POPULATION ESTIMATES FOR PEARY CARIBOU AND MUSKOX ON BANKS ISLAND, NT, JULY 2005

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ABSTRACT

A stratified strip transect aerial survey was conducted on Banks Island, NT during 24 July to 1 August 2005 to document the numbers and distribution of Peary caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*).

We observed 172 non-calf and 46 calf caribou on transect giving estimates of 929 ± 289 (95% CI) non-calf and 251 ± 104 (95% CI) calf caribou. Approximately 19.4% of the caribou observed were calves. Overall there were 0.013 non-calf caribou per km^2 on the island. The estimates of the numbers of non-calf and calf caribou in the population did not change significantly between 2001 and 2005. However, a comparison of the mean non-calf population estimates suggests that the population declined. The lack of growth in the population was likely a residual effect of the icing event that occurred on Banks Island during winter 2003–2004. The results of this survey indicate that the bull only quota (in effect since 1992) has not had a negative impact on the bull component of the population based on the number of bulls observed in 2005, nor has it had a negative impact on productivity based on the number of calves observed per 100 non-calf caribou in 2005.

We observed 9,274 non-calf and 974 calf muskoxen on transect giving estimates of 47,209 ± 3,997 (95% CI) non-calf and 4,924 ± 537 (95% CI) calf muskoxen.

Approximately 9.5% of the muskoxen observed on transect were calves. The estimates of the numbers of non-calf and calf muskoxen decreased significantly during 2001 to 2005, with the non-calf estimates declining to levels

observed in 1998. This primary cause of this decline was most likely the icing event that occurred on Banks Island during winter 2003–2004.

We observed fewer wolves in 2005 than in 2001. Whether this decrease in the number of sightings reflects a decline in the number of wolves on the island is not known.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The history of the Peary caribou and muskox population on Banks Island has been well documented (Nagy *et al*., 1996; Nagy *et al*., 1998). Between 1972 and 1989, five whole island surveys had been conducted to document the number of caribou and muskoxen on the island (Urquhart, 1983; Latour, 1985; Nagy *et al*., 2007a; McLean *et al*., 1986; McLean, 1992; McLean and Fraser 1992). Between 1972 and 1992, the Peary caribou population declined from about 12,000 to 2,600 non-calf animals, respectively, while the muskox population increased from about 3,800 to about 34,300 non-calf animals (Urquhart, 1983; Latour, 1985; Nagy *et al*., 2007a; McLean *et al*., 1986; McLean, 1992; McLean and Fraser, 1992).

Because of the “endangered” status of Peary caribou and the importance of Peary caribou and muskox to the community of Sachs Harbour (subsistence and commercial harvest), the Department of Environment and Natural Resources established a plan in the early 1990s to continue to survey these population every two to four years to monitor their status (McLean, 1992; McLean and Fraser, 1992; Nagy *et al*., 2007b; Nagy *et al*., 2007c; Nagy *et al*., 2007d; Nagy *et al*., 2007e; Nagy *et al*., 2007e). Surveys conducted between 1989 and 1998 indicated that Peary caribou population continued to decline between 1989 and 1992 (Nagy *et al*., 2007b), appear to be stable between 1992 and 1994 (Nagy *et al*., 2007c), declined between 1994 and 1998 (Nagy *et al*., 2007d), and increased between 1998 and 2001 (Nagy *et al*., 2007e). The muskox population continued to increased between 1989 and 1994 (Nagy *et al*., 2007b; Nagy *et al*., 2007c),

declined between 1994 and 1998 (Nagy *et al*., 2007d), and increased between 1998 and 2001 (Nagy *et al*., 2007e). The declines in the number of non-calf caribou and muskoxen on the island between 1994 and 1998 may have been a residual effect of the icing event that occurred on Banks Island during winter 1993–1994 (Larter and Nagy, 1994). The decline in the number of non-calf muskox may have also been driven by density dependent population regulatory effects.

A stratified strip transect aerial survey designed to obtain population estimates for and Peary caribou and muskox on Banks Island was conducted during 24 July to 1 August 2005 with the following objectives:

- to obtain estimates of the number of non-calf and calf caribou and muskoxen,
- to determine the status of the Peary caribou and muskox population,
- to document observations of wolves and den sites,
- to document the distribution of caribou and muskoxen,
- to recommend whether the current quotas for caribou and muskoxen are sustainable, and
- if necessary, recommend management options to facilitate recovery of the Peary caribou population.

This report summarizes the results of the survey completed on Banks Island during July/August 2005.

METHODS

In order to conduct a strip transect survey, we partitioned Banks Island into survey blocks of a size that transect lines, when oriented to intersect major river systems and drainages at approximately a 90° angle, could be flown in about 20 to 25 minutes (Figures 1 and 2). This was done to minimizing observer fatigue. All survey blocks were flown at 20% coverage (transects spaced at 5-km intervals).

In preparation for the survey, we downloaded rasterized versions of the 1:250,000 NTS map sheets covering Banks Island from Toporama http://toporama.cits.rncan.gc.ca/toporama_en.html. These were appended using PCI Geomatica software (Geomatica software Geomatica) to create a single raster covering the entire study area. We also created a transect line raster and added it to the 1:250,000 NTS raster using Geomatica software. The resulting digital map was imported into OziExplorer GPS software (OziExplorer GPS Mapping Software). Ozi Explorer is a computer software package that is designed to upload and download waypoint and track files from a GPS. We used OziExplorer to create waypoints at the start and end of each transect and gave each of these a unique identification number. These were stored in a digital database on a laptop computer.

Shape files were created for each survey block so that total area of each could be measured using ArcView 3.2 GIS software (Environmental Systems Research Institute). The specifications of the projection used are as follows:

Lambert Conformal Conic, NAD83, Central Meridian: 123.0 W, Latitude of Origin: 73.0 N, SP1: 72.0 N, SP2: 74.0 N.

The survey crews were comprised of a pilot, two observers seated in the back of the aircraft (Helio Courier and Cessna 185), and a recorder seated in the right front seat. Survey crews were equipped with a laptop computer with OziExplorer, a digital map of the survey area, and the digital transect waypoint database installed. Each day we used OziExplorer to download the waypoints of the transect end points from the laptop to the GPS of the aircraft. The pilot used these waypoints to navigated to the start and end points of each transect using the GPS of the aircraft. The aircraft flew at an altitude of 100 m above ground level and airspeed of 160 km/h.

Caribou were counted within and outside of the boundaries of a 500-m wide strip on each side of the aircraft. Muskoxen were counted within the strip. Strip width was marked using wooden dowels taped to the wing struts (Cessna 185) or tape marker on a wire stretched between the tie-down rings and the fuselage (Helio Courier) using the formula:

$$w = W \times h \div H$$

where w is the calculated strip width on the ground, W is the chosen survey strip width, h is the height of the observer on the ground, and H is the chosen survey altitude (Norton-Griffiths, 1987). All sightings of wolves were recorded.

The recorder had a Garmin 12XL GPS equipped with an external antenna mounted on the windscreen of the aircraft. The recorder created a waypoint for each caribou, muskox, and wolf observation and recorded the number of the

waypoint and the number and types of caribou, muskoxen, and wolves observed at each waypoint. At the end of each day the waypoint files were downloaded to the laptop computer. The files were then imported into Microsoft Excel and the waypoint coordinate data (number, latitude and longitude coordinates, date and time) and were appended to the observation data. We used the GPS to create a track file of all transects flown (location recorded every 30 seconds). The track files were down loaded to the laptop computer at the end of each flight.

Caribou were classified as adults (cows and yearlings), bulls, calves, or unknown. Muskoxen were classified as adults (age ≥ 1 year) and calves. Observers were equipped with binoculars to help ensure that counts and classifications were done accurately. If an observer had difficulty, the pilot flew the aircraft off transect and flew in a tight circle around the caribou or muskoxen, so that an accurate count and classification could be done. The pilot then flew the aircraft back to the transect and the survey resumed.

The waypoints and track files for all observations made along each transect line within each block were mapped using OziExplorer. All observations that were recorded before the starting point and after the end point of each transect were deleted. Only caribou that were observed off transect between transect lines within a survey block were included in the analyses. This was done to minimize the probability of including individuals/groups of caribou in the analyses more than once. The numbers of non-calf and calf caribou and muskoxen observed on and off transect for each transect were summarized using Microsoft Excel. The length of each transect was derived using the

waypoints for the start and end of each transect and the route function in OziExplorer.

