DISTRIBUTION AND ABUNDANCE OF MUSKOXEN BETWEEN BATHURST INLET AND CONTWOYTO LAKE, NWT, 1986

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ABSTRACT

We conducted a systematic strip transect survey for muskoxen (Ovibos moschatus) from the northeast side of Contwoyto Lake to Bathurst Inlet, Northwest Territories. The estimate of 3,400 +/- 460 (S.E.) was based on 641 muskoxen (non-calves) counted on transect between 28 August and 8 September, 1986. The estimate supports the observations of hunters that muskoxen have recolonized the area around Contwoyto Lake. There have no been comparable surveys to measure the rate of increase of muskoxen in the area. The east side of Bathurst Inlet was not surveyed but a compilation of sightings also indicates a muskox recolonization of that area. Muskoxen were mostly distributed in uplands and there were concentrations west of Bathurst Lake and in the high ground above the Burnside and Hood rivers. The proportion of calves to total muskoxen counted on transect was low (12.0%).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

The Department of Renewable Resources received reports of increased numbers of muskoxen in the 1980s from the area of Contowoyto Lake northeast to around Bathurst Inlet. In 1975, Parks Canada guessed that there were 400 to 500 muskoxen around Bathurst Inlet (Kingsley 1979). Southwest of Bathurst Inlet, hunters and geologists reported seeing more muskoxen (B. Algona, L. Covello pers. comm.), but there are no systematic data with which to estimate population size.

The Kugluktuk Hunters' & Trappers' Association (HTA) wanted a survey to find out whether or not the increase in muskox numbers was sufficient to establish a quota for the Contwoyto - Pellatt Lake area. The Kingoak HTA was also interested in information on the muskox increase in their area and the potential for a quota change to support commercial use.

The first objective of the survey was to estimate the numbers of muskoxen northeast of Contwoyto Lake and west of Bathurst Inlet. The second objective was to describe the distribution of muskoxen northeast of Contwoyto Lake. This report describes the results of the systematic strip transect survey of the study area conducted in August-September 1986.

STUDY AREA

The survey area's (Figures 1 and 2) southern boundary was an arbitary line between Pellatt Lake east to Beechey Lake thence north following the Western River and the west coast of Bathurst Inlet. The western boundary was arbitary and dictated by fuel supply.

The area northwest of Contwoyto Lake is a rolling, rocky morainic plateau with numerous lakes. Small drumlin fields and bedrock outcrops are common. The vegetation is mostly lichen tundra with sedges and willows in the wetter areas. The plateau is part of the Bear Slave Upland Ecodistrict (Zoltai et al. 1980). Bathurst Inlet is a long narrow lowland (the Bathurst Hills Ecodistrict) formed by a major faulting and intrusion of molten rock into the sedimentary rocks. The differential weathering of the intrusive and sedimentary rocks gives the Inlet its striking cuesta-and-vale topography. The Inlet's landscape also owes much to the Wisconsin glaciation. Successions of abandoned strandlines and raised beaches testify to the submergence and re-emergence of the landscape.

In the uplands south of the mouth of the Burnside River, the hills are relatively low with bedrock outcrops and thick glacial till which is notable high in nutrients. North of the Burnside River, the topography is more broken with many steep hills.

