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DISTRIBUTION, ABUNDANCE AND COMPOSITION OF MUSKOXEN NORTH OF GREAT BEAR LAKE, MARCH 1983

Northwest
Territories Renewable Resources
Wildlife Service
The Honourable Nellie Cournoyea, Minister

DISTRIBUTION, ABUNDANCE AND COMPOSITION OF MUSKOXEN NORTH OF GREAT BEAR LAKE, MARCH 1983

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ABSTRACT

A systematic transect survey of muskoxen north of Great Bear Lake, between the Coppermine and Anderson rivers, was carried out between 8 and 21 March 1983. A total of 1880 muskoxen were counted, 705 on transect and 1175 off transect, giving a population estimate of 3315 ± 1262 (95% C.I.). Mean herd size was 21.06 ± 2.65 (S.E.). While the estimate from this study is 50.7% lower than that obtained in 1980, problems identified in the 7980 survey and visibility difficulties encountered in 1983 reveal no significant overall change in the population. Ground composition counts took place from 16 to 23 March south of Paulatuk and in the Rae River valley, west of Coppermine; however, only the data collected in the latter counts were useable. A short-yearling count of 10.6% (26/248) or 31 short-yearlings per 100 cows, 3 years old and older, was obtained. Although the ground counts suggest poor production in the muskox population west of Coppermine, the aerial surveys show, in general, an increase in numbers in the Rae–Richardson valley and a stable population in the Horton River area. We were unable to establish trends for the area south of Paulatuk and the Brock River area. A quota increase from 18 to 35 is recommended for the area west of Coppermine (Muskox Managment Area C/1-2) as is a change in the boundaries of the Muskox Management Area. No change is recommended for Muskox Management Area C/l-l south of Paulatuk.

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INTRODUCTION

At the beginning of this century muskoxen were believed to have been exterminated west of Dolphin and Union Strait where the last muskoxen west of the Strait were shot in 1902 (Hone 1934). Hone believed that there may have been a few animals present west of the lower Coppermine River, in the Dismal Lake area, but that these were the only muskoxen remaining north of Great Bear Lake. Since 1917, when muskox hunting was prohibited, the number of muskoxen in this area has increased. In 1955, Kelsall et al. (1971) estimated 525 animals, in 1966 the estimate was 625 (Kelsall et al. 1971) and in 1974 Hawley et al. (1976) estimated 2022 animals. Carruthers and Jakimchuk (1981), incorporating the results of Spencer (1980), estimated the population to be 6728 ± 2400 (95% C.I.) in March 1980. A closer look at the data reveals that the estimate should have been 5454 ± 1792 (95% C.I.).

With the exception of Spencer (1980), all of these previous estimates were obtained incidental to caribou surveys. The stratification and design of these surveys were directed towards caribou, and as such, resulted in imprecise and inaccurate estimates of muskox numbers.

In early 1983 funds became available through the Northern Oil and Gas Activity Program (NOGAP) for research into the impact of Beaufort Sea development. This development is likely to increase the harvest pressure on muskoxen north of Great Bear Lake through an increase in the potential for sport hunting and an increased market for muskox products such as hides, heads and meat. More importantly, an increase in the standard of living and a switch to a cash economy in the communities of Paulatuk and Coppermine could result in more and better snowmachines, more money for gas and more rifles for hunting and increased demand for "cash species" such as muskoxen. "Cash species" refers to those species which are taken with the objective of monetary return as opposed to those taken for subsistence purposes.

In order to establish current baseline information against which to monitor effects of development, to identify areas of heavy use and to evaluate the existing quotas and Muskox Management Areas, an aerial survey, designed specifically for muskoxen, was conducted between 8 and 21 March 1983.

Ground classification counts were carried out in conjunction with the aerial survey to evaluate the demography and productivity of North Great Bear muskoxen and to establish a base for monitoring population parameters. (Such counts have not previously been carried out north of Great Bear Lake.)

STUDY AREA

The area covered by this survey is bounded by 67" N latitude in the south, 127° W longitude in the west, Amundsen Gulf and Dolphin and Union Strait in the north, and the Coronation Gulf and Coppermine River in the east (Fig. 1). This expansive area of over 109,000 km2 includes a wide variety of terrain, vegetation and geographical features.

Much of the study area is characterized by rolling hills with numerous lakes and ponds. Several major river systems flow though the area. These include the Anderson, Horton and Hornaday in the west, the Rae and Richardson in the east, and the Haldane, Bloody and Dease in the south. Most of these rivers have their headwaters in the uplands near Bluenose Lake known as the Melville Hills.

Jacobson (1979) (cited in Carruthers and Jakimchuk 1981) divided the study area into four ecosystem types. Mossy forest is prevalent in the western portion of the study area around the Anderson River. North and west of this area is an extensive band of forest-tundra transition centered south of the Horton River. The remainder of the study area is mainly tundra. The Rae-Richardson valley and the headwaters of the Bloody and Haldane rivers have lush tundra vegetation. Sparse tundra vegetation is found along the lower reaches of the Horton River, the Brock River and northeast of Bluenose Lake. Most of the remaining area, including the Melville Hills and the area north of the Rae-Richardson valley, are essentially barren.

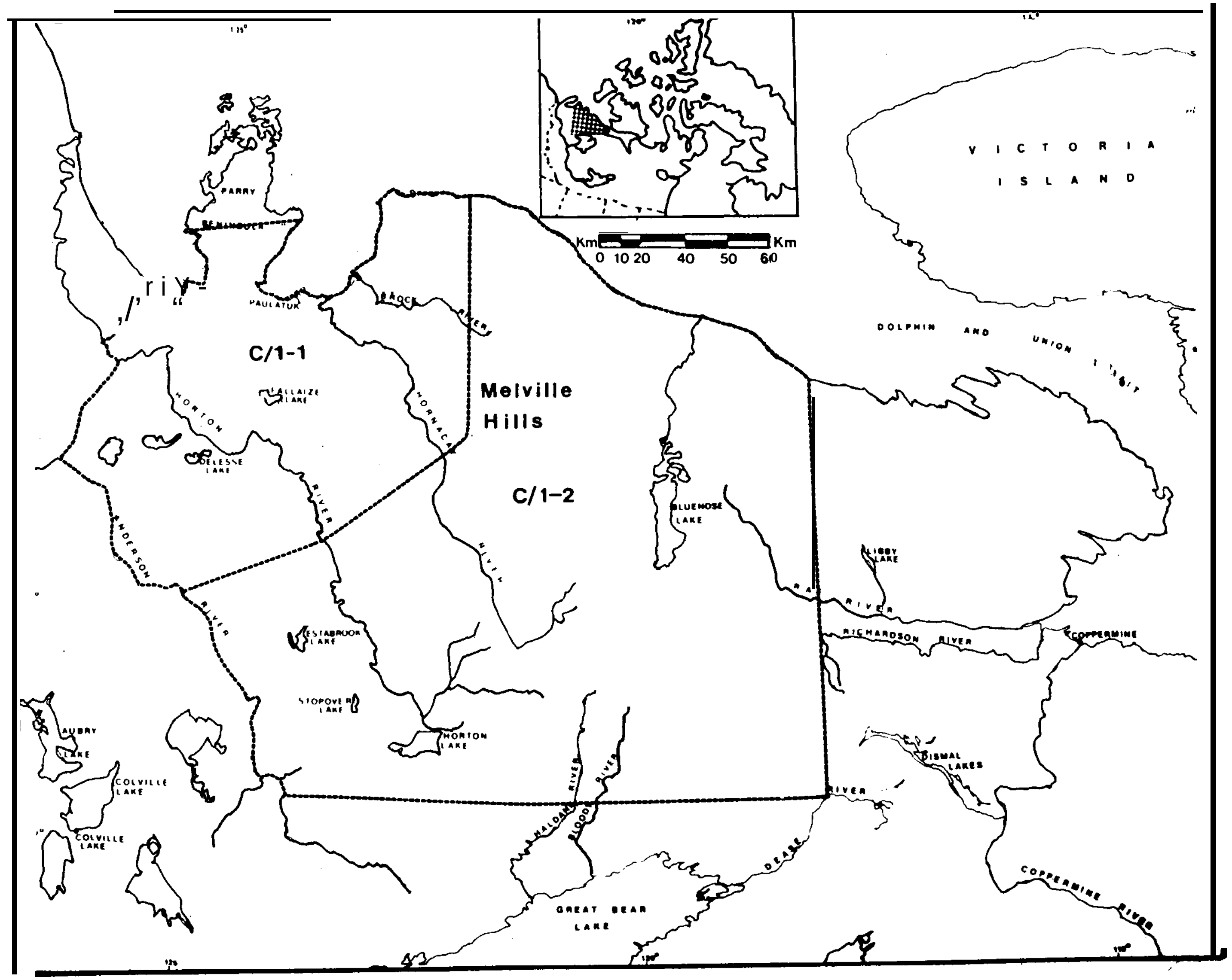

Figure 1. North Great Bear study area for March 1983 muskox survey and existing muskox management areas.