The population estimates and associated statistics were calculated using the Aerial2 version 3.0 method 2 (Krebs, 1999). Estimates for non-calf, calf, and all caribou and muskoxen, respectively, were derived for each survey block. Population and variance estimates from each stratum were combined to derive an overall population and population variance estimate for non-calf, calf, and all caribou and muskoxen, respectively, in all survey blocks.

The estimation of population number and variance from stratified surveys is given in Compton *et al*. (1995) cited by Johnson *et al*. (2004). The total population number is the summation of individual strata estimates (equation 1):

$$\hat{N}_{total} = \sum_{h=1}^{L} \hat{N}_h$$

where there are L strata units. Assuming that the selection of sample units within each strata is independent of other strata units, the variance is estimated as the sum of individual variance estimates for each strata (equation 2):

$$\mathrm{var}_{total} = \sum_{h=1}^{L} \mathrm{var}_h$$

Confidence intervals for the population estimate can be approximated by (equation 3):

$$\hat{N}_{total} \pm t\sqrt{\mathrm{var}_{total}}$$

The degrees of freedom (*d*) for the t-statistic can be approximated by the following formula (equation 4):

$$\boldsymbol{d} = \frac{\left(\sum_{h=1}^{L} \boldsymbol{a_h s_h^2}\right)^2}{\left[\sum_{h=1}^{L}\left(\boldsymbol{(a_h s_h^2)^2} \big/ \boldsymbol{(n_h - 1)}\right)\right]}$$

where $a_h = N_h(N_h - n_h)/n_h$ where N_h is the possible number of transects in an individual block and n_h is the actual number of transects flown. The sample variance from each block is denoted as s^2 in the above formula, and L is the total number of strata (Compton *et al.*, 1995) cited by Johnson *et al*. (2004). This assumes that the population estimates and variance estimates from each stratum are unbiased and independent.

We used a two-tailed t-test to determine whether the estimates of the non-calf and calf caribou and muskoxen in 2005 were significantly different from those in 2001. We calculated the t-statistic (t^2) using the following formula (equation 5) (from Section 4.2.1.2, page 62, Gasaway *et al*., 1986):

$$t^2 = T_{2005} - T_{2001} / [V(T_{2005} + V(T_{2001})]^{0.5}$$

where:

T_{2005} and T_{2001} = population estimates of non-calf and calf caribou and muskox from surveys in 2005 and 2001, respectively

$V(T_{2005})$ and $V(T_{2001})$ = variances of population estimates of non-calf and calf caribou and muskoxen from surveys in 2005 and 2001, respectively

We used the following formula to estimate the total degrees of freedom (v_t) associated with the t-statistic (equation 6) (from Section 4.2.1.2, page 62, Gasaway *et al*., 1986):

$$[V(T_{2005}) + V(T_{2001})]^2 / \{[V(T_{2005})^2 / v_{o2005}] + [V(T_{2001})^2 / v_{o2001}]\}$$

where:

- $V(T_{2005})$ and $V(T_{2001})$ = variances of population estimates of non-calf and calf caribou and muskox from surveys in 2005 and 2001, respectively
- v_{o2005} and v_{o2001} = degrees of freedom from surveys in 2005 and 2001, respectively (derived from equation 4).

Maps showing the distribution of caribou observed on and off transect, muskoxen observed on transect, and wolves on Banks Islands were created using ArcView (Environmental Systems Research Institute).

RESULTS

The survey was completed during 24 July to 1 August 2005 on Banks Islands. Weather conditions we generally moderate to poor with periods of low cloud, fog, and rain during the survey period. All transect lines were flown as planned except for portions of 11 lines in survey block A (Figure 3). Persistent fog and low cloud prevented us from surveying the coastal portions of these transects.

Peary caribou

The distribution of non-calf and calf Peary caribou observed during the survey is shown in Figures 4 and 5, respectively. We observed a total of 172 non-calf and 46 calf caribou on transect giving estimates of 929 ± 289 (95% CI) non-calf and 251 ± 104 (95% CI) calf caribou on the island (Table 1). Overall

there were 0.013 non-calf caribou per km^2 on the island. The 2005 estimate of non-calf caribou was not significantly different than that reported for 2001 (Nagy *et al*., 2007e) (t^2 = 1.014, 50 df, P>0.05). Similarly, the estimate of calf caribou was not significantly different from that reported for 2001 (Nagy *et al*., 2007e) (t^2 = 1.559, 35 df, P>0.05). A comparison of the mean population estimates for 2001 and 2005 indicates that the caribou population decreased at an annual finite rate of 23% (Caughley, 1980).

We observed a total of 228 non-calf and 55 calf caribou on and off transect giving a ratio of 24.1 calves per 100 cows. Approximately 19.4% of the caribou observed were calves. The majority of these caribou (86 non-calf) and (26 calves) were found on the northwestern portion of the island in survey block A (Table 1 and Figures 4 and 5).

We observed 65 mature bulls (54 on transect and 11 off transect) or 29% of all non-calf caribou observed. At 20% survey coverage, this indicates that there may be approximately 270 bulls (54 X 5) in the population. This indicates that the bull-only quota that has been in effect since 1992 has not had a negative impact on the bull segment of the population, nor has it had a negative impact on productivity based on the number of calves observed per 100 non-calf caribou.

We found no evidence of mortalities.

Muskox

The distribution of non-calf and calf muskoxen observed during the survey is shown in Figures 7 and 8, respectively. We observed a total of 9,274 non-calf

and 974 calf muskoxen on transect giving estimates of 47,209 ± 3,997 (95% CI) non-calf and 4,924 ± 537 (95% CI) calf muskoxen on the island (Table 2). Overall there were 0.669 non-calf muskoxen per km^2 on the island, with densities exceeding one non-calf muskox per km^2 in south western Banks Island (includes the Egg and Massik river drainages). Approximately 9.5% of the muskoxen observed on transect were calves. There were 10.5 calves per 100 non-calf muskoxen.

The 2005 estimate of non-calf muskoxen was significantly lower than that reported for 2001 (Nagy *et al*., 2007e) (t^2 = 5.373, 67 df, P<0.001). Similarly, the 2005 estimate of calf muskoxen was significantly lower that reported for 2001 (Nagy *et al*., 2007e) (t^2 = 10.541, 56 df, P<0.001). There was a significant decline in the number of non-calf and calf muskoxen on the island between 2001 and 2005. A comparison of mean population estimates for 2005 and 2001 (Nagy *et al*., 2007e) indicates that the non-calf muskox population decreased at an annual finite rate of 17% per year during this period (Caughley, 1980) (Figure 9).

We did not document the distribution of dead muskoxen because of the large number of carcasses observed during summer 2004 (Nagy and Gunn, 2004) following the icing event that occurred on Banks Island during winter 2003–2004.

Wolves

We observed a total of 28 wolves. The majority of these were found in areas with high densities of muskoxen on the northern portion of the island in survey block H (Figure 10).

DISCUSSION

The results of our survey indicate that there were approximately 929 ± 289 (95% CI) non-calf and 251 ±104 (95% CI) calf caribou on Banks Island (70,583 km^2) in July 2001. The 2005 and 2001 estimates for non-calf and calf caribou were not significantly different. The lack of growth in the population was likely a residual effect of the icing event that occurred on Banks Island during winter 2003–2004.

The majority of the Peary caribou in early July are typically found on the post-calving ranges on the extreme northwestern portion of Banks Island. The majority of caribou observed during the July 2005 survey were found in this area. There were approximately 47,209 ± 3,997 (95% CI) non-calf and 4,924 ± 537 (95% CI) calf muskoxen on Banks Island in July 2005. Overall there were 0.669 non-calf muskoxen per km^2 on the island, with densities exceeding 1 muskox per km^2 on southwestern portion of the island (includes Egg and Massik river drainages) and in the Thomsen River drainage. This is consistent with previous observations. Population changes documented during the period 1994 to 2005 suggest that maximum carrying capacity of Banks Island is between 65,000 and

70,000 non-calf muskoxen, and that the number of non-calf muskoxen on the island will fluctuate between approximately 45,000 and 70,000 animals over time.

