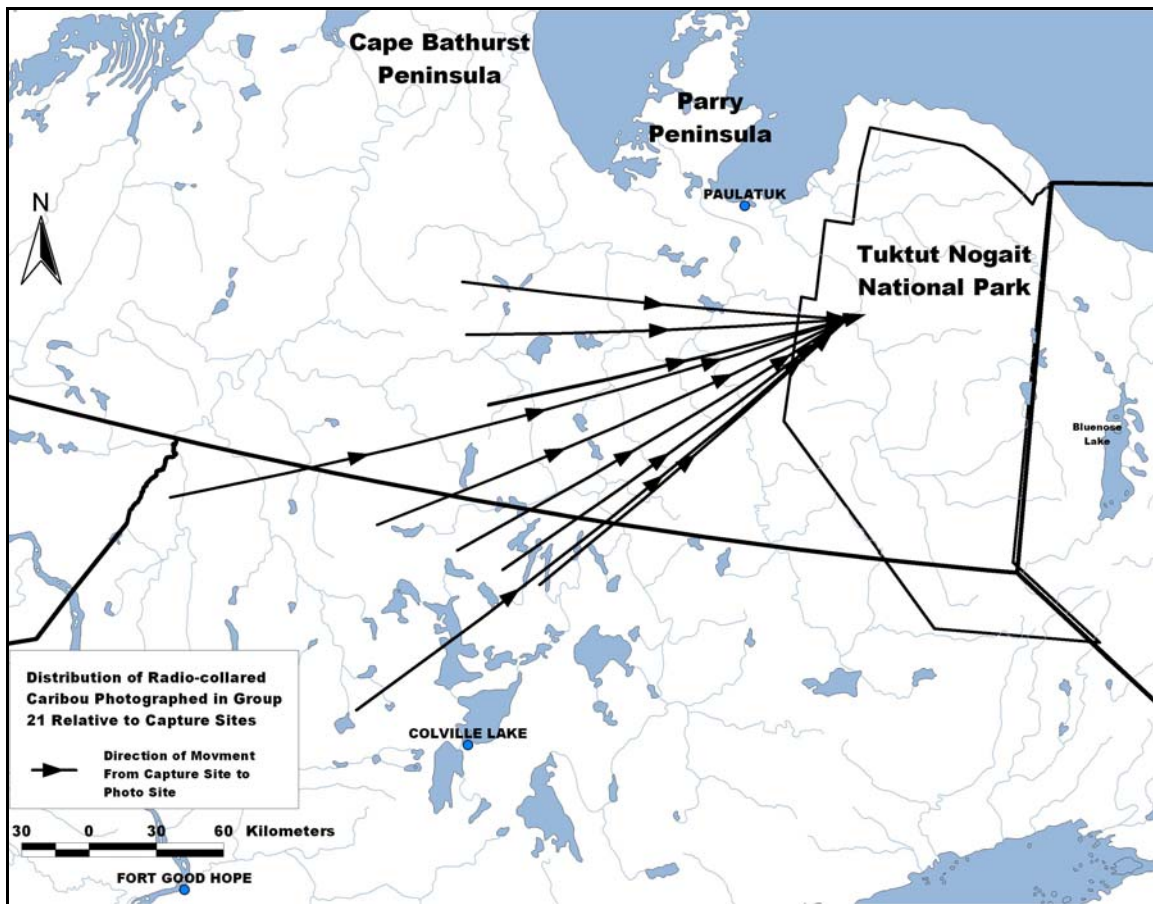


Figure 14. Site where Cape Bathurst herd group 6 was photographed on 9 July 2005 relative to the sites where radio-collared caribou in the group were captured.

