NUMBERS AND ABUNDANCE OF MUSKOXEN, EAST OF ARTILLERY LAKE, NWT, July 1998

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ABSTRACT

In 1997, hunters in Lutsel K'e reported increasing numbers of muskoxen and requested a larger quota. In response to their request, we flew an aerial survey to determine how much muskox numbers had increased in the area previously surveyed in 1989 and how far muskoxen have spread outside management unit boundaries. We flew the survey between July 16 and 28 1998 and counted 537 muskoxen on transect to estimate 1606 ± 278 (Standard Error) muskoxen although the precision was not high (coefficient of variation 0.17). Muskox numbers doubled between 1989 and 1998 in management unit U/MX/02 and muskoxen had spread into the taiga to the west and southwest compared to 1989. The survey's low precision leads us to recommend a quota increase from 14 to 34 based on a rate of 3% of the lower end of the 90% confidence interval for the estimate (1,606).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

During the 1980s and 1990s, two aerial surveys documented the muskox, *Ovibos moschatus,* recolonization of the central barrens west of the Thelon Game Sanctuary (Graf and Shank 1989, Shank and Graf 1992). Muskoxen had disappeared from west of the Sanctuary after the late 19th and early 20th century where unregulated commercial hunting had reduced numbers (Barr 1991). The Government of Canada banned muskox hunting in 1917 and established the Thelon Game Sanctuary in 1927 partly because some of the last known muskoxen were found along the Thelon River. Barr (1991) summarizes the relatively slow increase of muskoxen on the central mainland including in the vicinity of the Thelon Game Sanctuary.

The first aerial muskox survey near Lutsel K'e was in March 1989 when Graf and Shank (1989) surveyed the area east of Artillery Lake (Figure 1). The survey results led to a quota of 14 for muskox management unit U/MX/02 based on a harvest rate of 2.5% of the estimated population size of 563 ± 154 (Standard Error). That survey revealed relatively high densities in the survey area's northeast section and a subsequent aerial survey was flown in July 1991 to determine if the higher muskox numbers and distribution extended north and west of Artillery Lake. The 1991 survey, however, did not find muskoxen west of Aylmer, Clinton-Colden and Artillery Lakes. The muskoxen counted were east of Aylmer Lake (management zone U/MX/01) and in 1993, four tags were assigned based on a harvest rate of 2.5% of the estimated population size of 161 ± 39 (SE, Standard Error) (Shank and Graf 1992).

Since 1989, local hunters have reported a range expansion westward and an increase in muskox sightings. In 1997, the Lutsel K'e band requested that another survey be conducted to determine if the muskox population was large enough to support an increased harvest. We designed the survey to determine if muskox numbers had significantly increased in the area surveyed in 1989 and to determine the extent of muskoxen spreading outside the management unit boundaries.

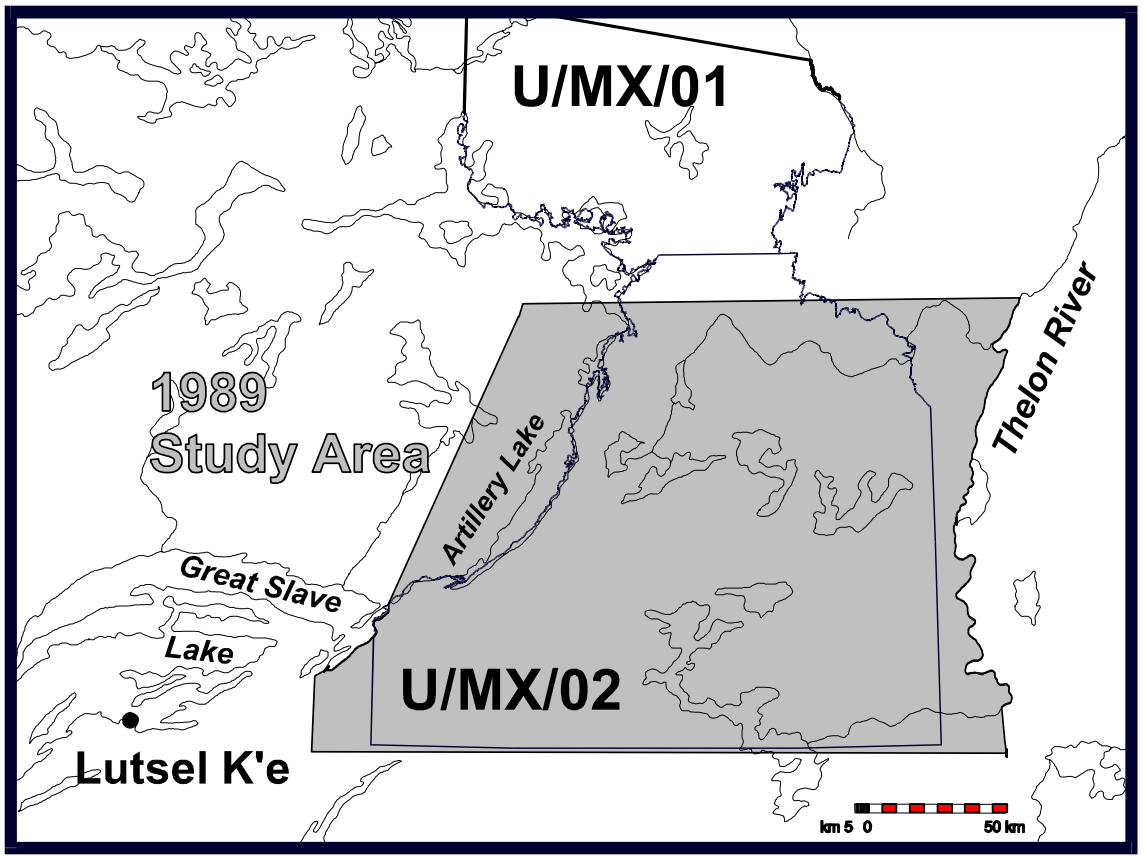

Figure 1. 1989 study area and muskox management zones.

