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Population demography of Peary caribou and muskox on Banks Island, N.W.T., 1982-1992

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Abstract: The Peary caribou population (excluding calves) on Banks Island declined from 6 970 (± 1133) in 1982 to 897 (± 151) in 1991. The 1992 estimate was 1 005 (± 133). Percent calves in the population varied among years (range 3.2-31.1%). Mean group sizes dropped from 5.0 in 1985 to a low of 2.0 in 1989 and 1991. Median group sizes were significantly larger between 1982 and 1987 than between 1989 and 1992 ($P<0.001$). Large post-calving aggregations prevalent on the NW portion of Banks Island in the early 1980's were absent by the 1990's. The muskox population (excluding calves), increased from 29 168 (± 2104) in 1985 to 52 959 (± 2240) in 1992. Percent calves in the population varied among years, (range 11.8-17.1%). These values may be underestimates, because calves are small and muskox groups sometimes form defensive circles in response to aircraft. Muskoxen were distributed throughout the island during all surveys; however, the greatest increase in density occurred in the southern parts of the island.

Key words: Peary caribou, muskox, Banks Island, population demography

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Introduction

Peary caribou (*Rangifer tarandus pearyii*) and muskox (*Ovibos moschatus*) are an important subsistence food source for the residents of Sachs Harbour, Banks Island. These ungulate populations have been systematically monitored by the Department of Renewable Resources, Government of the Northwest Territories since 1982.

During the past decade, caribou numbers decreased. Severe winter weather is believed to be the major cause of declining caribou numbers (Parker *et al.*, 1975; Gunn, 1992). Annual die-offs of 60-300 caribou were recorded following the winters of 1987-88, 1988-89, and 1990-91 when freezing rains occurred. In response to decreasing caribou numbers, the Sachs Harbour Hunter's and Trapper's Committee established a quota of 150 animals in 1990 and 30 males in 1991. In 1992, the quota was increased to 36 males to allow each family to harvest one caribou.

Over the same period muskox numbers increased. The residents of Sachs Harbour harvest muskoxen to support a local subsistence economy and conduct guided sport hunts for non-resident hunters. In addition, a commercial harvest program has been in place since 1981. During the quota years 1980-81 to 1989-90, the average commercial take was 124 muskoxen/year (range 0 to 260). The first large-scale harvest was conducted during 1990-91 when 494 muskoxen were taken. During the quota year 1991-92, 2 031 muskoxen were taken. The annual quota has been 5 000 muskoxen since 1991.

Scat analysis indicates that both muskox and caribou are taken by wolves (*Canis lupus*); however, data on wolf numbers and predation rates are lacking. Inuvialuit in Sachs Harbour harvest wolves for subsistence use. Fewer than 10 wolves were harvested annually from 1988-89 to 1991-92; however, 50 wolves were harvested in winter 1992-93 (Larter & Clarkson, 1994).

This paper summarizes all Banks Island survey data for caribou and muskox collected during the 10-year period 1982-92. We document changes in population size and distribution of the two arctic ungulate populations and, where methodologies permit, we compare changes in group size and the proportion of calves in each population.

Study Area

Banks Island is the most western island in the Canadian Arctic Archipelago which covers an area of approximately 70 000 km^2 (Fig. 1). The climate is Arctic Maritime along coastal areas tending toward Arctic Desert inland. Winters are long and cold; summers are short and cool. Precipitation is low, with an annual mean of 9 cm (Zoltai *et al.*, 1980).

Sachs Harbour is the only permanent settlement on the Island (71° 59' N., 125° 17' W.). A general overview of the geology and glacial history can be found in Zoltai *et al.* (1980).

Habitat types were adapted from Kevan (1974), Wilkinson *et al.* (1976), and Ferguson (1991). We recognized four major terrestrial habitats: i) Wet Sedge Meadow, ii) Upland Barren, iii) Hummock Tundra, and iv) Stony barren. Wet Sedge Meadows are generally level hydric lowlands dominated by *Carex aquatilis*, *Eriophorum scheuchzeri*, and *Dupontia fisheri*. Upland Barrens are moist well-drained sites found on the upper and middle slopes. Vegetation is dominated by *Dryas integrifolia* and *Salix arctica*. Hummock Tundra is found on moderately steep slopes characterized by individual hummocks vegetated primarily by dwarf shrubs (*D. integrifolia*, *S. arctica*, and *Cassiope tetragona*). Stony Barrens are gravelly areas that are sparsely vegetated; typically these

