

**POPULATION ESTIMATES FOR PEARY
CARIBOU AND MUSKOX ON BANKS ISLAND,
NT, JULY 2001**

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ABSTRACT

A stratified strip transect aerial survey was conducted on Banks Island, NT during 7 to 15 July 2001 to document the numbers and distribution of Peary caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*).

We observed 235 non-calf and 77 calf caribou on transect giving estimates of $1,142 \pm 324$ (95% CI) non-calf and 391 ± 156 (95% CI) calf caribou. Approximately 26.3% of the caribou observed were calves. Overall there were 0.016 non-calf caribou per km^2 on the island. The estimate of the number of non-calf and calf caribou in the population increased significantly during the period 1998–2001, with the mean estimate for non-calf caribou exceeding 1,000 caribou for the first time since 1992. 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 2001, nor has it had a negative impact on productivity based on the number of calves observed per 100 non-calf caribou in 2001.

We observed 13,522 non-calf and 2,320 calf muskoxen on transect giving estimates of $68,585 \pm 6,972$ (95% CI) non-calf and $11,780 \pm 1,202$ (95% CI) calf muskoxen. Approximately 14.6% of the muskoxen observed on transect were calves. Overall there were 0.972 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. The estimate the number of non-calf muskoxen in the population increased significantly during the period 1998 to 2001, returning to levels observed in 1994.

The estimate of the number of calves in the population did not change significantly during this period. Population changes documented during the period 1994 to 2001 suggest that the non-calf muskoxen numbers will likely fluctuate between 45,000 to 65,000 animals over time.

The number of sightings of wolves have increased during the surveys done between 1992 and 2001. It is not known if this reflects an increase in the number of wolves on Banks Island.

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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), and declined between 1994 and 1998 (Nagy *et al.*, 2007d). The muskox population continued to increase between 1989 and 1994 (Nagy *et al.*, 2007b; Nagy *et al.*, 2007c), but declined between 1994 and 1998 (Nagy *et al.*,

2007d). The declines in the number of non-calf caribou and muskoxen on the island 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 responses.

A stratified strip transect aerial survey designed to obtain population estimates for and Peary caribou and muskox on Banks Island was conducted during 7 to 15 July 2001 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 2001.

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 minimize 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 the 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 navigate 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 inside and outside of the boundaries of a 500-m wide strip on each side of the aircraft. Muskoxen were counted within the boundaries of 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) 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):

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

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

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

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

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

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 2001 were significantly different from those in 1998. 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):

$$t^2 = (T_{2001} - T_{1998})^2 / [V(T_{2001}) + V(T_{1998})]^{0.5}$$

where:

- T_{2001} and T_{1998} = population estimates of non-calf and calf caribou and muskox from surveys in 2001 and 1998, respectively
- $V(T_{2001})$ and $V(T_{1998})$ = variances of population estimates of non-calf and calf caribou and muskoxen from surveys in 2001 and 1998, 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):

$$[V(T_{2001}) + V(T_{1998})]^2 / \{ [V(T_{2001})^2 / v_{o2001}] + [V(T_{1998})^2 / v_{o1998}] \}$$

where:

- $V(T_{2001})$ and $V(T_{1998})$ = variances of population estimates of non-calf and calf caribou and muskox from surveys in 2001 and 1998, respectively

- ν_{o2001} and ν_{o1998} = degrees of freedom from surveys in 2001 and 1998, 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 7 to 15 July 2001 on Banks Islands. Weather conditions were nearly ideal and we were able to complete the survey in a relatively short time period. All transect lines were flown as planned except for portions of 4 lines in survey block A (Figure 3). Persistent fog 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 235 non-calf and 77 calf caribou on transect giving estimates of $1,142 \pm 324$ (95% CI) non-calf and 391 ± 156 (95% CI) calf caribou on the island (Table 1). The 2001 estimate of non-calf caribou was significantly greater than that reported for 1998 (Nagy *et al.*, 2007d) ($t^2 = 4.155$, 27 df, $P < 0.001$). Similarly the estimate of calf caribou was significantly greater than that reported for 1998 (Nagy *et al.*, 2007d) ($t^2 = 3.503$, 24 df, $P < 0.001$). A comparison of the mean population estimates for 1998 and 2001 indicates that the caribou population increased at an annual finite

rate of 86% (Caughley, 1980). This growth rate is unlikely and suggests that the number of caribou on Banks Island may have been underestimated in 1998. A similar comparison of mean population estimates for 1994 and 2001 indicates that the caribou population increased at a rate of 22% during the period (Figure 6).

We observed a total of 345 non-calf and 123 calf caribou on and off transect giving a ratio of 35.6 calves per 100 cows. Approximately 26.3% of the caribou observed were calves. The majority of these caribou (181 non-calf) and (70 calves) were found on the northwestern portion of the island in survey block A (Table 1 and Figures 4 and 5).

We observed 67 mature bulls (52 on transect and 15 off transect) or 19% of all non-calf caribou observed. At 20% survey coverage, this indicates that there may be approximately 260 bulls (52×5) 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 13,522 non-calf and 2320 calf muskoxen on transect giving estimates of $68,585 \pm 6,972$ (95% CI) non-calf and $11,780 \pm 1,202$ (95% CI) calf muskoxen on the island (Table 2).

Overall there were 0.972 non-calf muskoxen per km² on the island, with densities exceeding one muskox per km² on southwestern portion of the island (includes Egg and Massik river drainages) and in the Thomsen River drainage (Table 2).

The 2001 estimate of non-calf muskoxen was significantly greater than that reported for 1998 (Nagy *et al.*, 2007d) ($t^2 = 5.688$, 63 df, $P < 0.001$). However, the estimate of calf muskoxen was not significantly different from that reported for 1998 (Nagy *et al.*, 2007d) ($t^2 = 1.449$, 66 df, $P > 0.05$). Approximately 14.6% of the muskoxen observed on transect were calves. There were 17.2 calves per 100 non-calf muskoxen. A comparison of mean population estimates for 1998 (Nagy *et al.*, 2007d) and 2001 indicates that the non-calf muskox population increased at an annual finite rate of 50% per year during this period (Caughley, 1980) (Figure 9).

We observed 31 dead muskoxen during the survey. The majority of these were found in the northern portion of block H and in block D (Figure 10). These are areas of high muskoxen densities (Figure 7).

Wolves

We observed a total of 40 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 11).

DISCUSSION

The results of our survey indicate that there were approximately $1,142 \pm 324$ (95% CI) non-calf and 391 ± 156 (95% CI) calf caribou on Banks Island ($70,583 \text{ km}^2$) in July 2001. The 2001 estimates for non-calf and calf caribou were significantly higher than those reported for 1998. The mean estimate of non-calf caribou exceeded 1,000 caribou for the first time since 1992. The annual finite growth rate estimate of 86% for the years 1998 to 2001 indicates that the population nearly double each year during this period. This is unlikely and suggests that the number of caribou on Banks Island may have been underestimated in 1998. A similar comparison of mean population estimates for 1994 and 2001 indicates that the caribou population increased at a rate of 22% during the period.

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 2001 survey were found in this area.

There were approximately $68,585 \pm 6,972$ (95% CI) non-calf and $11,780 \pm 1,202$ (95% CI) calf muskoxen on Banks Island in July 2001. Overall there were 0.972 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.

The 1998 estimate of non-calf muskoxen was significantly higher than that reported for 1998. The number of non-calf muskoxen on the island recovered to

levels documented in 1994. The 2001 and 1991 estimates of calves were not significantly different. Population changes documented during the period 1994 to 2001 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, and 26 wolves during the surveys conducted in 1992, 1994, and 1998, respectively. In 2001 we observed 40 wolves. Whether this increase in numbers of sightings reflects an increase 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).

