MUSKOXEN DISTRIBUTION AND ABUNDANCE BOOTHIA PENINSULA, KITIKMEOT REGION, NUNAVUT

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Summary

An aerial muskox survey was conducted from June 03 to June 11, 2006 on the Boothia Peninsula, Nunavut (MX 09). The survey area was divided into three strata: High Density Area (HAD, 3,250 km^2) covered at 27%, Medium Density Area (MDA, 12,655 km^2) covered at 14% and Low Density Area (LDA, 9630 km^2) covered at 20%. In the high density area (HDA), we counted 158 adult (> 1year old) muskoxen and 22 calves on the transects and estimated a density of 107 adult muskoxen per 1000 km^2 or 348 adult muskoxen (±62 S.E., CV=0.18) with 13.9% of calves in the population. In the medium density area (MDA), we counted 91 adult muskoxen and 9 calves on the transects and estimated a density of 51 adult muskoxen per 1000 km^2 or 645 adult muskoxen (±119 S.E., CV=0.18) with 9.9% of calves in the population. In the low density area (LDA), we counted 21 adult muskoxen and 4 calves on the transects and estimated a density of 1 adult muskox per 1000 km^2 or 104 adult muskoxen (±72 S.E., CV=0.70) with 19% of calves in the population. No muskoxen were observed during the survey south of the Boothia Peninsula. I propose management options based on the result of this survey.

Acknowledgements

I would like to thank Perry Linton, pilot of the Helio-Courier, for his enthusiasm, flexibility and amazing piloting skills. It made the survey a pleasure and a success. Thanks to Peter Qayutinnuaq (Taloyoak HTO Chairman), James Aiyout (Taloyoak HTO member) and Joe Ashevak (Taloyoak Conservation Officer) for their participation as observers. I also want to extend my thanks to Peter Qayutinnuaq, Taloyoak HTO chairman, for his assistance with the logistic and loader. Thanks to the Taloyoak HTO for supporting this project. Thanks to Inuk Charlie for his friendliness and taxi services. Funding was provided by the Department of Environment (Government of Nunavut).

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1.0. Introduction:

Muskoxen on Boothia Peninsula were reduced to a very small number (or extirpated) in the early 1900's and remained absent or in very small number at least until the late 1980s (Barr 1991). In 1985, Gunn and Ashevak (1990) did not observe any muskox on the Boothia Peninsula during an aerial survey covering the area at 10 to 20%. Ten years later, in July – August 1995, Gunn and Dragon (1998) estimated the muskox population on Boothia Peninsula to be 554±205 (SE) with a coverage of 9%. Following the survey in 1995, a quota of 5 was allocated to the Boothia Peninsula Muskox population. In 1996 and 2000, the quota was increased to 10 and then 20 tags respectively following Taloyoak HTO requests and local reports of an increase in the muskox population. This report present the results and recommendation from an aerial survey conducted in June 2006 following the request of the Kitikmeot Hunters and Trappers and local knowledge indicating an increase in the muskox population and its progression southward.

2.0. Project Objectives:

To estimate muskoxen abundance on the Boothia Peninsula and determine if the muskoxen number have significantly changed since the last survey;
To assess the changes in distribution and progression southward;
To determine the proportion of muskox calves in the study area;
To recommend management actions.