METHODS

Study Area

The study area (46,865 km^2) overlapped both the 1989 study area and the current U/MX/02 muskox management zone (Figure 2). The study area was delineated in conjunction with the Lands and Environment Committee of Lutsel K'e. We extended the eastern boundary of the survey area about 30 km beyond the eastern banks of the Thelon River as muskoxen would likely be abundant along the river valley. We also extended the western boundary beyond both the management unit and 1989 survey boundary as the survey was to describe any western expansion.

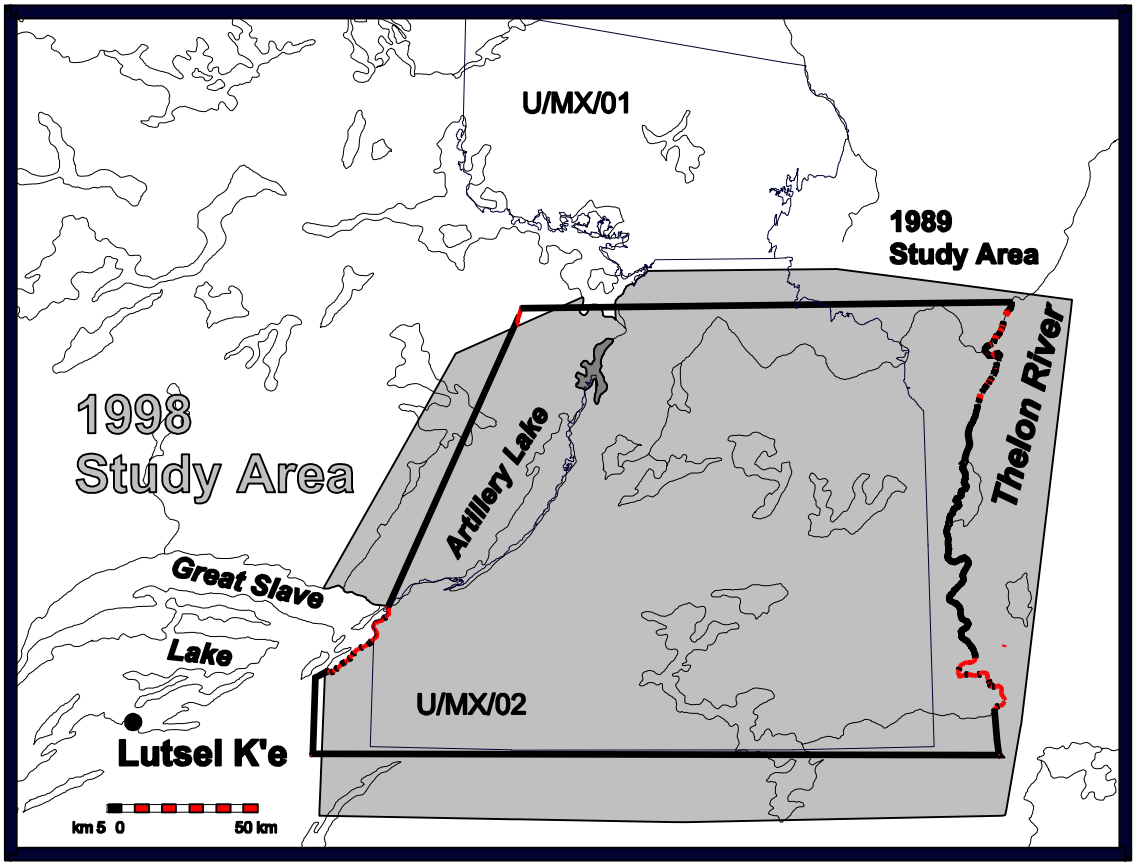

Figure 2. Study area for Lutsel K'e muskox survey.

Survey

The survey was a systematic stratified strip transect survey. The survey aircraft was a Cessna 206 with STOL kit and long range fuel tanks. We flew the survey at 185m above ground level and 160 kph. Transect width was usually 2 km (1 km on each side of the aircraft), except below treeline, where transect width was adjusted to 1 km (500 m on each side of the aircraft). Transect width was established by flying at survey altitude past fuel drums placed at the transect widths and marking their apparent position on the wing struts (Figure 3).

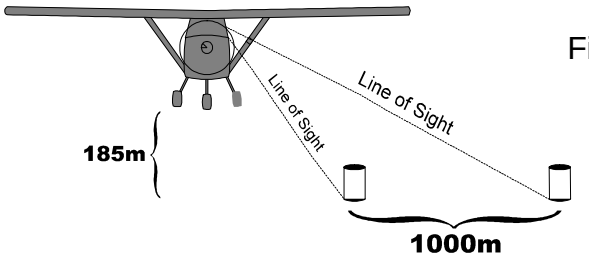

Figure 3. Method for establishing transect width.