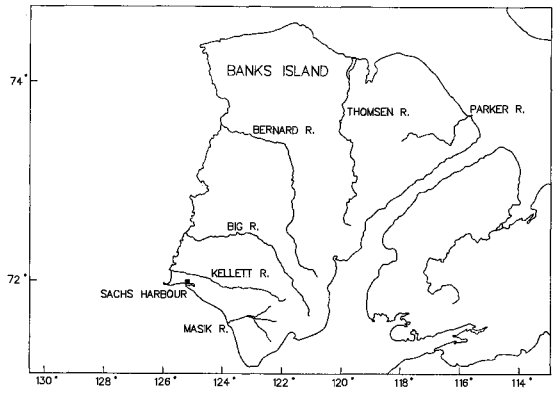

Fig. 1. The study area, Banks Island, Northwest Territories, Canada.

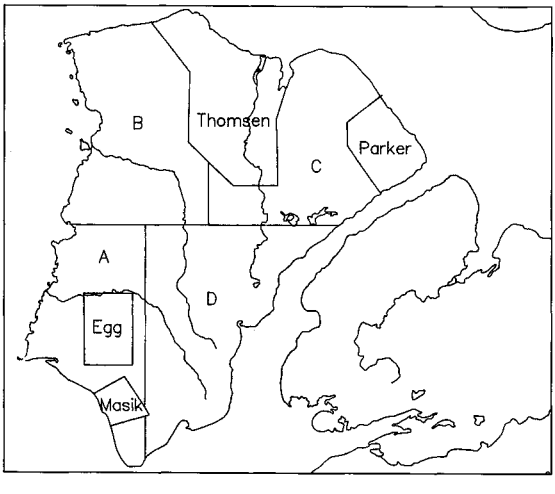

Fig. 2. Banks Island dehneated into the 8 strata: A, B, C, D, Egg, Masik, Parker, and Thomsen.

are wind-blown ridges, and sand bars. A more detailed description of the flora of Banks Island can be found in Porsild (1955), Wilkinson *et al.* (1976), and Zoltai *et al.* (1980).

Wolves, arctic foxes (*Alopex lagopus*), and polar bears (*Ursus maritimus*) also inhabit Banks Island.

Methods

Population Estimates

Population surveys were conducted using fixed-wing aircraft in 1982 (Latour, 1985), 1985 (McLean *et al.*, 1986), 1987 (McLean, 1992), 1989 (McLean & Fraser, 1992), 1991 (Fraser *et al.*, 1992), and 1992 (Nagy, J. & Fraser, P., unpubl. data) using strip-transect techniques (Norton-Griffiths, 1978). Coverage varied considerably, lowest being in 1985 when some blocks were surveyed with parallel lines 20 km apart (McLean *et al.*, 1986), and highest in 1992 when some blocks were surveyed with lines 2.5 km apart (Nagy, J. & Fraser, P., unpubl. data).

Surveys were conducted in June and early July, except in 1992 when the survey was in late August. The entire island was surveyed, except in 1982 when an area of high muskox density was omitted. As a result, we believe the 1982 muskox population estimate is likely an underestimate. We estimated caribou and muskox numbers each year, except 1987 when muskoxen were not surveyed. The number of calves (both species) were counted on transect and their percentage in the population was calculated.

Verification of Original Survey Data

We verified the area of each stratum flown by digitizing 1:250,000 scale maps of Banks Island, entering the coordinates of the stratum boundaries, and calculating the resulting areas using a Lambert Azimuthal Equal Area projection in the Spans Geographical Information System (GIS). The accuracy of the Spans GIS was verified by entering the coordinates of an area of known size and then comparing it to the GIS area estimate. These resulting areas were then used to recalculate the survey estimates using the original observations and the Jolly (1969) method for unequal sized sampling units (Norton-Griffiths, 1978). The island-wide estimates of both caribou and muskox are reported. Because we recalculated survey areas, the estimates we report may differ from those found in the original survey reports.

Post-survey Stratification

In order to examine in more detail the changes in muskox density, especially in relation to harvest, we reanalyzed the 1985 and 1991 survey data. We placed the original observations from these surveys

into the 8 strata that were used for the 1989 and 1992 surveys (Fig. 2). We recalculated the estimates for each of the 8 strata and the island-wide population, and report both values for 1985, 1989, 1991, and 1992.

Growth Rate

Total estimates for the island population and for each stratum were compared with corresponding data from each subsequent year using two-tailed Student's *t*-tests. For caribou, we compared all estimates derived from 1982 to 1992. For muskoxen, we compared estimates derived for each of the 8 strata from 1985 to 1991. For total island population comparisons we also included the 1992 estimate. We calculated the instantaneous rate of population growth (r) for island and strata populations between surveys following Caughley (1977).

