Population Estimates for Peary Caribou and Muskox on Banks Island, NWT, July 1994

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ABSTRACT

A stratified strip transect aerial survey was conducted on Banks Island, NWT during early July 1994 to document the numbers and distribution of Peary caribou (*Rangifer tarandus pearyi*) and muskox (*Ovibos moschatus*).

We observed a total of 224 non-calf and 22 calf caribou on transects, giving estimates of 742 ± 269 (95% CI) non-calf and 70 ± 44 (95% CI) calf caribou. Approximately 7.5% of the caribou observed were calves. Overall there were 0.01 non-calf caribou per km^2 on the island. The 1992 and 1994 estimates for non-calf caribou were not significantly different. The results of this survey suggest that the population has stabilized.

We observed a total of 14,803 non-calf and 1,672 calf muskoxen on transect giving estimates of 66,297 ± 5,106 (95% CI) non-calf and 7,091 ± 760 (95% CI) calf muskoxen. Approximately 10.2% of the muskoxen observed were calves. Overall there were 0.94 non-calf muskoxen per km^2 on the island, with densities reaching 1.91, 2.9, 1.65, and 2.8 muskoxen per km^2 in the Egg, Massik, Parker, and Thomsen river drainages, respectively. The results of this study indicate that the muskox population on Banks Island continued to increase between 1992 and 1994.

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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; McLean et al. 1986; McLean 1992; McLean and Fraser 1992; Nagy et al. 2007e). Between 1972 and 1992, the Peary caribou population declined from about 12,000 to 2,600 non-calf animals, while the muskox population increased from about 3,800 to about 34,300 non-calf animals (Urquhart 1983; Latour 1985; McLean et al. 1986; McLean 1992; McLean and Fraser 1992; Nagy et al. 2007e).

Because of the national "endangered" designation 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 populations every two to four years to monitor their status (McLean 1992; McLean and Fraser 1992; Nagy et al. 2007a, b, c, d). A survey conducted in 1992 indicated the Peary caribou population continued to decline between 1989 and 1992 while the muskox population continued to increase (Nagy et al. 2007d).

A stratified strip transect aerial survey designed to obtain population estimates for Peary caribou and muskox on Banks Island was conducted in early July 1994 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 populations;
- 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 populations.

This report summarizes the results of the survey completed on Banks Island during July 1994.

METHODS

In order to conduct a strip transect survey, we partitioned Banks Island into survey blocks (Figure 1). Transects were oriented to intersect major river systems and drainages at approximately a 90° angle (Figure 2). Survey blocks A, B, C, D, P, and T were flown at 20% coverage (transects spaced at 5 km intervals). Survey blocks E and M were flown at 40% coverage (transects spaced at 2.5 km intervals).

Figure 1: Location of survey blocks for the July 1994 Banks Island Peary caribou and muskox survey.

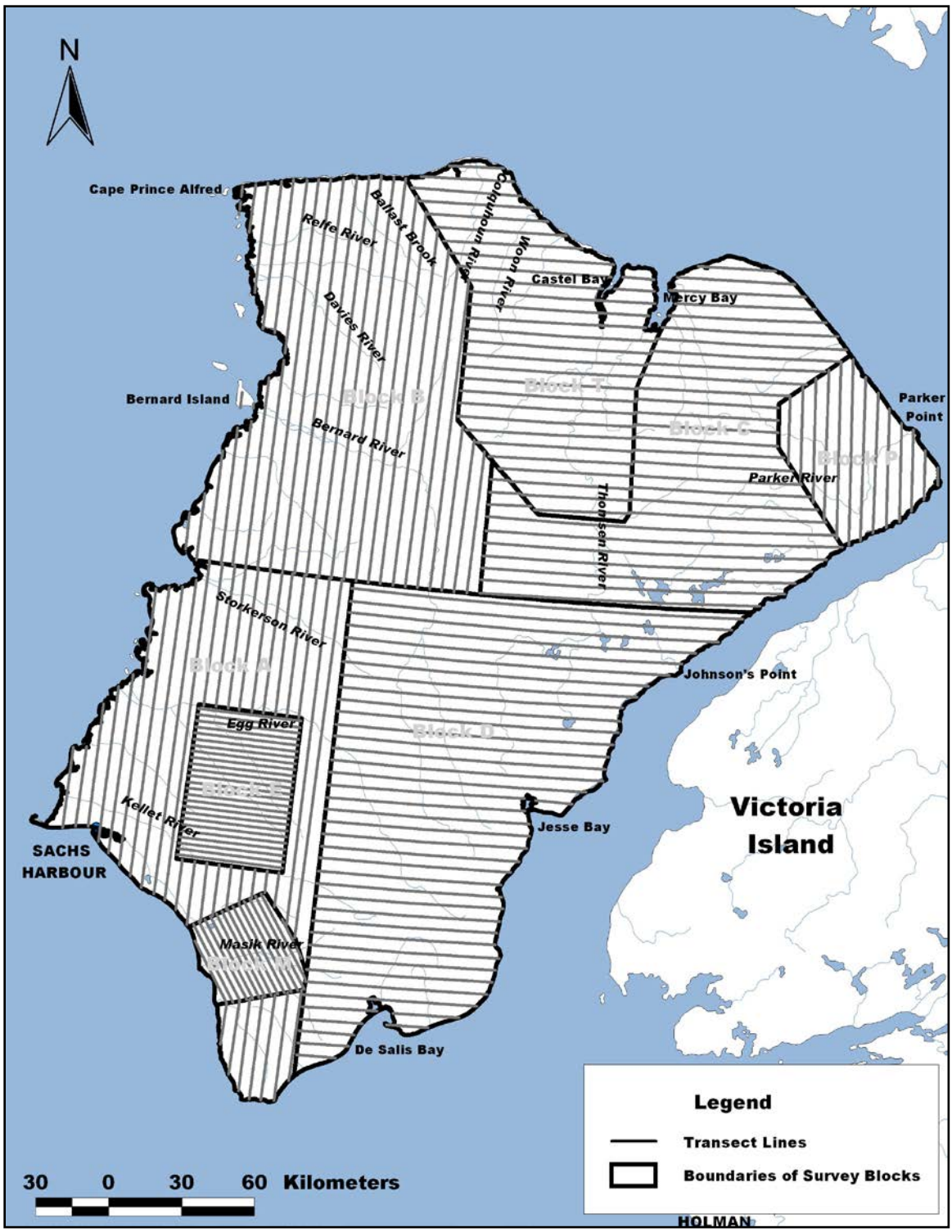

Figure 2: Distribution of survey blocks and transect lines for the July 1994 Banks Island survey as planned and flown.

The survey crews composed of a pilot, an observer in the left back seat, and an observer/recorder in the front right seat of the aircraft (Helio Courier and Cessna 185). Transect lines were marked on 1:250,000 scale NTS maps for each survey block. These maps were used by the pilots to navigate along transects. The aircraft flew at an altitude of 100 m above ground level and airspeed of 160 km/h.

Caribou were counted inside and outside 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 a 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).

Caribou were classified as adults (cows and yearlings), bulls, calves, or unknown. Muskoxen were classified as adults (age ≥1 year) and calves (age <1 year). Observers were equipped with binoculars to help ensure caribou and muskoxen were counted and classified 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 on transect and the survey resumed. The pilot recorded the sighting numbers on the 1:250,000 NTS maps. All sightings of wolves were recorded.

The field crew working on northern Banks Island surveyed block B first. This area has contained most caribou during past surveys (Latour 1985; McLean et al. 1986; McLean 1992;

McLean and Fraser 1992; Nagy et al. 2007d, e). Areas of high and low densities of caribou were stratified in block B and the area of high density of caribou was re-flown at 40% coverage.

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. The resulting digital map was imported into OziExplorer GPS software (OziExplorer GPS Mapping Software). We used OziExplorer to create waypoints at the start and end of each transect and to digitize the location of each observation made during the survey. The resulting OziExplorer waypoint files were parsed using Microsoft Excel and the data for each observation was then entered from the field data sheets. At the end of this process the survey data were geo-referenced. This allowed us to map the distribution of Peary caribou and muskoxen observed during the survey.

Shape files were created for each survey block so 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 numbers of non-calf and calf caribou and muskoxen observed on and off transect for each transect was summarized using Microsoft Excel. The length of each transect was derived using the start and end point coordinates 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 in 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 stratum is independent of other strata units, the variance is estimated as the sum of individual variance estimates for each stratum, or (equation 2):

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

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

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

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

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

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). 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 1994 were significantly different from those in 1992. We calculated the t-statistic (t^2) using the following formula (equation 5) (Gasaway et al. 1986:62):

$$t^2 = T_{1994} - T_{1992} / [V(T_{1994)} + V(T_{1992})]^{0.5}$$

Where:

- T_{1994} and T_{1992} = population estimates of non-calf and calf caribou and muskox from surveys in 1994 and 1992, respectively; and
- $V(T_{1994})$ and $V(T_{1992})$ = variances of population estimates of non-calf and calf caribou and muskoxen from surveys in 1994 and 1992, 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. 1986:62):

$$[V(T_{1994}) + V(T_{1992})]^2 / \{[V(T_{1994})^2 / v_{o1994}] + [V(T_{1992})^2 / v_{o1992}]\}$$

Where:

- $V(T_{1994})$ and $V(T_{1992})$ = variances of population estimates of non-calf and calf caribou and muskox from surveys in 1994 and 1992, respectively; and
- v_{o1994} and v_{o1992} = degrees of freedom from surveys in 1994 and 1992, 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 early July 1994. Weather conditions were generally good to excellent throughout the survey. All transect lines were flown as planned (Figure 2).

Peary caribou

The distribution of non-calf and calf Peary caribou observed during the initial survey of all blocks is shown in Figure 3 and Figure 4, respectively. During this component of the survey we observed a total of 99 non-calf and 9 calf caribou on transect giving estimates of 486 ± 171 (95% CI) non-calf and 46 ± 40 (95% CI) calf caribou (Table 1). We then stratified survey block B into areas of high and low densities of caribou (Figure 5) and re-surveyed the high-density area at 40% (Figure 6).