We observed 2, 23, 26, and 40 wolves during the surveys conducted in 1992, 1994, 1998, and 2001, respectively. In 2005 we observed 28 wolves. Whether this decrease in the number of sightings reflects a decline in the number of wolves on the island is not known. Most of the wolves were observed areas of high densities of muskoxen (Thomsen River drainage). This is consistent with observations made in 2001.

The results of this survey indicate that the bull-only quota for Peary caribou that has been in effect since 1992 has not had a negative impact on the bull segment of the population, nor has it had a negative impact on productivity based on the number of calves observed per 100 non-calf caribou in 2005.

ACKNOWLEDGEMENTS

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Figure 1. Location of survey blocks for the July 2005 Banks Island Peary caribou and muskox survey.

Figure 2. Distribution of survey blocks and transect lines for the July 2005 Banks Island survey as planned.

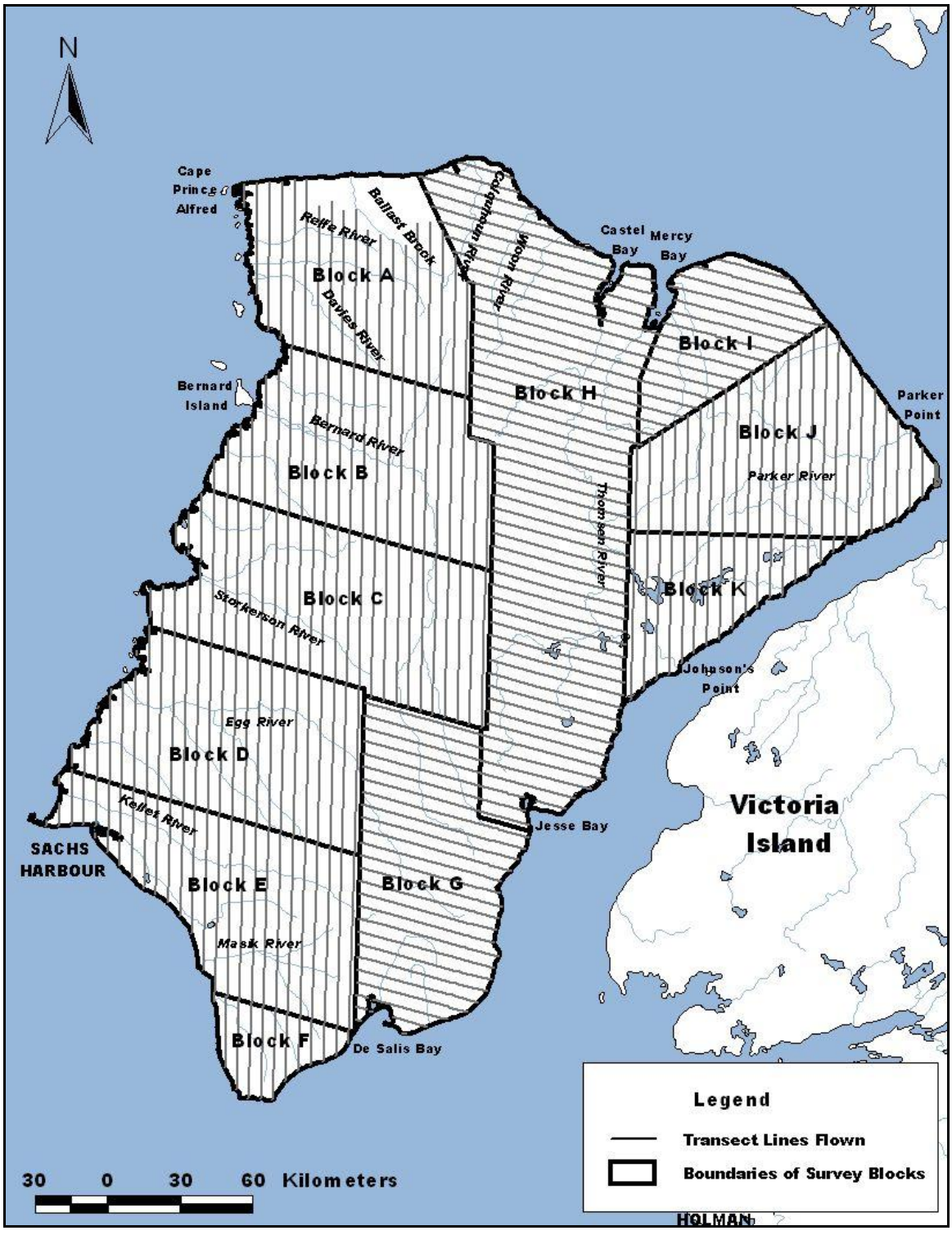

Figure 3. Distribution of survey blocks and transect lines for the July 2005 Banks Island survey as flown.

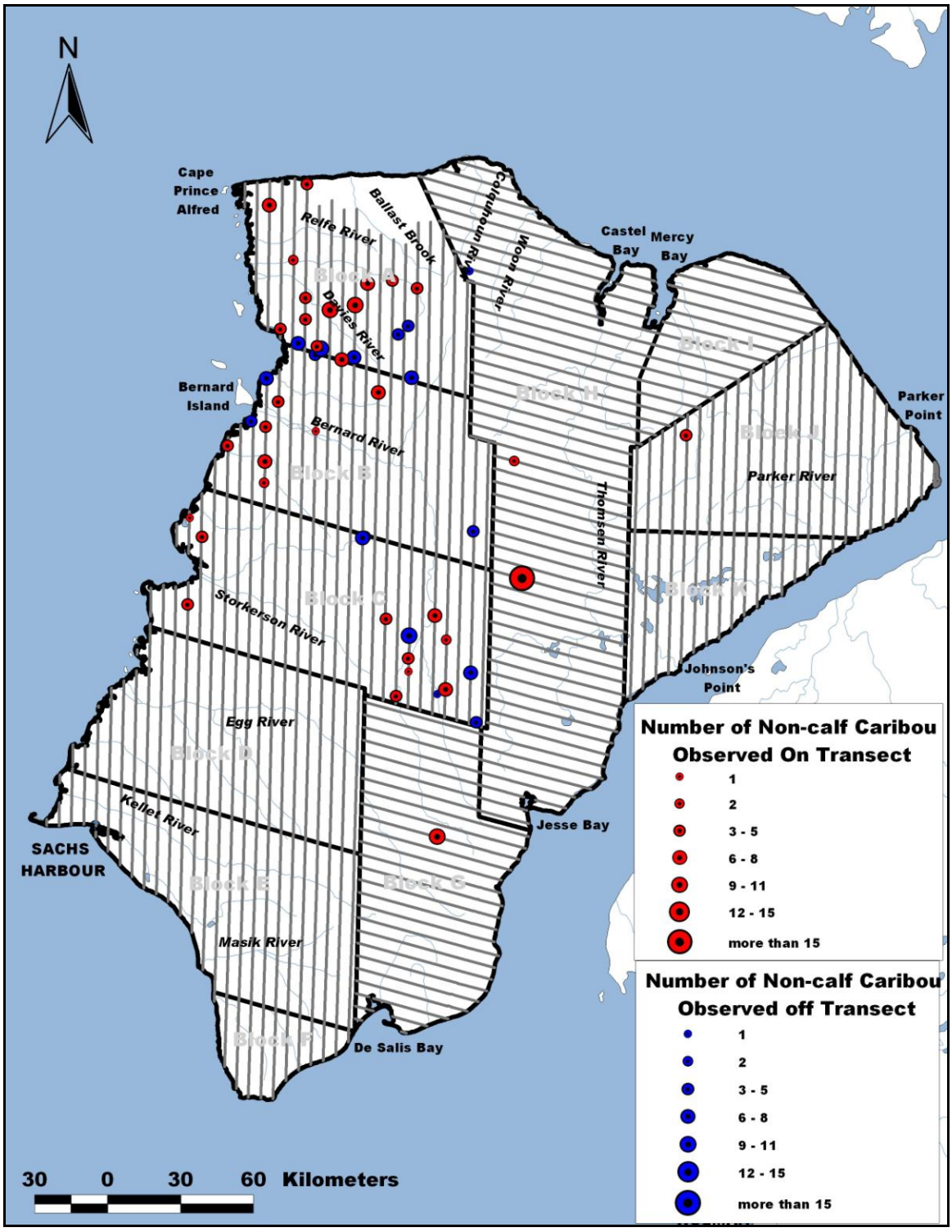

Figure 4. Distribution of non-calf caribou during the July 2005 Banks Island Peary caribou and muskox survey.