Group Size and Distribution

We used the Kruskal-Wallis (K-W) test (Gibbons, 1985) to assess differences in group size for caribou among years (1982, 1985, 1987, 1989, and 1991). When K-W tests indicated significant ($P<0.05$) results, multiple comparisons (Gibbons, 1985) were conducted on mean class ranks to identify significantly different population subsets. We used an overall significance level of 0.25 for multiple comparisons. Median and mean group sizes are reported.

The post-calving distribution of caribou and muskoxen observed during the 1982 to 1991 surveys was plotted for visual comparisons.

Results

Verification of Original Survey Data

The accuracy of the Spans GIS measurement was ±0.026%. In general, the difference between areas reported in the original surveys and those measured using the Spans GIS ranged between ± 8% for strata flown for caribou and from -7 to ± 6% for strata flown for muskoxen. The most notable differences were found for strata B, C and Thomsen River (Fig. 2). In 1985 the areas for strata B and Thomsen River were underestimated by 10 and 29% respectively, while stratum C was overestimated by 35%. These errors continued through 1992.

A comparison of population estimates presented in the original survey reports and those generated by our analyses indicates that caribou numbers were overestimated by 5.0, 0.3, and 5.6% in 1982, 1985, and 1987, respectively. Contrastingly, numbers were underestimated by 1.8, 1.0, and 1.7% in 1989, 1991, and 1992 respectively. Muskox numbers were underestimated by 11.9, 7.5, 2.1, and 7.4% in 1985, 1989, 1991, and 1992, respectively.

Caribou

The Peary caribou population (excluding calves) decreased from 6 970 (± 1133) in 1982 to 897 (± 151) in 1991 (Fig. 3a). The corresponding densities decreased from 0.11 to 0.01 caribou/km^2 (Table 1). Significant declines occurred during the periods 1982 to 1987 ($P<0.03$), 1985 to 1989 ($P<0.03$), and 1989 to 1991 ($P<0.001$) (Fig. 3a)(Table 1). The 1991 and 1992 estimates were not significandy different ($P>0.05$). The instantaneous rate of growth from 1982-1992 was -0.194. The growth rate declined from -0.099 between 1982 and 1987, to -0.238 between 1987 and 1989, and to -0.540 between 1989 and 1991. The proportion of calves in the total caribou population varied from a low of 3.2% in 1991 to a high of 31.1% in 1992 (Table 1).

Median group size decreased from a high of 2 (mean of 5.0) in 1985 to a low of 1.0 (mean of 2.0) in 1991 (Table 1). Group sizes during 1982, 1985,

Table 1. Population estimates (excluding calves, ±SE), with corresponding density, median and mean group sizes, and the percent calves of Banks Island caribou from 1982-1992.

Year	Area (km^2)	Estimate (+SE)	Density (km^2)	Number of Groups	Median Group Size	Mean Group Size	Percent Calves
1982[1]	61 237	6970±1133	0.11	337	2.0	4.2	18.8
1985[2]	70 266	4931±914	0.07	169	2.0	5.0	14.5
1987[3]	70 266	4251±663	0.06	156	2.0	2.9	20.7
1989[4]	70 266	2641±334	0.04	172	2.0	2.0	23.0
1991[5]	70 266	897±151	0.01	43	1.0	2.0	3.2
1992[6]	70 266	1005±133	0.01	94	2.0	2.1	31.1

[1] Latour (1985), [2] McLean *et al.* (1986), [3] McLean (1992), [4] McLean & Fraser (1992), [5] Fraser *et al.* (1992), [6] Nagy, J. & Fraser, P. (unpubl. data).