We chose to fly the survey in summer similar to the 1991 survey which was in July (the 1989 survey was in March) as herd sizes are smaller in summer which increases the accuracy of counting individual muskoxen in the herds. To minimize costs and any disturbance to the muskoxen, we only circled herds if they were too large to be counted from the transect.

The front seat passenger recorded data and the two observers sat in the rear seats. We used Trimble ProXL GPS unit to aid navigation and to record locations and flight lines and SPANS Explorer GIS software to lay out the strata and transect lines, as well as to calculate transect lengths and stratum areas.

Stratification

The study area was divided into 6 strata and a 7th stratum was added during the survey (Figure 4). There was no detailed muskox distribution data available, and a reconnaissance survey was too expensive, so stratification was based on information from several sources. Tom Lockhart (Lutsel K'e Resource Officer), Alex Hall (tourist outfitter), and Dave Oleson (pilot) provided distribution information gathered incidentally during their respective jobs. Habitat information on a coarse scale was obtained from an unsupervised classification of Landsat TM data and from 1:500,000 topographical maps. We assigned higher coverage to the river drainage strata (Thelon and Hanbury) and to the Treed strata on the basis of those reported muskox sightings.

Initially we had 6 strata: two strata were delineated as river drainages (the Thelon and Hanbury rivers) and therefore probably high muskox density. One stratum was delineated by the presence of trees and therefore had lower sightability, and the remaining three strata were delineated on the basis of geography and a maximum strata size. We decided to use the narrower 1 km transect width in the treed stratum to increase chances of seeing muskoxen. During the first few transects however, it became apparent that the border for the treed stratum had been placed too far out into the tundra, and that there was an opportunity to increase sampling effort. The treed stratum was therefore split into two strata based on sightability: treed and treeline. On each transect the flight crew would decide when the trees had become too thick for the observers to adequately cover the 2 km transect width and would then switch to the 1 km transect width.

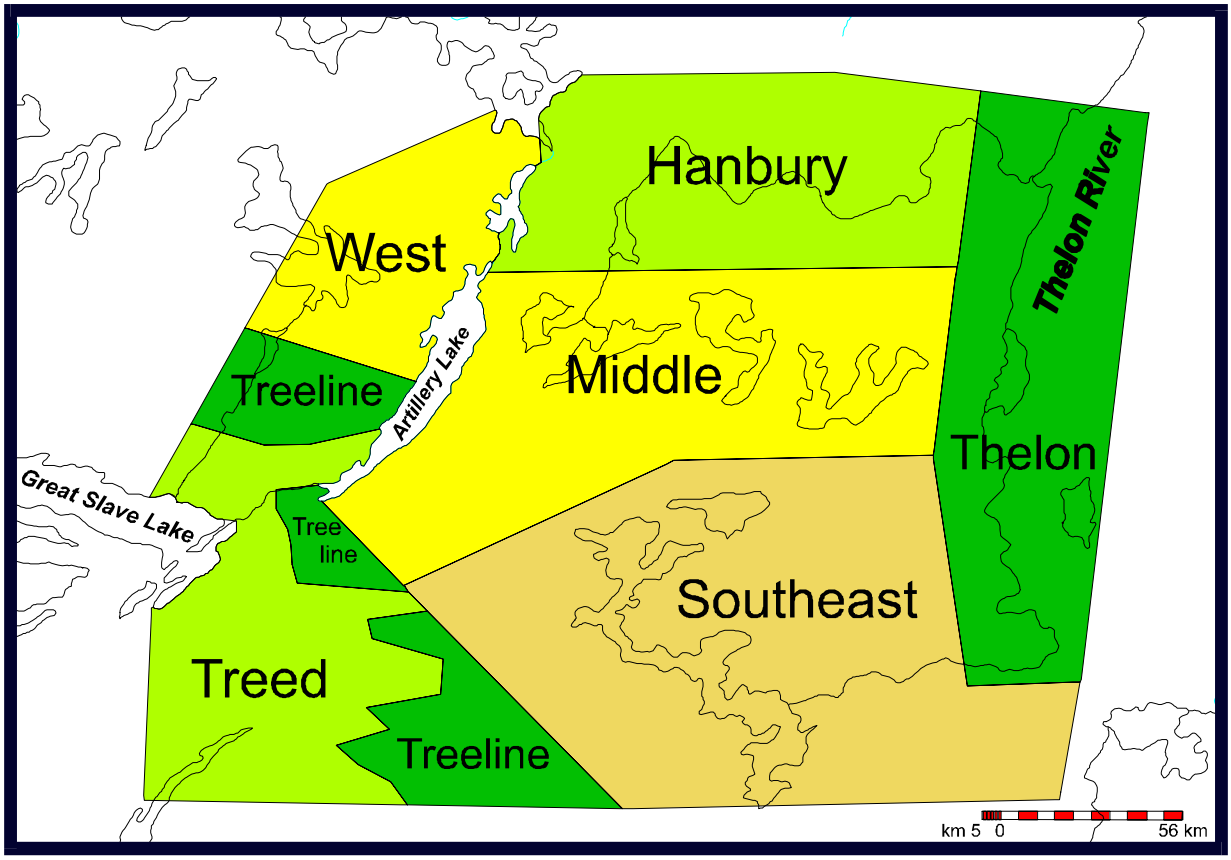

Figure 4. Strata for the 1998 muskox survey.

Data Analysis

The population estimate and measures of precision (90% confidence interval and coefficient of variation) were calculated using Jolly's method II (Jolly, 1969) for transects of unequal length. Degrees of freedom were calculated using Gasaway et al.'s (1986) Moosepop program.