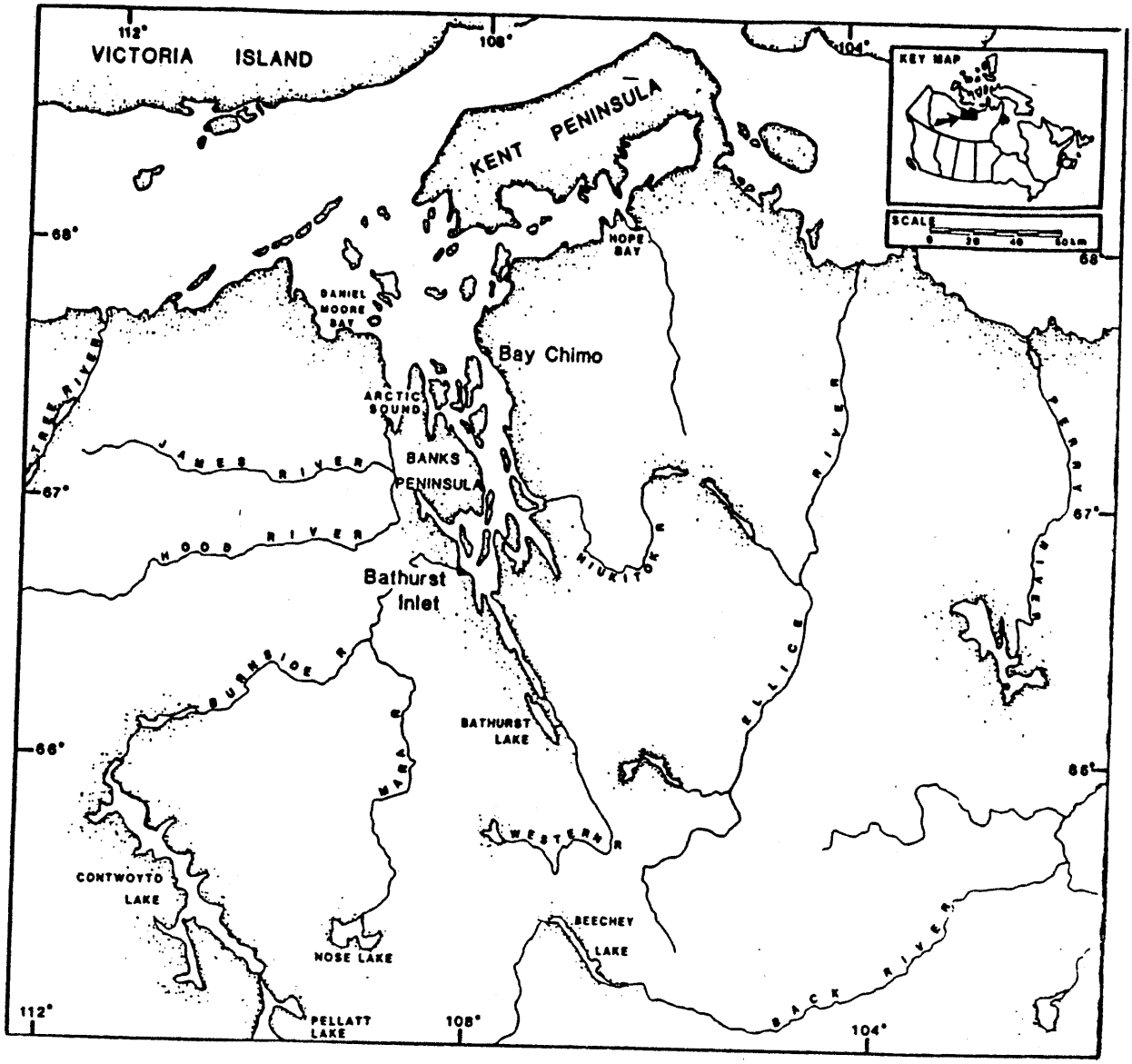

Figure 1. Contwoyto Lake and Bathurst Inlet, NWT.