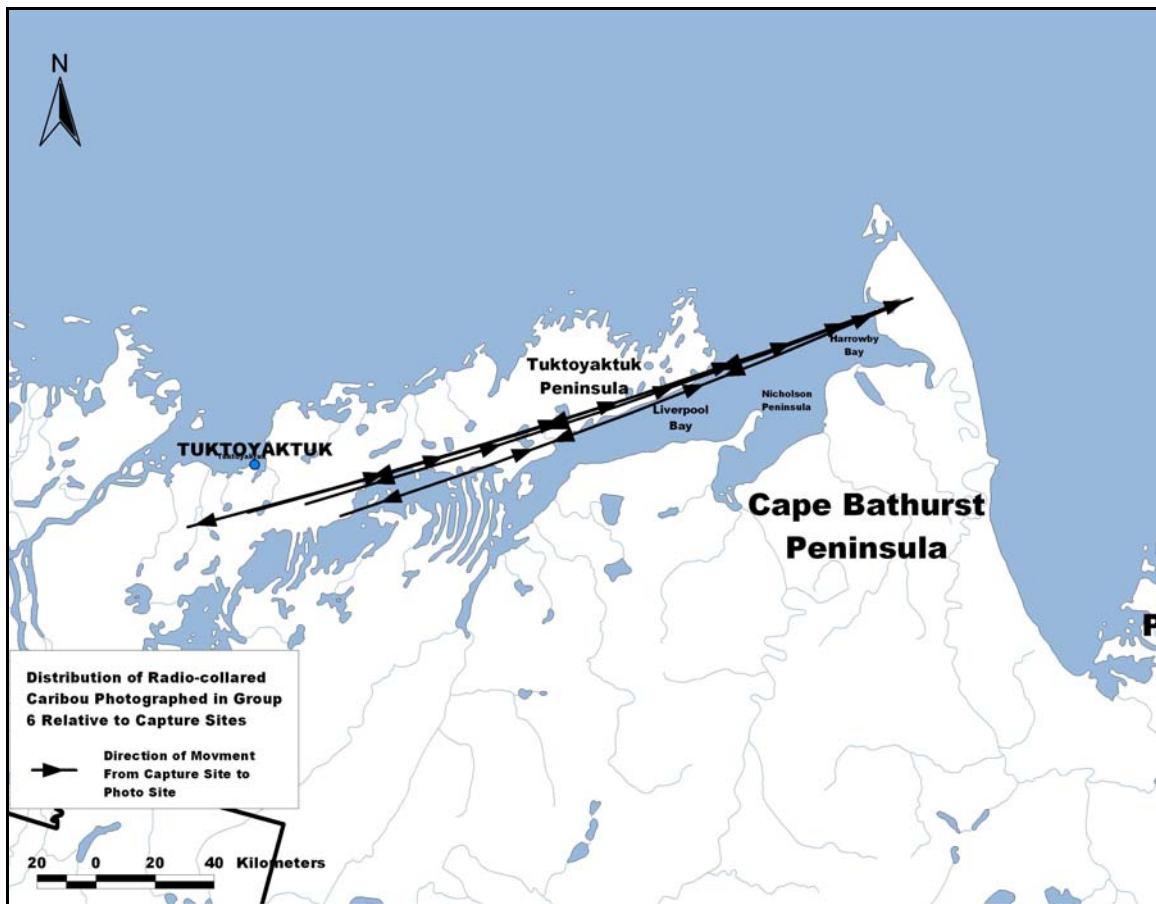
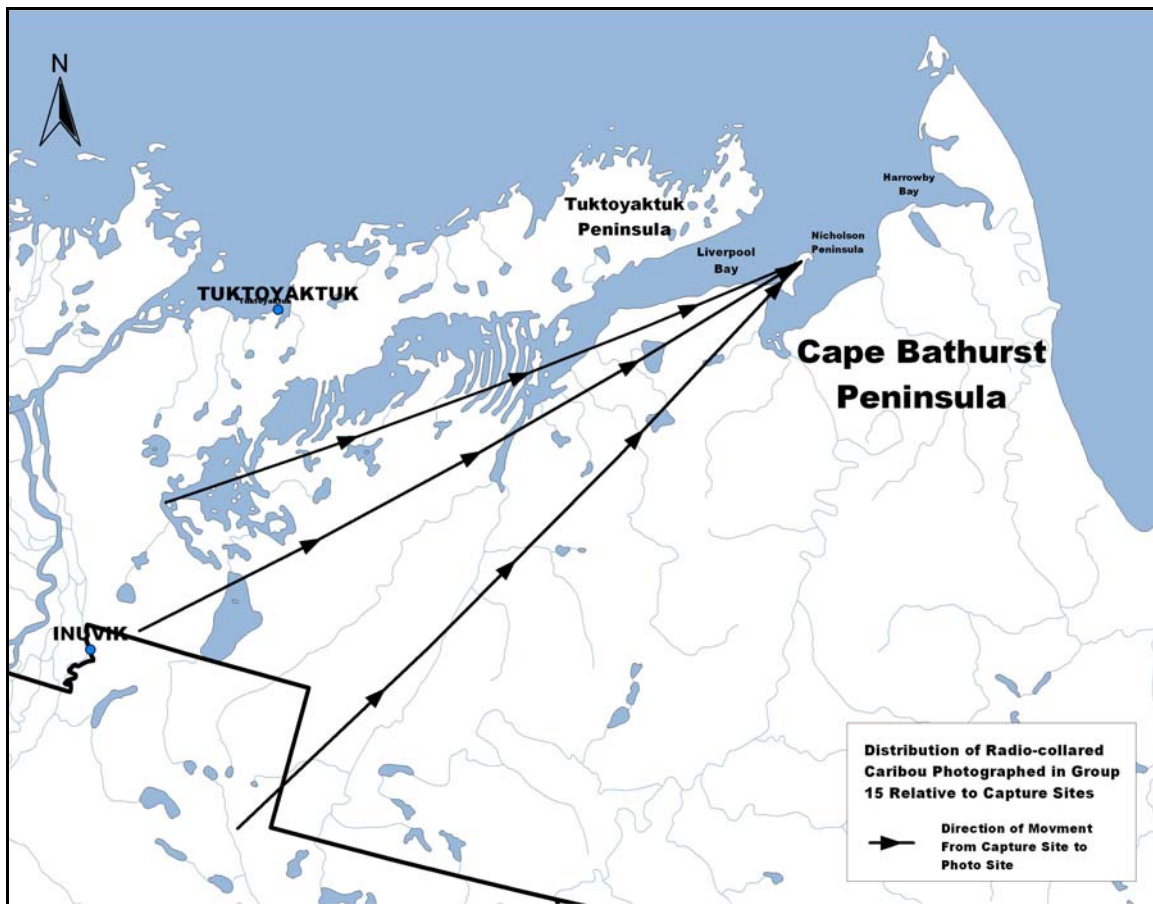


Figure 15. Site where Cape Bathurst herd group 15 was photographed on 9 July 2005 relative to the sites where the radio-collared caribou in the group were captured.



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