Sex and Age classification

We originally thought that we could at least count calves but quickly discovered that this would entail slowing down and circling each herd. Circling the herds disturbs the animals and uses up expensive airtime, so we decided to abandon the attempt at classifying calves. The population estimate in this report therefore includes all muskoxen, from calf to adult.

RESULTS

Population Estimate

We counted 537 muskoxen on transect (Table 1, Appendix A) resulting in a population estimate of 1606 ± 278 Standard Error. The 90% confidence interval was 464, or 28% of the estimate, and the coefficient of variation was 0.17. Density varied between strata and was highest along the Thelon and Hanbury river valleys (Table 1). We counted 315 muskoxen off transect. The average group size (excluding single muskoxen) on transect was 13.8 (Standard Deviation SD = 11.5, n = 76, range 2-46) and 11.6 (SD=8.2, n = 39, range 2-33) off transect.

We flew the survey between July 16 and 28 1998. Lack of visibility due to smoke caused the termination of a flight on July 15th (before any data could be collected), and wind prevented a flight on July 25th. Temperatures ranged from 8°C to 25°C, and winds from calm to about 40 knots.

Population Estimates: 1989 vs. 1998

For this analysis, a subset of the 1998 data was removed to reflect the smaller size of the 1989 study area. Population size was significantly larger in 1998 than in 1989 (Table

2). Relative distribution also has changed with more muskoxen being seen to the southwest than in 1989 (Figures 5 and 6).

Table 1. Estimated numbers of muskoxen by stratum, Lutsel K'e area, NWT, 1998.

Strata	Treed	Treeline	Middle	Hanbury	Thelon	SEast	West	Total
Total area (km^2)	5320.5	3741.3	8713.4	6451.3	7157.6	12369.8	3110.8	46864.86
Area surveyed (km^2)	1069.9	1524.7	2275.5	2611.0	2830.0	3170.5	848.1	14330.1
Total transects	103	58	43	65	81	93	37	480
No. transects surveyed	21	23	11	26	32	23	10	146
% transects surveyed	20.1	40.8	26.1	40.5	40.0	25.6	27.3	0.30
Muskoxen seen	29	32	69	156	179	72	0	537
Density (/100km^2)	2.7	2.1	3.0	6.0	6.3	2.3	0	3.4
Population Estimate	144.2	78.5	264.2	385.5	452.7	280.9	0	1606.0
Variance	4835.9	1137.27	3669.3	23906.4	31215.3	12278.6	Na	77042.8
Degrees of freedom	20	22	10	25	31	22	Na	93
Coefficient of variation	0.48	0.43	0.23	0.40	0.39	0.39	Na	0.17
90% C.I. (% of population estimate)	83	74	41	69	66	68	Na	29

Table 2. Comparison of Lutsel K'e muskox survey results: 1989 vs. 1998.

	1989	This Study: 1998
Total Area (km^2)	34 407	33 139
Area Surveyed (km^2)	7922	9736
% of Total Area Surveyed	23	29
# Transects Surveyed	41	146
# Muskoxen Seen	177	565
Population Estimate	563	1162
Density	0.016	0.035
Variance	23620	48856
Degrees of freedom	24	66
90% C.I. (% of population estimate)	47	32

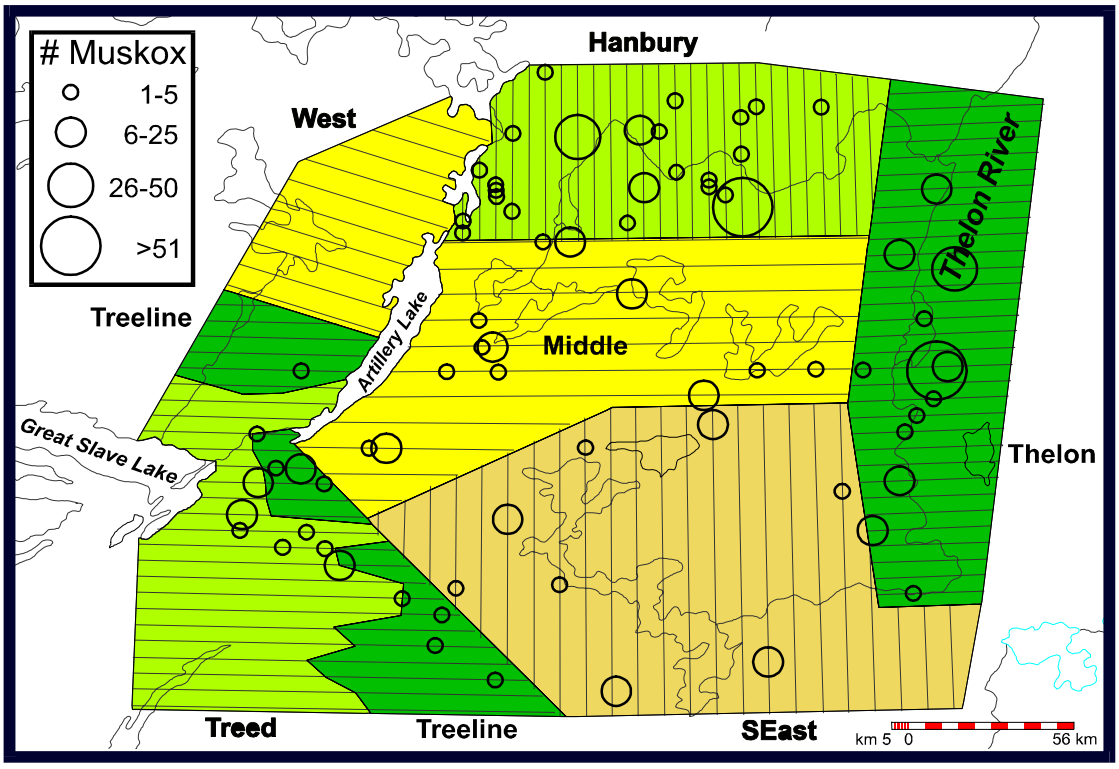

Figure 5. Transects and observations for the 1998 Lutsel K'e muskox survey.