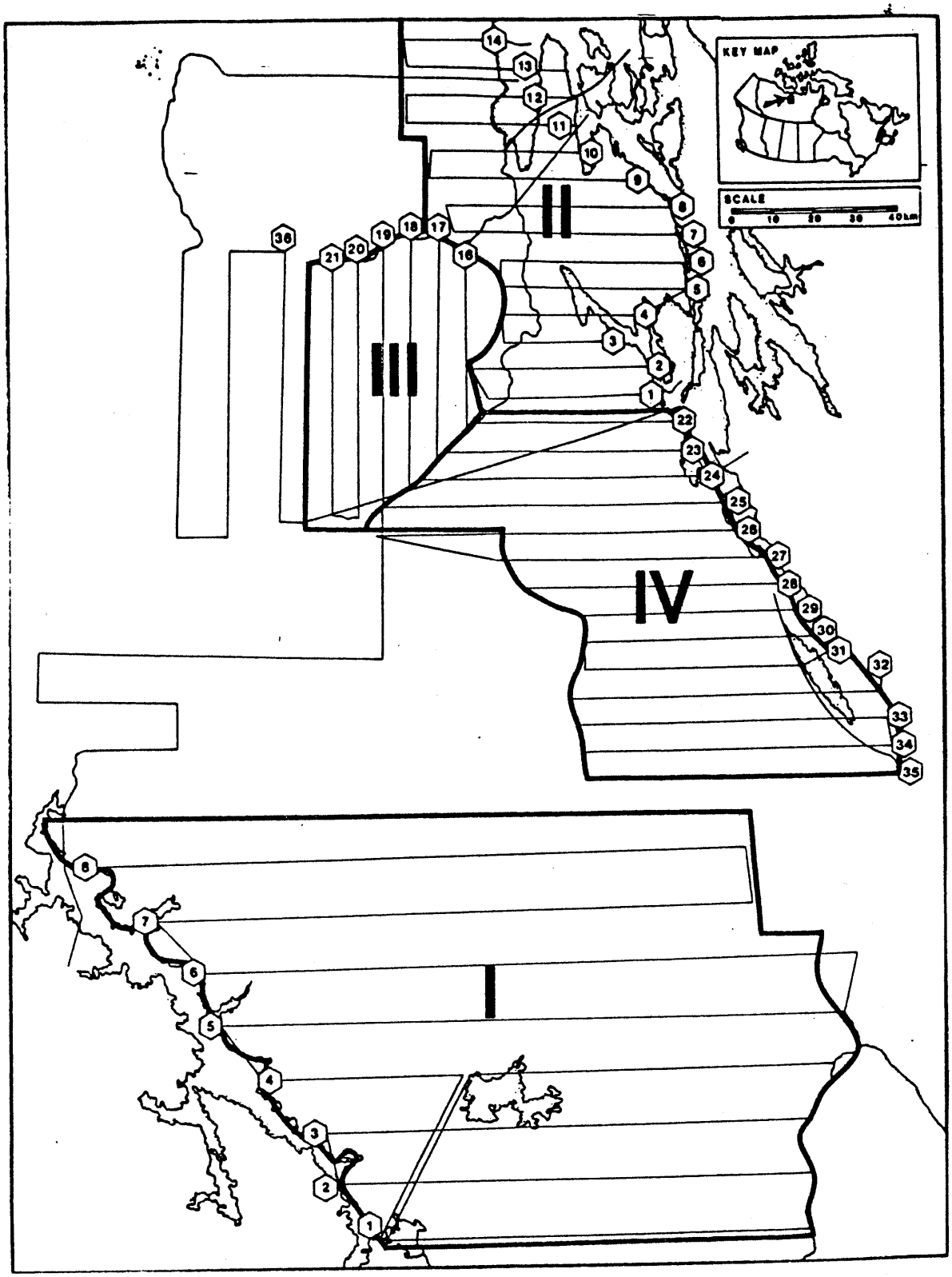

Figure 2. Strata and transects used for a muskox survery of Contwoyto Lake and Bathurst Inlet, NWT, 1986.

The varied landscape, high nutrient levels in the soil and the microclimate imposed by the topography has led to diverse and unique plant and animal communities. Vegetation around Bathurst Inlet was described when the area was under consideration as a National Park (Zoltai et al 1980).

The Back Lowland ecodistrict lies east of Bathurst Inlet and is mostly low-elevation bedrock hills, numerous lakes and disrupted drainages. The hills are mostly bare granite with occasional thin acidic till.

METHODS

We did not precede the systematic aerial survey with an aerial reconnaissance survey so as to use the available flying time to cover the largest area possible. The survey effort was higher west of Bathurst Inlet based on previous reports of the muskoxen there. Coverage of 13.0% was acheived in Stratum I (northeast of Contwoyto Lake) by surveying transects 12.8 km apart. In Stratum II (Banks Peninsula) and Stratum III (Hood River south to 68 N) coverage was 22.0% and 21.1%, respectively, the transects were 6.4 km apart. The coverage was 24.8% in Stratum IV (south Bathurst Inlet). We oriented the strip transects perpendicular to the long axis of the coastline and the major rivers to avoid a sampling bias if the muskoxen were concentrated along drainages and in the lowlands. The transects were east-west in strata I, II and IV and north-south in Stratum III. After the transects in the four strata were finished we followed an additional three lines (36, 37 and 38) spaced at 13km intervals to ascertain whether or not the muskox distribution continued west.

The survey aircraft was a Helio-Courier on floats. The survey crew was a right and left observer both seated in the rear and the pilot who navigated and plotted observation numbers on 1:250,000 scale topographic maps. The left observer recorded the sightings for both observers by location number in a field notebook.

A wire was stretched from an eye bolt on the wing to the fuselage (the Helio-Courier does not have wing struts). Boundaries for the inside and outside of the transect were calculated (Norton-Griffiths 1978) and marked by red tape on the wires and windows. The transect width was 0.8 km on either side of the aircraft. We checked the markers by flying at 150 m above ground level over a truck parked 0.8 km from the runway end markers on the Cambridge Bay airstrip. When flying along the transects, the aircraft altitude was 150 m above ground level and airspeed was 160 km/h.