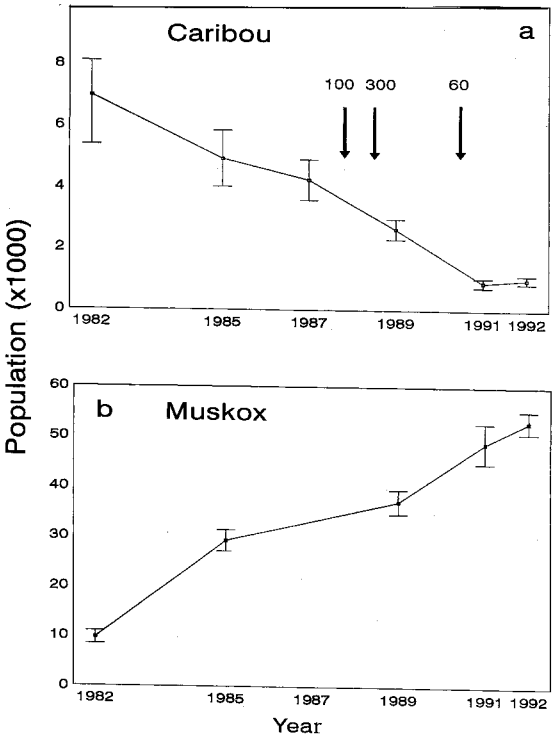

Fig. 3. Estimated population size (± SE) for (a) Peary caribou and (b) muskox from the originally flown surveys. The arrows in (a) point to winters which had freezing rains. The numbers above the arrows correspond to the recorded number of dead caribou. The 1982 value for muskox (b) is likely an underestimate.

and 1987 were significantly ($P<0.001$) larger than those observed during 1989 and 1991. Concomitant with the population decline and decreasing group sizes, was the disappearance of post-calving aggregations that had been prevalent on the northwest portion of Banks Island in the early 1980's (Fig. 4).

Muskoxen

The muskox population (excluding calves) increased from 29 168 (± 2104) to 52 959 (± 2240) between 1985 and 1992 (Fig. 3b) with an overall growth rate of 0.085. Corresponding densities increased from 0.42 to 0.75 muskoxen/km^2 (Table 2). Significant increase in growth occurred between

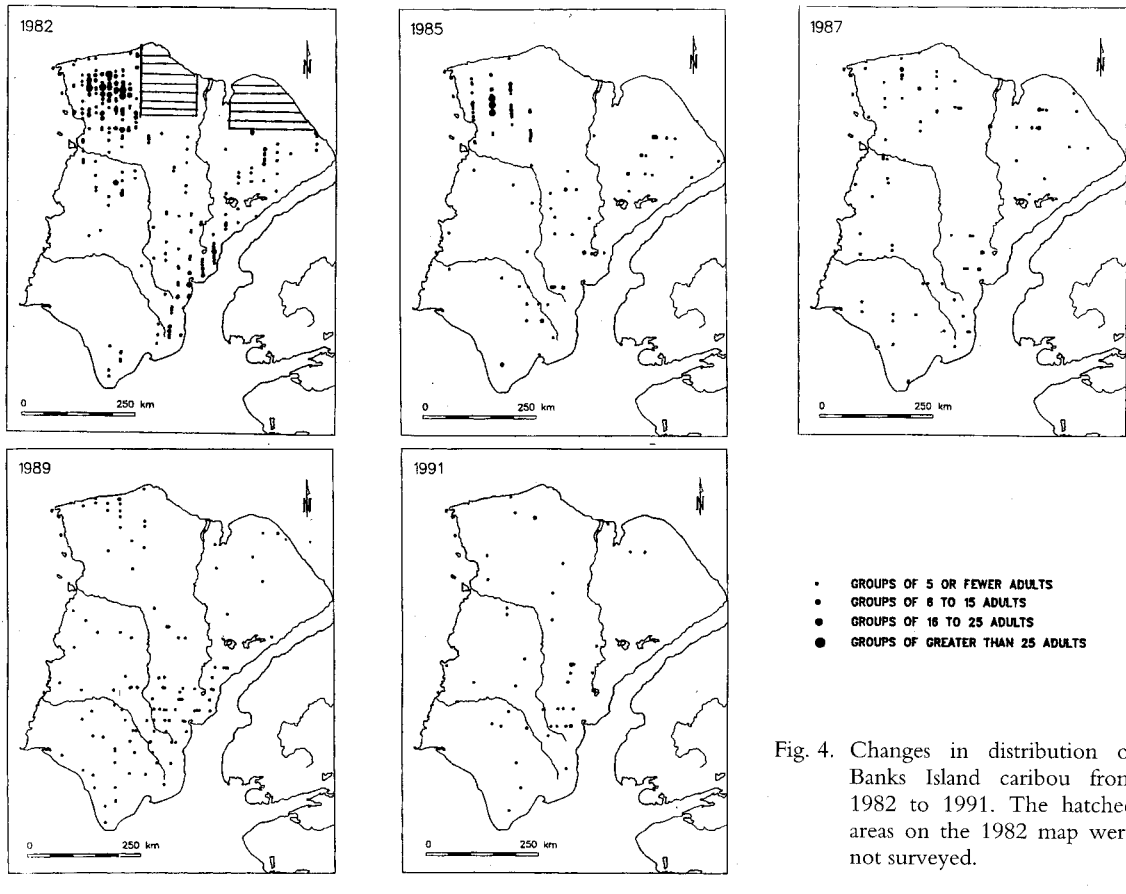

Fig. 4. Changes in distribution of Banks Island caribou from 1982 to 1991. The hatched areas on the 1982 map were not surveyed.