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 2001.

ACKNOWLEDGEMENTS

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Figure 1. Location of survey blocks for the July 2001 Banks Island Peary caribou and muskox survey.



Figure 2. Distribution of survey blocks and transect lines for the July 2001 Banks Island Peary caribou and muskox survey as planned.



Figure 3. Distribution of survey blocks and transect lines for the July 2001 Banks Island Peary caribou and muskox survey as flown.

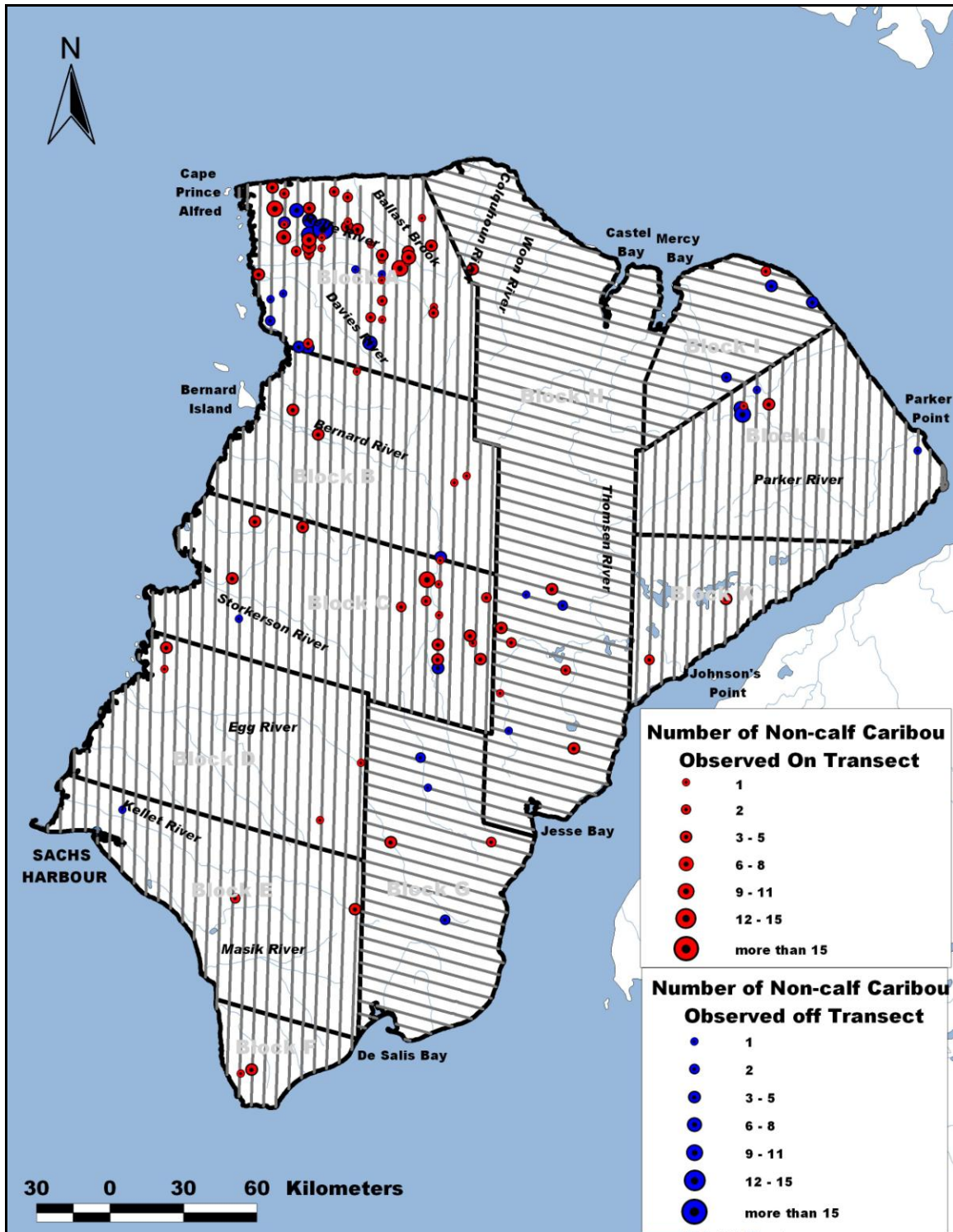


Figure 4. Distribution of non-calf caribou during the July 2001 on Banks Island Peary caribou and muskox survey.

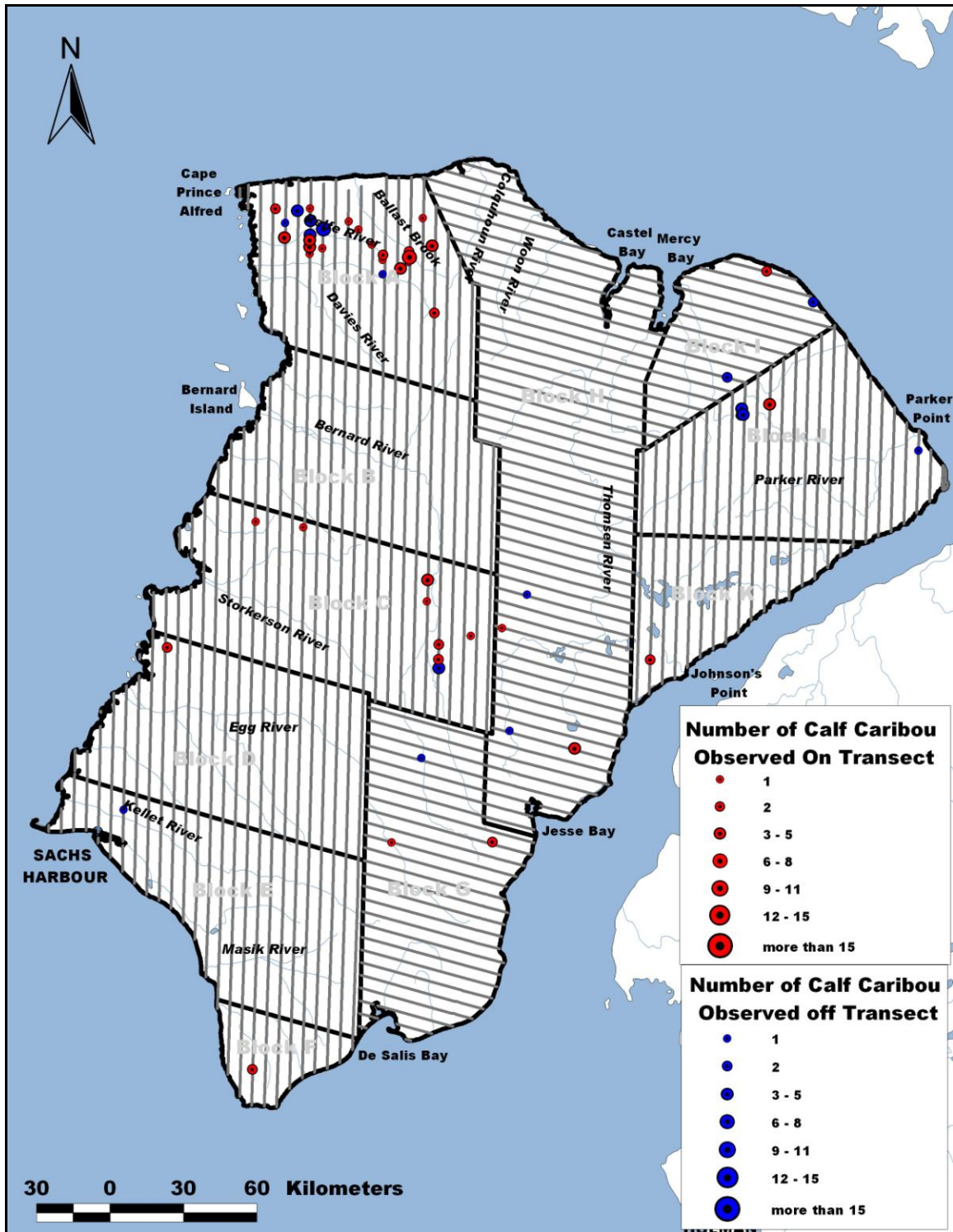


Figure 5. Distribution of calf caribou during the July 2001 on Banks Island Peary caribou and muskox survey.