3.0. Study Area

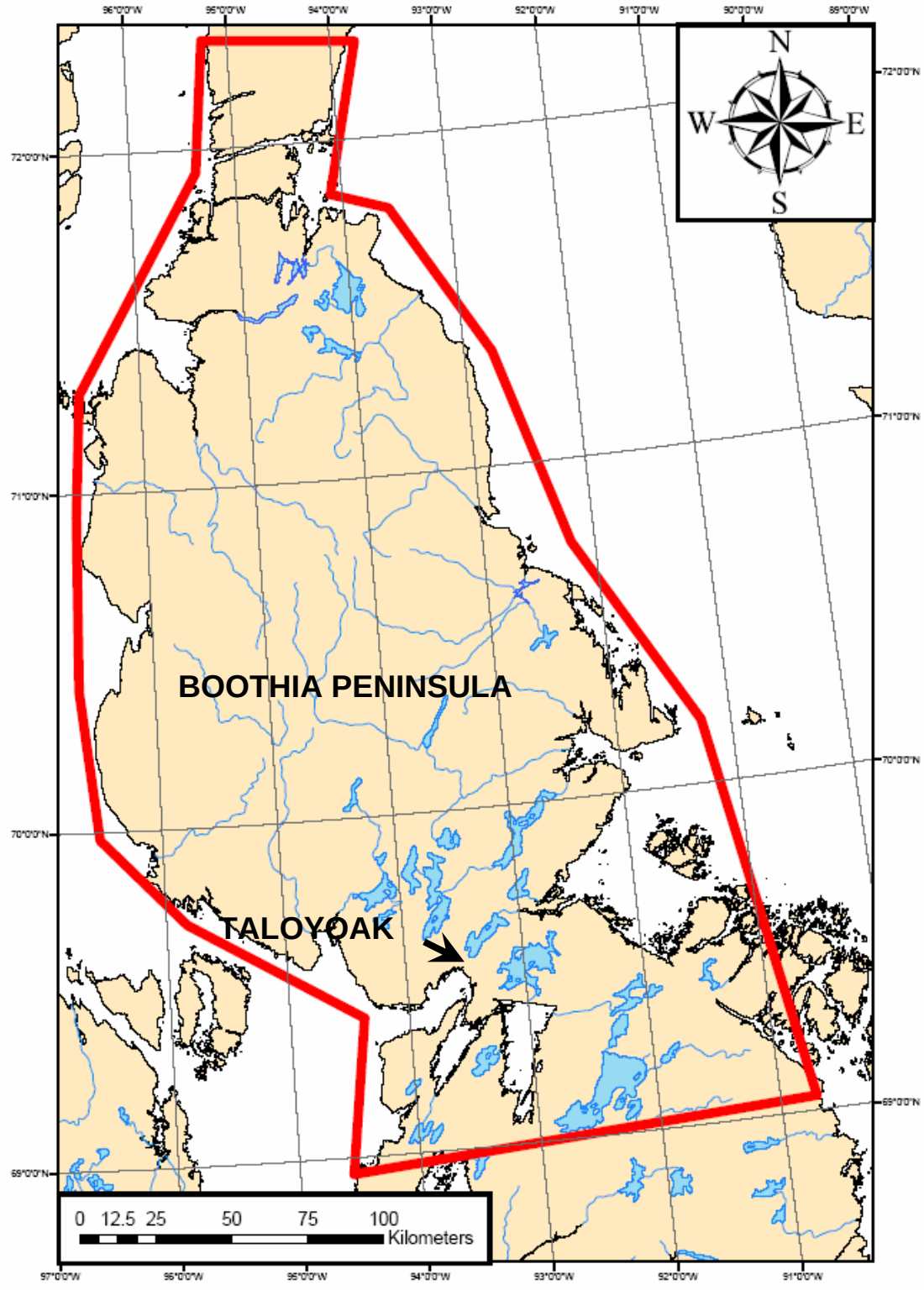

Figure 3.1: General study area for the muskox aerial survey conducted from June 03 to 11, 2006 in the Eastern Kitikmeot, Nunavut (delineated in red).

4.0. Methods

I conducted an aerial survey using stratified random/systematic strip transects (the first transect was randomly placed and then each sequential line was evenly spaced at a set interval within each survey block). The stratification was based on local knowledge, previous surveys (Gunn and Dragon 1998), habitat information, and aircraft capability rather than a reconnaissance survey to reduce study costs. We use the Helio-Courier at a speed of 160km/h, at 500 feet above ground level (154m), and set up markers to record muskoxen within 1500m on each side of the aircraft. The survey was conducted from June 03 to 11, 2006 covering 1964 km of transects (after excluding lengths where visibility was poor and not including transects flown south of Taloyoak), representing an area of 4534 km^2. The study area was 25,533 km^2 covered at 18% overall (26% in Stratum 1= HAD; 7.5km spacing between transects, 14% in Stratum 2 = MDA; 13.5km spacing between transects, and 20% in Stratum 3 = LDA; 12.5km spacing between transects). Caribou (*Rangifer tarandus*) observations were also recorded during the survey and are presented in a separate report (Dumond, *in prep.*). For all observations a way point was added on a GPS and the track of the airplane was recorded during the whole survey (Figure 4.1).

Two observers from the community (Taloyoak) were on board during the survey.

When muskoxen were observed, I recorded the number of individuals ≥1 year old (non-calves) and the number of observed calves. For large group I took high resolution digital pictures (Canon EOS Digital Rebel XTi10.1 MegaPixels / 18mm – 55mm zoom lense) and recounted the number of individuals ≥1 year old (non-calves) and the number of observed calves. When necessary, I would ask the pilot to make a loop around a group in order to count calves and non-calves. The loop was made at a distance from the muskox group to avoid the formation of a defence circle that make the count difficult for adults and impossible for calves.

For the calculation of the estimate, I used only the individuals observed within the 3km strip of the transects. Muskoxen observed outside the 3km strip were

presented to illustrate the distribution and were used in stratum 2 (MDA) to adjust the lower limit of the confidence interval.

The muskox population estimate for the whole area and within each stratum (HAD, MDA and LDA) was calculated using Jolly's Method 2 for unequal sample sizes (Jolly 1969 *In* Norton-Griffiths 1978). Only counts of non-calves were used for the final population estimates. Lake areas were not subtracted from the total area calculations used in density calculations (Statistical analysis based on Campbell and Setterington 2001). However, within each stratum, I did subtract areas that were not surveyed due to fog or low sealing conditions.

To determine if there was an increase in muskox numbers in the study area, comparison of the 2007 population estimate to the 1995 estimate was conducted using equation 5.3 of Thompson et al. (1998):

$$z = \frac{Y_{1991} - Y_{1999}}{\sqrt{Var(Y_{1991}) + Var(Y_{1999})}}$$

Where:

z = z statistic;

Y_x = population estimate for year x

$Var(Y_x)$ = variance of the population estimate.

The statistics were based on the hypothesis that the population estimate did not change between surveys and therefore I used the two tailed probability of the z statistic.