Table 2. Estimates and densities of muskox based upon original transect flight lines and strata, 1985 to 1992.

	1985			1989			1991			1992		
Stratum	Area (km^2)	Estimate (±SE)	Density ($/km^2$)	Area (km^2)	Estimate (±SE)	Density ($/km^2$)	Area (km^2)	Estimate (±SE)	Density ($/km^2$)	Area (km^2)	Estimate (±SE)	Density ($/km^2$)
A	57 550	12 524±1839	0.22	10 319	4353±1287	0.42	14 331	17 495±2818	1.22	10 319	7517±1082	0.73
B	n/a	n/a	0.27	14 396	5191±1300	0.36	16 266	8474±1565	0.52	14 396	6637±549	0.46
C	n/a	n/a	0.32	11 584	4282±652	0.37	21 237	18 471±2187	0.87	11 584	5560±726	0.48
D	n/a	n/a	0.09	18 409	4835±651	0.26	18 432	4263±809	0.23	18 409	7546±755	0.41
Egg	n/a	n/a	n/a	2662	2411±439	0.91	n/a	n/a	n/a	2262	4354±332	1.64
Masik	766	766±185	1.00	1372	2524±965	1.84	n/a	n/a	n/a	1372	2684±261	1.96
Parker	3 437	2995±585	0.87	3011	2193±271	0.73	n/a	n/a	n/a	3011	2929±416	0.97
Thomsen	8 513	12 883±818	1.51	8513	11 257±712	1.32	n/a	n/a	n/a	8513	15 733±1448	1.85
TOTAL	70 266	29 168±2104	0.42	70 266	37 046±2429	0.53	70 266	48 704±3979	0.69	70 266	52 959±2240	0.75

Table 3. Estimates (±SE) and densities of muskoxen (excluding calves) based upon restratified data from 1985, 1989, 1991, and 1992 population surveys.

		1985		1989		1991		1992	
Stratum	Area (km^2)	Estimate (±SE)	Density ($/km^2$)	Estimate (±SE)	Density ($/km^2$)	Estimate (±SE)	Density ($/km^2$)	Estimate (±SE)	Density ($/km^2$)
A	10 319	2288±1081	0.21	4353±1287	0.42	9128±1675	0.88	7517±1082	0.73
B	14 396	3957±2117	0.27	5191±1300	0.36	6136±848	0.43	6637±549	0.46
C	11 584	3613±1678	0.31	4282±652	0.37	2837±431	0.24	5560±726	0.48
D	18 409	1727±910	0.09	4835±651	0.26	4258±606	0.23	7546±755	0.41
Egg	2 662	1342±924	0.50	2411±439	0.91	4120±616	1.55	4354±332	1.64
Masik	1 372	933±366	0.68	2524±965	1.84	3923±476	2.86	2684±261	1.96
Parker	3 011	2650±1184	0.88	2193±271	0.73	3940±639	1.31	2929±416	0.97
Thomsen	8 513	12 883±2322	1.51	11 257±712	1.32	13 030±1070	1.53	15 737±1448	1.85
TOTAL	70 266	29 294±4132	0.42	37 046±2429	0.53	47 374±2497	0.67	52 959±2240	0.75

1985 and 1989 ($r=0.059$, $P<0.05$), 1989 and 1991 ($r=0.123$, $P<0.003$), but not between 1991 and 1992 ($r=0.111$, $P>0.05$).

The rate of growth of the island-wide population increased during this time period (1985-92), but growth rates were dissimilar across strata (Table 3). Consistent positive growth occurred in strata A, B, Egg and Masik, whereas strata C, D, Parker and Thomsen showed both positive and negative growth during periods between surveys. All strata except for C however, showed an overall trend for positive growth during the period 1985 to 1991 (Table 3).

The proportion of calves in the total muskox population was less variable than in caribou: 11.8% in 1985, 14.5% in 1989, 14.0% in 1991, and 17.1% in 1992. Because calves are small and muskox groups tend to form defensive circles in response to the aircraft, the number of calves and therefore their proportion in the population are likely underestimated.

Muskoxen were distributed throughout the island during all surveys during 1982-1991 (Fig. 5); however the greatest increases in density occurred in strata A, D, Egg and Masik (Table 3). High, but stable, densities of muskoxen were observed in the Thomsen River strata during the period 1985 to 1991 (Table 3). Densities were variable, but generally low, in the remaining strata.