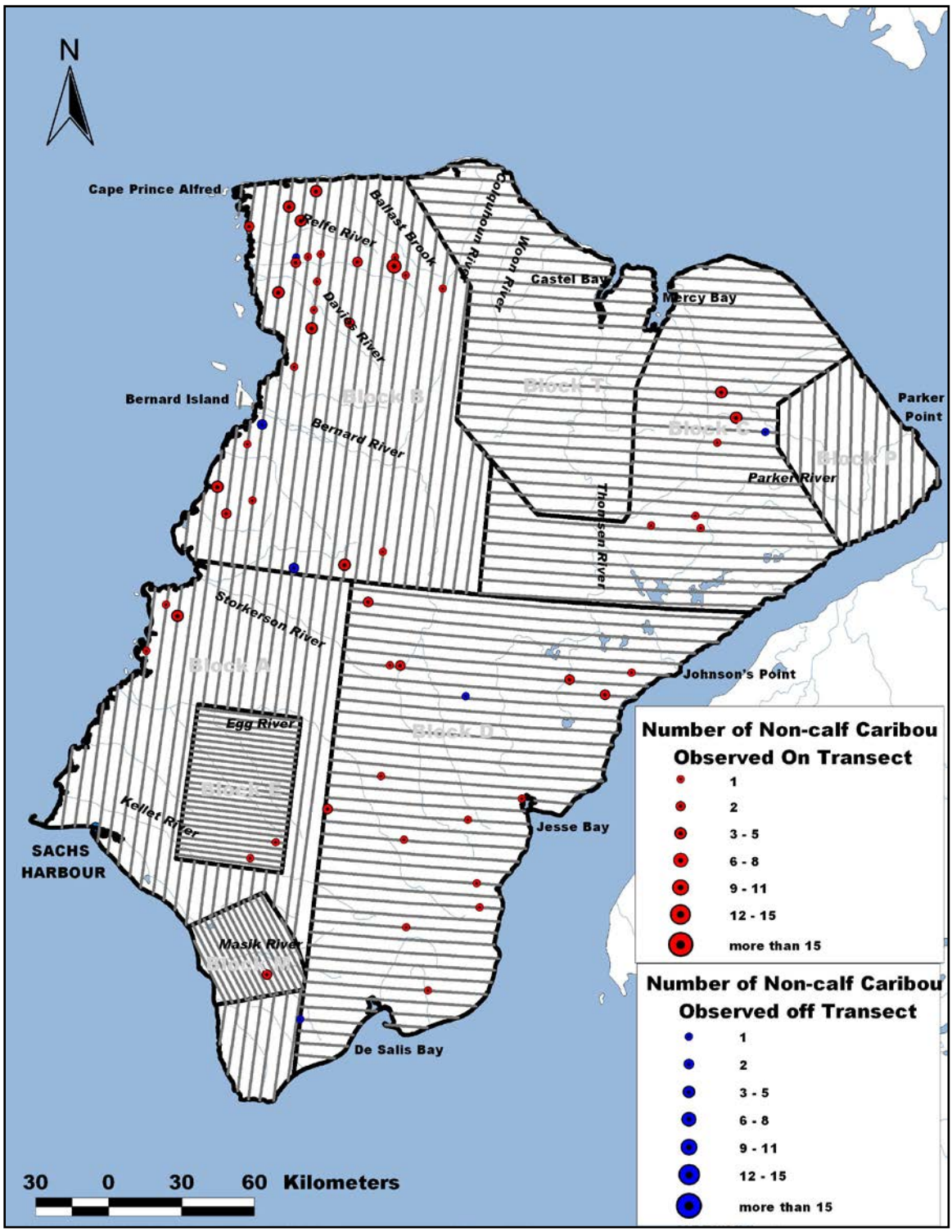

Figure 3: Distribution of non-calf caribou on Banks Island during the July 1994 Banks Island Peary caribou and muskox survey.

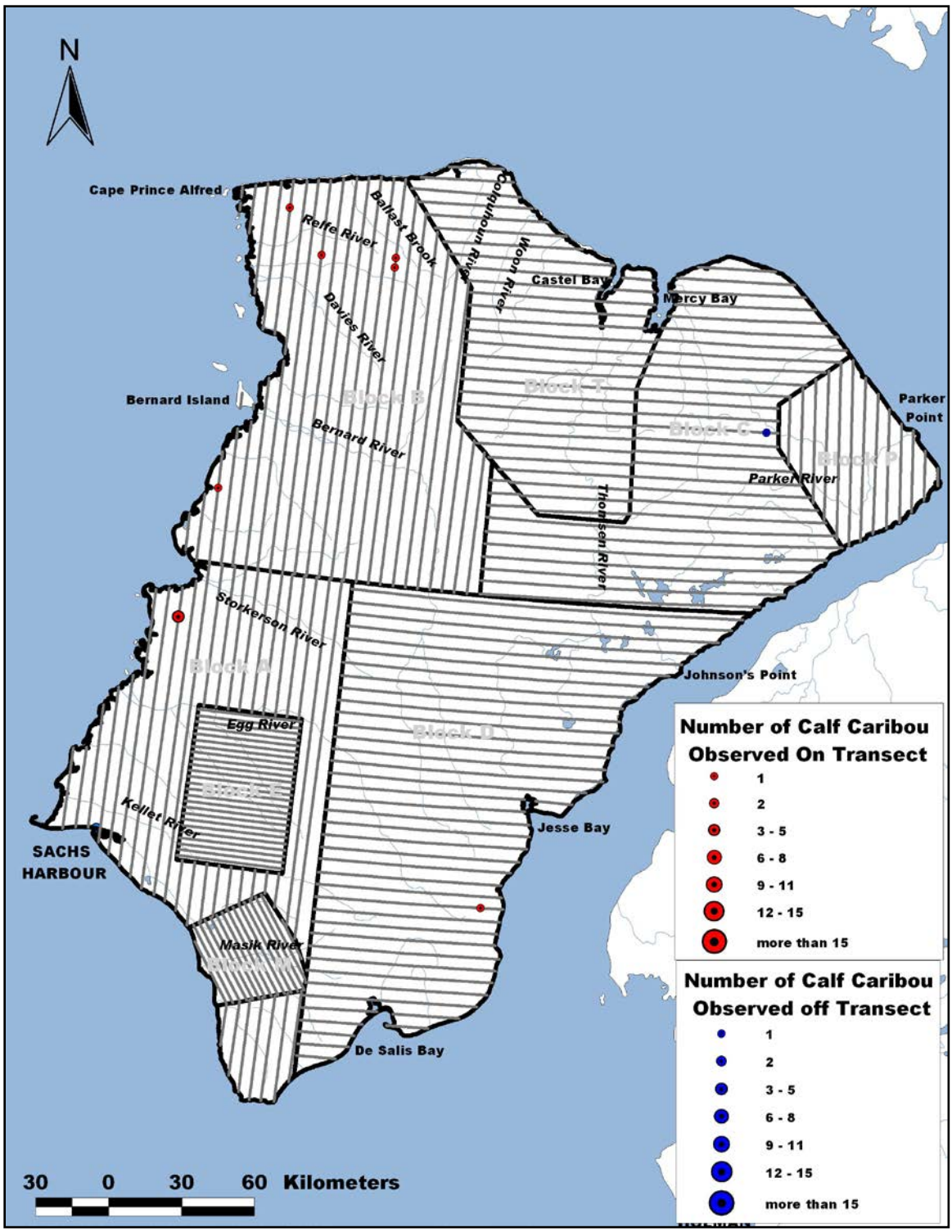

Figure 4: Distribution of calf caribou on Banks Island during the July 1994 Banks Island Peary caribou and muskox survey.

Table 1: Population estimates for Peary caribou on Banks Island pre-stratification, July 1994.

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	10,851	21	112.3	0.00	26	231.2	15.2	31.72	18.9	5	0	0.58	
B	14,828	24	126.1	0.02	280	4,622.0	68.0	140.66	20.0	56	5	0.24	
C	11,477	28	142.8	0.01	70	1,113.9	33.4	68.49	20.0	14	1	0.48	
D	17,832	39	202.4	0.01	100	844.8	29.1	58.83	20.1	20	2	0.29	
E	2,698	25	63.3	0.00	5	7.4	2.7	5.62	39.6	2	0	0.54	
M	1,427	15	45.7	0.00	5	24.7	5.0	10.66	38.9	2	0	0.97	
P	2,983	13	66.0	0.00	0				19.9	0	0		
T	8,487	28	140.7	0.00	0				19.4	0	0		
Sum of Blocks	70,583	193	899.3	0.01	486	6,844.0	82.7	171.14	20.9	99	8	0.17	24
Caribou: Calf													
A	10,851	21	112.3	0.00	16	205.6	14.3	29.91	18.9	3	0	0.91	
B	14,828	24	126.1	0.00	25	136.2	11.7	24.15	20.0	5	0	0.47	
C	11,477	28	142.8						20.0	0	1		
D	17,832	39	202.4	0.00	5	22.0	4.7	9.50	20.1	1	0	0.94	
E	2,698	25	63.3						39.6	0	0		
M	1,427	15	45.7						38.9	0	0		
P	2,983	13	66.0						19.9	0	0		
T	8,487	28	140.7						19.4	0	0		
Sum of Blocks	70,583	193	899.3	0.00	46	363.9	19.1	39.67	20.9	9	1	0.42	21
Caribou: Total													
A	10,851	21	112.3	0.00	42	830.5	28.8	60.11	18.9	8	0	0.68	
B	14,828	24	126.1	0.02	305	5,911.8	76.9	159.08	20.0	61	5	0.25	
C	11,477	28	142.8	0.01	70	1,113.9	33.4	68.49	20.0	14	2	0.48	
D	17,832	39	202.4	0.01	104	891.8	29.9	60.44	20.1	21	2	0.29	
E	2,698	25	63.3	0.00	5	7.4	2.7	5.62	39.6	2	0	0.54	
M	1,427	15	45.7	0.00	5	24.7	5.0	10.66	38.9	2	0	0.97	
P	2,983	13	66.0	0.00	0				19.9	0	0		
T	8,487	28	140.7	0.00	0				19.4	0	0		
Sum of Blocks	70,583	193	899.3	0.01	532	8,780.1	93.7	193.84	20.9	108	9	0.18	24