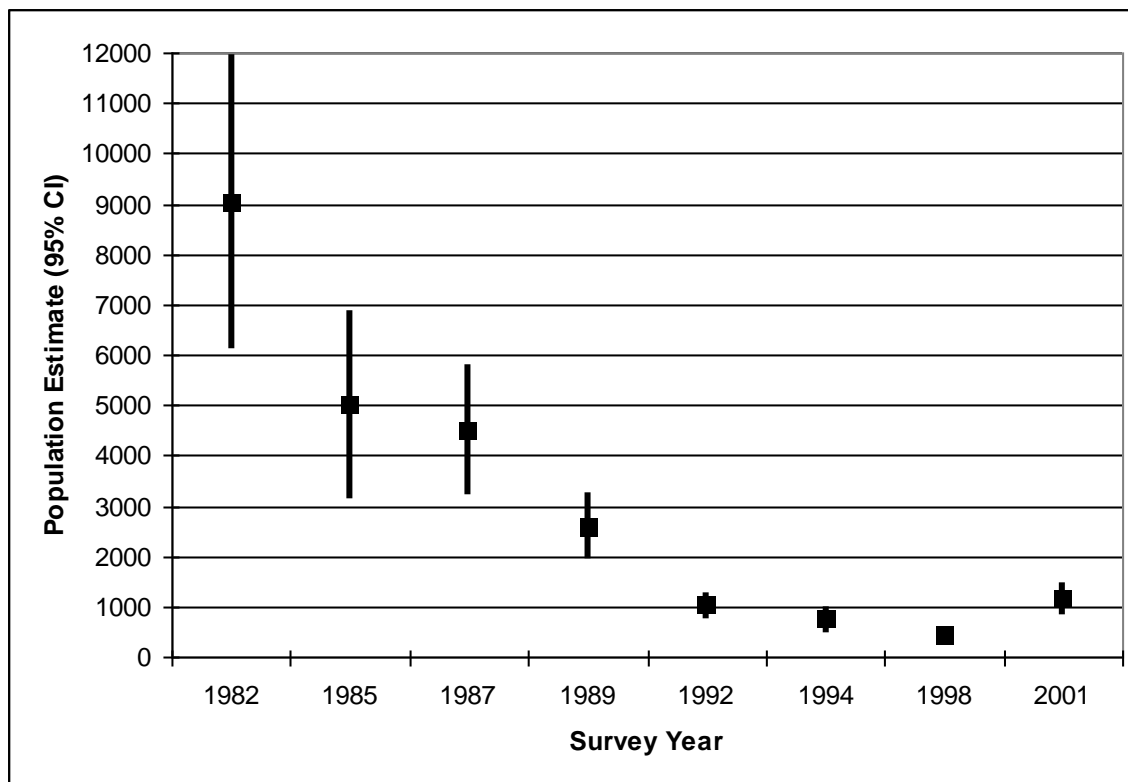


Figure 6. Population estimates with 95% CI for non-calf Peary caribou on Banks Island, NT, 1982 to 2001^A.

^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 $SE \times 1.96$.
- 1989 (McLean and Fraser, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as $SE \times 1.96$.
- 1992 (Nagy *et al.*, 2007b)
- 1994 (Nagy *et al.*, 2007c)
- 1998 (Nagy *et al.*, 2007d)
- 2001 (this report)

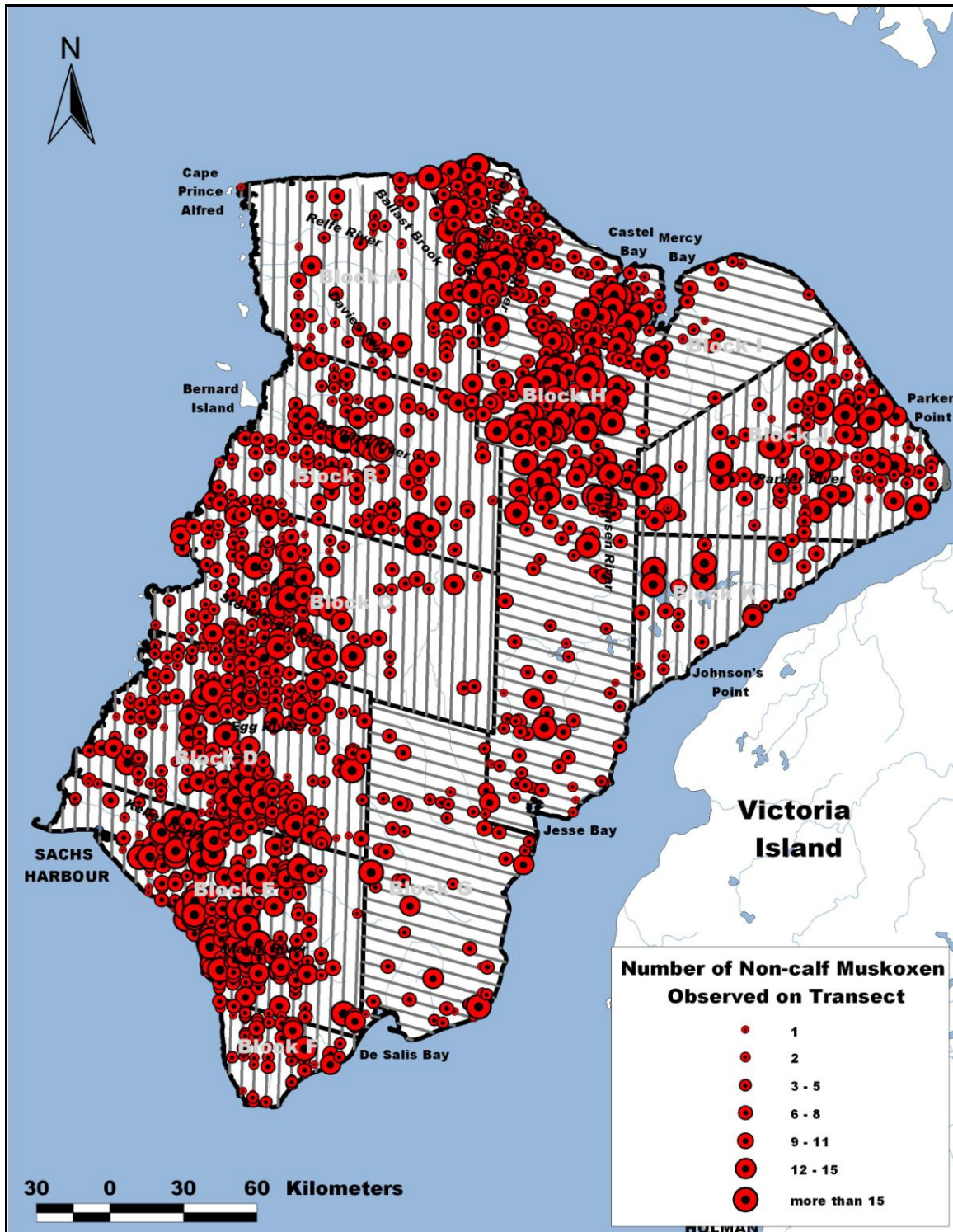


Figure 7. Distribution of non-calf muskox during the July 2001 on Banks Island Peary caribou and muskox survey.