Discussion

Caribou

Based on current and historical data, we cannot attribute the decline of the Peary caribou population on Banks Island to any one cause. Our review indicates that some of the apparent decline in cari-

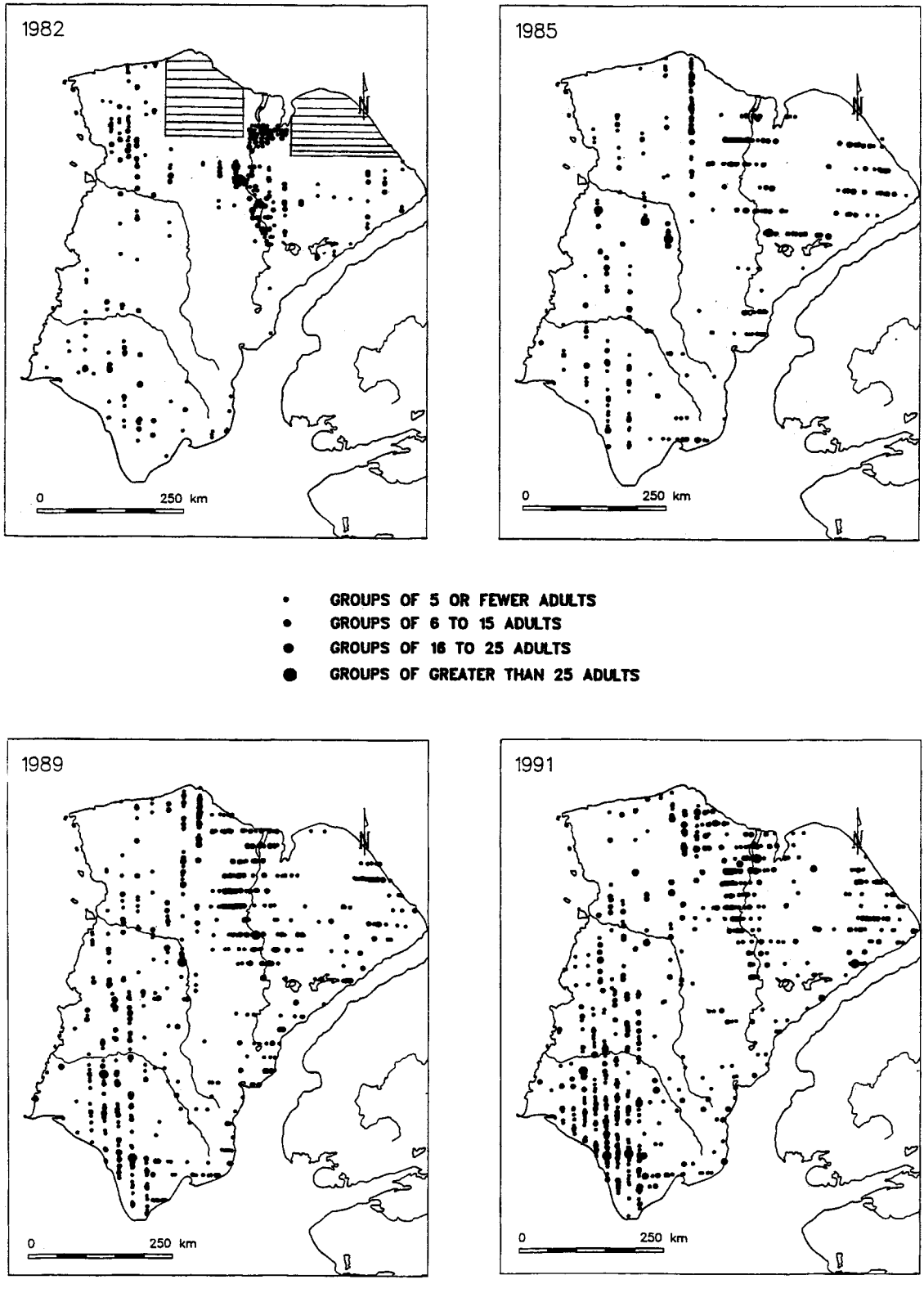

Fig. 5. Changes in distribution of Banks Island muskoxen from 1985 to 1991. The hatched areas on the 1982 map were not surveyed. See fig. 2 for strata boundaries.

bou numbers was due to errors in calculating population estimates. Human harvest and weather caused mortality do not fully account for the decline.