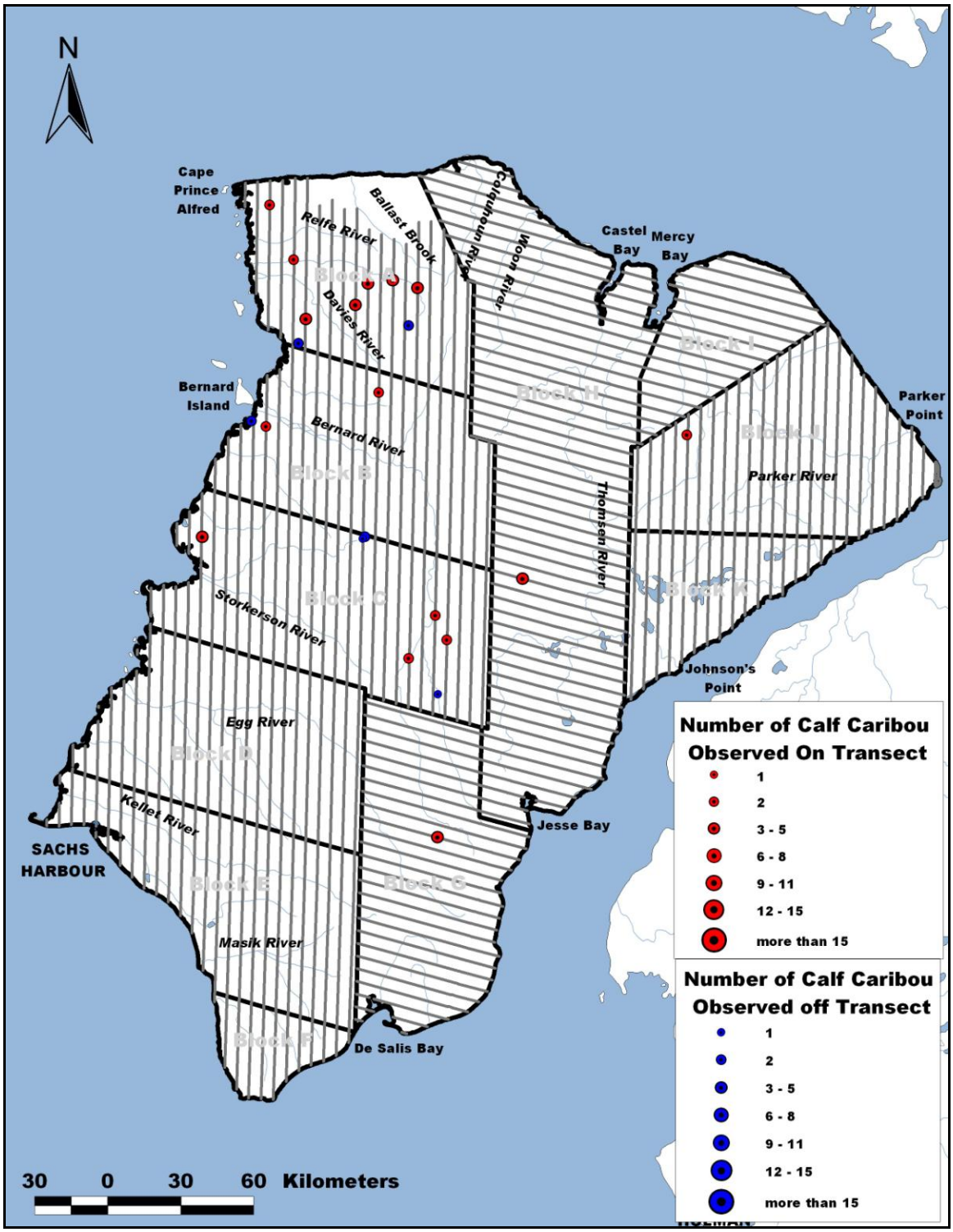

Figure 5. Distribution of calf caribou during the July 2005 Banks Island Peary caribou and muskox survey.

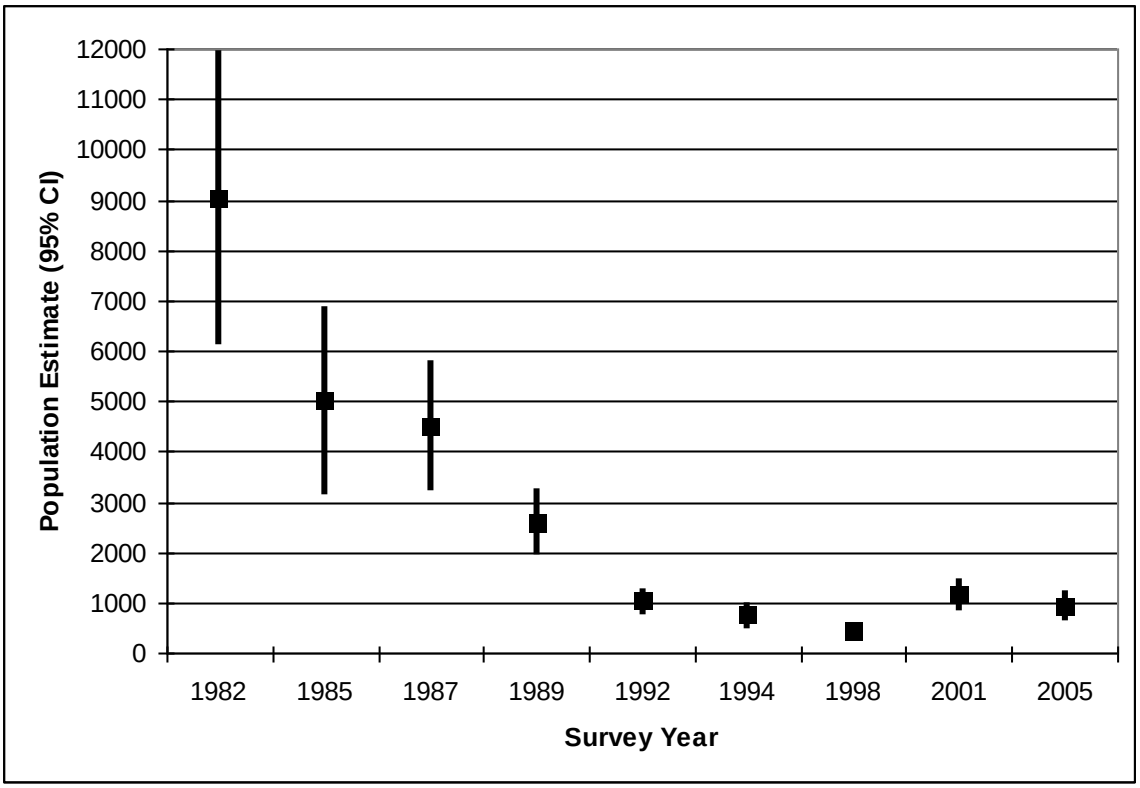

Figure 6. Population estimates with 95% CI for non-calf Peary caribou on Banks Island, NT, 1982 to 2005[A].