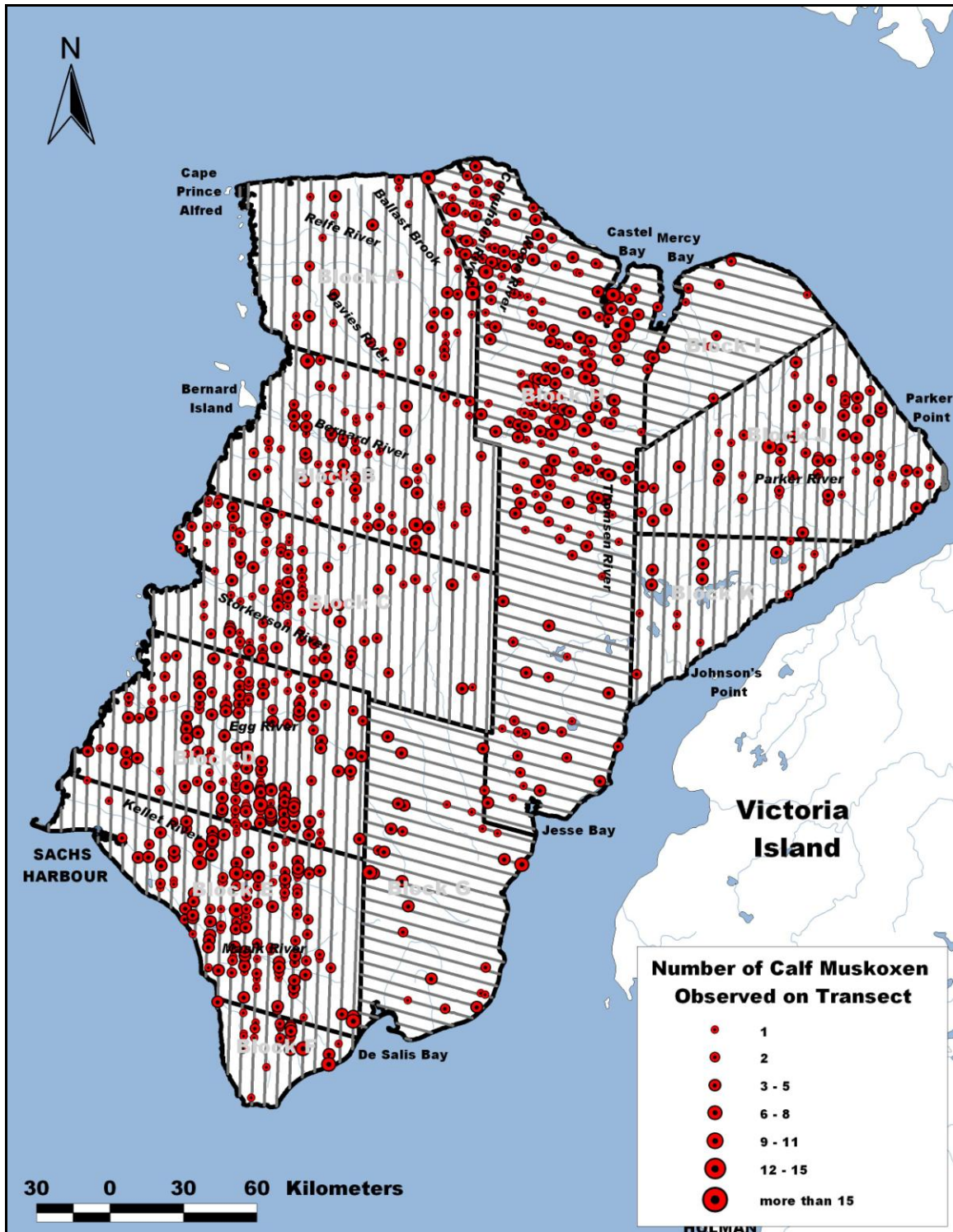


Figure 8. Distribution of calf muskox during the July 2001 on Banks Island Peary caribou and muskox survey.

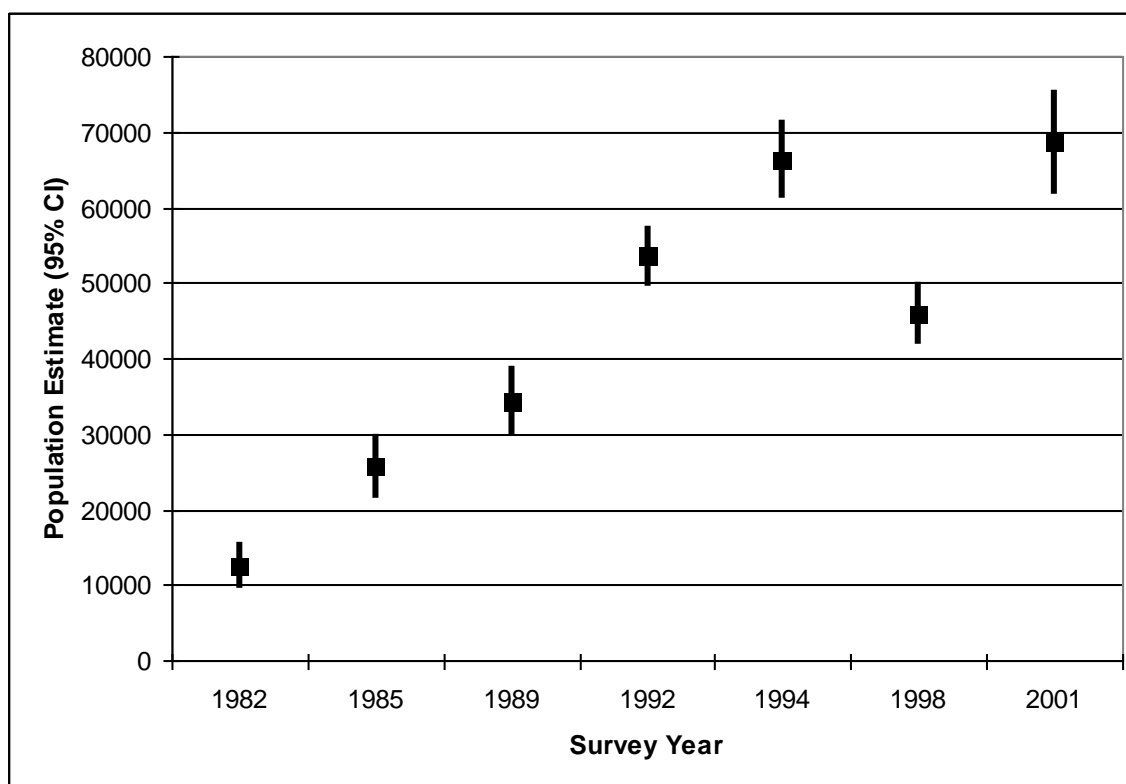


Figure 9. Population estimates with 95% CI for non-calf muskoxen on Banks Island, NT, 1982 to 2001^A.