METHODS

The design for the aerial survey portion of this study was adapted from that used by Gunn and Case (1984) for a survey of muskoxen in the area south of Queen Maud Gulf. The design includes an extensive systematic reconnaissance covering 10% of the study area. The purpose of this reconnaissance is twofold; first to determine areas of muskox concentrations, which would then be resurveyed at more intensive coverage, and second to provide an estimate of muskox numbers in the areas between these concentrations. Part of the reconnaissance was flown out of Coppermine. These transects were laid out in an east-west direction in order to minimize aircraft ferry time. The remainder of the reconnaissance was flown out of Paulatuk. These transects were flown north-south, again to minimize ferry time.

The transect width for most of the reconnaissance was 1.5km on each side of the aircraft, or 3 km in total. Survey altitude for these transects was 300 m above ground level (agl). However, in the Paulatuk portion of the reconnaissance the transects extended into treed areas. In order to reduce visibility biases, the transect width and survey altitude were halved to 1.5km and 150 m agl, respectively. In order to maintain 10% coverage, additional transects had to be flown between these narrow transects. Flying speed for all transects was maintained at approximately 160 kph.

The aircraft used was a Helio Courier and the survey crew consisted of the pilot, a navigator-recorder and two observers. In order to minimize observer biases, the observers were instructed to concentrate on muskoxen and to ignore other wildlife sightings.

The markers for the outside boundary of the transects were set up as outlined in Norton-Griffiths (1978). The markers consisted of 1/4 inch doweling wrapped in black electrical tape and attached to a cable between the wing and fuselage of the aircraft. The markers were then checked against a known distance marked out on the Coppermine runway.

The reconnaissance flights delineated four areas of muskox concentration which were then resurveyed with systematic transects. These transects were 3 km wide and 12 km apart in strata 2 and 3, and 1.5 km wide and 6 km apart in strata 4 and 5 for a coverage of approximately 25% in each stratum. Stratum 2 was flown out of Coppermine immediately following the Coppermine portion of the reconnaissance. Strata 3, 4 and 5 were flown out of Paulatuk.

During the reconnaissance survey and the Rae-Richardson stratum survey (stratum 2), photographs were taken of large muskox groups in order to compare them with visual counts made concurrently. In order to photograph large herds off transect, the plane deviated from the line and then resumed the transect, once the photographs were taken. No photographs were taken during the surveys of strata 4 and 5, as photography was difficult in the trees, nor were any taken in stratum 3, as no large herds were encountered.

Data analysis was done with an Apple II Plus micro-computer. Calculation of strata areas and transect lengths was done with the aid of an Apple Graphics Tablet. The analysis of the transect data was based on Jolly's method 2 (Jolly 1969), with calculations of degrees of freedom after Cochran (1977:90).

Ground classification surveys were undertaken in two portions of the study area. Surveys were carried out near the tree line south of Paulatuk (Fig. 2, Latour and Baird 1983) and along the Rae River west of Coppermine (Fig. 3). Observations from the reconnaissance flights were used to delineate the general area for ground classification. Ground crews were in the field 16-21 March in the area south of Paulatuk, and 17-23 March along the Rae River.

The ground crews established base camps in a suitable location and travel led by snowmachine to locate and segregate herds. Search patterns were of a generally systematic nature, to ensure that herds were enumerated only once. Using binoculars (7X) and spotting scopes (20-50X) from local vantage points, herds could be located at distances of up to 10 km.

Each herd was approached, preferably downwind and using available cover, as close as possible by snowmachine without frightening the animals. Final approach was generally made on foot. Depending upon the composition of the herd, classification could be carried out with reasonable accuracy at up to 800 m. Closer observation distances of 400-600 m were preferable, but not always possible.

Field classification was based mainly on horn configuration and size (Henricksen and Grue 1980), and to a lesser extent on body size and length of skirt. Muskoxen were classified as short-yearlings (10-11 months), 2-year-olds, 3-year-olds and 4 years and older. Sexes were not determined for the short-yearling

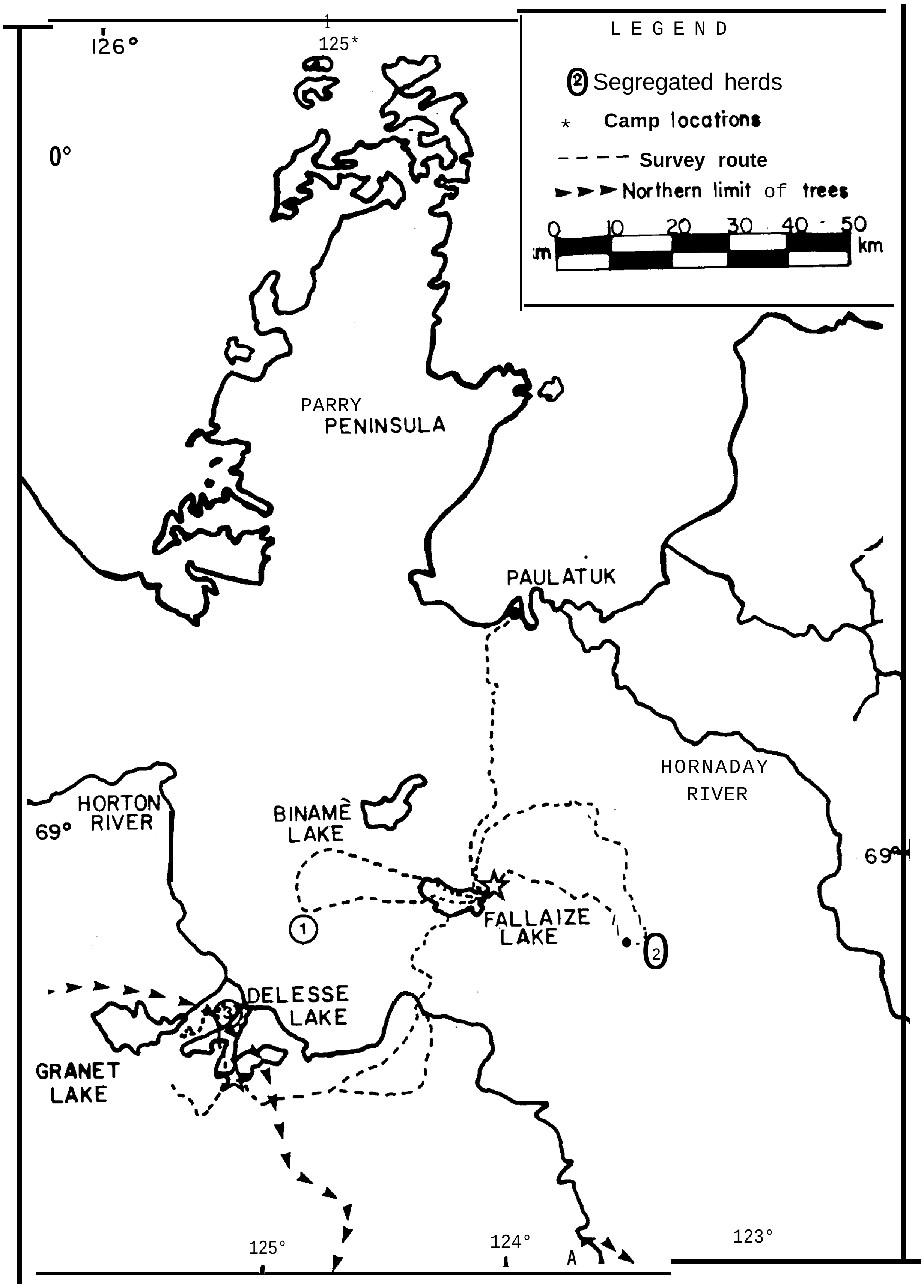

Figure 2. Route and segregation locations for muskox ground survey conducted out of Paulatuk, March 1983.