The first transect was randomly placed along a line of latitude and then the other lines were evenly spaced. No sex and age classification counts were systematically attempted but we counted calves when they were conspicuous.

We were based at a mining exploration camp on the south side of Contwoyto Lake with fuel at the camp. We then moved to Bay Chimo to survey strata II, III and IV and where fuel had been previously cached.

I used Jolly's (1969) Method 2 estimate to calculate a population estimate from the numbers of muskoxen (excluding calves) counted on transect. The difference between the right and left observer's counts was tested for significance with a Wilcoxon matched-pairs signed ranks test. A Kruskal-Wallis One-Way analysis of variance was used to test whether or not herd sizes varied significantly between strata.

RESULTS

Population Estimate

We counted 641 muskoxen and 79 calves on 4,547 km2 of strip transects across the survey area (Table 1, Appendix A). We counted 86 muskoxen and 2 calves off transect and a further 150 muskoxen and 10 calves during ferry flights. The total flying time of 52.7 h was composed of 20.6 h survey time, 12.1 h of return ferry time from Norman Wells to Contwoyto Lake and 20.0 h ferry time between either Contwoyto Lake or Bay Chimo (our operational bases) and the transects. We surveyed the transects in Stratum I between 31 August and 1 September, those in Stratum II on 3 September, the transects in Stratum III on 4 September and Stratum IV on 5 and 7 September, 1986.

The overall estimate for Contwoyto Lake northeast to Bathurst Inlet is 3,400 +/- 460 (S.E.) muskoxen or (2,498 -4,318 based on the 95% confidence interval). The overall coefficient of variation is 0.136. The low-coverage stratum (I) and the stratum with few muskoxen (II) had high coefficients of variation compared to Strata II and IV (Table 1).

Weather that would influence the conspicuousness of the muskoxen varied (Table 2). On overcast days, muskoxen were relatively inconspicuous among the rocks on the higher elevations. The numbers of muskoxen counted by the left and right observer did not significantly differ ($p<0.05$).

Table 1. Analysis of data from a transect survey of muskoxen between Bathurst Inlet and Contwoyto Lake, NWT in August-September 1986.

		STRATUM			
			I	II	III
IV TOTAL					
Maximum number of transects	(N)	56	60	24	56
Number of transects surveyed	(n)	8	14	6	14
Stratum area, km	(Z)	13,870	4,000	2,407	5,743
Transect area, km	(z)	1,734	877	508	1,429
Number of muskoxen counted	(y)	152	39	286	164
Muskoxen density, Muskoxen/km	(R)	0.09	0.04	0.56	0.11
Population estimate 3,408	(Y)	1,216	178	1,355	659
Population variance 215,491		124,328	9,436	55,837	25,889
Standard error 464	(SE,Y)	353	97	236	161
Coefficient of 0.14 variation	(CV)	0.29	0.55	0.17	0.24

Table 2. Weather and light conditions during strip transect aerial survey of Contwoyto Lake and Bathurst Inlet area, NWT, August-September 1986.

Date	Transect (stratum)	Weather and light conditions
31 Aug.	1 - 3 (I)	Broken cloud; bright patches.
1 Sep.	4 - 8 (I)	Broken cloud; bright patches.
2 Sep.	-	Overcast then broken cloud.
3 Sep.	1 - 13 (II)	Broken cloud and bright patches.
4 Sep.	16 - 21 (III)	Bright overcast becoming dull by line 19; strong gusty winds.
5 Sep.	24 - 31 (IV)	Broken to overcast cloud with bright to dull light; turbulent winds.
6 Sep.	-	Low cloud, strong winds and snow showers.
7 Sep.	22,23, (IV) 32 - 35 36 - 38 (III)	Overcast, and dull light.
8 Sep.	38 - 41	Broken cloud with fog patches.

Group sizes ranged from 2 to 73 and mean herd size was not significantly different ($p<0.05$) among the three strata (Table 3). The overall mean herd size of 54 herds was 18.1 +/- 13.3 (S.D.). The proportions of social units that were single bulls were 59% and 61% in the two higher density strata (Tables 1 and 3). In the two strata with lower densities of muskoxen the proportions of single bulls were 55% and 30% (Tables 1 and 3).