[A] Population estimates obtained from:

- 1982 (Nagy *et al*., 2007a)
- 1985 (McLean *et al*., 1986)
- 1987 (McLean, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as SE*1.96.
- 1989 (McLean and Fraser, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as SE*1.96.
- 1992 (Nagy *et al*., 2007b)
- 1994 (Nagy *et al*., 2007c)
- 1998 (Nagy *et al*., 2007d)
- 2001 (Nagy *et al*., 2007e)
- 2005 (this report)

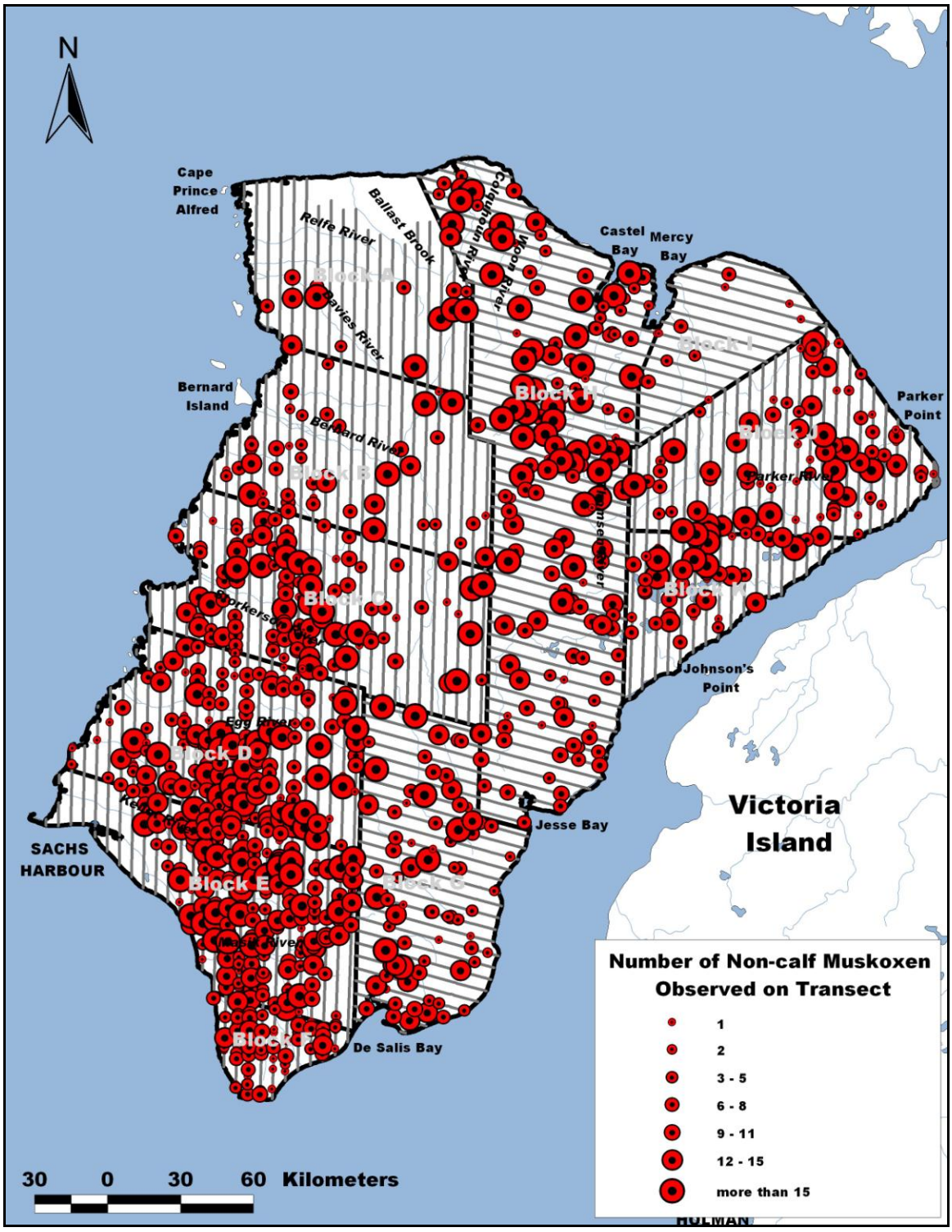

Figure 7. Distribution of non-calf muskox during the July 2005 Banks Island Peary caribou and muskox survey.

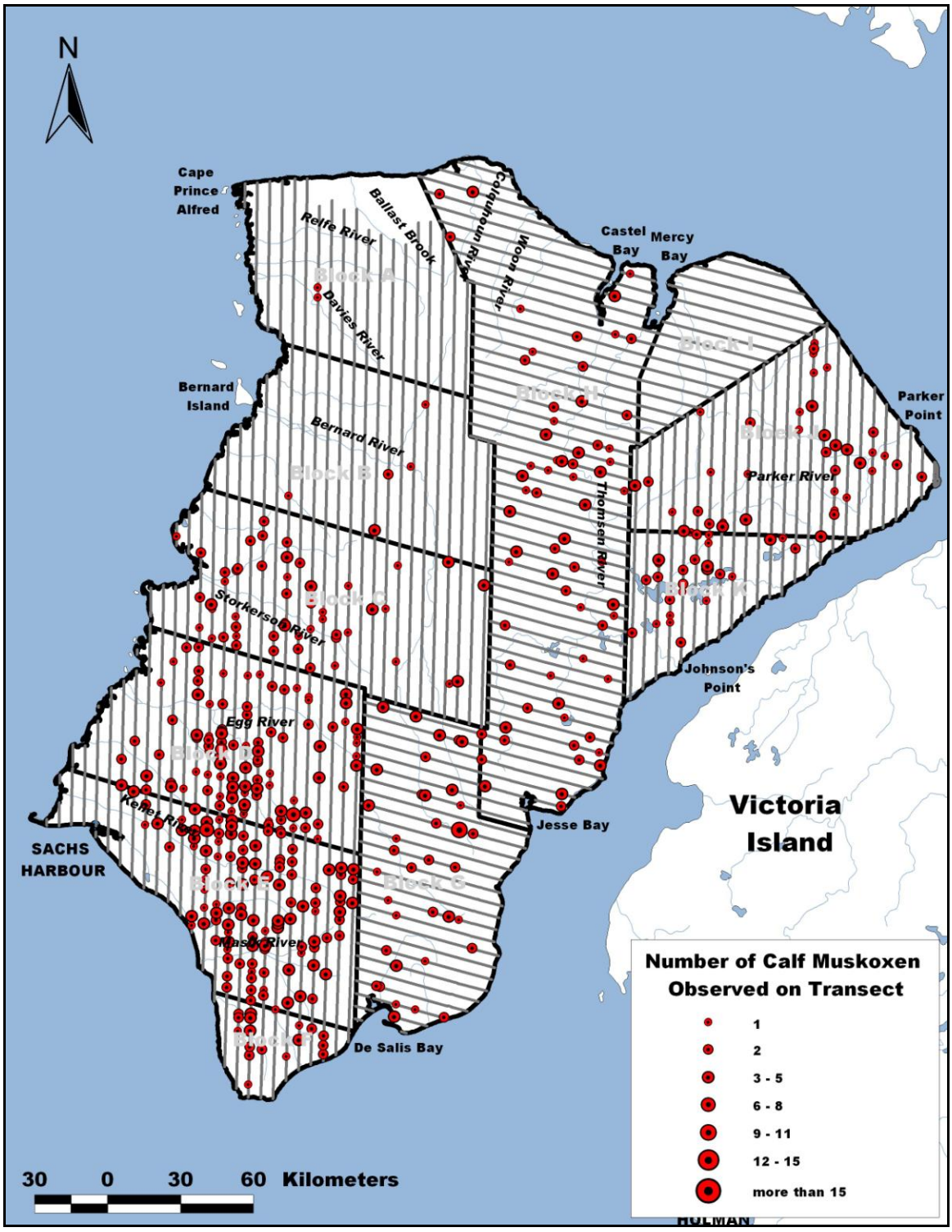

Figure 8. Distribution of calf muskox during the July 2005 Banks Island Peary caribou and muskox survey.