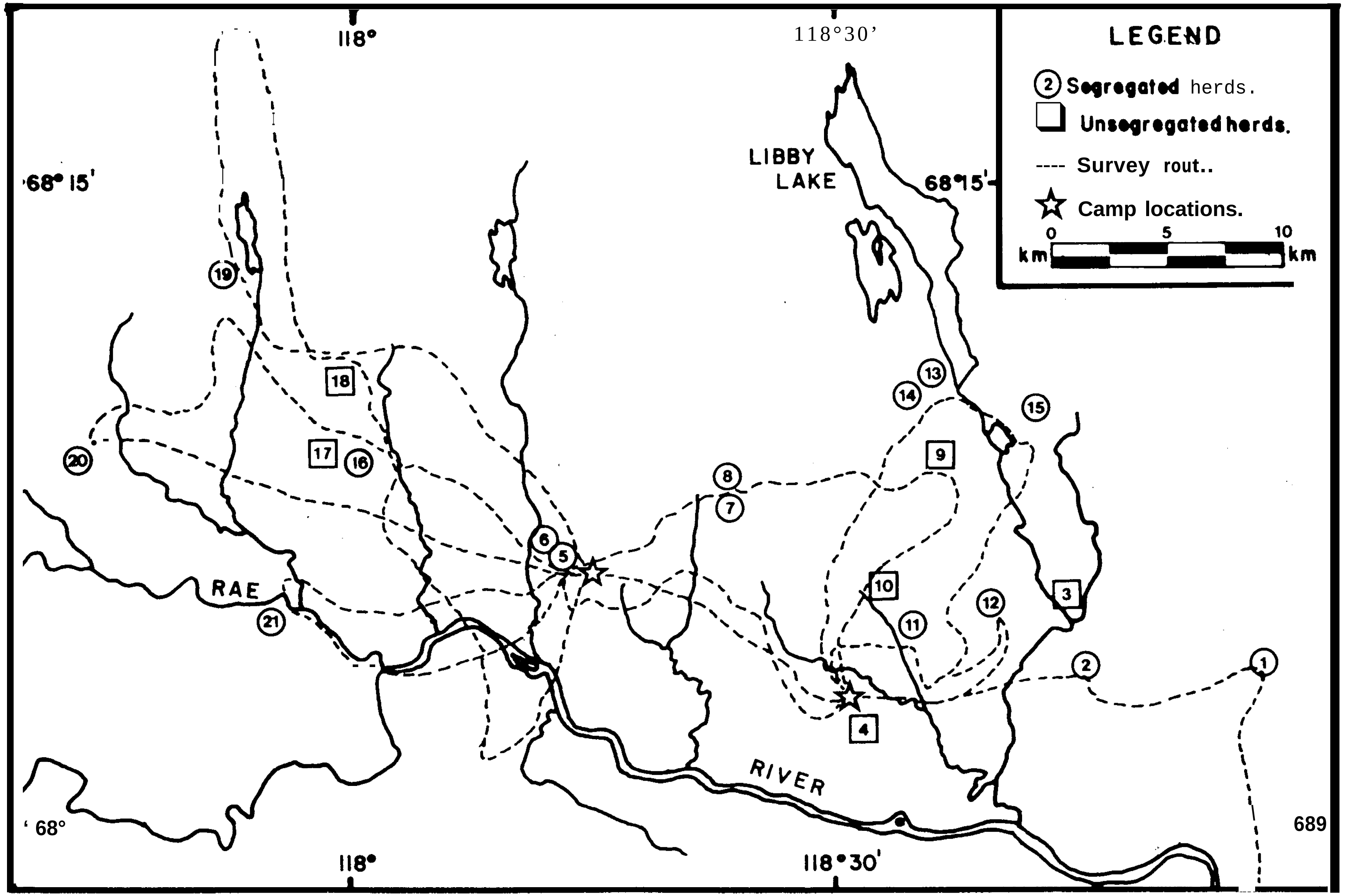

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Figure 3. Route and segregation locations for muskox ground survey conducted out of Coppermine, March 1983.

category. Unidentified muskoxen or animals of questionable age or sex were listed as unknowns. During classification one member of the team classified while the other recorded. Herds were often classified a number of times at decreasing distances to increase the accuracy of the work.

RESULTS

Aerial Surveys

For comparative purposes, two population estimates were derived. The first used only the data from the systematic reconnaissance transects (Fig. 4, Appendix A). This resulted in a population estimate of 2693 ± 1528 (95% C.I.).

When the high density strata (Fig. 5) were included in the calculations, the population estimate increased to 3148 ± 1274 (95% C.I.). There is a problem with this estimate, however. In two strata the estimates were lower than the number of muskoxen observed on and off transect. In stratum 3, the area around Brock River, the estimate was 28 muskoxen, while 52 muskoxen were actually observed. In stratum 4, the area encompassing Fallaize and Delesse lakes, the estimate was 145 muskoxen while 288 muskoxen were observed. The problem in both strata resulted when many more muskoxen were observed off transect than on. The estimates for these strata have, therefore, been adjusted upwards to the minimum count figures. This adjustment increases the estimate for the entire area to 3315 ± 1262 (95% C.I.) (Appendix B, Table 1).

During the survey a total of 1880 muskoxen were counted; 705 on transect and 1175 off transect. These totals do not include the muskoxen counted on the reconnaissance transects which were later resurveyed during the transect surveys of the high density areas.

Table 1. Analysis of data from the transect survey of muskoxen north of Great Bear Lake, March 1983.

STRATUM	1	2	3	4	5	TOTAL
(z)	90467	7760	1434	2920	6712	109293
(z)	8494.7	1923	359.7	744.2	1759.4	
(N)	213	46	20	60	96	
(n)	30	12	5	15	24	
(Y)	56	321	7	37	284	705
(Y)	596	1295	28	145	1083	3148
(R)	.01	.17	.02	.05	.16	
(VAR, Y)	32783	78072	608	6321	283998	401782
(SE, Y)	181	279	25	80	553	634
(CV)	.304	.216	.884	.548	.492	.201
(CI)						±1274

Corrected Estimate:

Stratum 1	596
Stratum 2	1295
Stratum 3	52
Stratum 4	288
Stratum 5	1083
Total	3315±1262

Z= Stratum area (km2)
z= Area counted (km2)
N= Maximum number of transects
n= Number of transects surveyed
y= Number of muskoxen counted
Y= Population estimate
R= Muskoxen density (per km2)
Var,Y= Population variance
SE,Y= Population standard error
CV= Coefficient of variation
CI= 95% Confidence interval