A comparison of the July 1987 and June 1989 population estimates indicates that non-calf caribou declined by 1610 animals. A total harvest of 615 non-calf caribou was reported during that period (Fabijan, unpubl. data), accounting for 38% of decline in numbers. The average annual harvest between 1987 and 1989 was 7.2% of the 1987 population estimate. A loss of 400 caribou due to weather caused winter morality was documented during that period (McLean & Fraser, 1992; McLean, B., unpubl. data), accounting for an additional 25% of animals lost. The loss of 595 non-calf caribou (37%) cannot be explained.

Similarly between June 1989 and June 1991 the population estimate for non-calf caribou declined by 1744 animals. A total harvest of 361 non-calf caribou was reported during that period (Fabijan, unpubl. data), accounting for 21% of the decline in numbers. The average annual harvest between 1989 and 1991 was 6.8% of the 1989 population estimate. A loss of 60 animals due to weather caused winter mortality was documented (Fraser *et al.*, 1992), accounting for an additional 3% of the animals lost. However, the loss of 1342 non-calf caribou (76%) cannot be explained.

During both periods it is unlikely that the unexplained losses were a result of unreported harvest or winter mortality. The annual subsistence harvest by residents of Sachs Harbour ranged from 211-354 adult caribou during the late 1980's (Fabijan, unpubl. data), and was similar to that reported during 1962-72 (Urquhart, 1973). The traditional winter range is located in southwest Banks Island (Urquhart, 1973). Therefore, substantial die-offs on the winter range would have been detected by residents or others travelling in the area.

The current impact of wolf predation is unknown. The vulnerability of the primary prey relative to an alternate prey determines the impact of predation (Messier, 1994). In some areas of western North America, moose populations are the main prey for wolf populations which can remain at levels high enough to deplete caribou populations (*Rangifer tarandus*) populations. This scenario has been used to explain declines in the hunted Nelchina caribou population (Bergerud & Ballard, 1988), and various woodland caribou populations (Bergerud & Elliot, 1986; Edmonds, 1988). Seip (1992) documented that a woodland caribou population that lived apart from wolves and moose during summer, was therefore less vulnerable to wolf predation, had a lower adult mortality rate and higher calf survival than a similar woodland caribou population that lived with wolves and moose. Whether or not one or both populations were hunted was not indicated. Larter *et al.* (1994) documented increasing wolf predation on moose caused by an increasing wood bison population which provided a substantial alternate prey source that maintained high wolf populations capable of depleting the more vulnerable prey population. Wolf predation has a greater impact on moose populations when the moose population is declining (Gasaway *et al.*, 1983).

Peary caribou on Banks Island may be in a situation similar to that described for some hunted moose and caribou populations, where a high biomass of muskoxen supports an increasing wolf population. Wolf numbers were reduced on Banks Island during poisoning programs conducted during the 1950's (Zoltai *et al.*, 1980). Local residents believe wolf numbers on Banks Island have increased during the 1990's. The annual number of wolves harvested increased dramatically from an average of approximately 4/winter during 1988-89 to 1991-92 to 50 during the winter of 1992-93 (Larter & Clarkson, 1994). Although available diet data are limited, they indicate that caribou and muskox are consumed by wolves (Zoltai *et al.*, 1980; Larter, N. & Nagy, J., unpubl. data). Hunters travelling on the land have found caribou killed by wolves (Esau, E. & Lucas, J., pers. comm.). Even if predation rates on caribou are low, the impact may be significant especially given their recent low numbers. Assuming that there were only 50 wolves and 1005 adult caribou on Banks Island during the winter of 1992-93, a predation rate of 1 adult caribou per wolf per year represents an approximate annual adult caribou mortality due to predation of 5%. All wolves on Banks Island were not harvested during the winter of 1992-93, thus adult caribou mortality due to predation may be higher.

The impact of disease in unknown. There have been no reported incidences of harvested animals appearing diseased, but studies have not been conducted to directly address the issue.

Inter-island movement of Peary caribou may have contributed to declining numbers. Miller & Gunn (1978, 1980) documented movements between islands in the Prince of Wales-Somerset Island complex. Residents of Holman (Victoria Island) and Sachs Harbour (Banks Island) and observations from wildlife surveys suggest that caribou cross in small groups between Banks Island and Victoria Island in fall and winter (Jingfors, K., pers. comm.). Residents of Sachs Harbour reported large numbers of caribou travelling past Sachs Harbour and out onto the sea ice south of Banks Island in 1951

(Manning & Macpherson, 1958). This movement appears to have occurred when available forage was scarce (Urquhart, 1973). They noted that some of the animals returned later in the winter only to starve along with caribou that remained on the island. During this time period Peary caribou were observed on the mainland coast near Baillie Island approximately 160 km south of Banks Island (Carpenter, A. & Wolki, F., pers. comm.). The caribou were weak and covered in ice.

