AGE AND SEX COMPOSITION SURVEY OF BANKS ISLAND MUSKOXEN, JULY - AUGUST, 1986.

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2005

Manuscript Report No.161

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ABSTRACT

We classified 3891 muskoxen *Ovibos moschatus* into age and sex classes on Banks Island from 24 July to 1 August 1986. A Bell 206B helicopter was used to land near large groups ($\geq$6) while small groups (<6) were classified from the air. Calves accounted for 14 percent of the all island sample. The calf/cow ratio for the island sample was 37/100 ($\pm$1.0 SE) for cows 3 years of age and older. Yearlings were 12 percent of the total or 33/100 ($\pm$1.1 SE) cows. The adult sex ratio was 78 males/100 females 3yrs of age and older overall, but only 52 $\pm$1.6 (SE) males/100 cows in mixed groups. There were 260 bulls in all male groups and 106 single bulls were observed. The mean group size excluding single animals was 8.14 ($\pm$ 5.87 SD). Proportions of calves and yearlings varied from location to location. The calf/cow ratio varied from a high of 54 $\pm$ 3.8 (SE)/100 cows in the Big River area on the south part of the island to a low of 24 $\pm$ 1.9 (SE)/100 cows in the Parker River area. Overall, the calf/cow ratio was significantly higher in the pooled low density areas (48 $\pm$1.9 SE) than in the pooled high density areas (31 $\pm$ 1.1 SE)($p<0.001$). The yearling/100 cows ratios were also significantly higher in the low density areas (40 $\pm$ 1.7 SE) than in the high density areas (29 $\pm$ 1.3 SE)($p<.001$). Lower calf and yearling numbers in the higher density areas may be a reflection of reduced productivity or reduced survivorship of young. The use of a helicopter to conduct the survey was very efficient and can be done with a minimum of disturbance to the animals provided large groups are classified from the ground. The ratios and their corresponding variances were calculated using the unweighted mean, the ratio estimator (binomial), and the jackknife estimator. The ratio estimator or the jackknife are recommended and gave similar results, with the jackknife giving a larger variance. Unbiased sampling to determine the adult sex ratio is more difficult because of the segregation of males as solitary animals or into male only groups.

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INTRODUCTION

Muskox (*Ovibos moschatus*) abundance on Banks Island has increased since the 1970's (Vincent and Gunn 1981, McLean *et al.* 1986, Gunn *et al*. 1991). As numbers increased, so did management concerns. Inuvialuit from Sachs Harbour were concerned about possible competition between increasing numbers of muskoxen and caribou. We anticipated that as muskox densities increased, the grazing pressure on the forage might be translated into reduced physical condition for the muskoxen and thence decreased productivity and calf survival. We noted, however, that weather and climate are highly variable and affect both plant growth as well as the relative availability and quality of forage for the muskoxen (density-independence). Density-dependence and density-independence could either separately or in combination cause differential survival between the adult bulls and cows. A measure of current survival of the younger cohorts, and the adult sex ratio would not only be the baseline for future comparisons, but would also help interpret any changes in the rate of increase in the population size as determined by aerial surveys.

Body size, coat and horn development are sufficiently different between the sexes and first three cohorts of muskoxen to facilitate field classifications into sex and age classes (Tener 1965, Henrichson and Grue 1980, Smith 1987). Previous surveys to classify muskox into those sex-age classes had not examined the data for appropriate and efficient sampling strategies such as the sample sizes necessary to achieve acceptable levels of precision.

Our objectives were: (1) to establish baseline levels of subadult survival for calves, yearlings and 2-year olds, as well as the adult sex ratio; and (2) to determine an

appropriate sampling strategy to measure those parameters. We chose a precision level of Coefficient of Variation of ≤ 0.1 which is the same level that we aim for with the estimates of population size in the NWT (Graf and Case 1990). We were principally interested in sampling muskoxen from two areas where previous surveys had observed high densities, the Thomsen River and the Parker River (McLean et al. 1986), and comparing the composition with other parts of Banks Island which had lower densities.

Editor's note: The report was drafted but not completed until 2005. Although the Department has published subsequent papers on the Banks Island muskox and Peary caribou, the information in this paper is still a baseline for sex and age composition with which to measure subsequent changes in muskox abundance.