5.0. Results

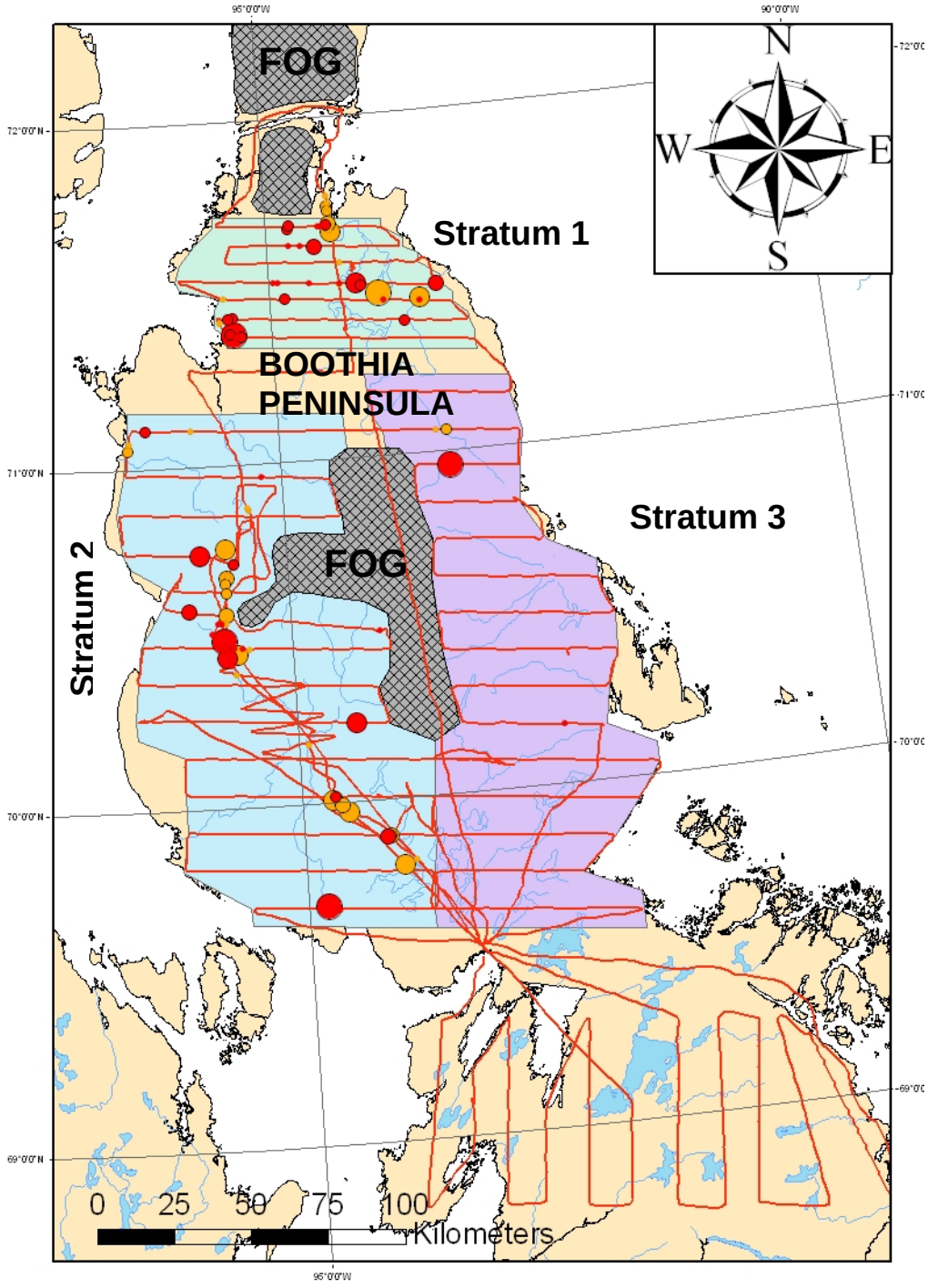

Figure 5.1: Survey flight lines, strata, and muskox observations during amuskox aerial survey on Boothia Peninsula (Nunavut) from June 03 to June 11, 2007. Dots are representing muskox observations (red=on transect; orange=outside transect) and are proportional to group size.

A total of 562 adult muskoxen (≥ 1year old) were observed, including 292 individuals observed outside the transect width or during taxi (I subtracted double counts from muskox groups that we observed more than once during the survey). Muskoxen were mainly distributed in the north and western portion of the study area (Figure 5.1).

The population estimate for the entire study area was approximately 1100 muskoxen with an overall coverage of 18%. The overall percentage of calves (all observations included) was 13%. In the high density area (HDA) (3250 km^2), we counted 158 adult muskoxen and 22 calves on the transects. The population estimate for that area is 348 adult muskoxen (±62 S.E., CV=0.18) or 107 adult muskoxen per 1000 $km^2$with 14% of calves in the population. In the medium density area (MDA) (12655 km^2), I counted 91 adult muskoxen and 9 calves on the transects. The population estimate for that area is 645 adult muskoxen (±119 S.E., CV=0.18) or a density of 51 adult muskoxen per 1000 km^2 with 10% of calves in the population. In the low density area (LDA) (9629 km^2), we counted 21 adult muskoxen and 4 calves on the transects. The population estimate for that area is 104 adult muskoxen (±72 S.E., CV=0.70) or a density of 1 adult muskoxen per 1000 km^2 with 19% of calves in the population.

Mean group size in the HAD, MDA and LDA was 6.3, 7.6 and 10.5 individuals ≥ 1year old respectively. Overall (all observations included), the mean group size was 6 (variation from 1 to 21 with similar min and max in each stratum).

The muskox population increased significantly (z=-1.77, *P*=0.04) at a rate of approximately 6.1% per year between 1995 and 2006.