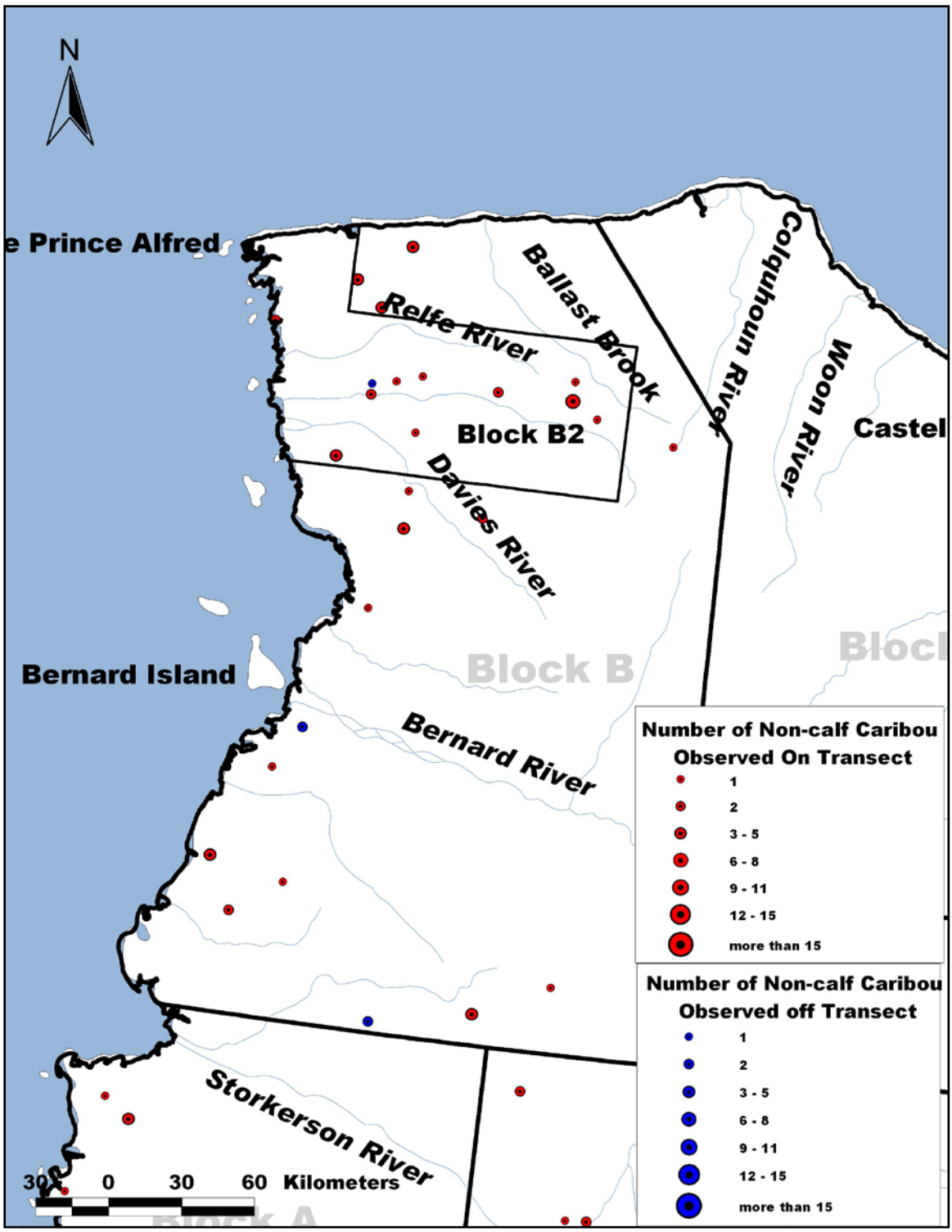

Figure 5: Stratification of areas of high and low densities of Peary caribou in survey block B during the 1994 Banks Island Peary caribou and muskox survey.

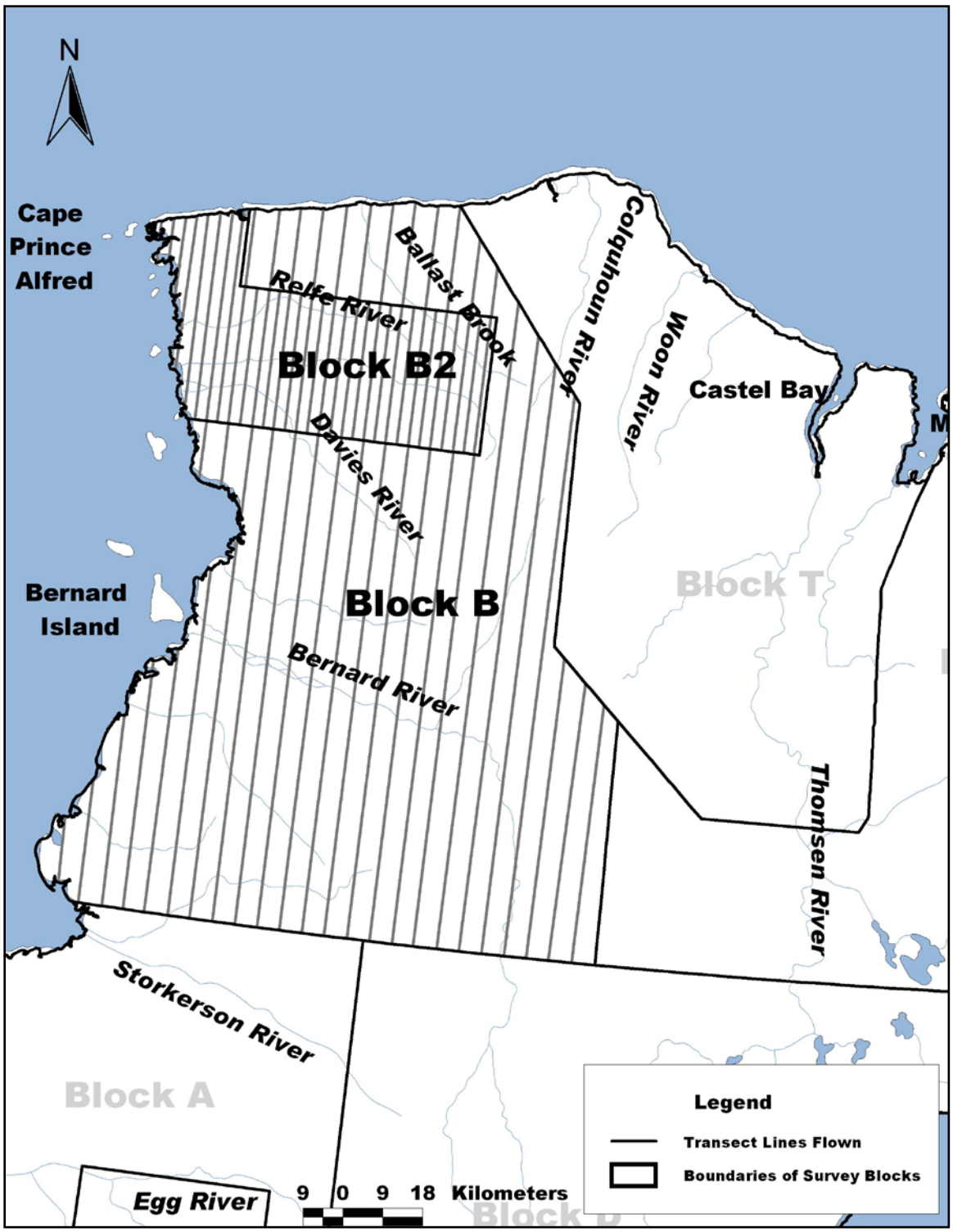

Figure 6: Distribution of survey blocks and transects flown in survey blocks B and B2 during the 1994 Banks Island Peary caribou and muskox survey.

The distribution of non-calf and calf Peary caribou in survey blocks B2 and B minus B2 is given in Figure 7 and Figure 8. During this component of the survey we observed 143 non-calf and 16 calf caribou in survey block B2 (Table 2). There were a total of 224 non-calf and 22 calf caribou on transect in blocks B2, block B minus B2, and the remainder of the island giving estimates of 742 ± 269 non-calf and 70 ± 44 calf caribou (Table 2). These estimates and the original estimates were not significantly different for non-calf (t^2 = 1.645, 48 df, p>0.05) or calf caribou (t^2 = 0.857, 41 df, P>0.05).