The highest density of muskoxen (Table 1) was found on the rocky uplands of Stratum III west of Bathurst Inlet between the James and the Hood rivers (Figures 1 and 3). Fewest muskoxen were found on Banks Peninsula and west of Arctic Sound, despite the observation of a herd of 73 during a ferry flight. The distribution of muskoxen by elevational category (Table 4) reflects the tendency of the muskoxen to be distributed away from the coast and up on the more rocky elevated areas. The distribution by elevational zone does not necessarily reflect preference as much of the land of the study area is relatively high.

The proportion of calves to total muskoxen counted on transect was 12.3% (720) and varied among strata. In strata I and IV the proportion of calves was 8.4% and 8.3%, respectively. The relatively high proportion in Stratum II (17.0%) probably reflects the small sample size (3 herds) and the proportion of calves in Stratum III was 12.8%.

Table 3. Mean group size of muskoxen by stratum observed during a strip transect aerial survey of Contwoyto Lake and Bathurst Inlet area, NWT, August-September, 1986.

Stratum	No. of groups	Group size (excluding singles) mean	S.D.	range	No. of singles
I	15	14.6	11.1	2 - 44	18
II	7	18.2	23.0	5 - 73	3
III	18	24.7	15.5	2 - 43	26
IV	14	14.9	10.1	2 - 39	22

Table 4. Muskox distribution by elevational categories from observations on transect during an aerial survey of Contwoyto Lake and Bathurst Inlet area, NWT, August-September, 1986.

Stratum	Elevational category <150m	150 - 300m	300 - 450m	>450m
I	0	0	40	112
II	9	9	21	0
III	0	1	284	1
IV	0	21	107	36
TOTAL	9	31	452	149