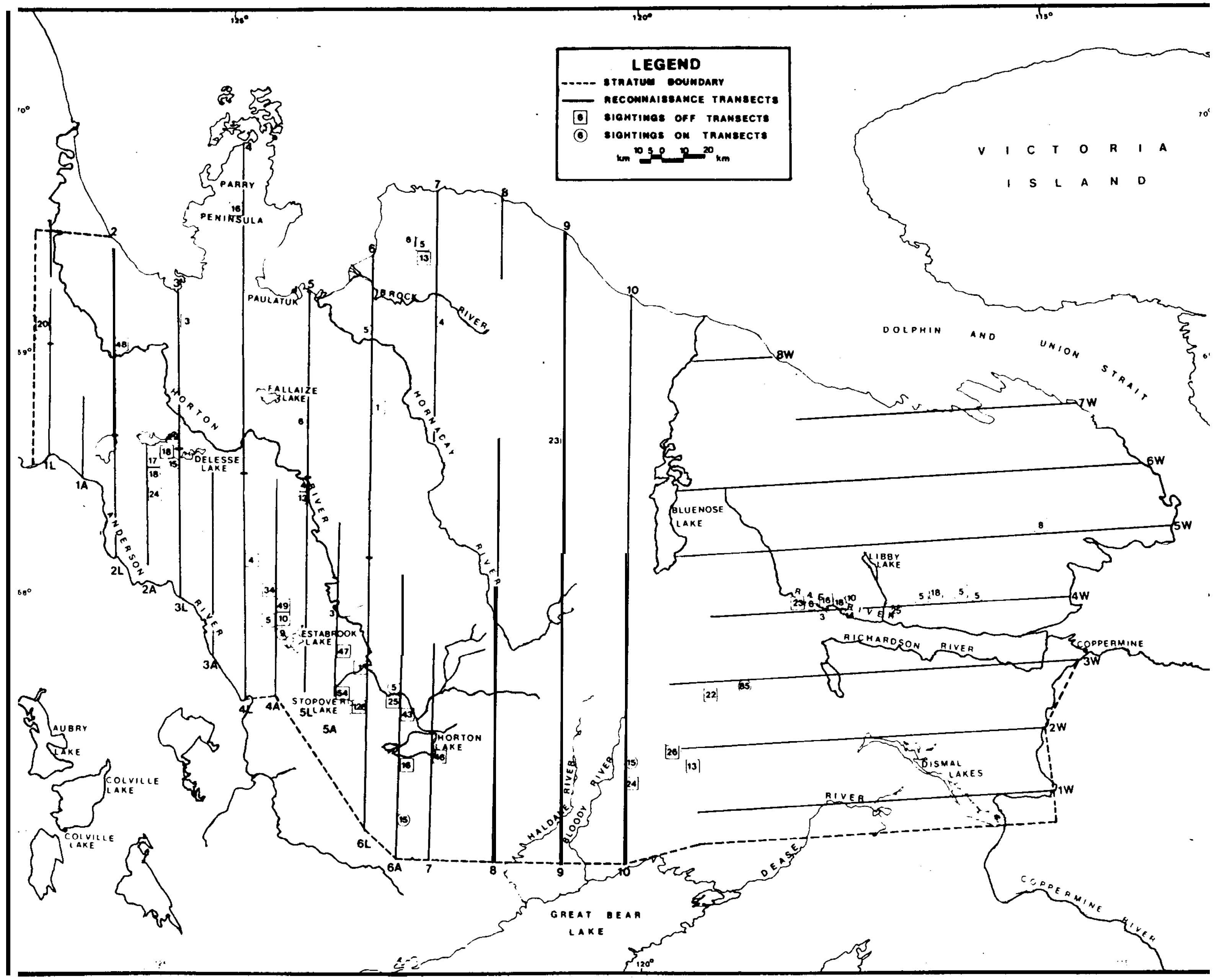

Figure 4. Reconnaissance transects and muskox sightings, North Great Bear, March 1983.

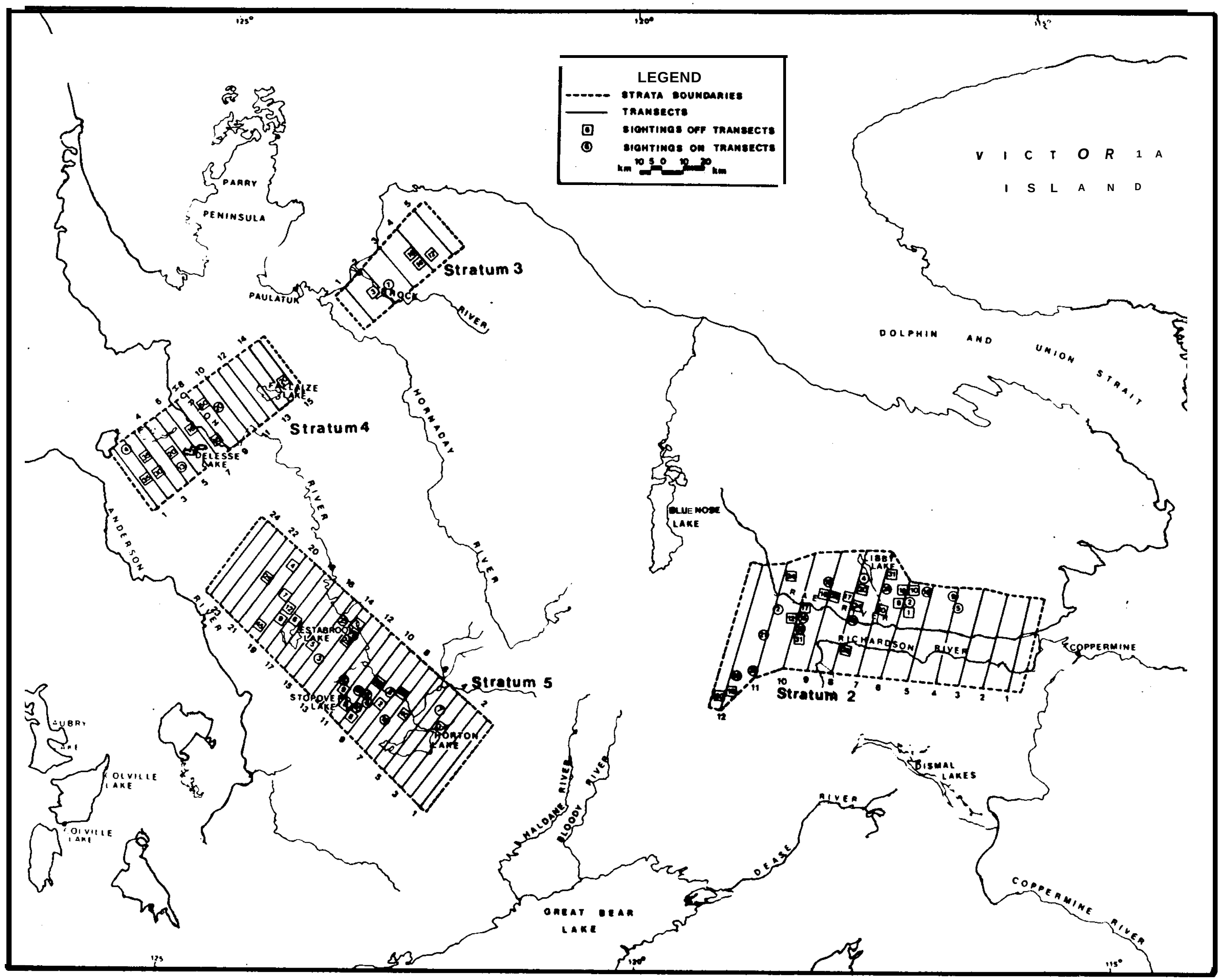

Figure 5. High density strata, transects and muskox sightings, North Great Bear, March 1983.

The weather conditions during the survey were excellent, with mainly clear weather and good visibility (Appendix C). On one day, 9 March, ice crystals reduced visibility and prevented the completion of transect 4W. This transect was reflown the next day with no difficulty. Visibility was, however, hampered by trees in the area south of Delesse Lake and in the Estabrook Lake area. Even with the reduction in transect width and flying altitude, the presence of trees made the detection and counting of muskoxen difficult.

Photographs were taken of 23 herds with an average size of 42.2 muskoxen. Two photographs were unclear and of little use for comparisons, thus reducing the sample size to 21 (Table 2). The difference between the photographic counts and those made visually during the survey was calculated. The two counts were found to be significantly different ($0.01<P<0.05$) using the Wilcoxon Signed Ranks Test after Sokal and Rohlf (1981:449). The sum of visual counts was 84 animals lower than that from the photographic counts. This represents a difference of 9.5%.

During the aerial survey, 143 herds and 4 single animals were observed, for a total of 2948 muskoxen. This total includes all the herds seen during the reconnaissance and the transect survey so there was likely some duplication. The mean herd size was 21.06 $\pm$ 1.42 (S.E.) muskoxen (Fig. 6). This figure includes short-yearlings, but excludes the four single animals.

Table 2, Comparison of visual and photographic counts of muskox herds north of Great Bear Lake, March 1983.

Stratum Number	On/Off Transect	Transect Number	Visual Count	Photo Count	Difference Vis. -Photo
1	ON	4W		PHOTO UNCLEAR	
1	ON	4W	23	18	5
1	OFF	2W	40	26	14
1	ON	3W	70	85	-15
1	OFF	4W	55	69	-14
1	ON	4W	60	68	-8
1	OFF	4A	25	34	-9
1	OFF	4A	45	49	-4
1	OFF	7	37	46	-9
1	OFF	6		PHOTO UNCLEAR	
1	OFF	3	22	29	-7
1	OFF	5A	38	38	0
1	OFF	5A	37	41	-4
1 "	OFF	6L	40	45	-5
1	OFF	6L	52	73	-21
1	OFF	6A	40	43	-3
2	ON	7	24	26	-2
2	OFF	7	38	31	7
2	OFF	8	18	17	1
2	OFF	8	36	34	2
2	ON	8	42	45	-3
2	ON	10	40	38	2
2	OFF	10	20	31	-11
		TOTALS	802	886	-84