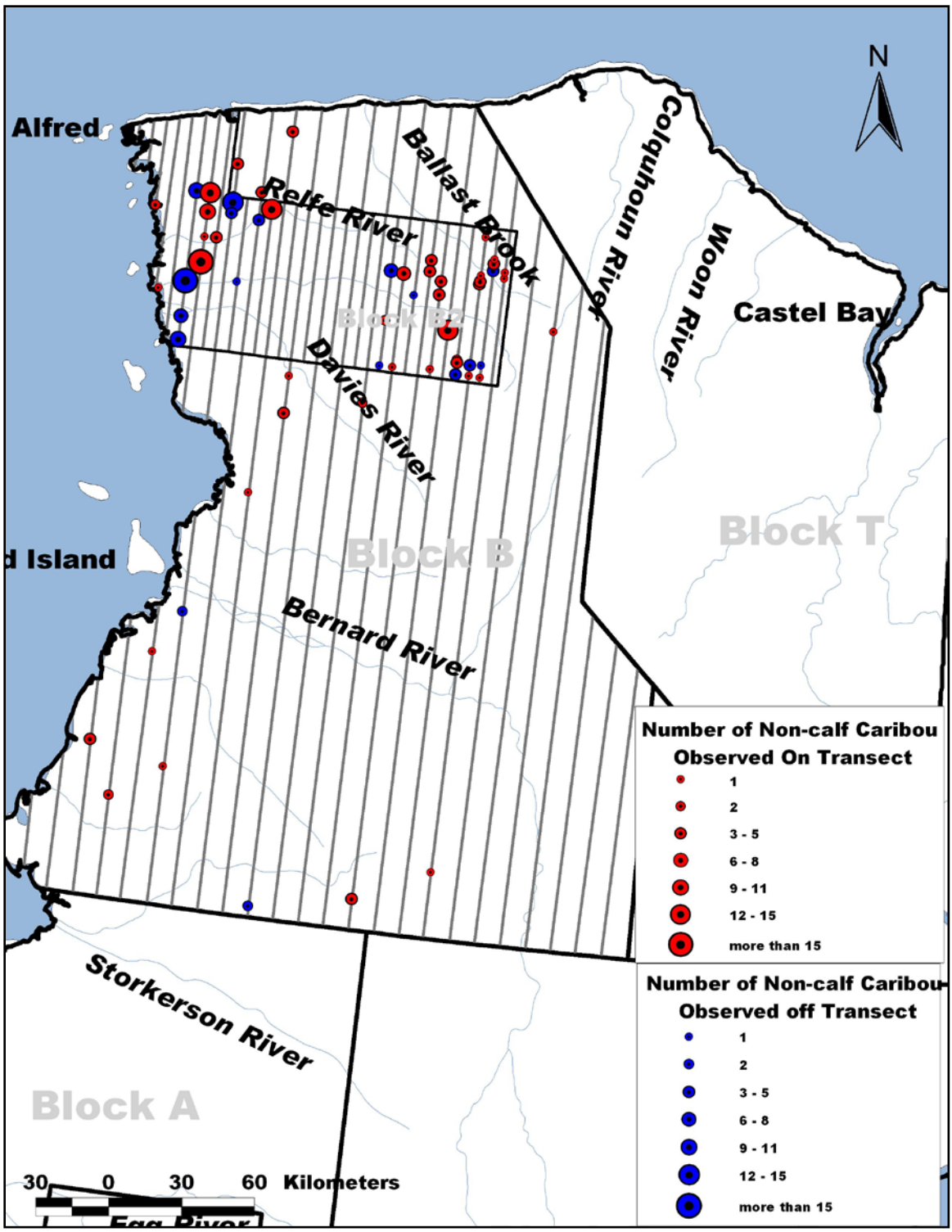

Figure 7: Distribution of non-calf Peary caribou in survey blocks B and B2 during the July 1994 Banks Island Peary caribou and muskox survey.

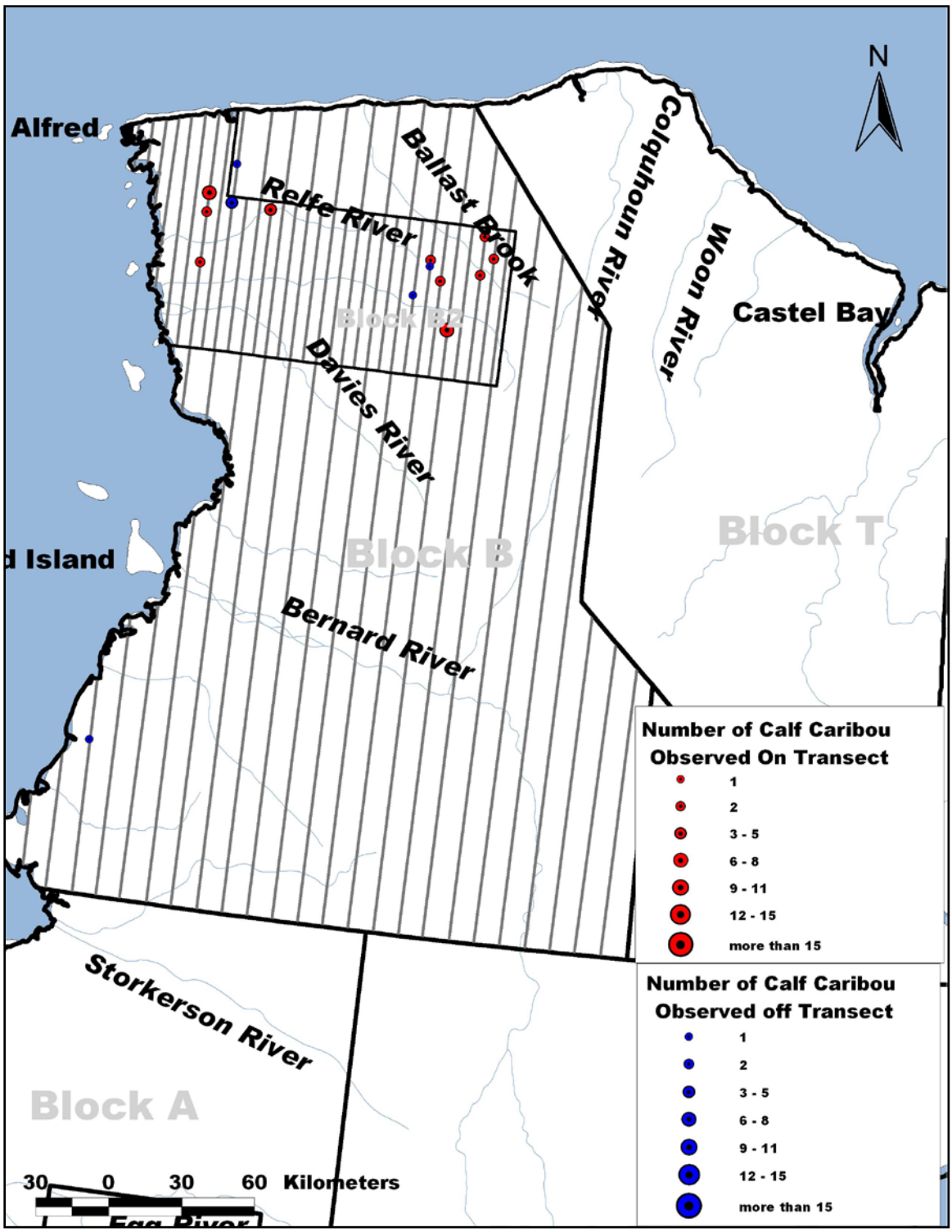

Figure 8: Distribution of calf caribou in survey blocks B and B2 during the July 1994 Banks Island Peary caribou and muskox survey.

The 1994 estimate of non-calf caribou was not significantly different from that reported for 1992 (Nagy et al. 2007d) (t^2 = 1.479, 61 df, P>0.05). In comparison, the estimate for calf caribou was significantly lower than that reported for 1992 (Nagy et al. 2007d) (t^2 = 5.486, 40 df, P<0.001). A comparison of the mean population estimates for 1992 and 1994 indicate that the caribou population declined at an annual finite rate of 36% per year during this period (Caughley 1977). The Peary caribou population trend for the period from 1982 to 1994 is shown in Figure 9.

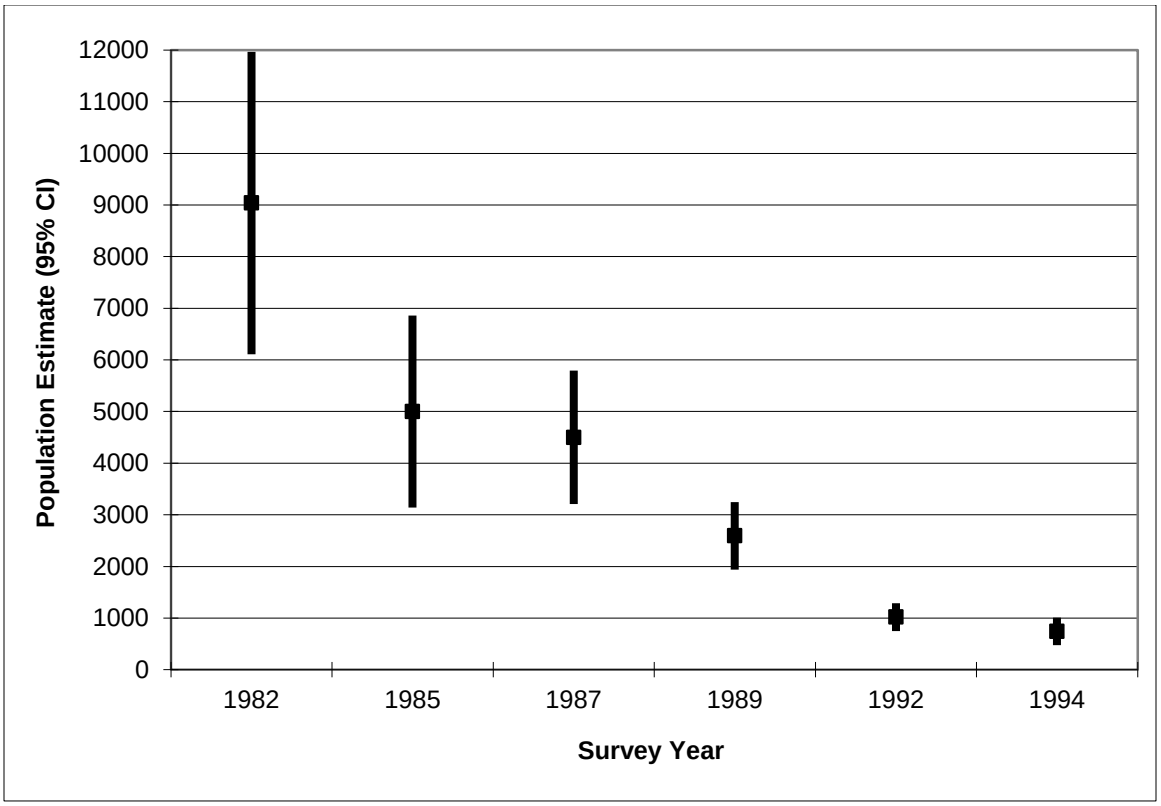

Figure 9: Population estimates with 95% CI for non-calf Peary caribou on Banks Island, NWT, 1982 to 1994.[1]

[1] Population estimates obtained from sources as follows: 1982 (Nagy et al. 2007e); 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.2007d); 1994 (this report).

Following stratification of survey block B, we observed a total of 334 non-calf and 27 calf caribou on and off transect. There were 8.1 calves per 100 cows. Approximately 7.5% of the caribou observed were calves. The majority of these caribou (246 non-calf and 20 calves) were found on the northwestern portion of the island in survey block B (Table 2 and Figures 3, 4, 5, 7 and 8).

Table 2: Population estimates for Peary caribou on Banks Island post-stratification, July 1994.