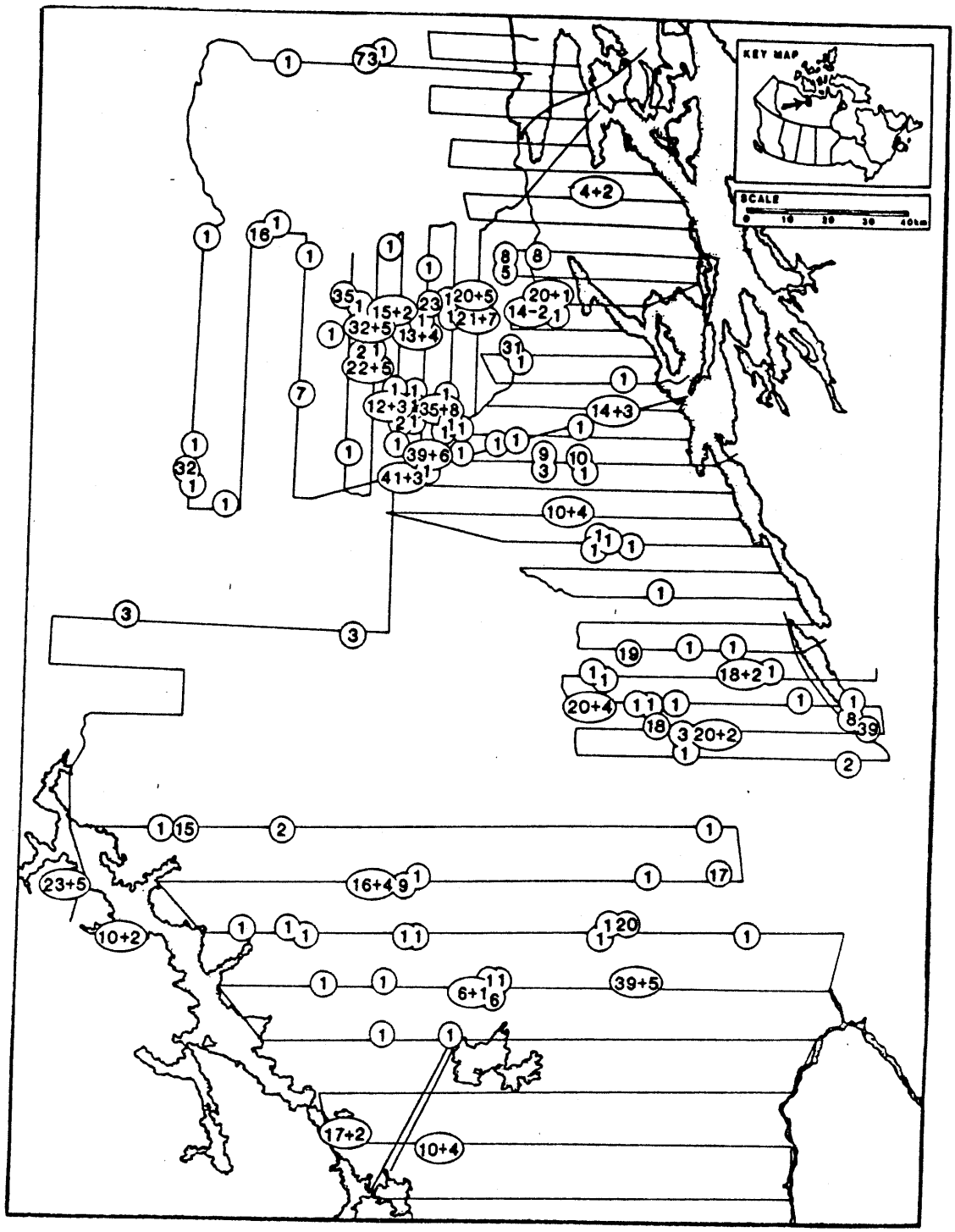

Figure 3. The locations of muskox herds observed on transect during an aerial survery of contwoyto Lake and Bathurst Inlet, NWT, August-September, 1986.

DISCUSSION

The estimate of 3,400 +/- 460 (S.E.) muskoxen for Contwoyto Lake northeast to the west coast of Bathurst Inlet supports the observations of hunters that muskoxen are relatively common. There are no previous estimates for comparison with which to describe the rate of increase.

The percentage of calves (12.3%) is within the range of 10.2% to 15% calves to total muskoxen observed east of Ellice River from 1975 to 1982 (Gunn and Case 1984). The mean herd size observed during this survey is to the 107 herds (19.19 +/- 9.52 S.D.) observed east of the Ellice River in mid- August 1986 (unpubl. data). The survey was conducted after the peak of the rut which is usually mid-August and the herds had not started to merge into the larger herds typical of winter. The smaller herds in summer may be the result of competition within herds for high quality forage which causes fragmentation of the larger winter herds. Adult bulls in particular tend to become solitary or to form small groups.

The estimate was relatively precise considering the absence of previous information on which to base stratification. Graf and Case (1989), however, have recommended that an acceptable level of precision for muskox surveys is Coefficient of Variation of 0.10 or less. The design of muskox surveys has improved (Graf and Case 1989), but the accuracy of counts remains unknown (Gunn 1982). Typically, muskox surveys are conducted at high altitudes

with wide strips to increase coverage but the validity of the assumption that muskoxen are sufficiently conspicuous that wide transects (>1 km) at relatively high altitudes (>300m) are feasible remains untested. Doubts about this caused me to conduct this survey at a relatively low altitude in anticipation that muskoxen would not be conspicuous against bare ground. Another consideration is the observer's maintenance of a search image may be more difficult when the image is very small. Testing of the effect of altitude on conspicuousness of muskoxen and observer concentration may lead to improvements in muskox survey design.

The dynamics of herd sizes are a factor in the timing of muskox surveys. In winter, muskoxen are more conspicuous against a snow background but are in large herds. Muskox herds on the mainland are larger than on the arctic islands both in winter as well as summer (Table 5). Case and Graf (1986) recorded that visual counts were 27% lower than photographic counts of 6 herds (21-68 muskoxen) in November, 1985, at an altitude of 185 m above ground level. In the cold, the aircraft's noise often causes clumping of the muskoxen at a greater distance which increases the difficulties of counting the individuals in large herds. The use of 35mm photography can offset the trade-off between the advantage of conspicuousness of muskoxen against a snow background, but with the disadvantage of muskox being in larger herds.

Table 5. A comparison of muskox herd sizes between winter and summer from mainland and the arctic islands, NWT.

Mean herd size +/- S.D, (n, range).	
March	July-August
West of Coppermine	
1988	1987
22.53 +/- 12.17 (n = 30, 3-42) (1987 and 1988 unpubl. data)	11.21 +/- 7.74 (n = 29, 2-28)
1983	
20.86 +/- 16.92 (n = 30, 2-85 Case and Poole 1985)	
S.E. Victoria Island	
1988	1987
10.81 +/- 8.14 (n = 595, 2-51) (1987 and 1988 unpubl. data)	9.90 +/- 4.63 (n = 145, 2-24)
1983	
10.50 +/- 5.5 (n = 134, 2-27, Jingfors 1984)	

The timing of the survey also depends on the topography. Muskoxen concentrate along drainages and on coastal lowlands in late June and July to feed on greening vegetation. Such a distribution facilitates a block design for a survey (e.g., Gunn and Case 1984). In more rolling areas, the clumped distribution is less marked and systematic transect surveys are a more appropiate design.