METHODS

We used a Bell 206B Jet Ranger helicopter to search for and then classify the muskox groups. The crew was the pilot, an observer/recorder in the left front seat, and an observer/recorder in the right rear seat. We subjectively spaced out the sampling of groups to sample a variety of locations within an area. When flying, the front seat observer assigned a number to each group, recorded locations of groups on 1:250,000 maps and classified the animals. The data was recorded in a field book by the observer in the rear seat. Groups with $\geq$ 6 muskoxen were classified from the ground while smaller groups were done from the air. To minimize disturbance during ground classification, the helicopter landed between 0.5-1 km downwind and behind a hill or ridge out of sight of the groups if possible. The observers walked to where they could view the animals with a spotting scope. We classified the muskoxen as $\geq$ 4yr, 3yr, or 2yr old males; $\geq$ 3yr females, or 2yr females; yearlings (15 months old); or calves (3 months old) using body size and horn development (Henrichsen and Grue 1980). The yearlings and calves cannot be accurately sexed in the field.

We could not classify all individuals in a few large groups, and rather than harassing those groups, we recorded the total number of animals and calves in the group, and classified as many other individuals as we could. The remaining individuals were classified as unknown. Those groups were excluded from calculations of the adult sex ratio and the calf/cow, yearling/cow ratios.

The areas chosen to survey were based upon density stratum determined during the July 1985 whole island aerial population survey (McLean et al. 1986). Generally the high density areas had densities $\geq$ 1.0 muskoxen/km ^{2}. When summarizing the data we

pooled together groups from the high density areas and compared it with lower density areas.

The classification data was entered in a Lotus spreadsheet file and then transferred to the SAS (SAS Institute Inc. 1989) program for data analysis. Frequencies of the age and sex categories were determined by location and comparisons made using a Chi-square test.

The calf/cow, yearling/cow and bull/cow ratios were calculated and a variance estimated using: (1) the unweighted means by group; (2) the Jackknife estimator of variance by group (Cochran 1977); and (3) the ratio estimator recommended by Bowden et al. (1984) based on Cochran (1977). A chi-square statistic was calculated to compare ratios between areas, p=.05 unless otherwise stated in all tests.

To determine how sample size affected precision of the ratios, we plotted the coefficients of variation (CV) for the various ratios against sample size. The point at which the CV dropped and stayed below 0.10 was considered the point when additional sampling would not appreciably improve the estimate.

The data were analysed for sex ratio using the number of mixed sex herds and bachelor groups combined. We express the sex-age composition as conventional ratios and descriptive statistics (mean herd size) to facilitate comparisons with existing published data.

In this report, we use the term group to refer to any aggregation of muskoxen that were separated by at least an arbitrary distance of 250 m from the nearest muskoxen. Single bulls are bulls that remained at least 250 m from the nearest herd even though on occasion they may have galloped toward another social unit in response to the helicopter.

We termed groups of only male bulls as "Bachelor groups" and we used the term "mixed herd" for groups with cows. Adult muskoxen were $\geq$ 3 years and sub-adults were $\leq$ 2 years.

RESULTS

We classified 3891 muskoxen in 465 groups on Banks Island from 24 July to 1 August 1986 (Figure 1, Table 1). We observed 106 single bulls, and an additional 260 males in 100 bachelor groups. The mean group size overall, excluding single animals was 8.14 ± 5.87 (S.D.) (Table 2).