^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 $SE \times 1.96$.
- 1989 (McLean and Fraser, 1992) Information required to calculate 95% CI was not provided. We estimated the 95% CI as $SE \times 1.96$.
- 1992 (Nagy *et al.*, 2007b)
- 1994 (Nagy *et al.*, 2007c)
- 1998 (Nagy *et al.*, 2007d)
- 2001 (this report)

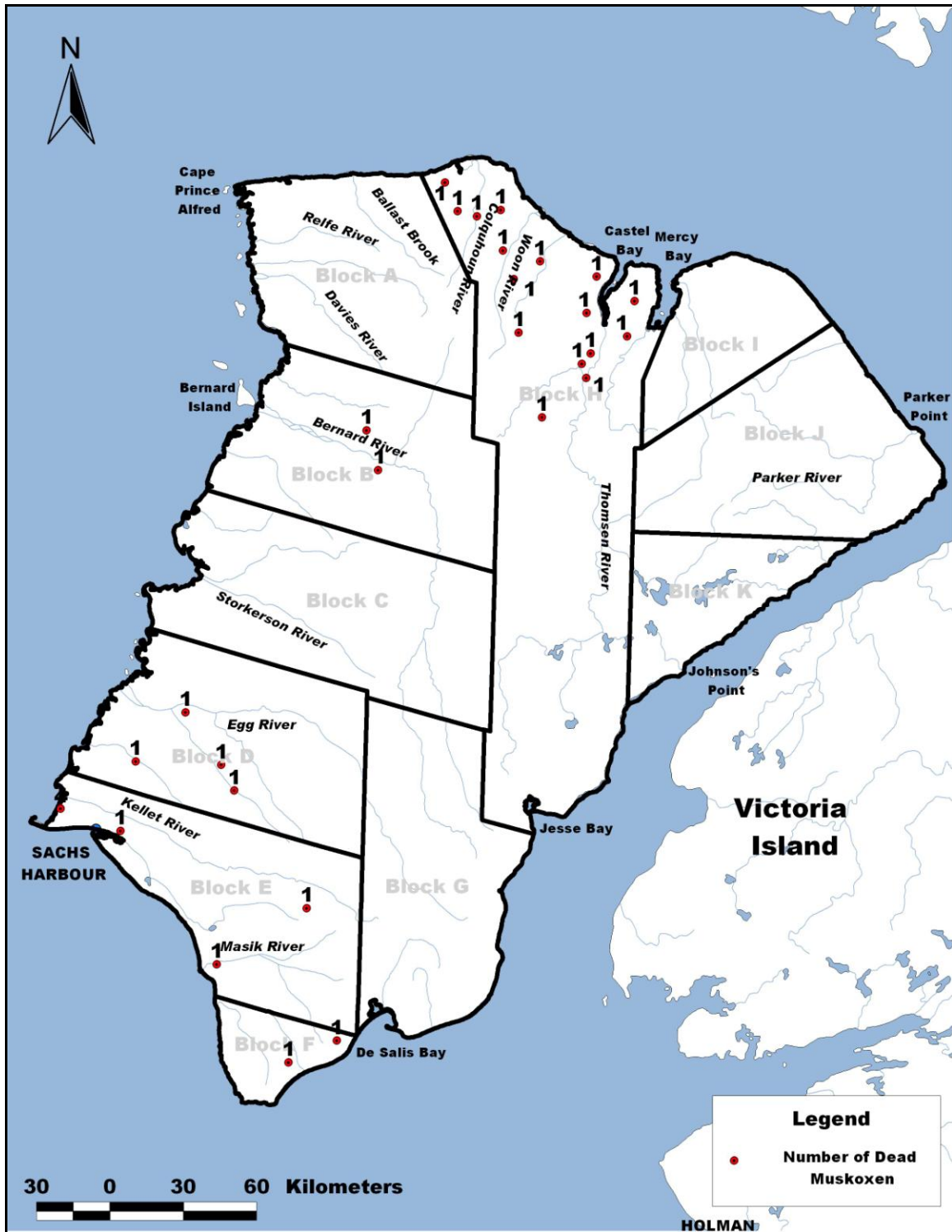


Figure 10. Distribution of dead muskox observed during the July 2001 Banks Island Peary caribou and muskox survey.

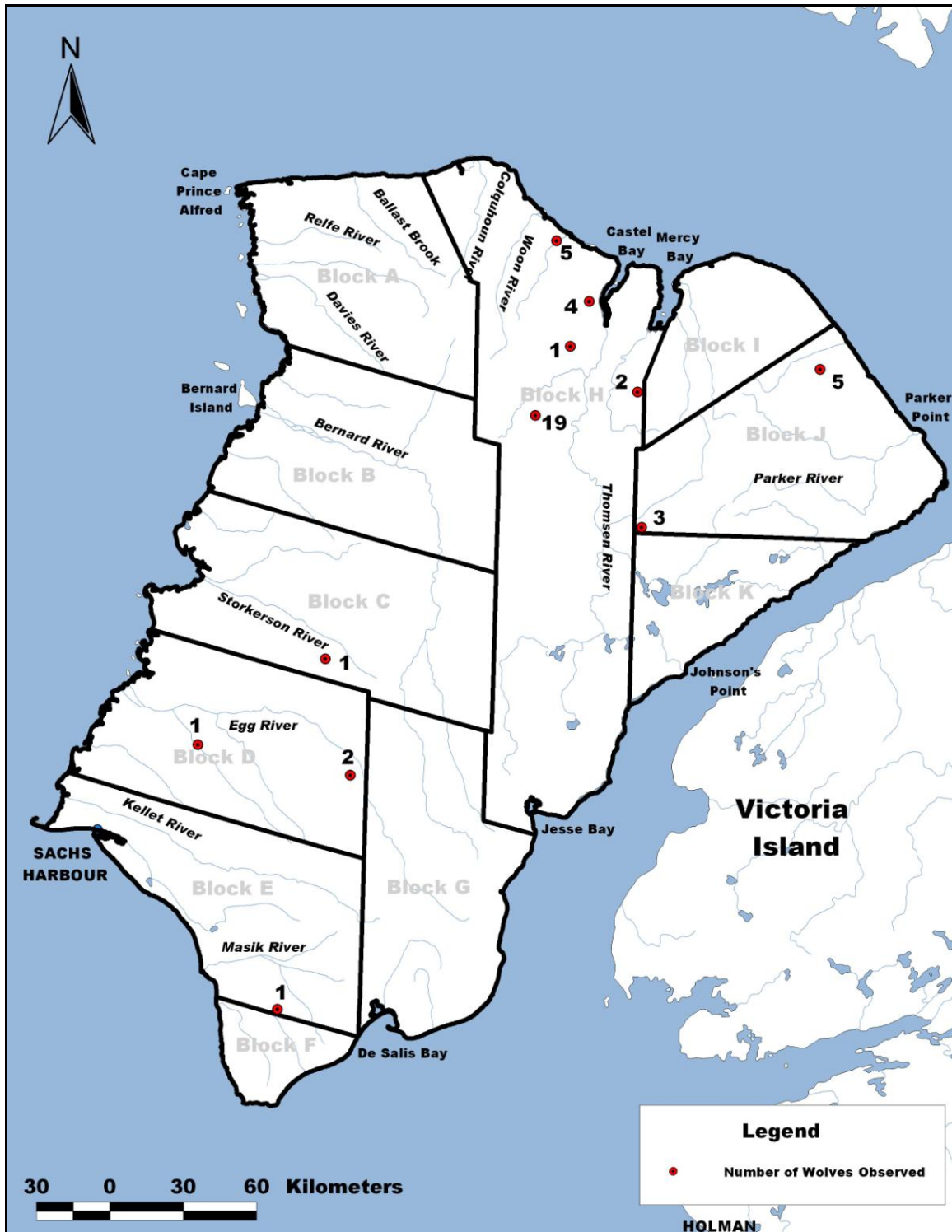


Figure 11. Distribution of wolves observed during the July 2001 Banks Island Peary caribou and muskox survey.