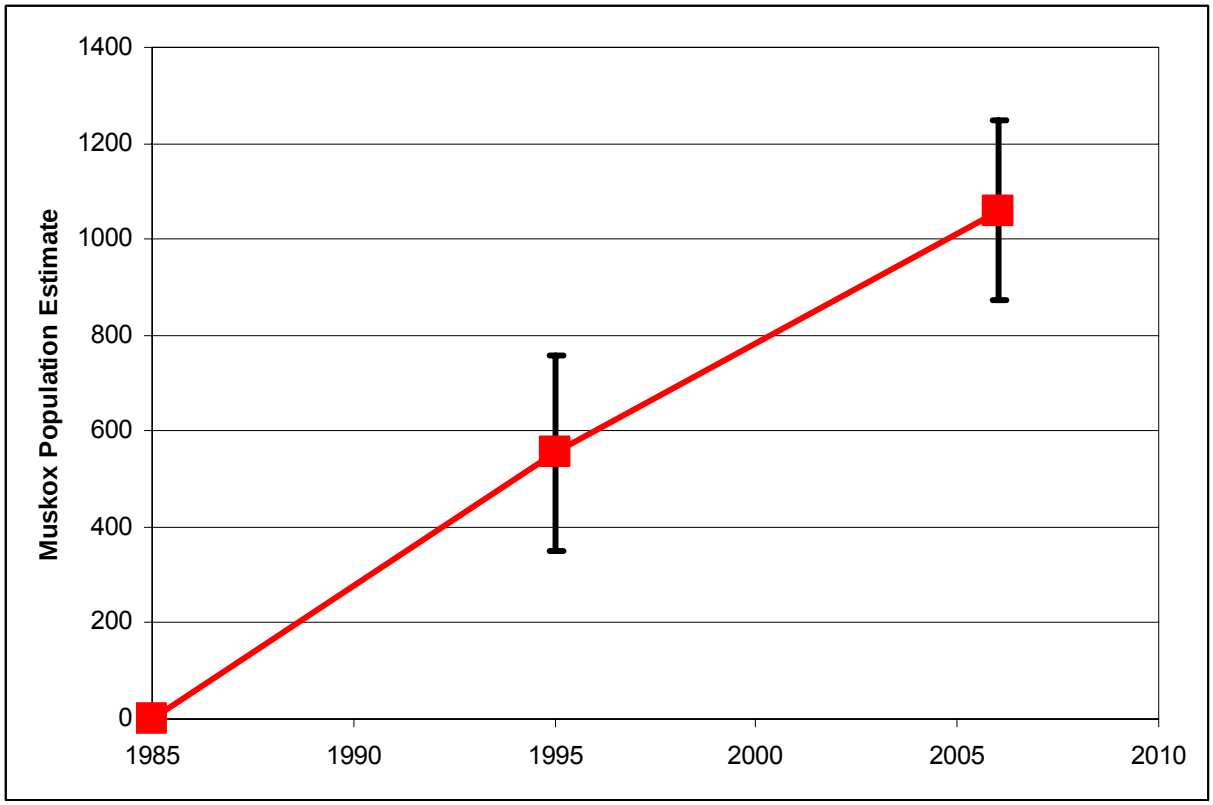

Figure 5.2: Muskox population estimates from 1985 to 2006 on the Boothia Peninsula (Nunavut). Vertical bars represent the standard error (SE).

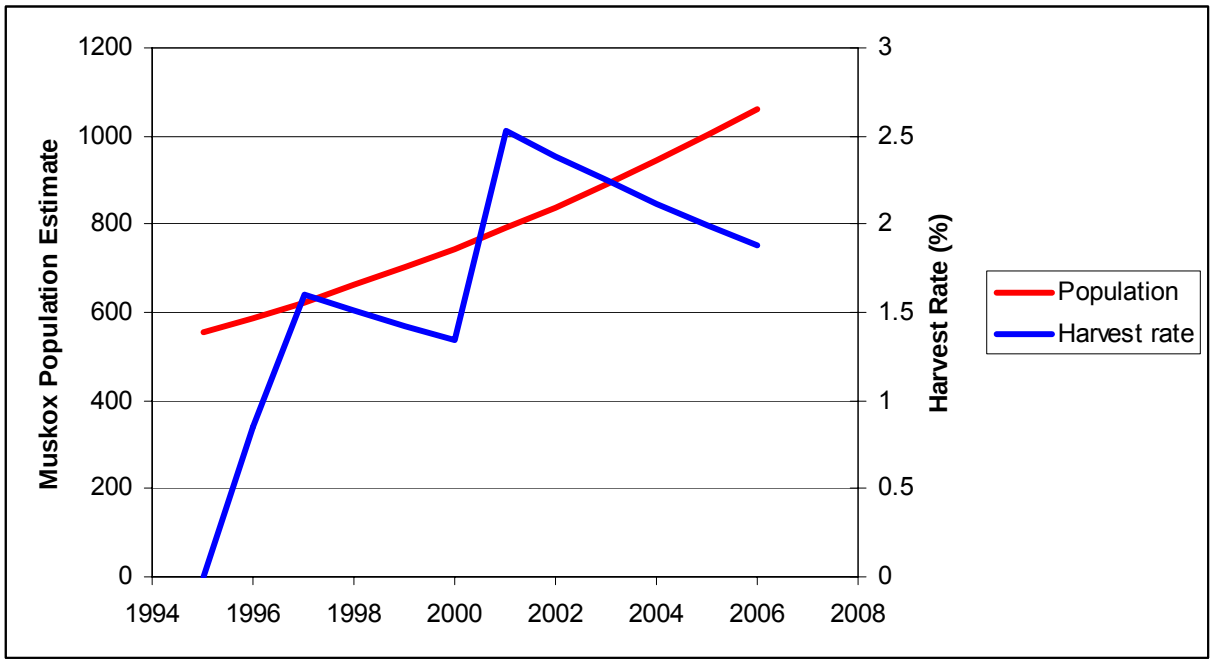

Figure 5.3: Estimated muskox harvest rate on Boothia Peninsula based on the number of tags allocated and muskox population estimates of 1995 and 2006.