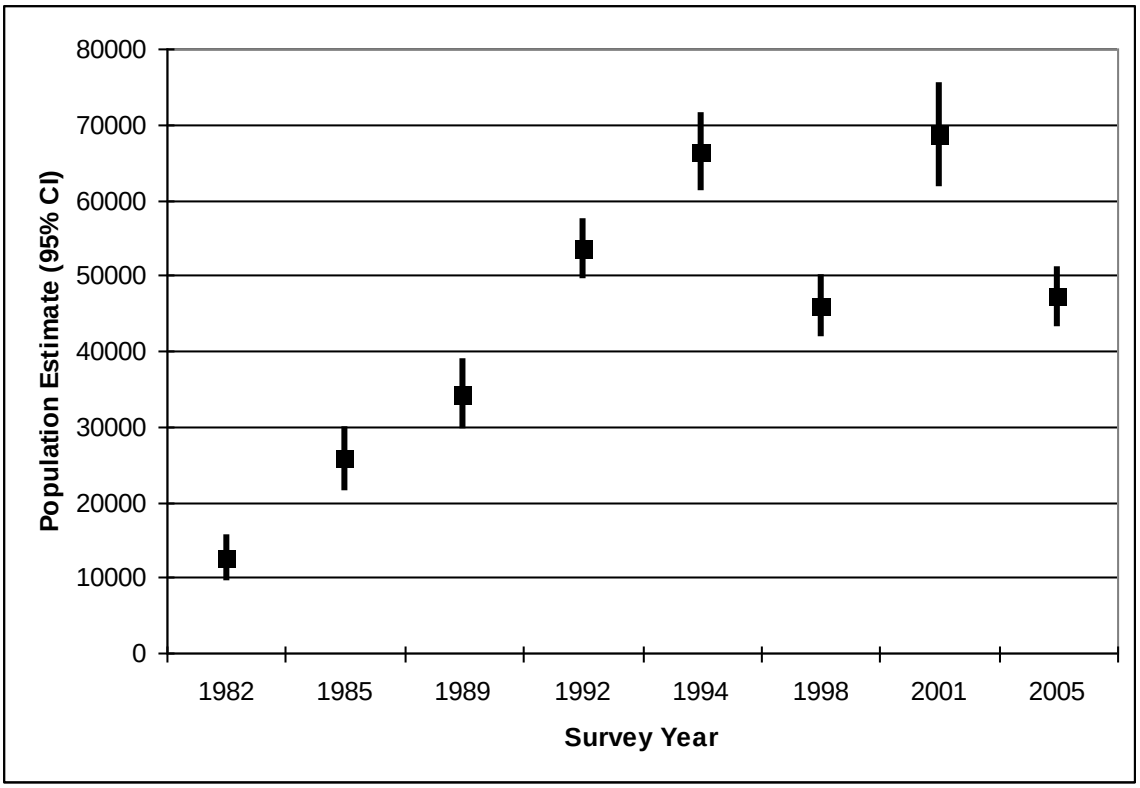

Figure 9. Population estimates with 95% CI for non-calf muskoxen on Banks Island, NT, 1982 to 2005[A].

[A] Population estimates obtained from:

- 1982 (Nagy *et al*., 2007a)
- 1985 (McLean *et al*., 1986)
- 1987 (McLean, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as SE*1.96.
- 1989 (McLean and Fraser, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as SE*1.96.
- 1992 (Nagy *et al*., 2007b)
- 1994 (Nagy *et al*., 2007c)
- 1998 (Nagy *et al*., 2007d)
- 2001 (Nagy *et al*., 2007e)
- 2005 (this report)

Figure 10. Distribution of wolves observed during the July 2005 Banks Island Peary caribou and muskox survey.

Table 1. Population estimates for Peary caribou on Banks Island, July 2005.

Stratum	Census Area (km^2)	Number of Transects Flown	Number of Possible Transects	Density (per km^2)	Population Total	Variance of Totals	S.E. of Y	95% Confidence Interval (±)	% of Total Area Sampled	Number On Transect	Number Off Transect	Coefficient Of Variation	df
Caribou: Non-calf													
A	6,249	20	96.1	0.069	430	5243.1	72.4	152	17.2	74	12	0.168	
B	6,626	23	114.1	0.023	150	4392.6	66.3	137	20.1	30	26	0.443	
C	8,009	28	138.5	0.023	187	3649.4	60.4	124	19.8	37	16	0.323	
D	6,926	24	116.5	0.000	0				20.1	0	0		
E	6,603	27	126.0	0.000	0				20.2	0	0		
F	1,406	12	56.6	0.000	0				19.9	0	0		
G	6,770	27	129.5	0.007	47	1574.0	1574.0	82	19.0	9	0	33.284	
H	14,765	51	253.5	0.000	95	5130.2	71.6	144	19.0	18	0	0.754	
I	3,050	17	83.8	0.000	0				20.2	0	0		
J	6,970	25	122.8	0.000	20	312.7	17.7	37	20.0	4	2	0.884	
K	3,211	19	91.8	0.000	0				19.9	0	0		
sum of blocks	70,585	273	1329.2	0.013	929	20302.0	142.5	289	19.4	172	56	0.153	36
Caribou: Calf													
A	6249	20	96.1	0.022	139	1444.7	38.0	80	17.2	24	2	0.274	
B	6626	23	114.1	0.003	20	150.0	12.2	25	20.1	4	6	0.614	
C	8009	28	138.5	0.006	45	360.3	19.0	39	19.8	9	1	0.418	
D	6926	24	116.5	0.000	0				20.1	0	0		
E	6603	27	126	0.000	0				20.2	0	0		
F	1406	12	56.6	0.000	0				19.9	0	0		
G	6770	27	129.5	0.002	16	174.9	12.2	27	19.0	3	0	0.776	
H	14765	51	253.5	0.001	21	317.0	17.8	36	19.0	4	0	0.844	
I	3050	17	83.8	0.000	0				20.2	0	0		
J	6970	25	122.8	0.001	10	78.2	8.8	18	20.0	2	0	0.884	
K	3211	19	91.8	0.000	0				19.9	0	0		
sum of blocks	70585	273	1329.2	0.004	251	2525.0	50.2	104	19.4	46	9	0.200	23
Caribou: Total													
A	6249	20	96.1	0.091	570	10187.9	100.9	212	17.2	98	14	0.177	
B	6626	23	114.1	0.026	169	5913.6	76.9	159	20.1	34	32	0.454	
C	8009	28	138.5	0.029	232	5487.0	74.1	152	19.8	46	17	0.319	

Stratum	Census Area (km^2)	Number of Transects Flown	Number of Possible Transects	Density (per km^2)	Population Total	Variance of Totals	S.E. of Y	95% Confidence Interval (±)	% of Total Area Sampled	Number On Transect	Number Off Transect	Coefficient Of Variation	df
D	6926	24	116.5	0.000	0				20.1	0	0		
E	6603	27	126	0.000	0				20.2	0	0		
F	1406	12	56.6	0.000	0				19.9	0	0		
G	6770	27	129.5	0.009	63	2798.2	52.9	109	19.0	12	0	0.839	
H	14765	51	253.5	0.008	116	7977.7	89.3	179	19.0	22	0	0.770	
I	3050	17	83.8	0.000	0				20.2	0	0		
J	6970	25	122.8	0.004	30	703.6	26.5	55	20.0	6	0	0.884	
K	3211	19	91.8	0.000	0				19.9	0	0		
sum of blocks	70585	273	1329.2	0.017	1180	33068.0	181.8	369	19.4	218	63	0.154	35

Table 2. Population estimates for muskox on Banks Island, July 2005.

Stratum	Census Area (km^2)	Number of Transects Flown	Number of Possible Transects	Density (per km^2)	Population Total	Variance of Totals	S.E. of Y	95% Confidence Interval (±)	% of Total Area Sampled	Number On Transect	Number Off Transect	Coefficient Of Variation	df
Muskox: Non-calf													
A	6249	20	96.1	0.205	1279	9631.9	310.3	652	17.2	220	not recorded	0.243	
B	6626	23	114.1	0.242	1605	54417.7	233.3	484	20.1	322	not recorded	0.145	
C	8009	28	138.5	0.671	5377	685795.9	828.1	1699	19.8	1065	not recorded	0.154	
D	6926	24	116.5	1.195	8275	740582.3	860.6	1781	20.1	1664	not recorded	0.104	
E	6603	27	126	1.404	9268	726207.3	852.2	1752	20.2	1867	not recorded	0.092	
F	1406	12	56.6	1.241	1744	71637.9	267.7	589	19.9	347	not recorded	0.153	
G	6770	27	129.5	0.534	3615	180604.6	425.0	875	19.0	688	not recorded	0.118	
H	14765	51	253.5	0.680	10035	1092051.7	1045.0	2099	19.0	1902	not recorded	0.104	
I	3050	17	83.8	0.057	174	3226.3	56.8	120	20.2	35	not recorded	0.327	
J	6970	25	122.8	0.514	3581	198295.7	445.3	919	20.0	716	not recorded	0.124	
K	3211	19	91.8	0.703	2256	148586.3	385.5	810	19.9	448	not recorded	0.171	
sum of blocks	70585	273	1329.2	0.669	47209	3911037.5	1977.6	3997	19.4	9274		0.042	40
Muskox: Calf													
A	6249	20	96.1	0.002	12	81.9	9.0	19	17.2	2	not recorded	0.779	
B	6626	23	114.1	0.006	40	256.9	16.0	33	20.1	8	not recorded	0.402	
C	8009	28	138.5	0.058	465	5629.2	75.0	154	19.8	92	not recorded	0.162	
D	6926	24	116.5	0.156	1079	17984.9	134.1	277	20.1	217	not recorded	0.124	
E	6603	27	126	0.206	1360	21051.8	145.1	298	20.2	274	not recorded	0.107	
F	1406	12	56.6	0.132	186	2915.2	54.0	119	19.9	37	not recorded	0.290	
G	6770	27	129.5	0.070	473	8170.6	90.4	186	19.0	90	not recorded	0.191	
H	14765	51	253.5	0.049	718	7678.3	87.6	176	19.0	136	not recorded	0.122	
I	3050	17	83.8	0.000	0				20.2	0	not recorded		
J	6970	25	122.8	0.051	355	2595.5	50.9	105	20.0	71	not recorded	0.143	
K	3211	19	91.8	0.074	237	2326.4	48.2	101	19.9	47	not recorded	0.204	
sum of blocks	70585	273	1329.2	0.070	4924	68690.6	262.1	537	19.4	974		0.053	28
Muskox: Total													
A	6249	20	96.1	0.207	1290	98209.3	313.4	658	17.2	222	not recorded	0.243	
B	6626	23	114.1	0.248	1645	57738.0	240.3	498	20.1	330	not recorded	0.146	
C	8009	28	138.5	0.729	5842	800657.1	894.8	1836	19.8	1157	not recorded	0.153	