The prehistoric and early historic numbers and distribution of muskoxen in the Contwoyto Lake area and Bathurst Inlet area are not known in detail. Freeman (1976) does not specifically mention muskox hunting in the area of Contwoyto Lake before 1916. In the period 1916-1955, the establishment of trading posts and fox trapping had become significant influences on the activities and movements of the people. During this period, the Contwoyto Lake area was intensively hunted and as people travelled to trade at Bathurst Inlet, they hunted along their travel routes. Muskoxen were most frequently taken northeast of Contwoyto Lake (Freeman 1976). By the 1950s, muskoxen had decreased in the area and had become scarce (B. Algona, C. Adjun pers. comm.).

By the 1960s, people had moved to Coppermine and their dependance on dogs limited the extent of travel until snowmachines were introduced in the early 1960s. By the 1970s, muskoxen were again sighted in the area and by the 1980s, muskoxen were seen along the north and south shores of Contwoyto Lake in winter and summer (B. Algona pers. comm.). In June 1984, a herd of about 20 muskoxen were stranded on an island in Pellatt

Lake until fall freeze-up when apparently they left (B. Algona pers. comm.).

Early European explorers described mostly the coastal areas as overland travel was more difficult. Franklin (1969) noted that there were muskoxen at the mouth of the Western River. Hanbury (1904) believed that muskoxen were "fairly numerous" east of the Inlet. Bay Chimo area is known as "Umingmaktok" ("place of the muskoxen"), and Freeman (1976) mentions east and south of Bathurst Inlet as good muskox hunting territory prior to the 1920s. In the period 1920 to 1954, muskoxen were rare east of Bathurst Inlet (Freeman 1976). Monaghan (1970) in April 1970 did not survey the area east of Bathurst Inlet except for two transects on Kent Peninsula as he believed the habitat looked unsuitable for muskoxen. Kingsley (1979) flew east of the Inlet in February 1979 but observed no sign of muskoxen.

The sightings of muskoxen during surveys of caribou calving grounds east of Bathurst Inlet toward the Ellice River document muskox use of the area. Differences in the areas previously surveyed hamper any extrapolations to estimate the extent of the apparent recolonization. In June 1986, 112 muskoxen were counted compared to 122 in June 1984 and 63 in June 1980 (S. Fleck pers. comm.). Muskox herds were occasionally seen in the vicinity of Hope Bay (K. Poole pers. comm.) in the mid-1980s. Herds have been seen on Kent Peninsula since the early 1980s (D. Kaomayok pers. comm.). Our sighting of a bull near Bay Chimo in September 1986 and other reports of the occasional muskoxen near the

community (J. Hakungak pers. comm.) indicate that muskoxen are continuing to spread to the east. In September 1986, we found tracks, wool and summer fecal pellet groups along a river about 40km northwest of Hope Bay.

West of Bathurst Inlet, sightings of muskoxen are more frequent. Freeman (1976) records that muskoxen were plentiful west of Gordon Bay, although they were only hunted out of necessity between the 1920s and 1960s. Subsequently the numbers have increased (Freeman 1976).

The lowlands of the Bathurst Inlet area are characterized by vegetation which is luxuriant for the latitude. Well-grown thickets of willows including the feltleaf willow (Salix alaxensis) colonize floodplains and river gravel bars. The lowlands are used by the muskoxen in June and July but as the willow leaves turn to yellow the muskoxen return to the uplands (J. Tikhak pers. comm.). The granitic uplands west of Banks Peninsula are rugged and poorly vegetated compared to the lowlands. Semi-aquatic sedges grow along creeks and around some lakes on the uplands and several herds of muskoxen were grazing up to their bellies in the water in early September, 1986. The rugged terrain of the uplands probably serves as escape terrain for muskoxen pressed by wolves but perhaps, more importantly, the snow is shallower and forage more accessible than on the lowlands.

Previous surveys of the Bathurst Inlet were unstratified and unsystematic and did not lead to estimates of population size.

Monaghan (1970) counted a total of 96 muskoxen west of Bathurst Inlet in April 1970 and believed that the population numbered 108 which he recommended was insufficient to justify a quota. Spencer (1976) surveyed around Bathurst Inlet in July 1976 and counted 110 muskoxen which included 19 calves. Kingsley (1979) counted 80 muskoxen during his non-systematic survey of Bathurst Inlet in late February 1979 and he concluded that muskoxen did not use the low ground around the Inlet in winter.