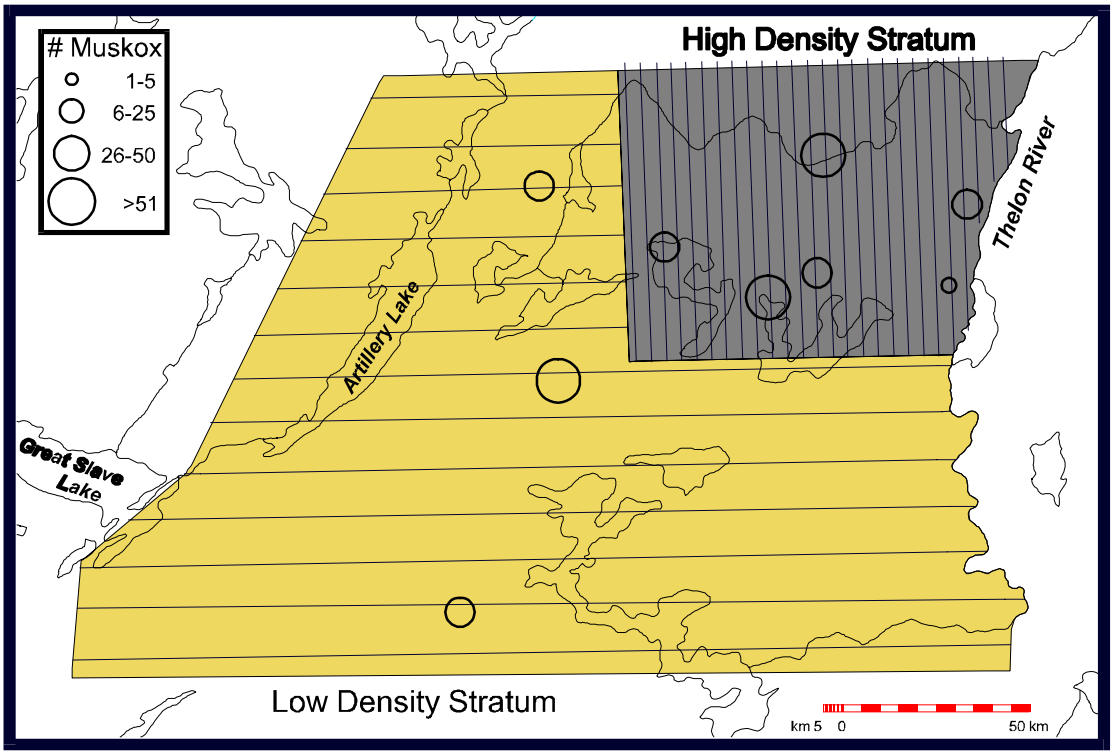

Figure 6. Muskoxen observations, Lutsel K'e, NWT, March 1989 (Graf and Shank 1989).

Habitat and Distribution

Most muskoxen were above the treeline and in the vicinity of lakes and rivers especially the Thelon and Hanbury rivers. Muskoxen were relatively abundant along the treeline (Table 1, Figure 5).

Other Species

As well as muskoxen, we observed 7 wolves, 1 grizzly bear, 1 black bear and 3 moose on transect. Between 4000 and 5000 caribou were observed on survey.

DISCUSSION

The 1998 adjusted estimated number (1162 ± 221 SE) is a significant increase in muskox numbers in the management unit U/MX/02 compared to 563 ± 154 in 1989 (Graf and Shank 1989). The muskox density we calculated (3.5 muskoxen/100km^2) was about double that recorded in 1989 (Graf and Shank 1989). Between 1989 and 1998, the exponential rate of increase was 0.0805 which can also be expressed as a doubling time of 8.6 years which is a moderate rate of increase for muskoxen.

Graf and Case (1989) recommended that precision, as measured by a coefficient of variation (CV), for N.W.T. muskox surveys be 0.15 or lower, and that a CV of 0.15 to 0.20 was only marginally acceptable. By this standard, our survey was only marginally acceptable (CV of 0.17), so caution is necessary in interpreting the 1998 estimate. Another reason for caution between comparing the 1989 and 1998 estimates is likely differences in bias (accuracy) between the two surveys. We flew the survey in July at 185m above ground level and 160 kph. Transect width was 1 km on each side of the aircraft (except below treeline, where transect width was 500 m on each side of the aircraft). The 1989 survey was flown at a similar altitude, a faster speed (225 kmph) and similar transect width. However, it was flown in March and possibly the muskoxen were more visible against the snow background. On the other hand, herd size in March 1989 was large (27 ± 23.0 S.D.) which impedes accurate counting when the muskoxen group together.