Harvest rate in the past few years was around 2% of the population provided that all the tags were used successfully each year.

We flew transects oriented north – south in the area from Taloyoak to approximately 100 km south in order to assess a potential gradient of densities of muskoxen from Boothia Peninsula to the mainland. We did not observe any muskox on these transects and although muskoxen have been observed in the area (Taloyoak HTO *pers. comm.*) they are likely at very low density.

6.0. Discussion

Once abundant in the area of what has become Taloyoak, by the turn of the 20th century, muskoxen were extirpated from a major part of their historic range. Only for the past two decades, they have re-colonized and increased on most of Boothia Peninsula.

From 1980 to 1995, muskox population on Prince of Wales and Somerset Island increased dramatically by over 10 folds reaching 5259±414 (SE) on Prince of Wales and 1140±260 (SE) on Somerset Island in 1995 (Gunn and Dragon 1995, Gunn and Fournier 1998). A survey conducted in 2004 on both islands found that muskoxen had declined to 1934 (95% CI 1433-2600 with 17.2% of calves) on Prince of Wales Island but had continued to increase at an annual rate of 6% on Somerset Island (estimate of 1959 muskoxen with 12.5% of calves; Jenkins et al. *in prep.*).

The distribution between 1995 and 2006 hasn't change drastically except for a new area occupied southwest of the Peninsula. Immigration from Somerset Island could explain some of the increase in the muskox population on Boothia but because both populations had similar rate of increase during approximately the same period (1995 – 2004/2006), it would mean an actual minimum rate of increase on Somerset Island of 7 to 8% to account for half of the population growth on Boothia. Intrinsict mortality and natality on the Boothia Peninsula could be the major factor in MX09 population increase, especially considering that the distribution of muskoxen on Boothia hasn't changed dramatically. On the Nunavut western mainland, over a three years study, during only one year calf mortality was significant between early summer and fall (Gunn and Fournier 2000). With a

proportion of calf between 10 and 15%, it is possible that the Boothia Peninsula muskox population sustained an intrinsic rate of increase of 6%. However, female muskoxen do not reproduce until their second or third year (Gunn and Adamczewski 2004) and mortality of yearling and two years old individuals can affect dramatically the intrinsic rate of increase of the muskox population.

Nevertheless, it is also possible that the distribution of suitable habitats has limited the muskox distribution to particular areas of the Peninsula, regardless if the increase in the population is mainly due to immigration or an intrinsic high recruitment rate.

Arctic Island muskoxen are considered a subspecies genetically and morphologically distinct from mainland muskoxen (van Coeverden de Groot 2000). Genetic studies comparing muskoxen genetics on various areas of the Boothia Peninsula and muskox samples from Somerset and the mainland could shed some light on the amount of exchange between muskoxen on Somerset Island and Boothia Peninsula.

We planned to conduct transects between the northern tip of Boothia Peninsula and the south of Somerset Island but fog conditions prevented to complete this part of the study area.

7.0. Management Recommendations

Since the muskox population seemed to have constantly increased probably as a result of a positive rate of increase and immigration from Somerset Island, I recommend three management options and associated monitoring requirements:

Option 1: Management goal is to promote the maintenance of the muskox population at its current abundance in the muskox management zone MX09. Provided that natural mortality does not increase dramatically, I recommend a harvest level of 4% of the estimated population and increasing the TAH from 20 to 44 for the muskox management zone MX09. The productivity and recruitment will be important to monitor regularly (every two to three years). A new survey should be planned in 2011 to assess the trend of the population and confirm that this management strategy if efficient to achieve management goals in the area.

Productivity, recruitment and population trend over 5 years would give us good information to adjust the TAH level in order to achieve management goals.

The current rate of increase being about 6% per year, a yearly TAH based on 6% of the estimate could achieve the goal to maintain the muskox population on Boothia peninsula at it's current abundance but a slight change in recruitment and adult mortality could result in a drastic decline of the population if harvest is maintained. Because most of this muskox population is difficult to access, if muskox population declines, harvest success is likely to decline as well. I would recommend a harvest level of 6% provided that harvest is carefully monitored, that productivity/recruitment and population trend are monitored regularly and that local HTO report any sign of muskox population decline. The TAH at 6% of the population estimate would be 63 for the Boothia Peninsula muskox population.

Option 2: Management goal is to increase the muskox population in the muskox management zone MX09. In that case, I would recommend a harvest level of 3% of the population and increasing the TAH from 20 to 33 for the muskox management zone MX09. The productivity and recruitment will be important to monitor regularly (every two to three years). A new survey should be planned in 2011 to assess the trend of the population and confirm that this management strategy if efficient to achieve management goals in the area. Productivity, recruitment and population trend over 5 years would give us good information to adjust the TAH level and to confirm that this management strategy if efficient to achieve management goals in the area.

For all options: Because the high density areas are located mainly on the north and western parts of the peninsula, the increase in the TAH level, if harvest is concentrated around the community, may result in a local depletion of muskoxen around the community. To limit local depletion, I would recommend to the HTO to establish bylaws regulating the distribution of the harvest. The Boothia Peninsula could be divided into three areas: North – HAD; Southwest – MDA, and Southeast –

LDA with a respective share of the TAH of 14, 26, and 4 (Rate of harvest of 4%) or 25, 32, and 6 (Rate of harvest of 6%) or 11, 19, and 3 (Rate of harvest of 3%).