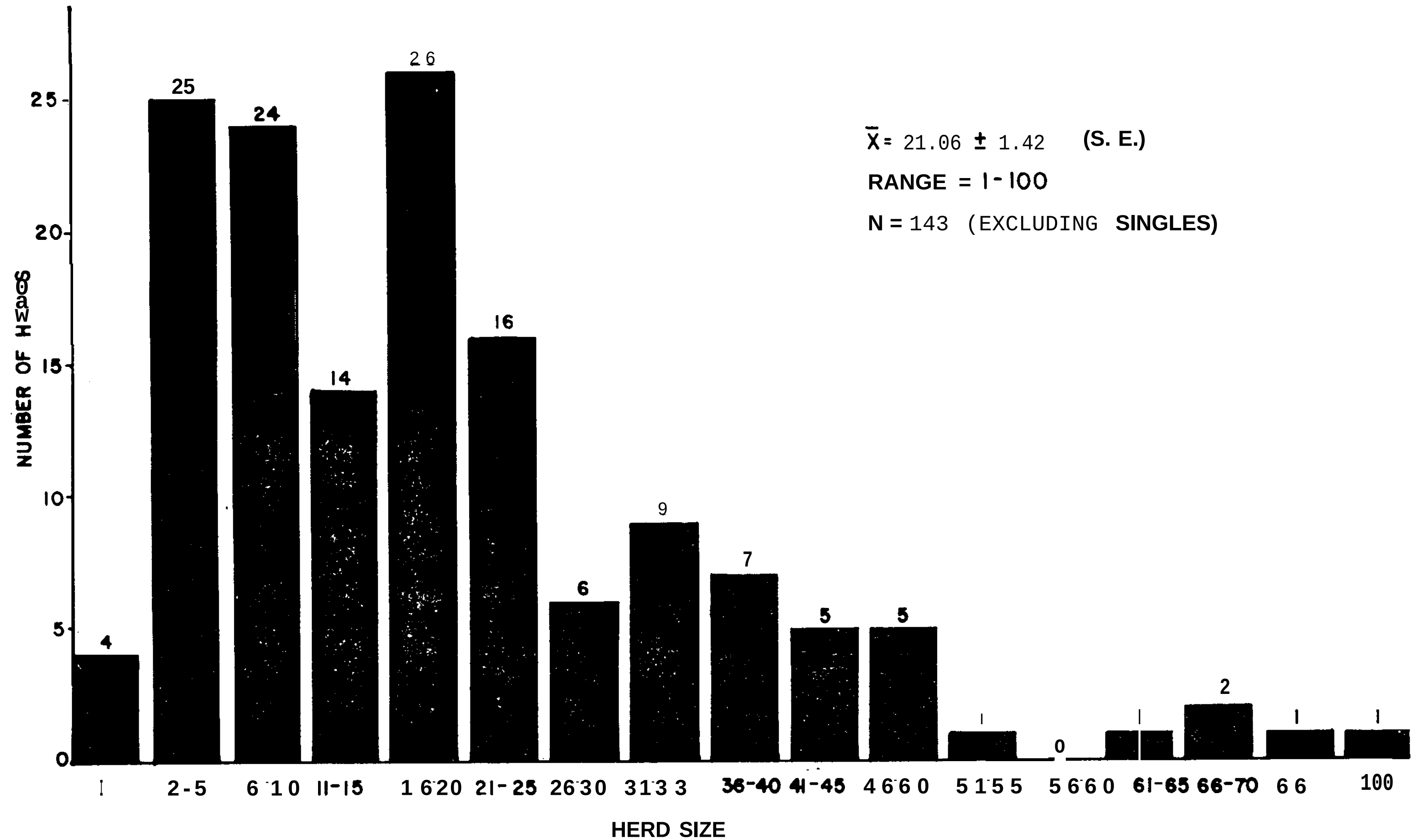

Figure 6. Distribution of muskox herd sizes observed during aerial surveys north of Great Bear Lake, March 1983.

Ground Surveys

South of Paulatuk

Due to the difficulty of locating and approaching muskoxen herds south of Paulatuk, little useable information was obtained (Latour and Baird 1983). Two of the three herds encountered were incompletely classified, precluding further analysis.

Rae River Valley

Classification counts in the Rae River valley were based out of two camps located south and south west of Libby Lake (Fig. 3). A total of 23 herds were encountered; however, the ground crew was only able to appoach 17 of these herds totalling 258 muskoxen (Appendix C). The other six herds, of mixed sex and age composition, ranging in size from 13 to 65 animals, took flight before the crew was close enough for accurate classification. (The herd containing 65 animals subsequently split into three groups after the initial disturbance. It is believed that all three of these groups were classified later.) Twelve of the 13 herds (92.3%) that reacted significantly to the ground crew exhibited flight behaviour. The remaining mixed herd of 27 animals bunched into the characteristic defense formation after disturbance.

The mean herd size of those groups classified was 15.2 $\pm$ 2.9 (S.E.)(n=17, range 3-38), somewhat smaller than that observed during the aerial survey (Table 3). Excluding bulls-only groups, herd size averaged 23.6 $\pm$ 3.5 (S.E.)(n=9, range 12-38).

Table 3. Herd characteristics of muskoxen observed during aerial and ground surveys in the Rae-Richardson valley, March 1983.

Characteristic	Aerial Survey	Ground Survey [a]
No. of muskoxen observed	711	258
Mean herd size (± S.E.)	21.9 ± 2.65	15.2 ± 2.9
No. of herds	35	17
Range	1-85	3-38
No. of muskoxen classified	0	248
No. of short-yrlings (% of total)		26(10.5)
No. of short-yrlings/100 cows 3+		31
Sex ratio (males:females) [b]		107:85

a Includes only those groups actually classified
b Includes muskoxen three years and older.

Bulls-only groups averaged 5.6 ± 2.3 (S.E.) (n=8, range 3-10) muskoxen.

The proportion of short-yearlings to total classified was 10.6% (26/248). The short-yearling to cow ratio (assuming that some cows produce their first offspring at 3 years of age) was 31:1oo (26/85). The sex ratio of animals classified was 107 males to 85 females (3 years+). This slightly skewed sex ratio was likely obtained because the most wary and unapproachable groups, also the most difficult to classify, were large, mixed herds containing proportionately more cows than bulls. Conversely, bulls-only groups were easier to recognize at greater distances.

DISCUSSION

Survey Design

The design for the 1983 North Great Bear survey was based on Latour (1984) and Gunn and Case (1984). The design worked well in both of these surveys, although low survey coverage during reconnaissance caused problems with the Queen Maud Gulf estimate (Gunn and Case 1984). The major difference between these two surveys and the present study was that the former surveys were conducted in July, while this study was conducted in March. Different distributions of muskoxen can be expected between July and March. In July, muskoxen tend to concentrate in low-lying meadows, often along the shores of rivers and lakes. This was found by both Latour (1984) and Gunn and Case (1984). In March, the distribution is less predictable and more dependent upon snow conditions. Muskoxen would be expected to use higher wind-swept areas where forage would be easier to obtain or, if the snow were very deep (as in 1983), in the trees where browse is available.

The above difference manifested itself in the results of this study. The coefficients of variation (C.V.) for the estimates in all the strata, with the exception of the Rae–Richardson valley, were high, and even the Rae-Richardson stratum was over 20%. This resulted from the difficulty encountered in accurately identifying areas of high density from the reconnaissance. The boundaries for the high density strata were drawn to enclose all nearby areas of observed or suspected high density. The final results were high density strata which contained vast areas with only scattered groups and pockets of muskox concentration.

The procedure of outlining high density strata worked well in the Rae-Richardson valley probably because the areas to the north and west are very poor muskox habitat. Therefore, the muskoxen remained concentrated in the valley.

Three solutions to this problem are available. One is to conduct the survey in July when the distribution of muskoxen is more predictable and the delineation of the high density strata easier. This approach sacrifices the high visibility of muskoxen encountered in the March surveys. The second solution is to conduct the surveys in March, but to expend extra effort to accurately delineate the high density strata. Inflated expenses may inhibit such an approach. The third solution would be to reduce survey areas to a more manageable size.

Another question which arose during this survey is the optimum transect width. The results from strata 3 and 4, where more muskoxen were seen off transect than on, tend to suggest that the transects could have been wider. This would hold true in spring surveys over open, flat terrain. However, in the trees, visibility was a problem even with the narrow 1.5 km wide transects.

Population Estimate and Distribution

In March 1980, Carruthers and Jakimchuk (1981) counted muskoxen while conducting an aerial survey of caribou. Except for a stratum in the Rae-Richardson valley, their survey was designed primarily to obtain information on caribou numbers, distribution and movements. In order to obtain an estimate of muskox numbers, they incorporated the results of a muskox survey conducted by Spencer (1980) in March 1980. Unfortunately, Spencer's results were misinterpreted. .

Spencer estimated 4502 ± 1768 (95% C.I.) muskoxen in four strata; Parry Peninsula, Brock River, South Paulatuk and Horton Lake. The problem with Carruthers and Jakimchuk's estimate arises because they also surveyed the Horton Lake area, yet still included Spencer's estimate for the Horton Lake area in their total.

Since the area in question includes parts of four strata in Carruthers and Jakimchuk's survey, and their survey was designed for caribou, it was felt that it would be best to use Spencer's estimate and delete Carruthers and Jakimchuk's observations in the area. This reduced Carruthers and Jakimchuk's estimate for stratum C from 917 ± 711 (S.E.) to 0 and stratum D1+D2 from 357 ± 323 (S.E.) to 0. The overall estimate is, therefore, reduced from 6728 ± 2400 (95% C.I.) to 5454 ± 1792 (95% C.I.).