The 1998 survey also documented a spread of muskoxen to the west and southwest compared to 1989 (Figures 5 and 6). In 1989, the westernmost muskox sighting was 107^o 35’ W and in 1998, in the same area as covered in 1989 west of 107^o 35’ W, we counted 14 muskox groups – an extension of the range by about 80 km. That rate of about 9 km/year is

similar to the rate of muskox spread (about 13 km/year) in the Queen Maud Gulf (Gunn and Case 1984). However spread to the northwest is less evident as we saw only one small herd west of Artillery Lake.

The 1998 survey did not define the west and southern edges of muskox distribution. People from Lutsel K'e have reported muskoxen as far west as the Lutsel K'e townsite, (T. Lockhart, pers. comm.). Given the low density of muskoxen in most of our Treed stratum however, (our observations were all near treeline, Figure 5), the treed area west of the study area likely has few muskoxen. Muskox distribution northwest of Artillery Lake is either not expanding or only expanding slowly based on the 1989, 1991 and our 1998 surveys where those survey areas overlapped west of Artillery Lake. Dave Oleson (pers.comm. 2000), a pilot based at the Hoarfrost River (northeast Great Slave Lake) reports only a few muskox sightings west of Artillery Lake on the Hoarfrost River which may suggest that muskox distribution may yet have to expand west. Muskoxen were only rarely recorded in the vicinity of Lac de Gras during the 1990s.

The pattern of muskoxen spreading toward the treeline south of the Thelon Game Sanctuary raises the question of whether the trends are local increases or muskoxen moving into the area or both. In the Thelon Sanctuary itself, muskox sightings along the Thelon River during canoe trips have markedly declined since the mid 1990s (Alex Hall, pers. comm). It is not clear whether the decline in sightings along the Thelon River is a local change in distribution or a decline. Further north to the mainland coast, in Queen Maud Gulf (N/MX/16) area, muskox numbers declined to 4260 ± 680 (SE) between 1988 and 1996 (J. Nishi pers. comm.). South of Queen Maud Gulf area, muskox numbers had increased as in 1999, M. Campbell (pers. comm.) estimated 1522 ± 336 muskoxen in N/MX/20.

The pattern of a decline in the area of initial population increase while herbivores expanded their range is the classic portrayal of an erupting herbivore (sensu Caughley 1970). In the now classical 1970 paper Caughley graphically summarised what happened when thar *Hemitragus jemlahicus*, a mountain goat were introduced 90 years ago to the Southern Alps of New Zealand's South Island. The thar went through increase, stabilisation and decrease phases with concomitant changes in adult female fecundity, juvenile survival, and fat reserves. A decrease in forage indexed by grass tussock size paralleled the populations stabilisation and decline and the decline was assumed to have included those animals that left to colonize unoccupied habitat.

Conclusions and Recommendations

The lower end of the 90% confidence interval for our estimate of 1,606 is 1,142. Maintaining a harvest rate of 3% would indicate a muskox quota of 34 for the community of Lutsel K'e. The previous study (Graf and Shank, 1989) recommended a quota of 14 based on 2.5% of the population estimate of 563, i.e. they used the estimate, not the lower end of the confidence interval, to calculate the quota. Because our CV (0.17) was less than the standard recommended by Graf and Case (1989), we use the lower end of the confidence interval for the purposes of calculating the quota. The conventional rule of thumb for muskox management has been to recommend quotas based on 3-5% of the most recent estimate.

The recommended quota of 34 is relatively conservative to encourage the trend toward increasing muskox distribution. To date, the current quota of 14 has only been filled twice since its inception (Figure 7), and the quota of 4 for muskox management zone U/MX/01 has not been used. Also, some members of the Lands and Environment

Committee of Lutsel K'e have expressed the concern that a quota in excess of the community's needs could lead to wastage. As our survey area approximately followed the boundaries of the management unit U/MX/02, we do not recommend any boundary changes.

ACKNOWLEDGEMENTS

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PERSONAL COMMUNICATIONS

Campbell, M. Regional Biologist, Department of Sustainable Development, Arviat, Nunavut

Hall, A. Canoe Arctic, Fort Smith, N.W.T.

Lockhart, T. Resource Officer. Resources, Wildlife and Economic Development. Lutsel K'e, N.W.T.

Oleson, D. Pilot, Hoarfrost River, Great Slave Lake, N.W.T.

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APPENDIX A. Population estimates for the muskox survey area and strata, Lutsel K'e, NWT, 1998**.**

Middle South

Transect		Area	#Muskox	y^2	z^2	yz
1	**7.35969114**	14.7	**0**	0	216.6602149	0
2	**18.3158512**	36.6	**0**	0	1341.881622	0
3	**30.5778046**	61.2	**0**	0	3740.008528	0
4	**41.8594093**	83.7	**1**	1	7008.840599	83.71881866
5	**53.7109222**	107.4	**0**	0	11539.45267	0
6	**65.5364532**	131.1	**8**	64	17180.10682	1048.583252
7	**76.975914**	154.0	**0**	0	23701.16535	0
8	**89.4403381**	178.9	**1**	1	31998.29634	178.8806763
9	**92.8819122**	185.8	**2**	4	34508.19848	371.5276489
10	**95.9396362**	191.9	**25**	625	36817.6552	4796.981812
11	**95.9409714**	191.9	**0**	0	36818.67995	0
12	**95.9447784**	191.9	**0**	0	36821.60204	0
13	**96.3294373**	192.7	**0**	0	37117.44193	0
14	**95.9501038**	191.9	**21**	441	36825.68965	4029.904358
15	**96.1444244**	192.3	**0**	0	36975.0014	0
16	**96.1520157**	192.3	**12**	144	36980.84048	2307.648376
17	**96.3474426**	192.7	**0**	0	37131.3188	0
18	**96.1717682**	192.3	**0**	0	36996.03599	0
19	**96.3572998**	192.7	**2**	4	37138.9169	385.4291992
20	**50.9044113**	101.8	**0**	0	10365.03637	0
21	**32.1363907**	64.3	**0**	0	4130.990425	0
22	**31.9983349**	64.0	**0**	0	4095.573742	0
23	**32.2078629**	64.4	**0**	0	4149.385718	0
Total	1585.18	3170.37	72	1284	523598.7792	13202.67414