If immigration from Somerset is playing a major role in the muskox population increase on Boothia Peninsula, it will be crucial to monitor both populations and in particular Somerset Island that may act as a source for the Boothia muskox.

8.0. Reporting to Communities/Resource Users

The draft of this report has been sent to the Taloyoak HTO and NWMB. A meeting with the HTO will be organized this winter to discuss the results and management implications. The final report will be available through GN-DoE and will be distributed to relevant co-management partners and other interested organizations and individuals.

9.0. Literature Cited

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APPENDIX 1

Aircraft Configuration

Aircraft Configuration

The survey was flown using a Helio Courier. The Helio Courier has no wing struts and therefore I ran a string from the wing to the body of the aircraft to position the markers.

Strip widths were established using strings with a little weight that would stay horizontal during the flight and attached to the main string (Figure A.1). Strip width (w) was calculated using the formula of Norton-Griffiths (1978):

$$w = W * h/H$$

where:

W = the required strip width**;**

h = the height of the observer's eye from the tarmac; and

H = the required flying height

Strip width calculations were confirmed by flying perpendicularly over a set of ground markers positioned to represent the 1.5km strip on the ground on each side of the plane.

The strip width area for density calculations was 1500 m, for a total of 3000 m along each transect.

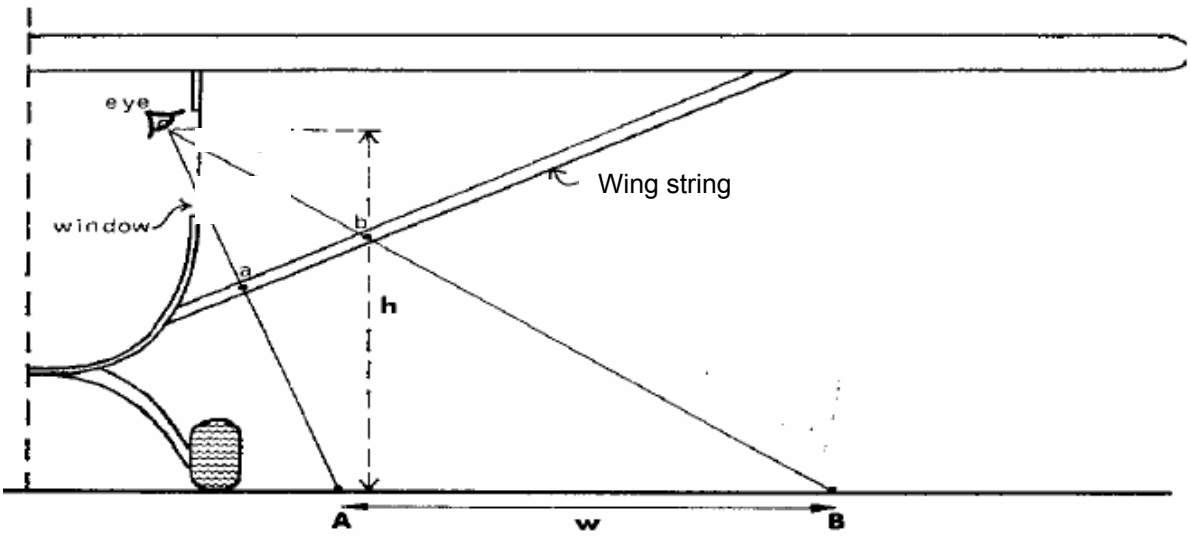

Figure A.1: Schematic diagram of aircraft configuration for strip width sampling (Norton-Griffiths, 1978). W is marked out on the tarmac, and the two lines of sight a – A and b – B established. The dowels are attached to the wing string at a and b. a' and b' are the window marks (adapted from Campbell and Setterington 2001).

APPENDIX 2

Estimate calculation for the whole study area and per stratum (HDA, MDA, and LDA)

Management Zone:	**MX09 ALL STRATA**
Location:	**BOOTHIA**
Area of strata (km^2) (Z):	**25533**
Altitude (km)	**0.154**
Strip width (km)	**3.00**
Base-line (km)	**429.0718565**
Transects sampled (n)	**33**
Total transects (N)	**143.0239522**
t-value for n-1 (95%CL):	**2.037**

				z	**y_1**	**y_2**				
Block_ID	**Tran_ID**	**Length (km)**	**Width(km)**	**Area(km^2)**	**Adults**	**Calves**	**z^2**	**y_1^2**	**y_2^2**	**$z*y_1$**
1	1	53.5	3.0	160.6	25	1	25789.15	625	1	4014.75
3	2	67.6	3.0	108.6	0	0	11793.96	0	0	0
3	3	47.8	3.0	85.8	0	0	7361.64	0	0	0
3	4	58.4	3.0	150.0	0	0	22500.00	0	0	0
3	5	66.1	3.0	107.1	0	0	11470.41	0	0	0
3	6	72.7	3.0	150.0	0	0	22500.00	0	0	0
3	7	46.4	3.0	99.0	1	0	9801.00	1	0	99
3	8	50.1	3.0	107.1	0	0	11470.41	0	0	0
3	9	55.8	3.0	153.6	0	0	23592.96	0	0	0
3	10	57.2	3.0	107.1	0	0	11470.41	0	0	0
3	11	52.9	3.0	153.6	0	0	23592.96	0	0	0
3	12	35.2	3.0	153.6	0	0	23592.96	0	0	0
3	13	31.7	3.0	105.6	0	0	11151.36	0	0	0
3	14	33.1	3.0	153.6	20	4	23592.96	400	16	3072
3	15	43.6	3.0	153.6	0	0	23592.96	0	0	0
3	16	45.5	3.0	153.6	0	0	23592.96	0	0	0
2	17	58.8	3.0	108.6	22	1	11793.96	484	1	2389.2
2	18	80.5	3.0	85.8	0	0	7361.64	0	0	0
2	19	79.9	3.0	150.0	0	0	22500.00	0	0	0
2	20	80.0	3.0	107.1	9	0	11470.41	81	0	963.9
2	21	80.0	3.0	150.0	0	0	22500.00	0	0	0
2	22	80.5	3.0	99.0	15	3	9801.00	225	9	1485