Table 1. Population estimates for Peary caribou on Banks Island, July 2001.

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
A	6,249	20	96.1	0.091	568	14786.0	121.6	255	19.7	122	59	0.214	
B	6,626	23	114.1	0.010	64	900.5	30.0	62	20.2	13	3	0.465	
C	8,009	28	138.5	0.027	212	4957.2	70.4	144	19.8	42	9	0.332	
D	6,926	24	116.5	0.004	30	315.4	17.8	37	20.1	6	0		
E	6,603	27	126.0	0.005	30	315.3	17.8	37	20.2	6	1		
F	1,406	12	56.6	0.018	25	245.7	15.7	35	19.9	5	0		
G	6,770	27	129.5	0.005	32	340.3	18.4	38	19.0	6	5	0.585	
H	14,765	51	253.5	0.008	116	1500.8	38.7	78	19.0	22	2	0.334	
I	3,050	17	83.8	0.003	10	80.4	9.0	19	20.2	2	8		
J	6,970	25	122.8	0.004	25	314.3	17.7	37	20.0	5	23	0.709	
K	3,211	18	91.8	0.009	30	378.2	19.4	41	19.9	6	0		
sum of blocks	70,585	272	1329.2	0.016	1142	24134.2	155.4	324	19.7	235	110	0.136	21
A	6249	20	96.1	0.039	244	4209.6	64.9	136	19.7	48	22	0.266	
B	6626	23	114.1	0.003	0				20.2	0	0		
C	8009	28	138.5	0.007	56	609.8	24.7	51	19.8	11	4	0.445	
D	6926	24	116.5	0.001	10	74.1	8.6	18	20.1	2	0	0.865	
E	6603	27	126	0.000	0				20.2	0	1		
F	1406	12	56.6	0.007	10	63.6	8.0	18	19.9	2	0	0.793	
G	6770	27	129.5	0.002	16	84.5	9.2	19	19.0	3	1	0.583	
H	14765	51	253.5	0.001	21	196.8	14.0	28	19.0	4	2	0.665	
I	3050	17	83.8	0.003	10	80.4	9.0	19	20.2	2	4	0.904	
J	6970	25	122.8	0.002	15	170.4	13.1	27	20.0	3	12	0.870	
K	3211	19	91.8	0.003	10	77.3	8.8	19	19.9	2	0	0.873	
sum of blocks	70585	273	1329.2	0.006	391	5566.5	74.6	156	19.7	77	46	0.191	19
A	6249	20	96.1	0.138	863	31975.4	178.8	374	19.7	170	81	0.207	
B	6626	23	114.1	0.010	64	900.5	30.0	62	20.2	13	3	0.465	
C	8009	28	138.5	0.033	268	8780.5	93.7	192	19.8	53	12	0.350	
D	6926	24	116.5	0.006	40	677.8	26.0	54	20.1	8	0	0.654	
E	6603	27	126	0.005	30	315.3	17.8	37	20.2	6	2	0.596	
F	1406	12	56.6	0.025	35	551.2	23.5	52	19.9	7	0	0.667	

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
G	6770	27	129.5	0.007	47	688.4	26.2	54	19.0	9	5	0.555	
H	14765	51	253.5	0.009	137	2161.7	46.5	93	19.0	26	4	0.339	
I	3050	17	83.8	0.007	20	321.4	17.9	38	20.2	4	12	0.903	
J	6970	25	122.8	0.006	40	933.4	30.6	63	20.0	8	35	0.764	
K	3211	19	91.8	0.013	40	577.4	24.0	51	19.9	8	0	0.596	
sum of blocks	70585	273	1329.2	0.022	1584	47883.0	218.8	456	19.7	312	154	0.138	20

Table 2. Population estimates for muskox on Banks Island, July 2001.

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	0.388	2426	263391.8	513.2	1074	19.7	478	not recorded	0.212	
B	6626	23	114.1	0.834	5526	494613.2	703.3	1459	20.2	1114	not recorded	0.127	
C	8009	28	138.5	0.900	7210	1680424.2	1296.3	1660	19.8	1448	not recorded	0.180	
D	6926	24	116.5	1.617	11199	1888268.1	1374.1	2843	20.1	2252	not recorded	0.123	
E	6603	27	126	1.811	11956	3212408.1	1792.3	3685	20.2	2409	not recorded	0.150	
F	1406	12	56.6	1.212	1704	86127.1	293.5	646	19.9	339	not recorded	0.172	
G	6770	27	129.5	0.251	1697	77786.3	278.9	573	19.0	323	not recorded	0.164	
H	14765	51	253.5	1.380	20377	3886559.4	1971.4	3961	19.0	3862	not recorded	0.097	
I	3050	17	83.8	0.177	541	9103.8	95.4	202	20.2	109	not recorded	0.176	
J	6970	25	122.8	0.702	4891	263904.3	513.7	1060	20.0	978	not recorded	0.105	
K	3211	19	91.8	0.329	1058	56230.2	237.1	500	19.9	210	not recorded	0.224	
sum of blocks	70585	273	1329.2	0.972	68585	11918816.6	3452.4	6972	19.7	13522		0.050	42
Muskox: Calf													
A	6249	20	96.1	0.073	457	12609.1	112.3	235	19.7	90	not recorded	0.246	
B	6626	23	114.1	0.136	898	19209.0	138.6	287	20.2	181	not recorded	0.154	
C	8009	28	138.5	0.133	1065	28187.7	167.9	345	19.8	211	not recorded	0.158	
D	6926	24	116.5	0.353	2447	88940.0	298.2	617	20.1	492	not recorded	0.122	
E	6603	27	126	0.274	1811	70999.6	266.5	548	20.2	365	not recorded	0.147	
F	1406	12	56.6	0.211	297	5662.1	75.2	166	19.9	59	not recorded	0.254	
G	6770	27	129.5	0.059	399	7127.0	84.4	174	19.0	76	not recorded	0.211	
H	14765	51	253.5	0.227	3356	110794.6	332.9	669	19.0	636	not recorded	0.099	
I	3050	17	83.8	0.034	104	530.1	23.0	49	20.2	21	not recorded	0.221	
J	6970	25	122.8	0.113	785	7025.5	83.8	173	20.0	157	not recorded	0.107	
K	3211	19	91.8	0.050	161	3396.5	58.3	123	19.9	32	not recorded	0.362	
sum of blocks	70585	273	1329.2	0.167	11780	354481.1	595.4	1202	19.7	2320		0.051	41
Muskox: Total													
A	6249	20	96.1	0.461	2883	387020.9	622.1	1302	19.7	568	not recorded	0.216	
B	6626	23	114.1	0.970	6424	673289.2	820.5	1702	20.2	1295	not recorded	0.128	
C	8009	28	138.5	1.046	8376	2057192.4	1434.3	2943	19.8	1659	not recorded	0.171	
D	6926	24	116.5	1.970	12646	2724263.0	1650.5	3415	20.1	2744	not recorded	0.131	
E	6603	27	126	2.084	13757	4156947.9	2038.9	4192	20.2	2772	not recorded	0.148	

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
F	1406	12	56.6	1.423	2001	131819.8	363.1	799	19.9	398	not recorded	0.181	
G	6770	27	129.5	0.310	2097	124591.7	353.0	726	19.0	399	not recorded	0.168	
H	14765	51	253.5	1.607	23733	5239275.2	2288.9	4598	19.0	4498	not recorded	0.096	
I	3050	17	83.8	0.212	645	13283.1	115.3	244	20.2	130	not recorded	0.179	
J	6970	25	122.8	0.811	5652	340565.2	583.6	1205	20.0	1130	not recorded	0.103	
K	3211	19	91.8	0.380	1219	82270.8	286.8	605	19.9	242	not recorded	0.235	
sum of blocks	70585	273	1329.2	1.125	79432	15930519.2	3991.3	8055	19.7	15835		0.050	42

APPENDIX A.