The estimate from this study, 3315 ± 1262 (95% C.I.), is 39% lower than the adjusted 1980 estimate. It is necessary to look at the areas separately in order to assess this difference.

Rae River Valley

The area surveyed in 1980 was much larger than that covered in the 1983 survey, yet the estimate was greater in 1983 (1295 vs 869 muskoxen), as was the average density (0.17 vs 0.01 muskoxen/km2) (Table 4). The survey coverage was also higher in

Table 4. Comparison between the 1980 survey north of Great Bear Lake and this study.

March 1980 (Carruthers and Jakimchuk 1981)

Area	Number On	Observed Off	Total	Area (Km 2)	Coverage (%)	Estimate (± S.E.)	Dens.
Brock River	59	?	59	1604	11.0	530 ± 139	0.33
South Paulatuk	332	?	332	10181	8.3	2749 ± 832	0.27
Horton Lake	107	14	121	1439	11.4	1223 ± 168	0.85
Parry Penin.	?	?	78	4760	?	100	0.02
Stratum D1A-Rae-Richardson	163	75	238	12523	19.0	869 ± 300	0.07
Stratum A (Low Density)	0	0	0	18400	6.2	0	0.00
Stratum B (Low Density)	5	0	5	45872	6.2	83±73	0.00
Stratum C (Low Density)	0	0	0	40160	6.2	0	0.00
Stratum D1+D2 (Low Density)	0	0	0	33336	18.8	0	0.00

Total estimate: 5454 ± 1792 (95% C.I.)
Total area: 168,275 km2
Average density: 0.032 muskox/km2

March 1983 (This study)

Area	Number On	Observed Off	Total	Area (Km 2)	Coverage (%)	Estimate (± S.E.)	Dens.
Brock River	7	45	52	1434	25.0	28 ± 25	0.04
South Paulatuk	37	251	288	2920	25.5	145 ± 80	0.10
Horton River	284	286	570	6712	26.2	1083 ± 533	0.16
Rae-Richardson	321	378	699	7759	24.7	1295 ± 279	0.17
Low Density	56	210	266	90467	9.4	596 ± 181	0.01

Total estimate: 3315 ± 1262 (95% C.I.)
Total area: 109,293 km2
Average density: 0.030 muskox/km2

1983 (24.7% vs 19%). The two estimates show an increase of 49% over the three intervening years. The 1983 survey also showed an eastward expansion in the area. This expansion of the population and distribution seems to be in line with sighting reports from Coppermine (Binne, pers. comm.) and with the trend indicated by past studies (Boxer 1980, Carruthers and Jakimchuk 1981, Hawley and Pearson 1966, Kelsall et al. 1971). However, the recent expansion into the Dease River area, surmised by Carruthers and Jakimchuk (1981), was not confirmed by this survey.

Muskoxen were first recorded east of Bluenose Lake in 1966, when 37 animals were observed between the headwaters of the Rae and Richarson rivers (Hawley and Pearson 1966). In 1974, 109 muskoxen were observed. An extensive reconnaissance survey conducted in 1979 located 841 muskoxen (Boxer 1980). This compares favorably with Carruthers and Jakimchuk's estimate of 869 ± 300 (S.E.) in March 1980. This population increase and eastward expansion is similar to that which has been documented in the area south of Queen Maud Gulf (Gunn and Case 1984).

A major portion of the population now resides east of Muskox Management Area C/1-2 (Fig. 1). This area currently has a quota of 18 muskoxen (9 males and 9 females), roughly 1.4% of the current population estimate. The quota is generally filled every year and it is likely that some animals are taken in excess of the quota and closer to Coppermine, east of Muskox Management Area C/1-2 (Binne, pers. comm.).

One of the management goals for this population is to promote a further increase in the population and encourage further expansion both south into the Dease River area and east across the Coppermine River (Jingfors 1983).

Horton Lake

The distribution of muskoxen found in the 1980 surveys (Spencer 1980, Carruthers and Jakimchuk 1981) differs significantly from that found in this study. In 1980 most of the muskoxen were located around Horton Lake. This study found the main concentration of muskoxen near Estabrook and Stopover lakes (Fig. 4-5).

This change in distribution has occurred before. An extensive survey in March 1966 (Hawley and Pearson 1966) did not locate any muskoxen in the Horton Lake area, but found herds to the northwest between Ewariege Lake and the Horton River. A survey one year later in March and April 1967 located 62 muskoxen in the area immediately surrounding Horton Lake (Hawley et al. 1976). In 1974 no muskoxen were found in either area, but they were observed back in the Ewariege Lake area during surveys in the summer of 1975 (Hawley et al. 1976).

The explanation for these implied movements can only be speculated upon. One possible reason is local differences in snow depth and hardness which would affect forage availability and, thus, range use. Unfortunately, there are no records of snow conditions in the Horton Lake area.

This major difference in distribution makes the comparison of population estimates difficult. In 1983 the population estimate for the Horton Lake area was 1083 ± 533 (S.E.), down slightly from the 1980 estimate of 1224 ± 466 (S.E.) (Table 4). However, the area surveyed was much larger in 1983 than in 1980 (6712 km2 vs 1439 km2), and the density was much lower in 1983 (0.16 vs 0.85 muskoxen/km2). The coverage in 1983 was much greater (26.2% vs 11.4%) and the number of muskoxen seen during the 1983 survey was over 5 times the number seen in 1980 (570 vs 121) (Table 4). Taking these factors into consideration, it is not possible to identify a trend in the Horton Lake sub-population.

South Paulatuk

The area referred to by Spencer (1980) as the South Paulatuk area includes the Fallaize and Delesse lakes regions, the northern sections of the Horton and Hornaday rivers and the vast expanse in between. In 1980 Spencer estimated that there were 2749 ± 832 (S.E.) muskoxen in this area (Table 4). The herds of muskoxen he found were widely scattered. In 1983 the reconnaissance flights found very few muskoxen in this area (Fig. 4). A small concentration was located south of Delesse Lake below the tree line. The subsequent transect survey located a total of 288 muskoxen (Fig. 5). It is felt, however, that some muskoxen could have been missed due to the poor visibility in the trees.

One possible explanation for the difference in distribution and densities between March 1980 and March 1983 is the depth and/or hardness of the snow. Latour and Baird (1983) reported that muskoxen below the tree line were browsing on dwarf birch (Betula glandulosa), as they appeared to be unable to dig through the deep snow.

With the information available, it is difficult to draw any conclusions regarding the population trend of muskoxen in the area south of Paulatuk. It is felt that the 1983 estimate is low. It is also possible that the low coverage in the 1980 survey (8.3%) and the fact that transects were flown until no more muskoxen were observed (Spencer 1980) resulted in an inflated estimate.

The South Paulatuk area falls within Muskox Management Area C/l-l (Fig. 1). The area currently has a quota of 50 animals (30 males, 20 females). About 20 animals are taken yearly (Baird, pers. comm.), and only a few of these are taken in the area south of Paulatuk.

Brock River

In 1980, Spencer estimated that there were 530 muskoxen in the Brock River area, based on a survey with 11% coverage and observing 59 muskoxen on transect and 16 off transect. In 1983, 52 muskoxen were sighted in essentially the same area during a survey with 25% coverage (Stratum 3 Fig. 5). However, only 7 of these were on transect.

Records of muskoxen in the Brock River area go back to 1955, when 53 muskoxen were observed (Kelsall et al. 1971). A survey by Hawley in 1966 found only 10 muskoxen in the area. The latest count, other than Spencer (1980), was in 1974, when 25 animals were observed (Hawley et al. 1976).

As in the south Paulatuk area, these estimates are difficult to interpret. It is possible that the 1980 estimate was inflated by the low survey coverage. It is also likely that the figure of 52 obtained in 1983 is low. The undulating terrain and deep river valleys may have resulted in variation in transect width as it was impossible for the pilot to maintain a constant elevation above ground.

The Brock River area also lies within Muskox Management Area C/l-l (Fig. 1). As mentioned earlier, only part of the quota of 50 muskoxen for area C/l-l is taken each year." However, most of these are taken from the Brock River area.

Group Size

The mean herd size observed during the aerial survey component of this study was slightly higher than that observed in March 1980 (Carruthers and Jakimchuck 1981), but compares favorably with that observed in 1974 (Table 5). Mean herd size records from before 1974 range from 10.5 to 28.7; however, the sample sizes for these were quite small.

Photographic Counts

The results from the comparisons between the visual counts and photographic counts suggest that it is difficult to get an accurate visual count of large herds. Unfortunately, not all of the large herds were photographed. In future surveys an effort should be made to photograph all large groups, preferably before they bunch up.