Stratum	Census Area (km^2)	Number of Transects Flown	Number of Possible Transects	Density (per km^2)	Population Total	Variance of Totals	S.E. of Y	95% Confidence Interval (±)	% of Total Area Sampled	Number On Transect	Number Off Transect	Coefficient Of Variation	df
D	6926	24	116.5	1.351	9354	961830.7	980.7	2029	20.1	1881	not recorded	0.105	
E	6603	27	126	1.610	10628	972239.5	986.0	2027	20.2	2141	not recorded	0.093	
F	1406	12	56.6	1.373	1930	97912.2	312.9	689	19.9	384	not recorded	0.162	
G	6770	27	129.5	0.604	4088	246433.8	496.4	1023	19.0	778	not recorded	0.121	
H	14765	51	253.5	0.728	10752	1188507.8	1090.2	2190	19.0	2038	not recorded	0.101	
I	3050	17	83.8	0.057	174	3226.3	56.8	120	20.2	35	not recorded	0.327	
J	6970	25	122.8	0.565	3936	238435.9	488.3	1008	20.0	787	not recorded	0.124	
K	3211	19	91.8	0.776	2493	184119.1	429.1	902	19.9	495	not recorded	0.172	
sum of blocks	70585	273	1329.2	0.739	52133	4849309.7	2202.1	4458	19.4	10248		0.042	39

APPENDIX A.

Transect data for the July 2005 Banks Island caribou and muskox survey.

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
A	A01	8.561	0	0	0	0	0	0
	A02	44.938	0	0	0	0	0	0
	A03	60.119	7	2	9	8	0	8
	A04	63.068	5	0	5	0	0	0
	A05	67.563	2	2	4	36	0	36
	A06	68.996	11	4	15	0	0	0
	A07	59.535	4	0	4	33	2	35
	A08	63.116	9	0	9	0	0	0
	A09	60.842	7	0	7	4	0	4
	A10	62.622	9	3	12	0	0	0
	A11	55.546	6	3	9	0	0	0
	A12	55.136	0	0	0	0	0	0
	A13	54.622	9	7	16	0	0	0
	A14	54.111	0	0	0	12	0	12
	A15	64.264	5	3	8	17	0	17
	A16	66.056	0	0	0	0	0	0
	A17	64.374	0	0	0	36	0	36
	A18	55.348	0	0	0	46	0	46
	A19	46.313	0	0	0	28	0	28
	Total	1075.130	74	24	98	220	2	222
B	B01	13.337	0	0	0	0	0	0
	B02	25.511	5	0	5	4	0	4
	B03	29.741	0	0	0	7	0	7
	B04	35.467	0	0	0	42	0	42
	B05	52.805	12	2	14	5	0	5
	B06	60.017	5	0	5	18	0	18
	B07	67.319	0	0	0	27	1	28
	B08	67.322	0	0	0	11	0	11
	B09	67.324	1	0	1	16	0	16
	B10	67.331	0	0	0	25	0	25
	B11	67.343	0	0	0	6	0	6
	B12	67.355	0	0	0	8	0	8
	B13	67.362	0	0	0	0	0	0
	B14	67.364	7	2	9	30	3	33
	B15	67.366	0	0	0	17	2	19
	B16	67.362	0	0	0	0	0	0
	B17	67.269	0	0	0	23	1	24
	B18	67.177	0	0	0	27	1	28
	B19	67.086	0	0	0	12	0	12
	B20	67.070	0	0	0	16	0	16
	B21	67.070	0	0	0	5	0	5
	B22	51.593	0	0	0	8	0	8

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	B23	51.598	0	0	0	15	0	15
	Total	1329.189	30	4	34	322	8	330
C	C01	14.347	0	0	0	0	0	0
	C02	18.658	0	0	0	0	0	0
	C03	28.974	0	0	0	11	1	12
	C04	39.876	6	0	6	13	0	13
	C05	60.097	3	3	6	52	5	57
	C06	62.143	0	0	0	51	5	56
	C07	62.093	0	0	0	37	5	42
	C08	62.064	0	0	0	109	10	119
	C09	62.088	0	0	0	7	2	9
	C10	62.101	0	0	0	51	6	57
	C11	62.124	0	0	0	39	4	43
	C12	62.099	0	0	0	139	14	153
	C13	62.061	0	0	0	57	5	62
	C14	62.025	0	0	0	141	9	150
	C15	61.981	0	0	0	50	2	52
	C16	61.936	0	0	0	39	5	44
	C17	61.889	0	0	0	57	2	59
	C18	61.842	0	0	0	37	1	38
	C19	61.795	0	0	0	32	3	35
	C20	61.748	4	0	4	10	1	11
	C21	61.707	4	0	4	18	2	20
	C22	61.754	4	2	6	0	0	0
	C23	61.801	0	0	0	8	0	8
	C24	61.846	6	2	8	0	0	0
	C25	61.868	10	2	12	15	3	18
	C26	61.832	0	0	0	22	4	26
	C27	61.795	0	0	0	38	0	38
	C28	61.752	0	0	0	32	3	35
	Total	1586.296	37	9	46	1065	92	1157
D	D01	9.646	0	0	0	3	0	3
	D02	12.384	0	0	0	0	0	0
	D03	26.135	0	0	0	1	0	1
	D04	38.380	0	0	0	6	0	6
	D05	42.784	0	0	0	32	5	37
	D06	50.983	0	0	0	44	2	46
	D07	66.908	0	0	0	42	6	48
	D08	67.487	0	0	0	49	3	52
	D09	67.462	0	0	0	59	8	67
	D10	67.439	0	0	0	47	3	50
	D11	67.415	0	0	0	86	18	104
	D12	67.391	0	0	0	123	10	133
	D13	67.367	0	0	0	199	29	228
	D14	67.342	0	0	0	119	18	137
	D15	67.327	0	0	0	160	20	180

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	D16	67.312	0	0	0	107	17	124
	D17	67.297	0	0	0	110	9	119
	D18	67.327	0	0	0	83	15	98
	D19	67.376	0	0	0	87	9	96
	D20	67.423	0	0	0	82	11	93
	D21	67.451	0	0	0	71	11	82
	D22	67.405	0	0	0	12	2	14
	D23	67.361	0	0	0	80	10	90
	D24	67.316	0	0	0	62	11	73
	Total	1392.718	0	0	0	1664	217	1881
E	E01	0.304	0	0	0	0	0	0
	E02	3.036	0	0	0	0	0	0
	E03	17.744	0	0	0	0	0	0
	E04	21.792	0	0	0	0	0	0
	E05	20.384	0	0	0	0	0	0
	E06	21.961	0	0	0	0	0	0
	E07	27.722	0	0	0	0	0	0
	E08	32.805	0	0	0	0	0	0
	E09	35.904	0	0	0	7	3	10
	E10	38.565	0	0	0	26	3	29
	E11	39.567	0	0	0	32	3	35
	E12	41.414	0	0	0	16	2	18
	E13	45.560	0	0	0	54	4	58
	E14	51.203	0	0	0	92	17	109
	E15	64.923	0	0	0	155	23	178
	E16	72.441	0	0	0	128	13	141
	E17	72.452	0	0	0	175	34	209
	E18	72.442	0	0	0	135	20	155
	E19	72.429	0	0	0	182	28	210
	E20	72.414	0	0	0	126	18	144
	E21	72.353	0	0	0	118	23	141
	E22	72.256	0	0	0	175	21	196
	E23	72.162	0	0	0	85	12	97
	E24	72.090	0	0	0	125	15	140
	E25	72.090	0	0	0	55	9	64
	E26	72.088	0	0	0	115	17	132
	E27	72.086	0	0	0	66	9	75
	Total	1330.187	0	0	0	1867	274	2141
F	F01	3.446	0	0	0	8	0	8
	F02	29.061	0	0	0	22	0	22
	F03	36.424	0	0	0	67	5	72
	F04	38.515	0	0	0	83	14	97
	F05	37.248	0	0	0	49	2	51
	F06	36.294	0	0	0	18	1	19
	F07	27.312	0	0	0	15	1	16
	F08	21.938	0	0	0	23	6	29