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	10,851	21	112.3	0.00	26	231.2	15.2	31.72	18.9	5	0	0.58	
B2	2,374	31	77.3	0.15	355	1,2076.2	109.9	224.40	40.3	143	103	0.31	
B-B2	12,454	28	126.1	0.01	181	3,063.8	55.4	114.80	21.0	38	4	0.31	
C	11,477	28	142.8	0.01	70	1,113.9	33.4	68.49	20.0	14	1	0.48	
D	17,832	39	202.4	0.01	100	844.8	29.1	58.83	20.1	20	2	0.29	
E	2,698	25	63.3	0.00	5	7.4	2.7	5.62	39.6	2	0	0.54	
M	1,427	15	45.7	0.00	5	24.7	5.0	10.66	38.9	2	0	0.97	
P	2,983	13	66.0	0.00	0				19.9	0	0		
T	8,487	28	140.7	0.00	0				19.4	0	0		
Sum of Blocks	70,583	228	976.6	0.01	742	17,362.1	131.8	269.49	21.8	224	110	0.18	29
Caribou: Calf													
A	10,851	21	112.3	0.00	16	205.6	14.3	29.91	18.9	3	0	0.91	
B2	2,374	31	77.3	0.02	40	161.0	12.7	25.91	40.3	16	4	0.32	
B-B2	12,454	28	126.1	0.00	10	48.0	6.9	14.37	21.0	2	0	0.73	
C	11,477	28	142.8						20.0	0	1		
D	17,832	39	202.4	0.00	5	22.0	4.7	9.50	20.1	1	0	0.94	
E	2,698	25	63.3						39.6	0	0		
M	1,427	15	45.7						38.9	0	0		
P	2,983	13	66.0						19.9	0	0		
T	8,487	28	140.7						19.4	0	0		
Sum of Blocks	70,583	228	976.6	0.00	70	436.7	20.9	43.59	21.8	22	5	0.30	21
Caribou: Total													
A	10,851	21	112.3	0.00	26	231.2	15.2	31.72	18.9	8	0	0.58	
B2	2,374	31	77.3	0.17	395	14,687.3	121.2	247.47	40.3	159	107	0.31	
B-B2	12,454	28	126.1	0.02	190	3631.0	60.3	124.97	21.0	40	4	0.32	
C	11,477	28	142.8	0.01	70	1,113.9	33.4	68.49	20.0	14	2	0.48	
D	17,832	39	202.4	0.01	100	844.8	29.1	58.83	20.1	21	2	0.29	
E	2,698	25	63.3	0.00	5	7.4	2.7	5.62	39.6	2	0	0.54	
M	1,427	15	45.7	0.00	5	24.7	5.0	10.66	38.9	2	0	0.97	
P	2,983	13	66.0	0.00	0				19.9	0	0		
T	8,487	28	140.7	0.00	0				19.4	0	0		

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
Sum of Blocks	70,583	228	976.6	0.01	791	20,540.3	143.3	293.58	21.8	246	115	0.18	29

We found seven caribou mortality sites (Figure 10). The majority of these were found on the caribou winter range on the southwestern portion of the island (survey blocks A, E, and M).

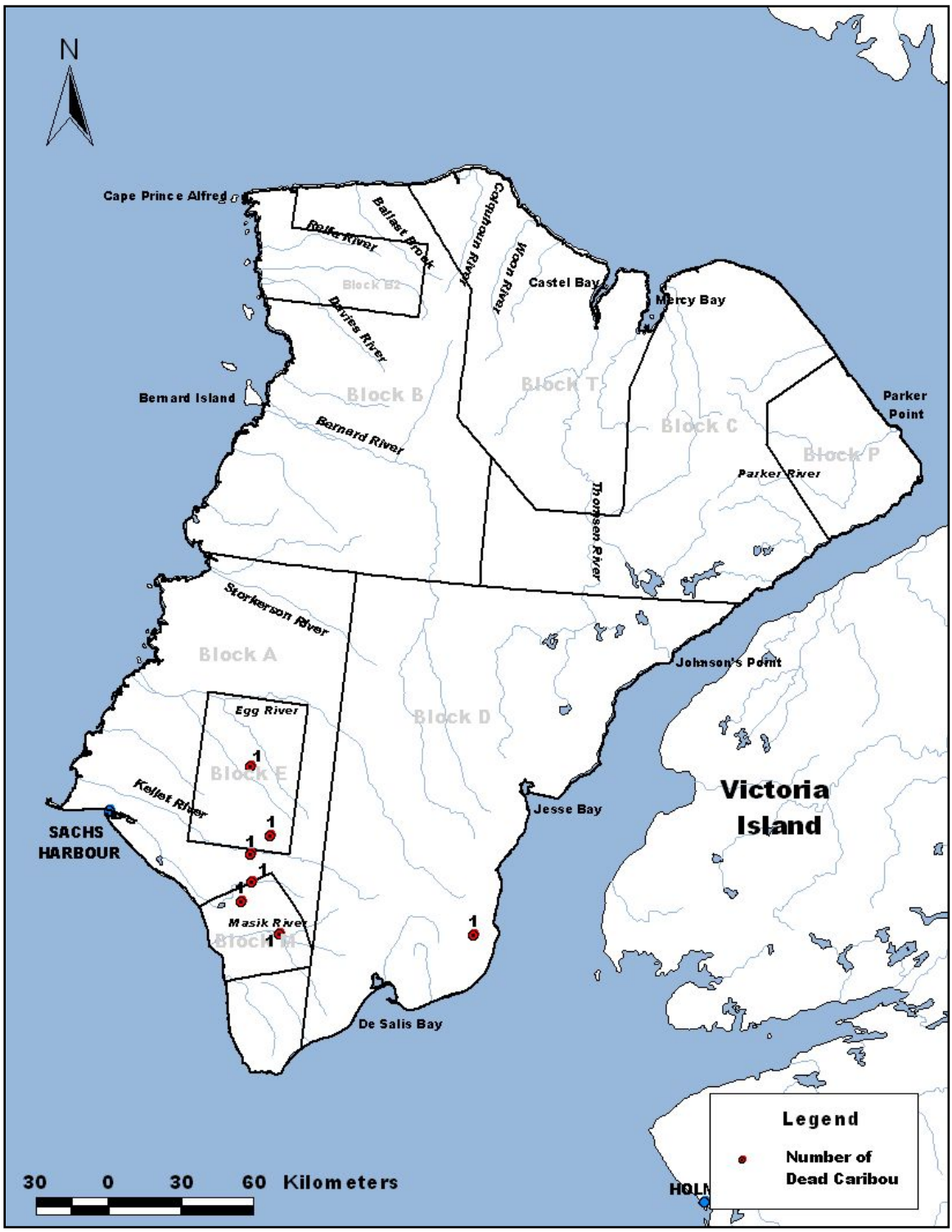

Figure 10: Number of dead caribou observed during the July 1994 Banks Island Peary caribou and muskox survey.

Muskox

The distribution of non-calf and calf muskoxen observed during the survey is shown in Figure 11 and Figure 12, respectively. We observed a total of 14,803 non-calf and 1,672 calf muskoxen on transect, giving estimates of 66,297 ± 5,106 (95% CI) non-calf and 7,091 ± 760 (95% CI) calf muskoxen (Table 3). Overall there were 0.94 non-calf muskoxen per km^2 on the island (Table 3). Densities exceeded one non-calf muskox per km^2 in the Egg and Parker river drainages and two non-calf muskox per km^2 in the Massik and Thomsen river drainages (Table 3).

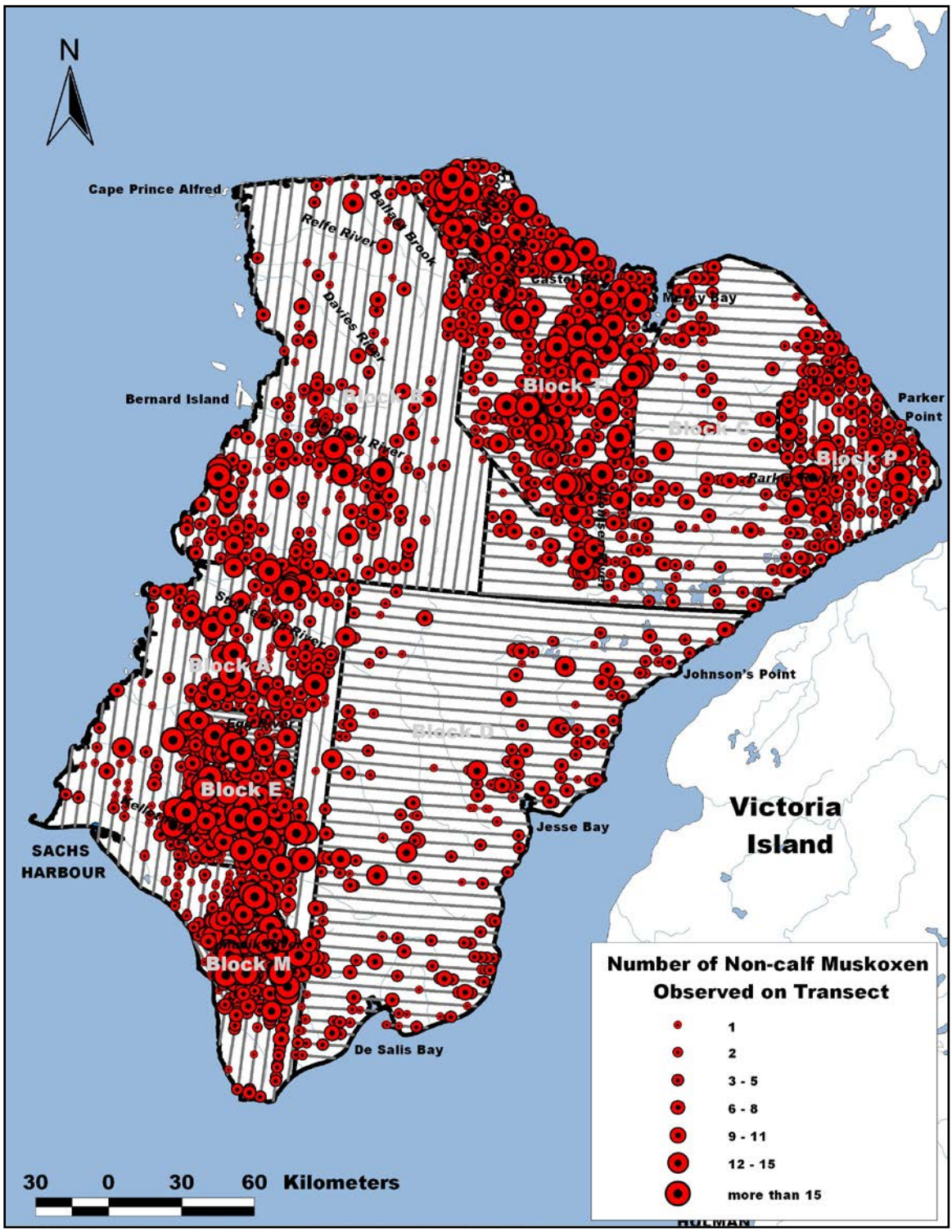

Figure 11: Distribution of non-calf caribou on Banks Island during the July 1994 Banks Island Peary caribou and muskox survey.