The difference between the two counts cannot be used to adjust the total population estimate as counting error is generally only a problem with large herds, and adjusting the total estimate would over-estimate the population size.

Table 5. Muskox herd size data for north of Great Bear Lake, 1953 - 1983. (Adapted from Carruthers and Jakimchuk 1981).

Year	Month	Mean Group Size± S.E.a		Range	Number of Singles	Na	Source
1953	Feb.	28.7	14.7	2-63	0	3	Kelsall et al .(1971)
1955	Mar.	10.5	3.2	1-25	1	6	"
1958	Mar.	17.0	5.0	4-32	0	5	"
1967	Mar.	21.0	11.7	6-73	0	5	"
1967	Apr.	14.0	4.6	2-50	0	9	"
1966	Mar.	19.8	4.3	1-35	1	5	Carruthers and
1974	Mar.	20.4	3.4	2-90	0	51	Jakimchuk (1981)
1980	Mar.	16.3	1.5	1-75	9	91	"
1983	Mar	21.06	16.99	1-100	4	143	This study

a Excluding Singles

Ground Surveys

Classification of muskoxen from aircraft is unreliable, due to the difficulty in distinguishing between the sometimes subtle differences in horn size and configuration among the various age and sex categories. Although some indication as to the ratio of calves or short-yearlings to the total number of animals can be obtained from aerial surveys, the grouping and milling about resulting from some overflights make even calf counts difficult to obtain, with calf number being consistently underestimated (McLaren et al. 1977, Jingfors 1984).

The proportion of short-yearlings in the population (10.6Z) classified during the ground survey is likely an under-representati on of the actual population. Ideally, all muskox groups encountered should be examined, ensuring that as near a representative portion of the population as possible is classified. In addition, groups from different density strata should be examined. Due to the skittish nature of many of the larger mixed herds encountered, making some of them unapproachable, bulls were likely over-represented in the sample. The large boss of adult bulls made them readily identifiable at great distances.

The ratio of short-yearlings to cows (31/100cows, 3yrs+) may be the best statistic to use for analytical purposes, although this figure is still low in comparison to healthy and expanding populations, such as that found on southeastern Victoria Island in March 1983 (66 short-yearlings: 100 cows 3ys+) (Jingfors 1984). Jingfors (1984) found 28 short-yearlings per 100 cows on northeastern Victoria Island; however, only 70 muskoxen were classified.

In July 1975, Hawley (in Gunn 1983) obtained a calf count of 15.3% during aerial surveys north of Great Bear Lake. Tener (1965) obtained summer calf counts ranging from 8.5 to 14.3% in the The Ion Game Sanctuary. A July 1976 count in the Queen Maud Gulf documented 16.0% calves (Spencer 1976). Thus, given the difficulty of comparing summer aerial counts to spring ground counts, while the 10.5% short-yearling count obtained in this study may be low, it still lies within the range of values obtained for mainland herds in the past.

The short-yearling count suggests either low calf production in the spring of 1982 or poor first year survival of that cohort or the possibility of confusing short-yearlings with 2-year-olds. There is little evidence to support either of the first two claims. Snow depths were typically low (10-30cm) in the Rae River valley. Large numbers of carcasses were not in evidence, with Renewable Resource Officers aware of only four non-hunting kills in the Rae River valley prior to the March 1983 survey (Adjun, pers. comm.). As to the possibility of misidentification of short-yearlings, the observers were reasonably confident with recognition of this group at the time of the survey.

The reason for the apparently unnatural skittishness of the muskox herds encountered is not clear, although the weather may have been partly responsible. The consistently clear, cold and calm conditions encountered enabled the sounds from snowmachines and walking on the hard, dry snow to be audible from great distances. As there was virtually no wind, the ground crew was unable to take advantage of a downwind approach. It is likely that, due to these conditions, the herds could detect an approaching snowmachine at distances up to 4 km and a person on foot at up to 2 km. Large herd size may also have been an important factor.

Harassment from hunters was not believed to be the cause of the skittish behavior. Evidence of caribou hunters was seen east of the animals classified in the Rae River valley, but little if any muskox hunting had taken place in the area that year (Adjun, pers. comma).

In the Rae River valley the herds that exhibited flight behaviour appeared to be traveling in a linear path, generally north, away from the river valley. A number of herds moved 8-10 km after initial disturbance. By following tracks it was determined that one herd of 27 individuals had moved 15 km in less than 24 hours after initial disturbance, and were so wary as to be unapproachable. These long distance movements are unusual, with no more than 1-10 km per day being normal (Gunn 1982).

RECOMMENDATIONS

As the muskox population has expanded eastward into the Rae-Richardson valley, the hunters of Coppermine have taken advantage of this readily available meat source. They no longer need to travel into Muskox Management Area C/1–2 to find muskoxen. With muskoxen nearby, the demand has also increased beyond the present quota of 18 animals. The results of this survey indicate that the area could support an increased harvest.

It is, therefore, recommended that the boundaries of Area C/1-2 be changed to reflect the hunting patterns of Coppermine residents and current muskox distribution. The quota for this area should be increased from 18 to 35 animals (no sex distinction). The population would then be harvested at 1.7%, a rate that should allow the population to continue to increase and expand. This concurs with the recommendations from Jingfors (1983).

The new boundaries of C/1-2 should exclude the Horton Lake area and the Dease River-Dismal Lake area (Fig. 7). The former should be excluded as it is not within any communities' hunting area and will provide an example of an unhunted population for comparison with the hunted populations around Paulatuk and west of Coppermine. The latter should be excluded as it is the last remaining area north of Great Bear Lake to be repopulated by muskoxen. Hunting in this area could slow the further expansion of the population. The logical route for expansion of the population to the east is through this area and across the Coppermine River. Immediately following the completion of the

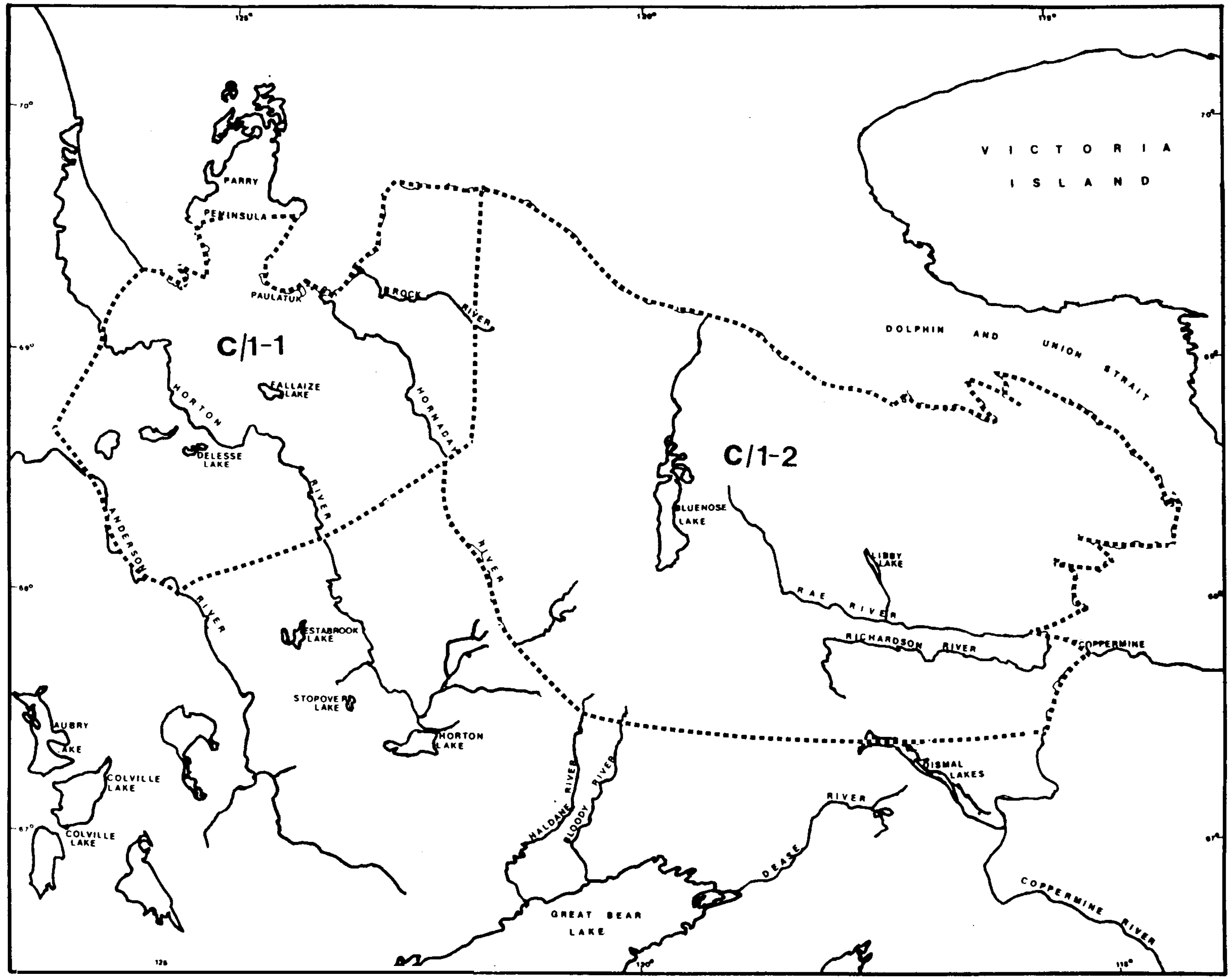

Figure 7. Recommended boundaries for muskox management
areas north of Great Bear Lake.