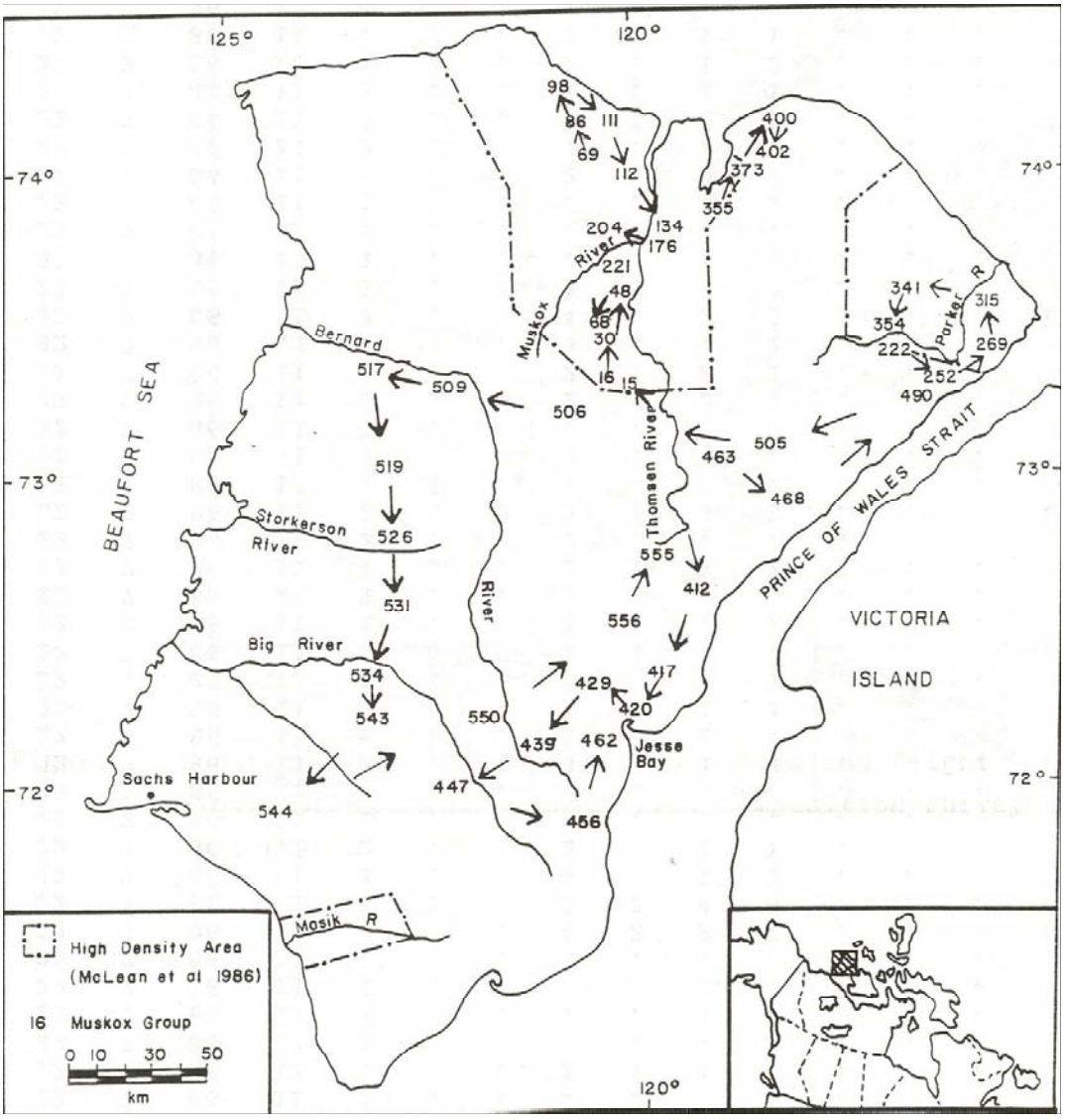

Figure 1. Locations of muskox groups classified and flight lines during composition survey Banks Island, NWT July-August 1986.

Calves accounted for 14 percent of the all island sample, while yearlings were 12 percent of the sample (Table 3, n=565). The percentage of calves and yearlings varied greatly between locations and appeared lower in the pooled high density area. The yearling percentage was almost as high as the calf percentage in some areas, suggesting very good survivorship of 1985 calves through the winter 1985-86.

Our estimates of the age and sex ratios using the unweighted means by group had very large variances, in some cases as large as the ratios (Appendix A). The ratio estimator, and the jackknife method gave much smaller variances, and some of the standard errors were less than 10% of the estimates. The ratio estimator was chosen for comparisons of data.