A quota of 5 muskoxen was assigned to the Bathurst Inlet area (F1-1) in 1977. The quota was used most years until it was arbitarily doubled to 10 in 1984. The annual harvest remained at 4-5 muskoxen and in 1987-88, one muskox bull was taken for the first guided non-resident trophy hunt as well as three muskoxen for domestic use. There is potential for the commercial use to increase either to supply meat for commercial sale or for guided non-resident hunting. In anticipation of this need a quota increase would be sustainable by the 1986 estimated population size. The quota should remain relatively conservative at 2-3% of the current estimate until there are data to interpret the trend in population size. Conservatism would also have the effect of fostering the continued spread of the muskoxen.

Currently, the area northeast of Contwoyto Lake is not within a Muskox Management Unit. There is demand for a quota for domestic use as well as commercial potential. Muskox meat could be sold for utilization at the Lupin goldmine and there is potential to establish guided non-resident hunting. The results

of this survey would support the establishment of a Muskox Management Unit and a quota assigned to Coppermine as the outpost camps at Contwoyto Lake and Pellatt Lake are part of Coppermine's hunting area. The boundaries of the unit should be when possible conspicuous topographical features on the ground to aid the hunters. The northeast coast of Contwoyto Lake and stretches of the Burnside and Back rivers suggest themselves in this context. In the absence of information on muskox movements and as to what, biologically, constitutes a muskox population the area surveyed as Stratum I would serve as a management unit.

The level of the quota should be conservative to foster the continued spread of the muskoxen. A second consideration in recommending a conservative quota is the absence of data on natural mortality. Wolves and grizzly bears are potential muskox predators and are relatively common in the study area. (See Editor's Note, Recommendations Section).

RECOMMENDATIONS

1. Establish a Muskox Management Unit northeast of Contwoyto Lake.
2. Establish a quota of 20 muskoxen (no sex differential) for the Contwoyto Lake unit and assign the quota to Coppermine.
3. Increase the quota for Bathurst Inlet area (MMU F1-1) from the present level of 10 to 30.
4. Investigate the trade-offs in accuracy and precision from aircraft altitude and transect strip width variation.
5. Adopt the use of 35mm photography of herds larger than 10 muskoxen during aerial surveys.

Editor's Note: Regulations under the Wildlife Act (S.N.W.T. 1978) were amended (R-048-87) in 1987 as per recommendations 1, 2 and 3. The area northeast of Contwoyto Lake was designated Muskox Management Unit F/2-2.

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Appendix A: Muskoxen observed on transect during an aerial survey of Contwoyto Lake and Bathurst Inlet, NWT, August - September, 1986.

Transect No.	Transect area (km2)	On transect		Off transect	
		left	right	left	right
Stratum I					
1	163	0	0	0	0
2	184	10+4	0	0	17+2
3	189	0	0	0	0
4	221	0	2	0	0
5	240	43+5	12+1	1	0
6	251	4	21	2	1
7	230	19	25+4	0	1
8	256	15	1	3	0
TOTAL	1,734	91+9	61+5	6	19+2
Stratum II					
1	62	0	1	0	0
2	67	0	1	0	0
3	38	0	0	0	0
4	48	24+6	1	0	0
5	67	0	0	13	0
6	72	0	8	0	0
7	86	0	0	0	0
8	86	4+2	0	0	0
9	82	0	0	0	0
10	53	0	0	0	0
11	62	0	0	0	0
12	62	0	0	0	0
13	58	0	0	0	0
14	34	0	0	0	0
TOTAL	877	28+8	11	13	0

APPENDIX A (Cont.)

Transect No.	Transect area (km2)	On transect		Off transect	
		left	right	left	right
Stratum III					
16	72	21+7	0	0	0
17	77	4	21+5	0	0
18	86	59+8	43+6	0	0
19	91	28+2	16+4	0	0
20	91	0	57+10	0	0
21	91	35	2	0	0
TOTAL	508	147+17	139+25	0	0
Stratum IV					
22	72	14+3	0	0	0
23	91	0	0	0	0
24	106	19	4	0	0
25	125	0	0	0	0
26	134	10+4	0	0	0
27	101	4	0	0	0
28	96	0	0	0	0
29	82	0	1	0	0
30	86	0	0	0	0
31	86	19	2	0	0
32	110	1	20+2	0	0
33	115	2	23+4	0	0
34	110	41+2	0	0	0
35	115	1	3	0	48
TOTAL	1,429	111+9	53+6	0	48