North Great Bear survey, the area east of the Coppermine River and west of the Tree River was surveyed south to Takijuq Lake (66° 40′ N). In 11 hours of flying transects, no muskoxen were observed (Poole, pers. data).

The southern boundary of area C/1-2 should follow the 67° 30′ parallel from the Coppermine River to the Haldane River, then north to the Hornaday River. The Hornaday River, with its deep gorges, provides a natural boundary. The northern boundary should follow the coast of Dolphin and Union Strait. The eastern boundary would be the Coppermine River (Fig. 7).

The boundaries and quota for Muskox Management Area C/l-l should not be changed. The present harvest rate, based on this study, is less than 3%. If the entire quota of 50 were taken, the harvest rate would be 7.1%. However, the population estimates for the Brock River area and the area south of Paulatuk obtained by this study are probably conservative. Another consideration is that the quota of 50 allows Paulatuk the option of sport hunts. To reduce the quota at this time, based on the uncertain estimates from this study, could jeopardize the good cooperation obtained from Paulatuk in supplying muskox harvest information (Baird, pers. comm.). The present boundaries of Area C/l-l need not be changed as they still reflect the hunting patterns of Paulatuk residents and the distribution of muskoxen in the Paulatuk area.

Due to the uncertainty surrounding the results for the Paulatuk portion of this survey, another stratified transect survey should be conducted in 1987, or sooner if hunting pressures out of Paulatuk increase. The Rae-Richardson area should also be included in order to monitor the growth and expansion of that population.

Ground classification surveys should be continued on an annual basis to monitor productivity and recruitment. The Rae River valley is an ideal location for such surveys because of the close proximity to Coppermine, and because it is the main harvest area for Coppermine residents. These surveys could be used as an indicator of the status of the population and could give us early warning of any population changes.

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Appendix A. Transect data and calculations: Reconnaissance

Transect	Area (km2)	Count
1	154.2	0
1L	79.7	0
1A	57.75	0
2	236.4	0
2L	96.4	0
2A	86.4	0
3	226.8	0
3L	96.4	15
3A	132.8	0
4	463.5	0
4L	159.3	0
4A	159.3	9
5	270.3	0
5L	149.7	17
5A	120.7	3
6	420	5
6L	195.6	0
6A	202.8	20
7	646.8	4
8	702.9	0
9	896.1	0
10	801.3	15
1W	498	0
2W	528	0
3W	614	85
4W	576	83
5W	690	0
6W	651	0
7W	363.6	0
8W	115.2	0
Totals	10390.95	256

Stratum area (km2)-(Z)	109293
No. of transects possible-(N)	213
No. of transects surveyed-(n)	30
Area surveyed (km2)-(z)	10390
Total count-(y)	256
Population estimate-(Y)	2693
Density-(R)	0.02
Variance-(VAR, Y)	558214
Standard error-(SE, Y)	747
Coefficient of var.-(CV)	0.277
95% confidence interval-(CI)	1165 to 4221

Appendix B. Transect data and calculations: Entire survey

Stratum 1

Transect	Area (km2)	Count
1W	498	0
2W	528	0
3W	258	0
4W	96	0
5W	690	0
6W	651	0
7W	393.6	0
8W	115.2	0
1	154.2	0
2	261	0
3	148.5	0
4	337.5	0
5	270.3	0
6	329.25	5
7	482.5	4
8	702.9	0
9	896.1	0
10	801.3	15
1L	79.7	0
1A	57.75	0
2L	64.5	0
2A	39	0
3L	72	0
3A	121.5	0
4L	95.25	0
4A	65.55	0
5L	46.5	17
5A	45.75	0
6L	91.9	0
6A	101.9	15
Totals	8494.65	56

Stratum 2

Transect	Area (km2)	Count
1	135	0
2	135.9	0
3	138.6	0
4	138.6	14
5	141	16
6	141	2
7	181.8	26
8	180.6	49
9	176.4	18
10	172.5	53
11	168.6	58
12	213	85
Totals	1923	321

Stratum 3

Transect	Area (km2)	Count
1	57.6	0
2	67.5	7
3	72.3	0
4	79.2	0
5	83.1	0
Totals	359.7	7

Stratum 4

Transect	Area (km2)	Count
1	53.1	0
2	52.2	4
3	52.2	0
4	51.2	13
5	50.7	0
6	50.7	0
7	50.3	0
8	49.8	0
9	49.2	20
10	48.3	0
11	48.3	0
12	47.3	0
13	47.3	0
14	46.8	0
15	46.8	0
Totals	744.2	37

Stratum 5

Transect	Area (km2)	Count
1	79	0
2	78.2	0
3	78.2	0
4	78.2	7
5	77.3	0
6	77.3	0
7	76.2	16
8	75.3	3
9	75.3	4
10	75.3	148
11	74.4	0
12	73.4	40
13	73.4	0
14	72.4	41
15	72.4	25
16	71.4	0
17	70.5	0
18	70.5	0
19	69.5	0
20	69.5	0
21	68.6	0
22	68.8	0
23	67.7	0
24	66.6	0
Totals	1759.4	284

Appendix C. Summary of weather conditions and flying times.

Date	Cloud	Temp	Mind	Visibility	Flying Time
March 8	Nil	-30oC	SW 15	CAVU	3.25 h
March 9	Cirrus	-30oC	6	15 km	2.9 h
March 10	Cirrus	-31OC	NW 22	15 km	4.5 h
March 11	Cirrus	-35oC	Calm	CAVU	4.5 h
March 12	Nil	-38oC	NW 9	CAVU	6.5 h
March 14	Nil	-30oC	Calm	CAVU	5.5 h
March 15	Nil	-35oC	S 25	CAVU	5.0 h
March 76	Nil	-30oC	Calm	CAVU	6.2 h
March 17	Nil	-35oC	Calm	CAVU	7.3 h
March 18	Nil	-30oC	Calm	CAVU	7.1 h
March 19	Nil	-30oC	Calm	CAVU	6.6 h
March 20	Nil	-30oC	Calm	CAVU	6.75 h
March 21	Nil	-25oC	Calm	CAVU	3.8 h
				TOTAL	69.9 h

Appendix D. Composition of 17 muskox herds classified in the Rae River valley, 17-23 March 1983.

Date	Herd No.	Herd Size	Adult M	Adult F	3 yrs M	3 yrs F	2 yrs M	2 yrs F	Short-Ylg.	Un-Classified
17 March	1	6	6	0	0	0	0	0	0	0
17 March	2	12	1	7	0	0	3	0	1	0
18 March	3	10	10	0	0	0	0	0	0	0
18 March	4	12	3	5	0	0	1	0	3	0
18 March	5	3	3	0	0	0	0	0	0	0
18 March	6	15	7	5	0	0	1	0	0	2
19 March	7	14	10	3	0	0	1	0	0	0
19 March	8	38	8	15	1	3	3	3	3	2
20 March	9	25	2	13	0	1	1	1	7	0
20 March	10	7	6	0	0	0	0	0	0	1
20 March	11	37	4	17	0	0	6	2	7	1
21 March	12	7	7	0	0	0	0	0	0	0
22 March	13	4	4	0	0	0	0	0	0	0
22 March	14	6	6	0	0	0	0	0	0	0
22 March	15	3	3	0	0	0	0	0	0	0
22 March	16	27	6	7	1	1	4	3	2	3
23 March	17	32	17	8	2	0	0	1	3	0
Totals		258	103	80	4	5	20	10	26	10
Proportion a			41.5	32.2	1.6	2.0	8.1	4.0	10.5	

Mean herd size = 15.2 ± 2.9 (S.E.)

a Proportion based on 248 classified muskoxen.