Transect data for the July 2001 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	A02	3.756	0	0	0	1	0	1
	A03	8.531	0	0	0	0	0	0
	A04	44.938	3	0	3	0	0	0
	A05	60.119	14	2	16	0	0	0
	A06	63.068	10	3	13	0	0	0
	A07	67.563	2	0	2	28	5	33
	A08	68.996	23	9	32	27	6	33
	A09	68.894	2	1	3	7	1	8
	A10	70.929	2	0	2	21	9	30
	A11	69.201	6	1	7	5	0	5
	A12	72.186	4	1	5	12	0	12
	A13	70.813	3	1	4	26	5	31
	A14	78.868	8	3	11	20	1	21
	A15	80.043	12	4	16	50	9	59
	A16	81.647	19	12	31	10	1	11
	A17	82.293	1	1	2	15	3	18
	A18	73.332	13	10	23	35	6	41
	A19	64.374	0	0	0	91	20	111
	A20	55.348	0	0	0	41	6	47
	A21	46.313	0	0	0	89	18	107
	Total	1231.212	122	48	170	478	90	568
B	B03	13.337	0	0	0	10	0	10
	B04	25.511	0	0	0	10	0	10
	B05	36.346	0	0	0	14	0	14
	B06	35.467	0	0	0	25	5	30
	B07	52.805	0	0	0	29	6	35
	B08	60.017	0	0	0	12	1	13
	B09	67.319	5	0	5	46	10	56
	B10	67.322	0	0	0	97	23	120
	B11	67.324	5	0	5	67	9	76
	B12	67.331	0	0	0	106	17	123
	B13	67.343	0	0	0	127	14	141
	B14	67.355	1	0	1	93	15	108
	B15	67.362	0	0	0	77	7	84
	B16	67.364	0	0	0	94	10	104
	B17	67.366	0	0	0	21	3	24
	B18	67.362	0	0	0	39	12	51
	B19	67.269	0	0	0	108	27	135
	B20	67.177	0	0	0	35	7	42
	B21	67.086	0	0	0	31	4	35
	B22	67.070	1	0	1	25	2	27
	B23	67.070	1	0	1	34	7	41

Survey Block	Transect Number	Transect						
		Area (km ²)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	B24	51.593	0	0	0	12	2	14
	B25	51.598	0	0	0	2	0	2
	Total	1335.794	13	0	13	1114	181	1295
C	C05	14.347	0	0	0	2	0	2
	C06	18.658	0	0	0	5	0	5
	C07	28.974	0	0	0	54	6	60
	C08	39.876	0	0	0	20	2	22
	C09	60.097	0	0	0	59	7	66
	C10	62.143	0	0	0	78	8	86
	C11	62.093	3	0	3	137	29	166
	C12	62.064	0	0	0	93	14	107
	C13	62.088	3	1	4	76	10	86
	C14	62.101	0	0	0	135	22	157
	C15	62.124	0	0	0	165	18	183
	C16	62.099	0	0	0	211	18	229
	C17	62.061	3	1	4	110	16	126
	C18	62.025	0	0	0	54	7	61
	C19	61.981	0	0	0	79	13	92
	C20	61.936	0	0	0	34	9	43
	C21	61.889	0	0	0	41	9	50
	C22	61.842	0	0	0	7	2	9
	C23	61.795	0	0	0	16	4	20
	C24	61.748	0	0	0	22	4	26
	C25	61.707	2	0	2	6	1	7
	C26	61.754	0	0	0	11	2	13
	C27	61.801	12	4	16	3	1	4
	C28	61.846	10	4	14	0	0	0
	C29	61.868	0	0	0	12	3	15
	C30	61.832	0	0	0	8	4	12
	C31	61.795	4	1	5	10	2	12
	C32	61.752	5	0	5	0	0	0
	Total	1586.296	42	11	53	1448	211	1659
D	D07	9.646	0	0	0	0	0	0
	D08	12.384	0	0	0	16	6	22
	D09	26.135	0	0	0	11	1	12
	D10	38.380	0	0	0	35	6	41
	D11	42.784	0	0	0	43	15	58
	D12	50.983	0	0	0	44	7	51
	D13	66.908	0	0	0	68	10	78
	D14	67.487	4	2	6	42	8	50
	D15	67.462	0	0	0	24	4	28
	D16	67.439	0	0	0	125	29	154
	D17	67.415	0	0	0	128	28	156
	D18	67.391	0	0	0	114	19	133
	D19	67.367	0	0	0	218	33	251
	D20	67.342	0	0	0	243	42	285

Survey Block	Transect Number	Transect						
		Area (km ²)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	D21	67.327	0	0	0	191	43	234
	D22	67.312	0	0	0	243	52	295
	D23	67.297	0	0	0	141	36	177
	D24	67.327	0	0	0	153	50	203
	D25	67.376	0	0	0	131	35	166
	D26	67.423	0	0	0	124	28	152
	D27	67.451	1	0	1	56	13	69
	D28	67.405	0	0	0	17	3	20
	D29	67.361	0	0	0	52	14	66
	D30	67.316	1	0	1	33	10	43
	Total	1392.718	6	2	8	2252	492	2744
E	E07	0.304	0	0	0	0	0	0
	E08	3.036	0	0	0	0	0	0
	E09	17.528	0	0	0	0	0	0
	E10	21.792	0	0	0	7	0	7
	E11	20.384	0	0	0	1	0	1
	E12	21.966	0	0	0	2	0	2
	E13	27.722	0	0	0	13	1	14
	E14	32.805	0	0	0	10	2	12
	E15	35.904	0	0	0	41	5	46
	E16	38.565	0	0	0	38	6	44
	E17	39.567	0	0	0	74	12	86
	E18	41.414	0	0	0	121	13	134
	E19	45.560	0	0	0	90	12	102
	E20	51.698	0	0	0	206	34	240
	E21	64.923	0	0	0	325	51	376
	E22	72.441	0	0	0	149	14	163
	E23	72.452	2	0	2	313	36	349
	E24	72.442	0	0	0	242	37	279
	E25	72.429	0	0	0	156	19	175
	E26	72.414	0	0	0	79	12	91
	E27	72.353	0	0	0	237	35	272
	E28	72.256	0	0	0	143	41	182
	E29	72.162	0	0	0	89	14	103
	E30	72.090	0	0	0	19	6	25
	E31	72.090	0	0	0	9	2	11
	E32	72.088	0	0	0	17	4	21
	E33	72.086	4	0	4	28	9	37
	Total	1330.471	6	0	6	2409	365	2772
F	F01	3.446	0	0	0	9	3	12
	F02	29.061	0	0	0	14	0	14
	F03	36.424	1	0	1	36	5	41
	F04	38.515	4	2	6	48	5	53
	F05	37.248	0	0	0	26	1	27
	F06	36.294	0	0	0	33	9	42
	F07	27.312	0	0	0	80	16	96