Z=	12369.84748	**R=**	0.0227	**Variance=**	12,278.64
N=	93	**Y=**	280.9231	**SE=**	110.8090
n=	23			**t, .05, 22**	1.7140
Coverage =	**25.63 %**			90%CI	189.93
				% of mean	0.676
				CV=	0.394

APPENDIX A. (Continued)

West

Transect		**Area**	**#Muskox**	**y^2**	**z^2**	**yz**
1	48.84589005	97.7	**0**	0	9543.683897	0
2	48.2875061	96.6	**0**	0	9326.732983	0
3	44.40535355	88.8	**0**	0	7887.341694	0
4	46.02723312	92.1	**0**	0	8474.024756	0
5	47.08576584	94.2	**0**	0	8868.277378	0
6	50.4429245	100.9	**0**	0	10177.95453	0
7	47.08907318	94.2	**0**	0	8869.523252	0
8	36.79600906	73.6	**0**	0	5415.785132	0
9	29.17498207	58.3	**0**	0	3404.718315	0
10	25.88156891	51.8	**0**	0	2679.422437	0
Total		848.0726128	0	0	74647.46437	0

Z=	3110.80244	**R=**	0.0000	**Variance=**	0.00
N=	37	**Y=**	0.0000	**SE=**	0.0000
n=	10			**t, .05, 10**	1.8120
Coverage =	**27.26 %**			90%CI	0.0000
				% of mean	
				CV=	

APPENDIX A. (Continued)

Middle

Transect		**Area**	**#Muskox**	**y^2**	**z^2**	**yz**
1	16.7	33.5	**0**	0	1119.5716	0
2	41.5	83.0	**0**	0	6889	0
3	66.1	132.2	**11**	121	17487.4176	1454.64
4	72.8	145.6	**0**	0	21205.1844	0
5	147.2	294.4	**18**	324	86671.36	5299.2
6	139.6	279.3	**8**	64	77997.3184	2234.24
7	135.4	270.8	**12**	144	73321.8084	3249.36
8	132.3	264.6	**1**	1	70034.3296	264.64
9	128.1	256.1	**8**	64	65607.6996	2049.12
10	129.0	258.0	**0**	0	66584.6416	0
11	129.0	258.0	**11**	121	66574.3204	2838.22
Total		2275.62	69	839	553492.6516	17389.42

Z=	8713.448234	**R=**	0.0303	**Variance=**	3,669.30
N=	43	**Y=**	264.2040	**SE=**	60.5748
n=	11			**t, .05, 10**	1.8120
Coverage =	**26.12 %**			90%CI	109.7615
				% of mean	0.415

APPENDIX A. (Continued)

Thelon

Transect		Area	#Muskox	y^2	z^2	yz
1	32.04031372	64.1	**1**	1	4106.326813	64.08062744
2	33.42195892	66.8	**0**	0	4468.109353	0
3	35.18130875	70.4	**0**	0	4950.89794	0
4	35.96661377	71.9	**0**	0	5174.389224	0
5	37.15913773	74.3	**7**	49	5523.206066	520.2279282
6	38.52547455	77.1	**0**	0	5936.848757	0
7	39.89966202	79.8	**0**	0	6367.932117	0
8	42.06609344	84.1	**9**	81	7078.224871	757.189682
9	43.04086685	86.1	**0**	0	7410.064877	0
10	44.61816788	89.2	**0**	0	7963.123619	0
11	45.59961319	91.2	**3**	9	8317.298892	273.5976791
12	47.23136139	94.5	**1**	1	8923.205995	94.46272278
13	48.16731262	96.3	**1**	1	9280.360021	96.33462524
14	48.16111755	96.3	**0**	0	9277.972976	0
15	47.97390366	95.9	**82**	6724	9205.981728	7867.7202
16	48.17422867	96.3	**0**	0	9283.025231	0
17	48.74328613	97.5	**0**	0	9503.631772	0
18	49.00075912	98.0	**1**	1	9604.297579	98.00151825
19	48.73572922	97.5	**0**	0	9500.685209	0
20	48.36139679	96.7	**0**	0	9355.298798	0
21	48.58321381	97.2	**37**	1369	9441.314655	3595.157822
22	48.02331161	96.0	**19**	361	9224.953834	1824.885841
23	48.41098785	96.8	**0**	0	9374.49498	0
24	48.21681595	96.4	**0**	0	9299.445361	0
25	48.03783417	96.1	**0**	0	9230.534046	0
26	47.84360504	95.7	**18**	324	9156.042173	1722.369781
27	47.84375	95.7	**0**	0	9156.097656	0
28	48.0302124	96.1	**0**	0	9227.605214	0
29	47.29154205	94.6	**0**	0	8945.959799	0
30	47.77187729	95.5	**0**	0	9128.609039	0
31	47.77187729	95.5	**0**	0	9128.609039	0
32	25.19785309	50.4	**0**	0	2539.727201	0
Total		2830.182373	179	8921	255084.2748	16914.02843