These observations suggest that Peary caribou may normally move between Banks and Victoria Island as part of an inter-island population as suggested by Miller (1985, cited in McLean, 1992). However, large scale movements from Banks Island may be driven by reduced forage availability during episodes of severe winter weather. This would have a net negative effect on the island population if these were one way movements.

Whether or not range conditions have deteriorated during 1982-1992 is unknown. Lichen has never been abundant (Wilkinson & Shank, 1974; Zoltai *et al.*, 1980). Current research is examining range conditions in areas of high and low muskox density on and adjacent to the core caribou winter range. Preliminary indications are that lichen biomass is low throughout the range.

Although, competition between muskox and caribou has been considered unlikely in the past (Kevan, 1974; Wilkinson *et al.*, 1976; Parker, 1978; Vincent & Gunn, 1981; Biddlecomb, 1992), reconsideration of caribou and muskox ecology and recent research indicates they may in fact compete for forage resources especially during winter or when muskox densities are high (McKendrick, 1981, White *et al.*, 1981; Klein & Staaland, 1984). It is generally agreed that lichen is an important winter food for caribou, but in areas supporting low lichen biomass caribou switch to other forages, either willow or monocots (Reimers *et al.*, 1980; Klein, 1992; Staaland & Olesen, 1992). Muskox can clearly make use of high protein foods (White *et al.*, 1984), and even though they show many attributes of a classic grazer can be quite selective in their feeding (Oakes *et al.*, 1992). Thing *et al.* (1987) showed willow as a major component of the summer diet of muskox in Greenland.

Because of low lichen biomass on Banks Island, it is not surprising that willows, sedges, and forbs make up most of the caribou diet. The muskox diet is dominated by sedge, but in high density areas willow becomes an important dietary component in late winter (Larter, N. & Nagy, J., unpubl. data).

The area between the Kellet and Big rivers and centered around the Egg River was identified as the core of the caribou winter range on Banks Island

Table 4. The instantaneous rates of growth (r) for each stratum, and the total island for the periods 1985-1989, 1989-1991, and 1985-1991. Rates followed by * indicate a significant ($P<0.05$) difference between population estimates from which the growth rate was calculated.

Stratum	1985-89	1989-91	1985-91
A	0.1608	0.3702 *	0.2306 *
B	0.0679	0.0836	0.0731
C	0.0425	-0.2058	-0.0403
D	0.2574 *	-0.0635	0.1504 *
Egg	0.1465	0.2679	0.1869
Masik	0.2488	0.2205	0.2394 *
Parker	-0.0473	0.2930 *	0.0661
Thomsen	-0.0337	0.0731	0.0019
Overall	0.0587 *	0.1230 *	0.0801 *

(Urquhart, 1973). From July 1985 to July 1991 muskox densities on the southern half of Banks Island increased from 0.19/km^2 to 0.65/km^2. In the Egg River strata, which overlaps in excess of 60% of the core caribou winter range, muskox densities increased from 0.5/km^2 to 1.55/km^2 during that period (Table 4). Because muskoxen are non-migratory, and seasonally utilize to a various extent forage consumed by caribou, there exists the potential for food competition in the core caribou winter range. If this is the case, some caribou may be displaced to less preferred winter ranges or may move to other areas on or off Banks Island in search of more adequate winter ranges. Competition for food cannot be ruled out as a factor contributing to the caribou population decline.

The decline was likely caused by the cumulative effects of a combination of factors including human harvest, severe winters, wolf predation, inter-island movement and possibly competition from the expanding muskox population.

Muskoxen

The island muskox population increased during the period 1985 to 1992. Recent data indicate that reproduction has been delayed from 2-year old to 3-year old females (Nagy, J., *et al.*, unpubl. data) possibly indicating some density dependent feedback mechanism. However, these data are limited to animals inhabiting the Egg and Masik strata. These two strata had continuous positive population growth, had the highest or among the highest densities of muskoxen since 1985 (Table 3), and are the two areas where commercial muskox harvests have been conducted. Age of first reproduction

may not be increasing in other strata where muskoxen densities are lower.

Population increase and consistent calf proportions continued in both the Egg and Masik strata even though 2 525 muskoxen were harvested from these areas between 1990 and prior to the 1992 survey. Approximately half of the muskoxen were harvested from each strata. Because age of first reproduction has increased, harvesting has not created an increased numerical response of muskoxen in these areas.

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