The calf/cow ratio for the whole island was 37 $\pm$ 1.0 (SE)/100 cows while the yearling/cow ratio was 33 $\pm$ 1.1 (SE)/100 cows (Table 4). Calf and yearling ratios varied widely within the island (Table 4). Overall the lower density areas (based on McLean et al. 1986) had a significantly higher calf ratio (48 $\pm$ 1.95 (SE)/100 cows) than the high density area (32 $\pm$1.1 /100 cows),($p<.001$). The yearling/100 cow ratios was also significantly higher for the low density areas, 40 $\pm$ 1.7 (SE) versus 29 $\pm$ 1.3 (SE) /100 cows for the high density areas (Table 4).($p<.001$). The variability of ratios by area suggests that real biological differences exist between areas. Therefore, a sample of classification data from one area may not be representative of the whole population on Banks Island.

The adult sex ratio was 78 $\geq$ 3yrs males/100 $\geq$ 3yrs females overall, including all observations, but only 52 $\pm$ 1.6 (SE) males/100 cows in mixed groups (Table 5). Because of the segregation of some adult males into male only groups it was not possible to include those observations into a calculation of the bulls/cows ratio and variance. The percentage

of adult bulls of total classified varied between 20.1 and 36 including single bulls (Table 3). The proportion of bulls which were single or in bachelor groups ranged from 4% to 15%. The proportion of bachelor groups and single bulls was higher in the pooled high density areas than in the pooled low density areas, 12% vs. 4.7% respectively.

The results of our analysis suggest that the precision of the estimates improved with increasing sample size. However, there was little appreciable improvement in the overall precision after 30-40 groups were included from an area.

Table 1. Number of muskoxen classified by age & sex on Banks Island, July-August 1986.

Location	**Males**					**Females**			
	4yr	3yr	2yr	yrlg	calf	3yr	2yr	unkn	total
High Density:[a]									
Thomsen River	355	52	50	126	172	551	57	6	1369
Castel Bay	77	9	13	22	29	11	78	0	239
Parker River	228	40	23	113	60	247	37	0	748
Mercy Bay	77	3	9	25	46	91	7	1	259
Low Density:									
N. Jesse Bay	61	17	21	61	72	143	14	0	389
S. Jesse Bay	63	15	22	25	50	134	23	3	368
Big River	93	20	26	62	101	175	22	20	519
Total	954	156	164	467	530	1419	171	30	3891

[a] High density areas (based on McLean et al. 1986)

Table 2. Number of groups, mean group size, and number of single bulls classified on Banks Island, July-August 1986.

Location	Group Size (±SD)	Groups (n)	Single Bulls
Thomsen River[a]	8.7 ± 7.01	155	23
Castel Bay[a]	7.0 ± 4.30	33	9
Parker River[a]	6.6 ± 5.38	109	25
Mercy Bay[a]	8.0 ±4.88	30	18
High Density[a]	7.8 ± 6.14	327	75
N. Jesse Bay	7.2 ± 3.37	52	16
S. Jesse Bay	9.8 ± 5.65	37	6
Big River	10.4 ± 5.67	49	9
Low Density	9.0 ± 5.1	138	31
Total	8.1 ± 5.9	465	106

[a] High density areas (based on McLean et al. 1986)

Table 3. Frequency of sex and age classes by location, Banks Island 1986

Location	m4yr	m3yr	m2yr	yrlg	calf	f3yr	f2yr	total
High Density:								
1	350	52	49	124	169	544	56	1344
%	26.0%	3.9%	3.6%	9.2%	12.6%	40.5%	4.2%	100.0%
2	77	9	13	22	29	78	11	239
%	32.2%	3.8%	5.4%	9.2%	12.1%	32.6%	4.6%	100.0%
3	228	40	23	113	60	247	37	748
%	30.5%	5.3%	3.1%	15.1%	8.0%	33.0%	4.9%	100.0%
4	75	3	7	22	43	87	7	244
%	30.7%	1.2%	2.9%	9.0%	17.6%	35.7%	2.9%	100.0%
Low Density:								
5	61	17	21	61	72	143	14	389
%	15.7%	4.4%	5.4%	15.7%	18.5%	36.8%	3.6%	100.0%
6	62	15	22	56	48	127	23	353
%	17.6%	4.2%	6.2%	15.9%	13.6%	36.0%	6.5%	100.0%
7	91	18	23	58	91	164	20	465
%	19.6%	3.9%	4.9%	12.5%	19.6%	35.3%	4.3%	100.0%
Total	944	154	158	456	512	1390	168	3782
%	25.0%	4.1%	4.2%	12.1%	13.5%	36.8%	4.4%	100.0%

Table 4. Calf/cow & yearling/cow ratios from Banks Island, July-August 1986.