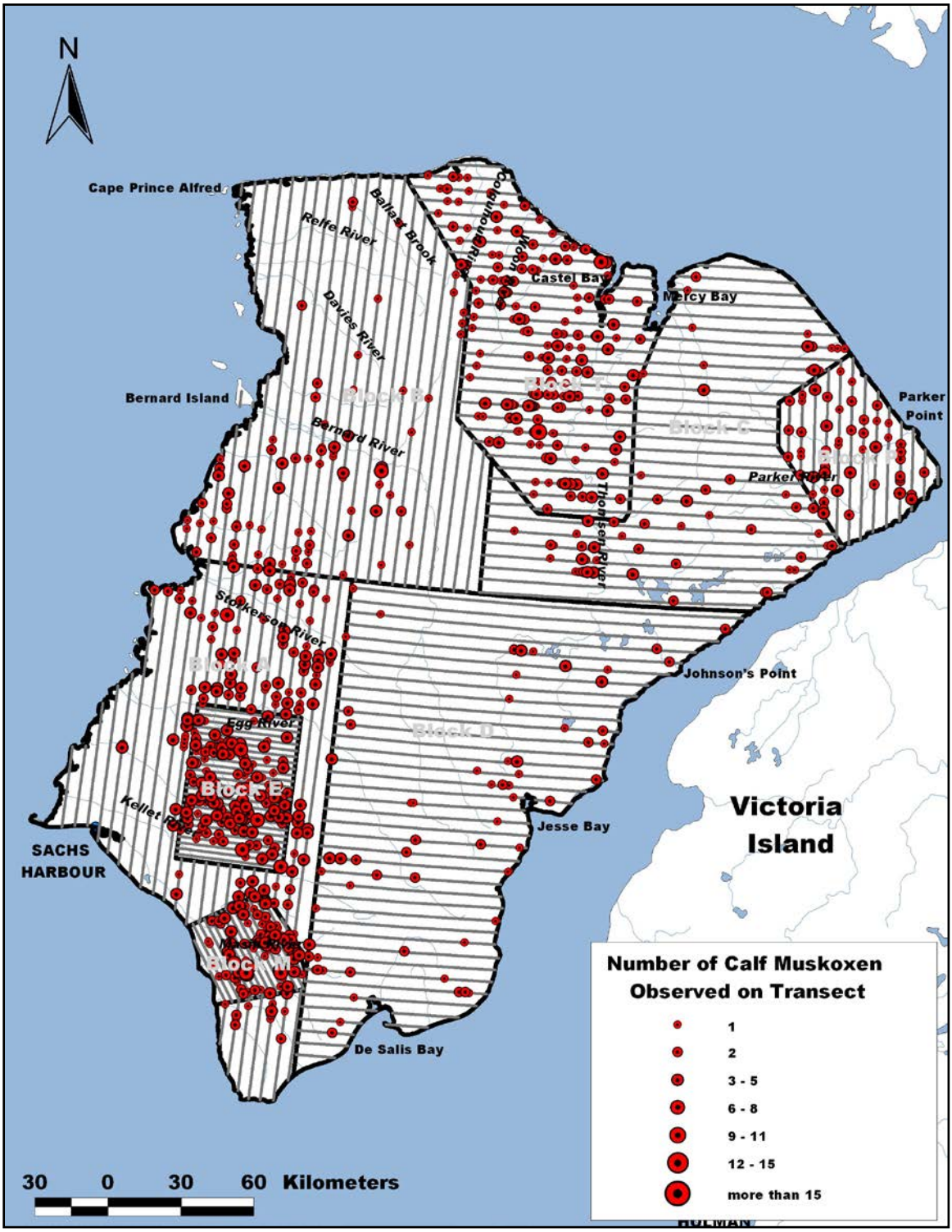

Figure 12: Distribution of calf muskox on Banks Island during the July 1994 Banks Island Peary caribou and muskox survey.

Table 3: Population estimates for muskox on Banks Island, July 1994.

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	10,851	21	112.3	0.94	10,220	1,694,753.1	1,301.8	2,715.61	18.9	1,936	not recorded	0.13	
B	14,828	24	126.1	0.48	7,139	712,821.1	844.3	1,746.83	20.0	1,430	not recorded	0.12	
C	11,477	28	142.8	0.54	6,170	522,661.9	723.0	1,483.50	20.0	1,232	not recorded	0.12	
D	17,832	39	202.4	0.27	4,791	275,264.8	524.7	1,061.91	20.1	963	not recorded	0.11	
E	2,698	25	63.3	1.91	5,148	257,446.9	507.4	1,047.26	39.6	2,038	not recorded	0.10	
M	1,427	15	45.7	2.90	4,141	258,634.8	508.6	1,090.86	38.9	1,610	not recorded	0.12	
P	2,983	13	66.0	1.65	4,913	382,359.8	618.4	1,347.39	19.9	978	not recorded	0.13	
T	8,487	28	140.7	2.80	23,774	2,016,206.7	1,419.9	2,913.70	19.4	4,616	not recorded	0.06	
Sum of Blocks	70,583			0.94	66,297	6,120,149.0	2,473.9	5,105.86	20.9	14,803		0.04	24
Muskox: Calf													
A	10,851	21	112.3	0.15	1,631	58,857.1	242.6	506.07	18.9	309	not recorded	0.15	
B	14,828	24	126.1	0.05	694	12,497.2	111.8	231.30	20.0	139	not recorded	0.16	
C	11,477	28	142.8	0.04	516	8,219.9	90.7	186.04	20.0	103	not recorded	0.18	
D	17,832	39	202.4	0.03	557	6,925.1	83.2	168.43	20.1	112	not recorded	0.15	
E	2,698	25	63.3	0.33	894	7,899.8	88.9	183.45	39.6	354	not recorded	0.10	
M	1,427	15	45.7	0.39	561	9,269.8	96.3	206.52	38.9	218	not recorded	0.17	
P	2,983	13	66.0	0.17	502	7,709.6	87.8	191.33	19.9	100	not recorded	0.17	
T	8,487	28	140.7	0.20	1,736	22,228.4	149.1	305.94	19.4	337	not recorded	0.09	
Sum of Blocks	70,583			0.10	7,091	133,607.0	365.5	760.15	20.9	1,672		0.05	21
Muskox: Total													
A	10,851	21	112.3	1.09	11,851	2,355,142.6	1,534.6	3,201.27	18.9	2,245	not recorded	0.13	
B	14,828	24	126.1	0.52	7,783	878,430.7	937.2	1,939.16	20.0	1,559	not recorded	0.12	
C	11,477	28	142.8	0.58	6,686	616,854.0	785.4	1,611.64	20.0	1,335	not recorded	0.12	
D	17,832	39	202.4	0.30	5,348	352,067.3	593.4	1,200.95	20.1	1,075	not recorded	0.11	
E	2,698	25	63.3	2.24	6,043	346,844.5	588.9	1,215.56	39.6	2,392	not recorded	0.10	
M	1,427	15	45.7	3.30	4,702	354,276.9	595.2	1,276.73	38.9	1,828	not recorded	0.13	
P	2,983	13	66.0	1.82	5,415	489,370.2	699.6	1,524.32	19.9	1,078	not recorded	0.13	
T	8,487	28	140.7	3.01	25,510	2,340,166.8	1,529.8	3,139.07	19.4	4,953	not recorded	0.06	
Sum of Blocks	70,583			1.04	73,338	7,733,153.1	2,780.9	5,752.63	20.9	16,465		0.04	24

The 1994 estimate of non-calf muskoxen was significantly higher than that reported for 1992 (Nagy et al. 2007d) (t^2 = 40.040, 48 df, P<0.001). In comparison, the estimate of calf muskoxen was significantly lower than that reported for 1992 (Nagy et al. 2007d) (t^2 = 7.085, 52 df, P<0.001). There were 11.3 calves per 100 non-calf muskoxen. Approximately 10.2% of the muskoxen observed on transect were calves. A comparison of the mean population estimates for 1992 and 1994 indicate that the non-calf muskox population increased at an annual finite rate of 62% per year during this period (Caughley 1977). The muskox population trend for the period from 1982 to 1994 is shown in Figure 13.