2	23	77.2	3.0	107.1	0	0	11470.41	0	0	0
2	24	79.3	3.0	153.6	7	0	23592.96	49	0	1075.2
2	25	59.9	3.0	107.1	14	2	11470.41	196	4	1499.4
2	26	19.5	3.0	153.6	0	0	23592.96	0	0	0
2	27	27.8	3.0	153.6	16	2	23592.96	256	4	2457.6
2	28	72.0	3.0	105.6	0	0	11151.36	0	0	0
2	29	65.9	3.0	153.6	1	0	23592.96	1	0	153.6
2	30	69.2	3.0	150.0	7	1	22500.00	49	1	1050
1	31	62.0	3.0	186.0	0	0	34581.49	0	0	0
1	32	74.2	3.0	222.6	13	1	49552.10	169	1	2893.839
1	33	79.4	3.0	238.3	38	12	56769.26	1444	144	9053.994
Totals		**1963.75**	**3.00**	**4534.02**	**188**	**27**	664159.97	3980	181	30207.48

Statistical Calculations

	Area	Adults(y_1)	Calves(y_2)	Percentage of Calves
SUM(z)	**4534.02**			
SUM(y)		**188**	**27**	**14.4%**
SUM(z^2) and/or SUM(y^2)	**664159.97**	**3980**	**181**	
SUM(z * y)		**30207.483**	**4933.749**	
R = SUM(y) / SUM(z)		**0.0415**	**0.0060**	
s_y^2		**90.91**	**4.97**	
s_z^2	**1287.85**			
s_{zy}		**132.65**	**37.09**	
Y = R x Z		**1058.71**	**152.05**	
Var(**Y**)		**39158.62**	**2179.11**	
SE(**Y**)		**197.89**	**46.68**	
95% Confidence Limits of Y (+/-)		**403.09**	**95.09**	
95% Confidence Limits of Y (%)		**38.07**	**62.54**	
Coefficient of Variation		**0.19**	**0.31**	
% area coverage			**18**	

Management Zone:	**MX09 Stratum 1**
Location:	**BOOTHIA**
Area of strata (km^2) (Z):	**3249**
Altitude (km)	**0.154**
Strip width (km)	**3.00**
Base-line (km)	**53.505912 39**
Transects sampled (n)	**7**
Total transects (N)	**17.835304 13**
t-value for n-1 (95%CL):	**2.447**

Block_ID	Tran_ID	Length (km)	Width(km)	z Area(km^2)	y_1 Adults	y_2 Calves	z^2	y_1^2	y_2^2	$z*y_1$	$z*y_2$
1	1	53.5	3.0	160.6	25	1	25789.15	625	1	4015	160.59
3	2	67.6	3.0	108.6	16	0	11793.96	256	0	1738	0
3	3	47.8	3.0	85.8	0	0	7361.64	0	0	0	0
3	4	58.4	3.0	150.0	47	5	22500.00	2209	25	7050	750
3	5	66.1	3.0	107.1	13	1	11470.41	169	1	1392	107.1
3	6	72.7	3.0	150.0	19	3	22500.00	361	9	2850	450
3	7	46.4	3.0	99.0	38	12	9801.00	1444	144	3762	1188
Totals		**412.56**	**3.00**	**861.09**	**158**	**22**	111216.16	5064	180	20807	2655.7

Statistical Calculations

	Area	Adults(y_1)	Calves(y_2)	Percentage of Calves
SUM(z)	**861.09**			

SUM(y)		**158**	**22**	**13.9%**
SUM(z^2) and/or SUM(y^2)	**111216.16**	**5064**	**180**	
SUM(z * y)		**20806.65**	**2655.69**	
R = SUM(y) / SUM(z)		**0.1835**	**0.0255**	
s_y^2		**249.62**	**18.48**	
s_z^2	**881.84**			
s_{zy}		**195.80**	**-7.23**	
Y = R x Z		**596.06**	**83.00**	
Var(**Y**)		**5727.23**	**536.16**	
SE(**Y**)		**75.68**	**23.16**	
95% Confidence Limits of Y (+/-)		**185.19**	**56.66**	
95% Confidence Limits of Y (%)		**31.07**	**68.27**	
Coefficient of Variation		**0.13**	**0.28**	
% area coverage			**26.5**	