	CALF/COW		YEARLING/COW	
	RATIO ESTIMATOR	**JACKKNIFE**	**RATIO ESTIMATOR**	**JACKKNIFE**
LOCATIONS	**MEAN ± SE**	**MEAN ± SE**	**MEAN ± SE**	**MEAN ± SE**
High Density:[a]				
Thomsen R.	31.07 ± 1.45	31.05 ± 2.09	22.79 ± 1.58	22.74 ± 2.22
Castel Bay	37.18 ± 3.22	37.4 ± 5.74	28.21 ± 3.93	28.37 ± 6.97
Parker R.	24.29 ± 1.93	24.27 ± 2.94	45.75 ± 2.66	45.75 ± 4.43
Mercy Bay	49.43 ± 4.33	49.53 ± 6.29	25.29 ± 3.21	25.28 ± 4.99
High Density (Pooled)	31.49 ± 1.09	31.48 ± 1.66	29.39 ± 1.33	29.37 ± 2.05
Low Density:				
N. Jesse Bay	50.35 ± 3.24	50.28 ± 4.56	42.66 ± 3.02	42.62 ± 5.33
S. Jesse Bay	37.01 ± 3.13	36.95 ± 4.88	44.09 ± 3.56	43.89 ± 4.36
Big River	54.27 ± 3.78	54.2 ± 4.14	34.15 ± 2.49	34.14 ± 3.88
Low Density (Pooled)	47.92 ± 1.95	47.9 ± 2.68	39.86 ± 1.71	39.84 ± 2.6
TOTAL	36.62 ± 0.99	36.61 ± 1.48	32.66 ± 1.07	32.64 ± 1.67

[a] High density areas (based on McLean et al. 1986)

Table 5. Adult bull per cow ratios in mixed groups and sex ratio including all observations, on Banks Island, July-August 1986.

BULL/COW[a]				
	RATIO ESTIMATOR	**JACKNIFE**	**SEX RATIO[b]**	**% BULLS OF TOTAL**
LOCATIONS	**MEAN ± SE**	**MEAN ± SE**	**Males/100 Females**	
Thomsen R.	47.79 ± 2.75	47.6 ± 3.89	74	30
Castel Bay	70.51 ± 7.84	69.44 ± 11.86	110	36
Parker R.	63.97 ± 4.41	63.56 ± 6.2	109	36
Mercy Bay	50.58 ± 5.71	49.86 ± 8.51	88	32
High Density	54.08 ± 2.16	53.97 ± 3.06	87	32.4
N. Jesse Bay	37.06 ± 2.91	36.87 ± 4.42	55	20.1
S. Jesse Bay	48.82 ± 4.2	48.55 ± 5.61	58	21.8
Big River	54.27 ± 4.15	54.02 ± 5.31	65	23.4
Low Density	47.01 ± 2.09	46.94 ± 3.0	60	21.9
TOTAL	51.87 ± 1.59	51.81 ± 2.27	78	29.0

[a] includes only group with bulls & cows, not single bulls or male only groups
[b] all observations included.

DISCUSSION

The percentage of calves and the calf/cow ratio from this survey suggests that calf production and survival was moderate in 1986. In 1985, 12% calves were observed on transect during the aerial survey, while 16% were observed in the Thomsen River area with low level flights.

In comparison with other increasing muskox populations such as on Alaska's North Slope, the ratio of calves to cows and the proportion of calves was low. Calf/cow (3 yrs and older) ratios as high as 89 calves/100 cows (Jingfors and Klein 1982, Reynolds *et al.* 1985) have been reported in June in a recently introduced population.