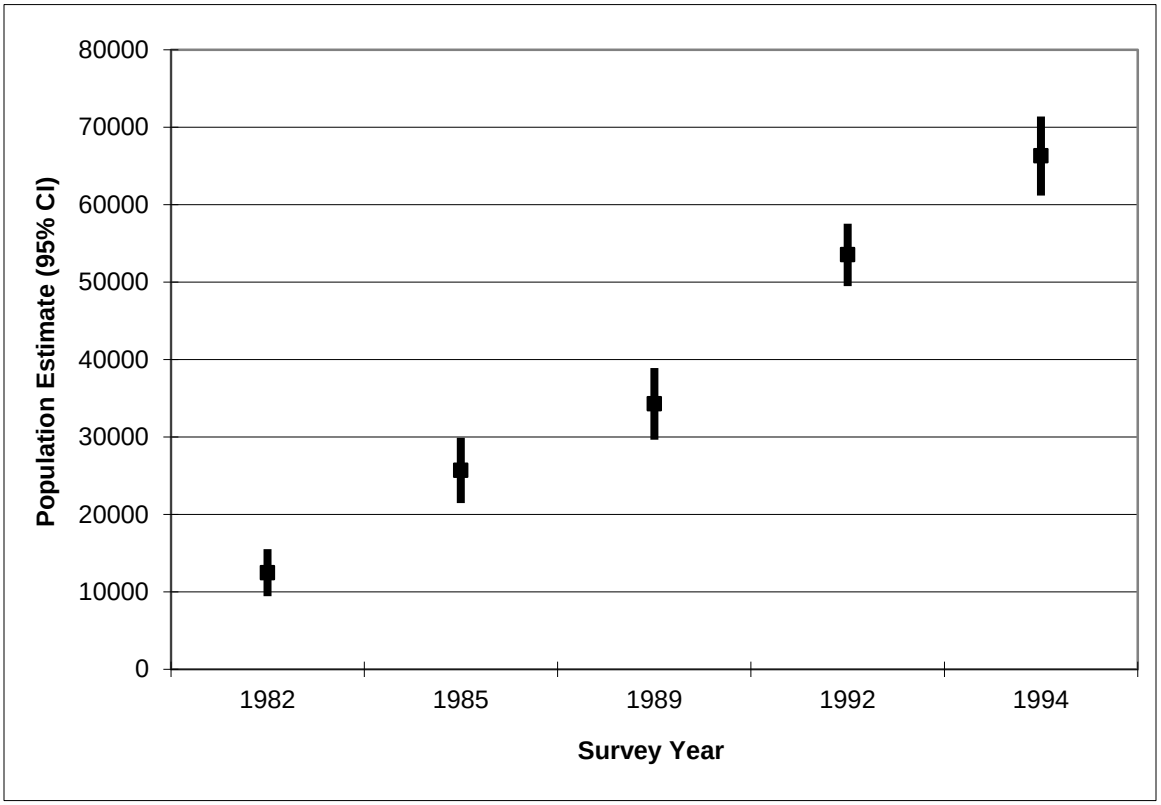

Figure 13: Population estimates with 95% CI for non-calf muskox on Banks Island, NWT, 1982 to 1994.[2]

[2] Population estimates obtained from:
1982 (Nagy et al. 2007e); 1985 (McLean et al. 1986); 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. 2007d); 1994 (this report).

We observed 189 dead muskoxen during the survey. The majority of these were found within the high-density muskox areas on the southwestern (survey blocks A, E, M) and northwestern (survey block B) portions of the island (Figure 14).

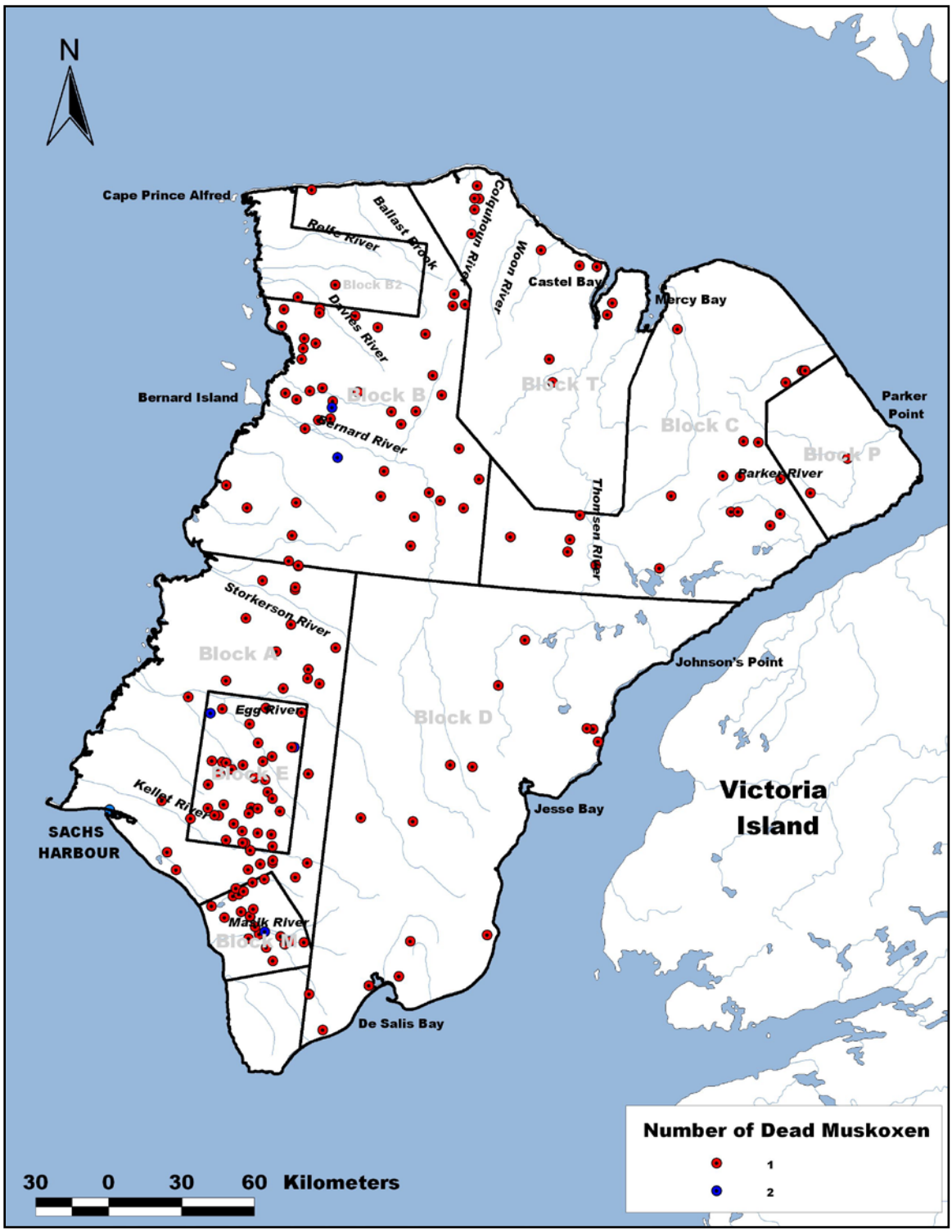

Figure 14: Number of dead muskox observed during the July 1994 Banks Island Peary caribou and muskox survey.

Wolves

We observed a total of 23 wolves. These were found in the northern portion of the island in survey blocks B, T, and P, with six found within the caribou post-calving range (Figure 15).

Figure 15: Distribution of wolves observed during the July 1994 Banks Island Peary caribou and muskoxen survey.

DISCUSSION

The results of our survey indicate there were approximately 742 ± 269 non-calf and 70 ± 44 calf caribou on Banks Island (70,583 km^2) in July 1994. The 1994 and 1992 estimates for non-calf caribou were not significantly different, however a comparison of the mean population estimates suggests a decline. There were significantly fewer calves in 1994 than 1992, indicating that a continued decline can be anticipated.

Freezing rains occurred on Banks Island during October and November 1993. Approximately 50% of the caribou winter range on southern Banks Island was ice-covered (Larter and Nagy 1994). These conditions may have had a negative impact on adult cow body condition resulting in lower pregnancy rates or higher pre- or post-natal mortality. The low number of calves observed in July 1994 may have been a result of these severe winter conditions.

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 1994 survey were found in this area.

There were approximately 66,297 ± 5,106 (95% CI) non-calf and 7,091 ± 760 (95% CI) calf muskoxen on Banks Island in July 1994, indicating that the population continued to increase between 1992 and 1994. The majority of muskoxen were found in the Egg, Massik, Parker, and Thomsen river drainages. This is consistent with observations made in the past. There were, however, significantly fewer calves in 1994. Whether this decline in the number of muskox calves was a result of the severe conditions that occurred in winter 1993-1994 or is due to other factors is not known.

We observed two and 23 wolves during the surveys conducted in 1992 and 1994, respectively. Whether this increase in numbers of sightings reflects an increase in the number of

wolves on the island is not known. Significantly, we observed six wolves within the post-calving range of the caribou herd.

ACKNOWLEDGEMENTS

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APPENDIX A: Transect Data for the 1994 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	32.914	0	0	0	4	0	4
	A02	32.723	0	0	0	6	0	6
	A03	50.044	0	0	0	6	0	6
	A04	63.618	0	0	0	21	0	21
	A05	73.0247	0	0	0	28	5	33
	A06	113.048	1	0	1	22	2	24
	A07	118.288	1	0	1	14	2	16
	A08	123.243	3	3	6	44	3	47
	A09	128.522	0	0	0	64	9	73
	A10	138.433	0	0	0	153	23	176
	A11	78.391	0	0	0	77	15	92
	A12	83.726	0	0	0	92	23	115
	A13	81.542	0	0	0	145	22	167
	A14	78.617	0	0	0	57	11	68
	A15	75.364	0	0	0	90	11	101
	A16	89.381	0	0	0	109	16	125
	A17	99.836	0	0	0	232	37	269
	A18	104.383	0	0	0	144	22	166
	A19	113.874	0	0	0	145	25	170
	A20	185.394	0	0	0	258	51	309
	A21	191.174	0	0	0	225	32	257
	Total	2,055.54	5	3	8	1,936	309	2,245
B	B01	57.543	0	0	0	1	0	1
	B02	61.941	0	0	0	0	0	0
	B03	66.955	0	0	0	0	0	0
	B04	125.082	0	0	0	23	3	26
	B05	131.543	0	0	0	60	2	62
	B06	137.219	1	0	1	49	2	51
	B07	144.208	0	0	0	41	3	44
	B08	151.351	1	0	1	43	3	46
	B09	157.032	1	0	1	125	14	139
	B10	163.865	7	2	9	38	1	39
	B11	163.387	3	0	3	89	6	95
	B12	163.596	0	0	0	85	12	97
	B13	162.633	4	0	4	73	6	79
	B14	161.79	0	0	0	119	14	133
	B15	160.904	0	0	0	118	9	127
	B16	159.6	8	1	9	37	3	40
	B17	159.015	5	0	5	93	13	106
	B18	155.016	7	0	7	43	5	48
	B19	139.348	9	1	10	31	1	32
	B20	120.663	1	0	1	114	13	127
	B21	106.171	2	0	2	92	8	90
	B22	68.583	7	1	8	122	14	136
	B23	37.795	0	0	0	22	5	27