				Variance=	31,215.31
Z=	7157.606236	**R=**	0.0632	**SE=**	176.6785
N=	81	**Y=**	452.6957	**t, .05, 31**	1.6970
n=	32			90%CI	299.8235
Coverage =	**39.54 %**			% of mean	0.662
				CV=	0.390

APPENDIX A. (Continued)

Middle North

Transect	Tran Length	Area	#Muskox	y^2	z^2	yz
1	14.9232121	29.8	**3**	9	890.8090317	89.53927231
2	26.4791088	53.0	**1**	1	2804.572814	52.95821762
3	45.524765	91.0	**3**	9	8290.016919	273.1485901
4	50.1272964	100.3	**2**	4	10050.9834	200.5091858
5	54.2349281	108.5	**0**	0	11765.70972	0
6	54.5638695	109.1	**0**	0	11908.86341	0
7	55.3753815	110.8	**0**	0	12265.73149	0
8	54.3521461	108.7	**30**	900	11816.62316	3261.128769
9	54.1879463	108.4	**0**	0	11745.33411	0
10	54.5193138	109.0	**0**	0	11889.42231	0
11	54.6805458	109.4	**1**	1	11959.84836	109.3610916
12	54.516346	109.0	**38**	1444	11888.12792	4143.242294
13	54.3551216	108.7	**1**	1	11817.91698	108.7102432
14	54.1931725	108.4	**1**	1	11747.59976	108.3863449
15	54.683506	109.4	**0**	0	11961.14332	0
16	54.1959076	108.4	**2**	4	11748.7856	216.7836304
17	54.6916389	109.4	**1**	1	11964.70148	109.3832779
18	54.363308	108.7	**69**	4761	11821.47701	7502.136497
19	54.1991425	108.4	**3**	9	11750.18817	325.1948547
20	54.0387192	108.1	**0**	0	11680.73268	0
21	53.382103	106.8	**0**	0	11398.59567	0
22	52.3971901	104.8	**0**	0	10981.86212	0
23	51.0884743	102.2	**1**	1	10440.12881	102.1769485
24	50.5000267	101.0	**0**	0	10201.01079	0
25	49.447155	98.9	**0**	0	9780.08455	0
26	40.4209328	80.8	**0**	0	6535.407224	0
Total		2610.882515	156	7146	271105.6768	16602.65922

Z=	6451.338532	**R=**	0.0597	**Variance=**	23,906.40
N=	65	**Y=**	385.4669	**SE=**	154.6170
n=	26			**t, .05, 25**	1.7080
Coverage =	**40.47 %**			90%CI	264.0858
				% of mean	0.685
				CV=	0.401

Spans Area 6458.398875

APPENDIX A. (Continued)

Trees

Transect	Total	Area	#Muskox	y^2	z^2	yz
1	56.86527252	113.7	**0**	0	12934.63688	0
2	56.86229324	113.7	**0**	0	12933.28157	0
3	61.14593124	122.3	**1**	1	14955.29963	122.2918625
4	61.9877243	124.0	**0**	0	15369.91186	0
5	42.55490875	85.1	**1**	1	7243.681036	85.1098175
6	42.84461212	85.7	**0**	0	7342.643151	0
7	17.84314346	35.7	**1**	1	1273.511075	35.68628693
8	12.76440907	25.5	**2**	4	651.7205551	51.05763626
9	6.914565563	13.8	**0**	0	191.2448677	0
10	21.28908348	42.6	**10**	100	1812.900302	425.7816696
11	18.04124641	36.1	**0**	0	1301.946289	0
13	28.00685692	56.0	**0**	0	3137.536138	0
14	24.42173576	48.8	**0**	0	2385.684711	0
15	20.57160378	41.1	**1**	1	1692.763528	41.14320755
16	16.07300186	32.1	**13**	169	1033.365555	417.8980484
17	14.13390064	28.3	**0**	0	799.0685895	0
18	13.21422577	26.4	**2**	4	698.4630507	52.85690308
21	29.66607857	59.3	**0**	0	3520.30487	0
22	52.01792526	104.0	**1**	1	10823.45819	104.0358505
23	53.44881439	106.9	**0**	0	11427.10304	0
24	53.77073288	107.5	**0**	0	11565.16686	0
25	39.29166412	78.6	**0**	0	6175.339478	0
26	18.77144432	37.5	**0**	0	1409.468488	0
Total	762.5011744	1525.002349	32	282	130678.4997	1335.861282

Z=		3741.274301	**R=**	0.020983574	**Variance=** 1,137.27
N=		58	**Y=**	78.50530704	**Stdev** 33.7234
n=		23			**t, .05, 22** 1.7170
Coverage =	**40.7615755 %**				90%CI 57.9031
	0.396551724				% of mean 0.738
					CV= 0.430

APPENDIX A. (Continued)

Population estimate – total survey area	**1606.0**
Var	77042.79
StError	277.57
T, .10, 93	1.67
90%CL	464.17
% of est	0.29
Total Z	46864.86
Total z	14330.06
%cover	0.306
Total N	480
total n	146
%transects	0.304
CV =	0.173

APPENDIX B. Muskox sightings provided by Dave Oleson, pilot, Hoarfrost River, NWT, 1995-00.