The low proportion of calves is likely the consequences of poor calf survival rather than low calf production. Calving in muskoxen on Banks Island occurs in April/May and pregnancy rates have been reported as high as 100% in the reproductive age classes 4 yrs and older (Tessaro et al. 1984, Rowell 1989). Calving by the 3 yr old age class is more variable, but was recorded as high as 70% in the early 1980's (Tessaro et al. 1984, Rowell 1989). A combined pregnancy rate of 93% of $\geq$ 3 yr old females was observed from the commercial harvest on southern Banks Island in May 1986 (Rowell 1989). The extent of neonatal or late pregnancy loss is unknown, but must be substantial to account for the difference between the early May pregnancy rates and the 58 calves/100 cows in July/August observed in this survey.

The yearling percentage was almost as high as the calf percentage in some areas, suggesting that the survival of 1985 calves over their first winter was high. Yet if the late spring imposed sufficient hardships to cause calf mortality, it is surprising that yearlings did

not also succumb. Deep wet snow may have contributed to the calves apparent deaths as much as nutritional stress but this is conjectural.

The 1986 survey suggests that on Banks Island calf production and survival are still high enough that the population will continue to grow. There is a great deal of variation in calf/cow ratios throughout the island and the lower calf/cow ratios in the high density Thomsen River and Parker River areas may be an indication that growth of the population in the future will be slower in those areas. The lower calf production and survival may not necessarily be a result of higher densities but may act together with severe winter conditions.

A major difficulty with age and sex classification data is the assumption of sampling all components of the population without bias. Female and young muskoxen are almost without exception found in groups. Adult males however, are often found in small male only groups or as solitary individuals. This creates a potential sampling problem for classification surveys. For this reason the percentage of the total of an age class, for example calf percentage, may be biased. Calf/cow and yearling/cow ratios are used as well and are not affected by the presence or absence of the bulls.

Our analysis suggests that the most useful method of calculating the ratios and their associated variance is the ratio estimator of Cochran (1977) or the Jackknife method. The variance calculated using the unweighted mean of the ratios is so large that comparisons between different areas cannot be made.

Our results suggest that a sample of at least 30-40 groups with the sampling effort spread out in an area should give an acceptably precise estimate of the sex/age ratios. If

previous knowledge of density or habitat is available it might be possible to stratify the sampling effort *a priori*.

RECOMMENDATIONS

1) Groups larger than 6 muskoxen should be classified from the ground to reduce potential disturbance.

2) Estimates of age and sex ratios should include an estimate of the associated variance. We suggest using either the ratio estimator from Cochran (1977) and Bowden et al. (1984) or the Jackknife method.

3) Sampling approximately 30-40 groups should be adequate to obtain an acceptable estimate of the local calf/cow and yearling/cow ratios and their variance.

ACKNOWLEDGEMENTS

Funding under the Northern Oil and Gas Action Program (NOGAP) of Indian and Northern Affairs Canada (INAC) during 1986 enabled us to conduct the composition survey of muskoxen on Banks Island. Polar Continental Shelf Project (PCSP) provided helicopter and logistical support during the survey. Their support was greatly appreciated. Rebecca Ritchie helped with the data analysis. Paul Fraser and Chris Shank (DRR) reviewed this paper and we appreciate their help.

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APPENDIX A. UNWEIGHTED MEAN OF CALF/COW, YEARLING/COW AND BULL/COW RATIOS, JULY - AUGUST 1986

	CALF/COW	**YRLG/COW**	**BULL/COW**
Locations	**Mean ± SE**	**Mean ± SE**	**Mean ± SE**
Thomsen River	30.26 ± 30.44	27.71 ± 33.40	77.47 ± 82.86
Castel Bay	26.78 ± 32.69	20.49 ± 27.97	116.93 ± 114.57
Parker R.	20.98 ± 27.19	50.37 ± 51.89	95.94 ± 81.21
Mercy Bay	49.19 ± 35.63	27.99 ± 31.65	85.43 ± 102.09
N. Jesse Bay	51.61 ± 35.21	44.53 ± 34.22	47.02 ± 37.39
S. Jesse Bay	39.50 ± 34.36	50.11 ± 37.71	60.99 ± 61.54
Big River	55.81 ± 34.24	34.31 ± 28.56	67.97 ± 54.32
TOTAL	35.96 ± 33.92	37.12 ± 38.91	78.10 ± 79.21