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	B24	14.798	0	0	0	12	2	14
	Total	2,970.038	56	5	61	1,430	139	1,559
C	C01	31.385	0	0	0	12	0	12
	C02	47.607	0	0	0	26	2	28
	C03	54.812	0	0	0	25	1	26
	C04	56.607	0	0	0	15	0	15
	C05	63.631	0	0	0	13	0	13
	C06	71.001	0	0	0	69	2	71
	C07	76.759	0	0	0	92	8	100
	C08	76.601	0	0	0	16	0	16
	C09	72.165	0	0	0	114	6	120
	C10	66.627	0	0	0	25	1	26
	C11	62.077	5	0	5	9	3	12
	C12	57.569	0	0	0	8	0	8
	C13	57.883	5	0	5	17	0	17
	C14	58.188	0	0	0	9	0	9
	C15	58.288	1	0	1	19	0	19
	C16	61.037	0	0	0	12	0	12
	C17	64.775	0	0	0	4	0	4
	C18	68.719	0	0	0	82	3	85
	C19	79.806	0	0	0	33	3	36
	C20	88.462	0	0	0	62	10	72
	C21	96.981	1	0	1	14	1	15
	C22	140.872	2	0	2	98	11	109
	C23	144.452	0	0	0	83	6	89
	C24	138.579	0	0	0	108	13	121
	C25	133.147	0	0	0	122	10	132
	C26	126.95	0	0	0	80	17	97
	C27	123.166	0	0	0	39	4	43
	C28	113.58	0	0	0	26	2	28
	Total	2,291.726	14	0	14	1,232	103	1,335
D	D01	158.884	0	0	0	11	1	12
	D02	155.075	2	0	2	16	2	18
	D03	150.448	0	0	0	35	1	36
	D04	141.714	0	0	0	14	2	16
	D05	136.652	0	0	0	51	9	60
	D06	132.067	1	0	1	33	4	37
	D07	124.288	5	0	5	32	4	36
	D08	120.305	2	0	2	9	0	9
	D09	115.019	0	0	0	13	1	14
	D10	114.365	0	0	0	5	0	5
	D11	114.362	0	0	0	46	5	51
	D12	112.927	0	0	0	24	5	29
	D13	111.745	0	0	0	17	0	17
	D14	110.93	0	0	0	29	4	33
	D15	110.729	0	0	0	49	7	56

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	D16	104.407	1	0	1	65	5	70
	D17	94.721	1	0	1	19	3	22
	D18	80.654	0	0	0	15	2	17
	D19	82.98	3	0	3	12	1	13
	D20	83.753	0	0	0	8	0	8
	D21	83.163	1	0	1	33	6	39
	D22	80.744	0	0	0	15	2	17
	D23	77.901	0	0	0	36	9	45
	D24	74.668	1	0	1	33	5	38
	D25	75.361	0	0	0	10	1	11
	D26	76.571	1	1	2	0	0	0
	D27	75.832	0	0	0	24	2	26
	D28	75.265	1	0	1	5	0	5
	D29	75.207	0	0	0	32	1	33
	D30	77.543	0	0	0	43	9	52
	D31	76.579	0	0	0	59	4	63
	D32	75.819	0	0	0	66	8	74
	D33	74.221	1	0	1	24	5	29
	D34	70.639	0	0	0	16	1	17
	D35	57.525	0	0	0	14	0	14
	D36	42.121	0	0	0	18	1	19
	D37	22.437	0	0	0	18	2	20
	D38	20.753	0	0	0	9	0	9
	D39	15.834	0	0	0	5	0	5
	Total	3,584.208	20	1	21	963	112	1,075
E	E01	42.099	0	0	0	10	3	13
	E02	42.149	0	0	0	10	1	11
	E03	42.202	0	0	0	40	11	51
	E04	42.254	0	0	0	35	8	43
	E05	42.306	0	0	0	42	6	48
	E06	42.357	0	0	0	83	18	101
	E07	42.411	0	0	0	112	21	133
	E08	42.46	0	0	0	98	22	120
	E09	42.514	0	0	0	48	13	61
	E10	42.566	0	0	0	45	8	53
	E11	42.617	0	0	0	51	8	59
	E12	42.668	0	0	0	89	13	102
	E13	42.722	0	0	0	91	18	109
	E14	42.774	0	0	0	136	27	163
	E15	42.826	0	0	0	79	18	97
	E16	42.877	0	0	0	153	27	180
	E17	42.929	0	0	0	238	32	270
	E18	42.982	0	0	0	169	35	204
	E19	43.032	0	0	0	78	13	91
	E20	43.085	0	0	0	90	13	103
	E21	43.138	1	0	1	93	8	101
	E22	43.194	0	0	0	95	11	106

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	E23	43.243	0	0	0	60	10	70
	E24	43.291	1	0	1	32	4	36
	E25	43.341	0	0	0	61	6	67
	Total	1,068.037	2	0	2	2,038	354	2,392
M	M01	28.31	0	0	0	4	0	4
	M02	35.481	0	0	0	46	2	48
	M03	36.221	0	0	0	77	4	81
	M04	36.858	0	0	0	105	8	113
	M05	37.488	0	0	0	176	24	200
	M06	38.136	0	0	0	183	24	207
	M07	38.743	0	0	0	176	19	195
	M08	39.442	0	0	0	70	5	75
	M09	40.078	2	0	2	53	6	59
	M10	40.692	0	0	0	133	20	153
	M11	41.459	0	0	0	186	34	220
	M12	42.171	0	0	0	74	9	83
	M13	42.69	0	0	0	107	22	129
	M14	39.097	0	0	0	149	25	174
	M15	17.881	0	0	0	71	16	87
	Total	554.747	2	0	2	1,610	218	1,828
P	P01	27.508	0	0	0	68	6	74
	P02	38.578	0	0	0	69	9	78
	P03	50.031	0	0	0	90	8	98
	P04	60.351	0	0	0	197	21	218
	P05	71.634	0	0	0	95	7	102
	P06	74.93	0	0	0	115	10	125
	P07	65.948	0	0	0	61	5	66
	P08	56.694	0	0	0	86	8	94
	P09	48.034	0	0	0	43	2	45
	P10	40.036	0	0	0	106	17	123
	P11	32.972	0	0	0	25	5	30
	P12	20.021	0	0	0	23	2	25
	P13	7.069	0	0	0	0	0	0
	Total	593.806	0	0	0	978	100	1,078
T	T01	22.042	0	0	0	24	0	24
	T02	37.379	0	0	0	122	6	128
	T03	44.09	0	0	0	171	5	176
	T04	45.481	0	0	0	174	5	179
	T05	48.682	0	0	0	84	5	89
	T06	9.392	0	0	0	152	8	160
	T07	56.072	0	0	0	225	16	241
	T08	65.768	0	0	0	285	23	308
	T09	74.399	0	0	0	215	14	229
	T10	70.971	0	0	0	156	9	165
	T11	74.513	0	0	0	188	19	207

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total	Muskox: Non-calf	Muskox: Calf	Muskox: Total
	T12	72.672	0	0	0	113	8	121
	T13	71.78	0	0	0	187	12	199
	T14	76.255	0	0	0	239	21	260
	T15	74.795	0	0	0	225	10	235
	T16	73.352	0	0	0	165	11	176
	T17	71.886	0	0	0	150	14	164
	T18	70.604	0	0	0	139	7	146
	T19	70.862	0	0	0	270	24	294
	T20	71.136	0	0	0	306	30	336
	T21	71.358	0	0	0	215	9	224
	T22	67.922	0	0	0	217	20	237
	T23	63.214	0	0	0	121	14	135
	T24	58.125	0	0	0	100	9	109
	T25	53.636	0	0	0	56	5	61
	T26	48.905	0	0	0	160	21	181
	T27	44.025	0	0	0	104	10	114
	T28	38.536	0	0	0	53	2	55
	Total	1,647.852	0	0	0	4,616	337	4,953

APPENDIX B: Transect Data for Survey Block B2, Banks Island Caribou and Muskoxen Survey, July 1994.

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: calf	Caribou: Total
B2	1	30.415	0	0	0
	2	30.394	0	0	0
	3	30.373	0	0	0
	4	30.444	15	2	17
	5	30.514	0	0	0
	6	30.462	0	0	0
	7	30.400	0	0	0
	8	30.439	0	0	0
	9	30.468	0	0	0
	10	30.495	0	0	0
	11	30.523	0	0	0
	12	30.493	0	0	0
	13	30.464	0	0	0
	14	30.489	2	0	2
	15	30.514	9	0	9
	16	30.518	0	0	0
	17	30.523	7	1	8
	18	30.516	10	1	11
	19	30.510	15	4	19
	20	30.512	7	0	7
	21	30.514	10	2	12
	22	30.514	6	1	7
	23	30.514	2	0	2
	24	8.031	0	0	0
	25	10.031	0	0	0
	26	19.556	0	0	0
	27	34.310	1	0	1
	28	44.414	0	0	0
	29	45.767	0	0	0
	30	46.346	56	5	61
	31	47.024	3	0	3
	Total	956.487	143	16	159

APPENDIX C: Transect Data for Survey Block B Minus B2, Banks Island Caribou and Muskox Survey, July 1994.

Survey Block	Transect Number	Transect Area (km^2)	Caribou: Non-calf	Caribou: Calf	Caribou: Total
B-B2	B-B2-01	57.543	0	0	0
	B-B2-02	61.941	0	0	0
	B-B2-03	66.955	0	0	0
	B-B2-04	125.082	0	0	0
	B-B2-05	131.543	0	0	0
	B-B2-06	137.219	1	0	1
	B-B2-07	144.208	0	0	0
	B-B2-08	120.837	1	0	1
	B-B2-09	126.518	0	0	0
	B-B2-10	133.355	0	0	0
	B-B2-11	132.865	3	0	3
	B-B2-12	133.082	0	0	0
	B-B2-13	132.169	2	0	2
	B-B2-14	131.268	0	0	0
	B-B2-15	130.435	0	0	0
	B-B2-16	129.189	6	0	6
	B-B2-17	128.501	4	0	4
	B-B2-18	124.644	5	0	5
	B-B2-19	139.348	6	1	7
	B-B2-20	120.663	1	0	1
	B-B2-21	106.171	2	0	2
	B-B2-22	68.582	7	1	8
	B-B2-23	37.802	0	0	0
	Total	2,619.92	38	2	40