Management Zone:	**MX 09 Stratum 02**
Location:	**BOOTHIA**
Area of strata (km^2) (Z):	**12655**
Altitude (km)	**0.154**
Strip width (km)	**3.00**
Base-line (km)	**190**
Transects sampled (n)	**14**
Total transects (N)	**63.4628673**
t-value for n-1 (95%CL):	**2.16**

				z	y_1	y_2					
Block_ID	**Tran_ID**	**Length (km)**	**Width(km)**	**Area(km^2)**	**Adults**	**Calves**	**z^2**	**y_1^2**	**y_2^2**	**$z*y_1$**	**$z*y_2$**
2	1	58.8	3.0	108.6	22	1	11793.96	484	1	2389.2	108.6
2	2	80.5	3.0	85.8	0	0	7361.64	0	0	0	0
2	3	79.9	3.0	150.0	0	0	22500.00	0	0	0	0
2	4	80.0	3.0	107.1	9	0	11470.41	81	0	963.9	0
2	5	80.0	3.0	150.0	0	0	22500.00	0	0	0	0
2	6	80.5	3.0	99.0	15	3	9801.00	225	9	1485	297
2	7	77.2	3.0	107.1	0	0	11470.41	0	0	0	0
2	8	79.3	3.0	153.6	7	0	23592.96	49	0	1075.2	0
2	9	59.9	3.0	107.1	14	2	11470.41	196	4	1499.4	214.2
2	10	19.5	3.0	153.6	0	0	23592.96	0	0	0	0
2	11	27.8	3.0	153.6	16	2	23592.96	256	4	2457.6	307.2
2	12	72.0	3.0	105.6	0	0	11151.36	0	0	0	0
2	13	65.9	3.0	153.6	1	0	23592.96	1	0	153.6	0
2	14	69.2	3.0	150.0	7	1	22500.00	49	1	1050	150
Totals		**930.54**	**3.00**	**1784.70**	**91**	**9**	236391.03	1341	19	11074	1077

Statistical Calculations

	Area	Adults(y_1)	Calves(y_2)	Percentage of Calves
SUM(z)	**1784.70**			
SUM(y)		**91**	**9**	**9.9%**
SUM(z^2) and/or SUM(y^2)	**236391.03**	**1341**	**19**	
SUM(z * y)		**11073.9**	**1077**	
R = SUM(y) / SUM(z)		**0.0510**	**0.0050**	
s_y^2		**57.65**	**1.02**	
s_z^2	**683.08**			
s_{zy}		**-37.62**	**-5.02**	
Y = R x Z		**645.24**	**63.82**	
Var(**Y**)		**14185.38**	**243.17**	
SE(**Y**)		**119.10**	**15.59**	
95% Confidence Limits of Y (+/-)		**257.26**	**33.68**	
95% Confidence Limits of Y (%)		**39.87**	**52.78**	
Coefficient of Variation		**0.18**	**0.24**	

% area coverage **14**

Management Zone:	**MX 09 Stratum 03**
Location:	**BOOTHIA**
Area of strata (km^2) (Z):	**9629**
Altitude (km)	**0.154**
Strip width (km)	**3.00**
Base-line (km)	**189**
Transects sampled (n)	**15**
Total transects (N)	**63.0081354**
t-value for n-1 (95%CL):	**2.145**

				z	y_1	y_2					
Block_ID	**Tran_ID**	**Length (km)**	**Width(km)**	**Area(km^2)**	**Adults**	**Calves**	z^2	y_1^2	y_2^2	$z*y_1$	$z*y_2$
3	1	67.6	3.0	108.6	0	0	11793.96	0	0	0	0
3	2	47.8	3.0	85.8	0	0	7361.64	0	0	0	0
3	3	58.4	3.0	150.0	0	0	22500.00	0	0	0	0
3	4	66.1	3.0	107.1	0	0	11470.41	0	0	0	0
3	5	72.7	3.0	150.0	0	0	22500.00	0	0	0	0
3	6	46.4	3.0	99.0	1	0	9801.00	1	0	99	0
3	7	50.1	3.0	107.1	0	0	11470.41	0	0	0	0
3	8	55.8	3.0	153.6	0	0	23592.96	0	0	0	0
3	9	57.2	3.0	107.1	0	0	11470.41	0	0	0	0
3	10	52.9	3.0	153.6	0	0	23592.96	0	0	0	0
3	11	35.2	3.0	153.6	0	0	23592.96	0	0	0	0
3	12	31.7	3.0	105.6	0	0	11151.36	0	0	0	0
3	13	33.1	3.0	153.6	20	4	23592.96	400	16	3072	614.4
3	14	43.6	3.0	153.6	0	0	23592.96	0	0	0	0
3	15	45.5	3.0	153.6	0	0	23592.96	0	0	0	0
Totals		**764.07**	**3.00**	**1941.90**	**21**	**4**	261076.95	401	16	3171	614.4

Statistical Calculations

	Area	Adults(y_1)	Calves(y_2)	Percentage of Calves
SUM(z)	**1941.90**			
SUM(y)		**21**	**4**	**19.0%**
SUM(z^2) and/or SUM(y^2)	**261076.95**	**401**	**16**	
SUM(z * y)		**3171**	**614.4**	
R = SUM(y) / SUM(z)		**0.0108**	**0.0021**	
s_y^2		**26.54**	**1.07**	
s_z^2	**691.33**			
s_{zy}		**30.16**	**6.44**	
Y = R x Z		**104.12**	**19.83**	
Var(**Y**)		**5237.41**	**210.35**	
SE(**Y**)		**72.37**	**14.50**	
95% Confidence Limits of Y (+/-)		**155.23**	**31.11**	
95% Confidence Limits of Y (%)		**149.09**	**156.86**	
Coefficient of Variation		**0.70**	**0.73**	
% area coverage			**20.2**	

Appendix 3:

Muskox Aerial Survey Budget Summary
Boothia Peninsula June 2006

Item	Cost
Aircraft ($550/h)	$34,846.40
Pilot and Biologist Accommodation and food	$6,292.06
Ground transportation	$523.36
Fuel (AvGas)	$2,434.32+last year fuel order
Field observers	$2,300.00
TOTAL	**$46,396.14**

Note: Salaries of GN employees are not included