Survey Block	Transect Number	Transect						
		Area (km ²)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	F08	21.938	0	0	0	51	9	60
	F09	18.242	0	0	0	1	0	1
	F10	15.310	0	0	0	32	10	42
	F11	11.698	0	0	0	9	1	10
	F12	4.222	0	0	0	0	0	0
	Total	279.710	5	2	7	339	59	398
G	G01	2.852	0	0	0	0	0	0
	G02	14.508	0	0	0	0	0	0
	G03	5.011	0	0	0	1	0	1
	G04	36.187	0	0	0	15	0	15
	G05	44.101	0	0	0	16	3	19
	G06	48.889	0	0	0	33	3	36
	G07	52.119	0	0	0	24	6	30
	G08	53.892	0	0	0	0	0	0
	G09	54.939	0	0	0	7	2	9
	G10	56.649	0	0	0	11	2	13
	G11	54.461	0	0	0	0	0	0
	G12	55.121	0	0	0	14	3	17
	G13	56.082	0	0	0	4	0	4
	G14	57.473	0	0	0	43	14	57
	G15	55.942	0	0	0	4	0	4
	G16	56.679	0	0	0	18	6	24
	G17	60.389	4	1	5	0	0	0
	G18	63.701	0	0	0	33	14	47
	G19	66.347	2	2	4	5	0	5
	G20	67.476	0	0	0	46	10	56
	G21	46.499	0	0	0	18	2	20
	G22	46.498	0	0	0	2	0	2
	G23	46.498	0	0	0	0	0	0
	G24	46.497	0	0	0	18	5	23
	G25	46.497	0	0	0	7	3	10
	G26	46.496	0	0	0	4	3	7
	G27	46.496	0	0	0	0	0	0
	Total	1288.299	6	3	9	323	76	399
H	H08	22.695	0	0	0	24	7	31
	H09	33.330	0	0	0	75	7	82
	H10	47.978	0	0	0	98	14	112
	H11	53.321	0	0	0	84	11	95
	H12	66.630	0	0	0	122	21	143
	H13	86.002	0	0	0	128	15	143
	H14	82.975	0	0	0	213	33	246
	H15	81.103	0	0	0	253	50	303
	H16	75.896	5	0	5	143	24	167
	H17	72.313	0	0	0	194	30	224
	H18	72.639	0	0	0	97	15	112
	H19	70.797	0	0	0	237	35	272

Survey Block	Transect Number	Transect			Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
		Area (km ²)								
	H20	68.956	0	0	0	0	0	189	23	212
	H21	67.169	0	0	0	0	0	96	15	111
	H22	67.149	0	0	0	0	0	186	21	207
	H23	67.144	0	0	0	0	0	143	24	167
	H24	67.139	0	0	0	0	0	122	27	149
	H25	67.134	0	0	0	0	0	202	36	238
	H26	62.708	0	0	0	0	0	201	33	234
	H27	61.896	0	0	0	0	0	150	28	178
	H28	61.892	0	0	0	0	0	103	15	118
	H29	51.567	0	0	0	0	0	124	30	154
	H30	51.562	0	0	0	0	0	62	10	72
	H31	51.558	0	0	0	0	0	130	23	153
	H32	51.553	0	0	0	0	0	75	12	87
	H33	51.549	0	0	0	0	0	18	6	24
	H34	51.543	0	0	0	0	0	63	9	72
	H35	51.538	0	0	0	0	0	42	7	49
	H36	51.533	0	0	0	0	0	5	2	7
	H37	51.528	0	0	0	0	0	25	1	26
	H38	51.523	0	0	0	0	0	6	0	6
	H39	51.518	5	0	5	0	0	0	0	0
	H40	51.513	0	0	0	0	0	0	0	0
	H41	51.494	0	0	0	0	0	14	3	17
	H42	51.465	0	0	0	0	0	5	3	8
	H43	51.439	4	1	5	2	0	2	0	2
	H44	51.427	2	0	2	12	3	15	3	15
	H45	51.415	2	0	2	1	0	1	0	1
	H46	51.403	0	0	0	17	8	25	8	25
	H47	52.693	0	0	0	5	0	5	0	5
	H48	51.608	1	0	1	13	0	13	0	13
	H49	51.405	0	0	0	15	1	16	1	16
	H50	49.253	0	0	0	55	10	65	10	65
	H51	47.944	3	3	6	19	5	24	5	24
	H52	51.487	0	0	0	6	2	8	2	8
	H53	50.990	0	0	0	21	5	26	5	26
	H54	46.361	0	0	0	10	2	12	2	12
	H55	39.838	0	0	0	25	4	29	4	29
	H56	31.422	0	0	0	16	3	19	3	19
	H57	20.264	0	0	0	14	3	17	3	17
	H58	21.065	0	0	0	2	0	2	0	2
	Total	2798.324	22	4	26	3862	636	4498	636	4498
I	I01	29.865	2	2	4	5	2	7	2	7
	I02	46.049	0	0	0	10	1	11	1	11
	I03	58.191	0	0	0	7	2	9	2	9
	I04	64.874	0	0	0	9	2	11	2	11
	I05	56.707	0	0	0	10	1	11	1	11
	I06	53.175	0	0	0	1	0	1	0	1
	I07	49.668	0	0	0	11	2	13	2	13

Survey Block	Transect Number	Transect						
		Area (km ²)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	I08	45.838	0	0	0	10	1	11
	I09	41.950	0	0	0	8	3	11
	I10	38.068	0	0	0	24	5	29
	I11	34.186	0	0	0	6	0	6
	I12	30.250	0	0	0	8	2	10
	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	2	2	4	109	21	130
J	J01	9.597	0	0	0	0	0	0
	J02	20.795	0	0	0	16	3	19
	J03	33.131	0	0	0	26	5	31
	J04	40.523	0	0	0	16	4	20
	J05	49.653	0	0	0	65	2	67
	J06	58.370	0	0	0	69	12	81
	J07	66.341	0	0	0	51	9	60
	J08	73.532	0	0	0	45	10	55
	J09	80.296	0	0	0	83	15	98
	J10	86.391	0	0	0	54	13	67
	J11	82.888	0	0	0	107	11	118
	J12	79.386	0	0	0	61	8	69
	J13	75.884	0	0	0	102	16	118
	J14	72.376	0	0	0	44	8	52
	J15	68.867	4	3	7	28	7	30
	J16	65.356	0	0	0	20	0	20
	J17	61.845	1	0	1	25	5	30
	J18	58.335	0	0	0	16	1	17
	J19	54.825	0	0	0	57	9	66
	J20	51.315	0	0	0	0	0	0
	J21	47.805	0	0	0	0	0	0
	J22	44.294	0	0	0	33	7	40
	J23	40.784	0	0	0	1	0	1
	J24	37.274	0	0	0	33	7	40
	J25	33.764	0	0	0	26	5	31
	Total	1393.627	5	3	8	978	157	1130
K	K02	1.981	0	0	0	0	0	0
	K03	5.842	0	0	0	0	0	0
	K04	10.664	0	0	0	0	0	0
	K05	15.618	0	0	0	11	1	12
	K06	18.159	0	0	0	8	1	9
	K07	24.064	0	0	0	12	2	14
	K08	25.298	0	0	0	14	3	17
	K09	29.182	0	0	0	7	0	7
	K10	32.291	0	0	0	27	0	27

Survey Block	Transect Number	Transect						
		Area (km ²)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	K11	37.806	0	0	0	0	0	0
	K12	41.853	4	0	4	0	0	0
	K13	44.987	0	0	0	0	0	0
	K14	48.395	0	0	0	48	12	60
	K15	52.494	0	0	0	0	0	0
	K16	57.509	0	0	0	15	2	17
	K17	59.448	0	0	0	18	0	18
	K18	63.726	2	2	4	35	8	43
	K19	68.224	0	0	0	15	3	18
	Total	637.541	6	2	8	210	32	242