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	F09	18.242	0	0	0	13	2	15
	F10	15.310	0	0	0	42	6	48
	F11	11.698	0	0	0	7	0	7
	F12	4.222	0	0	0	0	0	0
	Total	279.710	0	0	0	347	37	384
G	G01	2.852	0	0	0	0	0	0
	G02	19.519	0	0	0	32	3	35
	G03	36.187	0	0	0	43	4	47
	G04	44.101	0	0	0	37	4	41
	G05	48.889	0	0	0	27	0	27
	G06	52.119	0	0	0	51	5	56
	G07	53.892	0	0	0	38	3	41
	G08	54.939	0	0	0	11	0	11
	G09	56.649	0	0	0	14	2	16
	G10	54.461	0	0	0	13	1	14
	G11	55.121	0	0	0	57	8	65
	G12	56.082	0	0	0	4	0	4
	G13	57.473	0	0	0	12	1	13
	G14	55.942	0	0	0	16	2	18
	G15	56.679	0	0	0	47	6	53
	G16	60.389	0	0	0	8	1	9
	G17	63.701	9	3	12	6	0	6
	G18	66.347	0	0	0	60	16	76
	G19	67.476	0	0	0	30	0	30
	G20	46.499	0	0	0	48	7	55
	G21	46.498	0	0	0	29	8	37
	G22	46.498	0	0	0	21	0	21
	G23	46.497	0	0	0	12	2	14
	G24	46.497	0	0	0	0	0	0
	G25	46.496	0	0	0	26	10	36
	G26	46.496	0	0	0	46	7	53
	Total	1288.299	9	3	12	688	90	778
H	H01	22.695	0	0	0	0	0	0
	H02	33.330	0	0	0	15	0	15
	H03	47.978	0	0	0	41	3	44
	H04	53.321	0	0	0	45	2	47
	H05	66.630	0	0	0	46	0	46
	H06	86.002	0	0	0	106	1	107
	H07	82.975	0	0	0	37	2	39
	H08	81.103	0	0	0	37	3	40
	H09	75.896	0	0	0	57	0	57
	H10	72.511	0	0	0	6	0	6
	H11	72.639	0	0	0	60	4	64
	H12	70.797	0	0	0	32	2	34
	H13	68.956	0	0	0	9	0	9
	H14	67.169	0	0	0	134	3	137

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	H15	67.149	0	0	0	17	2	19
	H16	67.144	0	0	0	7	0	7
	H17	67.139	0	0	0	129	5	134
	H18	67.134	0	0	0	23	2	25
	H19	62.708	0	0	0	76	1	77
	H20	61.896	0	0	0	161	8	169
	H21	61.892	0	0	0	81	4	85
	H22	51.567	0	0	0	87	9	96
	H23	51.562	2	0	2	41	4	45
	H24	51.558	0	0	0	43	3	46
	H25	51.553	0	0	0	58	9	67
	H26	51.549	0	0	0	11	0	11
	H27	51.543	0	0	0	0	0	0
	H28	51.538	0	0	0	52	6	58
	H29	51.533	0	0	0	23	3	26
	H30	51.528	0	0	0	25	5	30
	H31	51.523	0	0	0	42	7	49
	H32	51.518	16	4	20	7	2	9
	H33	51.513	0	0	0	64	2	66
	H34	51.494	0	0	0	30	2	32
	H35	51.465	0	0	0	13	0	13
	H36	51.439	0	0	0	32	2	34
	H37	51.427	0	0	0	16	1	17
	H38	51.415	0	0	0	7	1	8
	H39	51.403	0	0	0	20	3	23
	H40	52.693	0	0	0	19	0	19
	H41	51.608	0	0	0	13	3	16
	H42	51.405	0	0	0	25	3	28
	H43	49.253	0	0	0	12	2	14
	H44	47.944	0	0	0	32	6	38
	H45	51.487	0	0	0	52	11	63
	H46	50.990	0	0	0	0	0	0
	H47	46.361	0	0	0	16	2	18
	H48	39.838	0	0	0	11	3	14
	H49	31.422	0	0	0	24	5	29
	H50	20.264	0	0	0	0	0	0
	H51	21.065	0	0	0	8	0	8
	Total	2798.522	18	4	22	1902	136	2038
I	I01	29.865	0	0	0	0	0	0
	I02	46.049	0	0	0	6	0	6
	I03	58.191	0	0	0	2	0	2
	I04	64.874	0	0	0	1	0	1
	I05	56.707	0	0	0	0	0	0
	I06	53.175	0	0	0	0	0	0
	I07	49.668	0	0	0	6	0	6
	I08	45.838	0	0	0	1	0	1
	I09	41.950	0	0	0	5	0	5

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	I10	38.068	0	0	0	3	0	3
	I11	34.186	0	0	0	0	0	0
	I12	30.250	0	0	0	11	0	11
	I13	24.557	0	0	0	0	0	0
	I14	18.859	0	0	0	0	0	0
	I15	13.161	0	0	0	0	0	0
	I16	7.462	0	0	0	0	0	0
	I17	1.763	0	0	0	0	0	0
	Total	614.623	0	0	0	35	0	35
J	J01	9.597	0	0	0	0	0	0
	J02	20.795	0	0	0	14	2	16
	J03	33.131	0	0	0	0	0	0
	J04	40.523	0	0	0	31	2	33
	J05	49.653	0	0	0	10	1	11
	J06	58.268	0	0	0	42	4	46
	J07	66.341	0	0	0	31	4	35
	J08	73.532	0	0	0	35	4	39
	J09	80.296	0	0	0	69	9	78
	J10	86.391	0	0	0	71	8	79
	J11	82.888	0	0	0	66	9	75
	J12	79.386	0	0	0	24	2	26
	J13	75.884	0	0	0	3	0	3
	J14	72.376	0	0	0	46	3	49
	J15	68.867	0	0	0	12	0	12
	J16	65.356	0	0	0	0	0	0
	J17	61.845	0	0	0	82	6	88
	J18	58.335	0	0	0	20	4	24
	J19	54.825	0	0	0	51	3	54
	J20	51.315	0	0	0	19	3	22
	J21	47.805	4	2	6	8	1	9
	J22	44.294	0	0	0	22	1	23
	J23	40.784	0	0	0	24	0	24
	J24	37.274	0	0	0	8	2	10
	J25	33.764	0	0	0	28	3	31
	Total	1393.525	4	2	6	716	71	787
K	K01	0.110	0	0	0	0	0	0
	K02	1.981	0	0	0	0	0	0
	K03	5.842	0	0	0	0	0	0
	K04	10.664	0	0	0	13	3	16
	K05	15.618	0	0	0	8	0	8
	K06	18.159	0	0	0	19	2	21
	K07	24.064	0	0	0	16	1	17
	K08	25.298	0	0	0	0	0	0
	K09	29.182	0	0	0	13	0	13
	K10	32.291	0	0	0	12	0	12
	K11	37.806	0	0	0	13	1	14

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	K12	41.853	0	0	0	16	2	18
	K13	44.987	0	0	0	94	9	103
	K14	48.395	0	0	0	48	4	52
	K15	52.494	0	0	0	59	10	69
	K16	57.509	0	0	0	31	4	35
	K17	59.448	0	0	0	66	7	73
	K18	63.726	0	0	0	21	2	23
	K19	68.224	0	0	0	19	2	21
	Total	637.651	0	0	0	448	47	495