Review of Muskox status in the Kitikmeot Region of Nunavut


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Working DRAFT – December 2006

File Report No.

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Nunavut

ABSTRACT:

This report reviews the history of muskox management and the species status in the Kitikmeot region of Nunavut. Currently, the Kitikmeot hosts in the order of 50,000 muskoxen. In general, muskoxen have increased on the Arctic Islands, and, on the mainland, after a sharp increase earlier, are generally declining with reduced calf production and/or survival. Some aspects of the past and current management are discussed and some recommendations are presented.

ACKNOWLEDGEMENT:

Thank you to Anne Gunn, Mitch Campbell and Mike Setterington who provided great comments and suggestions on earlier drafts.

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1.0. PURPOSE:

This report summarizes the status and recent management history of muskoxen in the Kitikmeot region of Nunavut (Figure 1.1). Previously, Fournier and Gunn (1998) had summarized the status of muskoxen in the Northwest Territories and Nunavut. I prepared this report using available reports, files, and papers as well as information from the communities. This review is meant to provide a background on muskox management in the Kitikmeot and provide a rational for current management practices including the GN-DoE recommendation for Non-quota limitations (NQL) and Total Allowable Harvest (TAH) levels on muskoxen. This document can be considered as a first necessary step to develop a management plan for muskoxen in Nunavut.

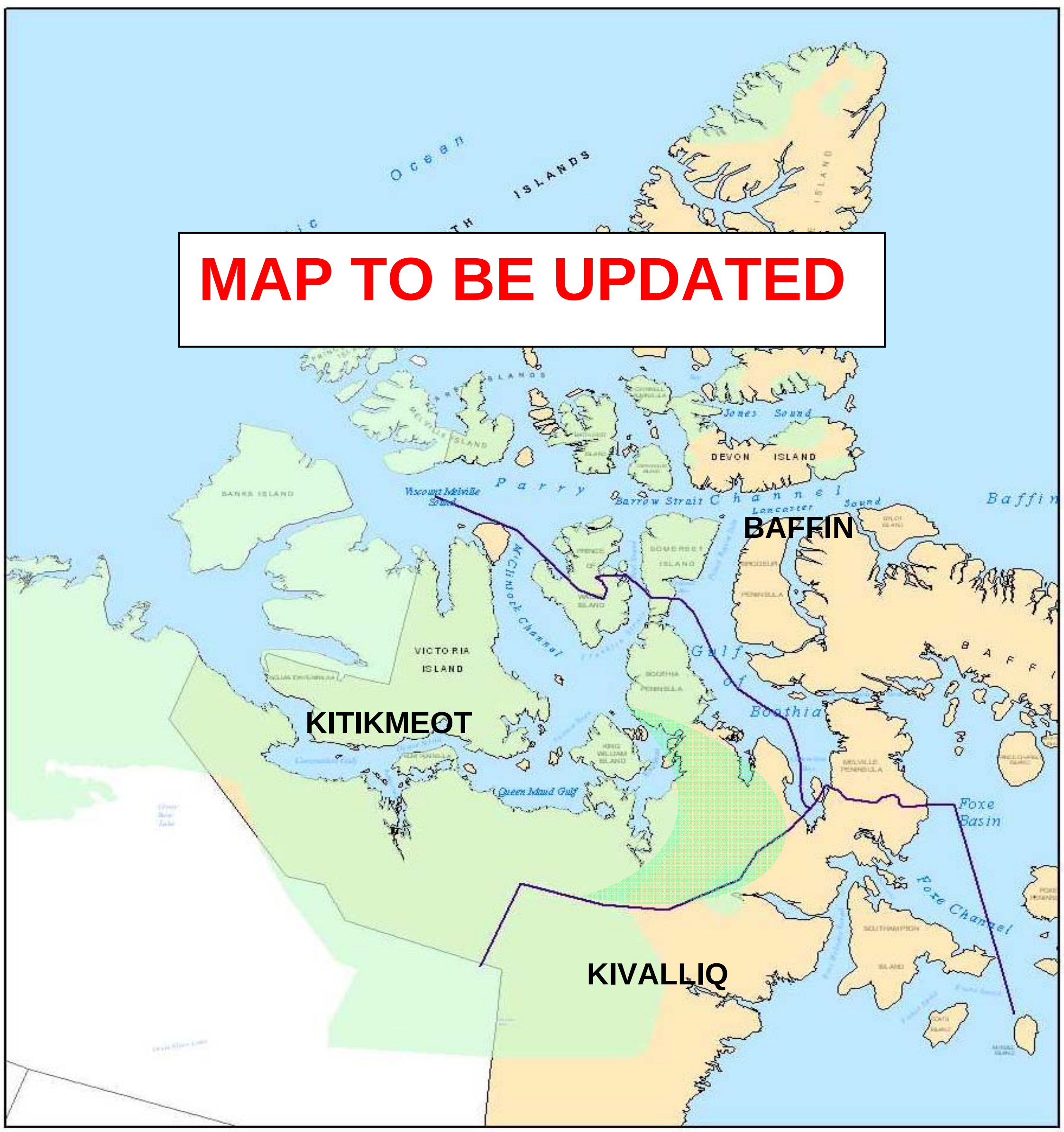


Figure 1.1: Known muskox distribution in Nunavut as of 1997 (Source: Fournier and Gunn 1998) and updated where new information was available.

2.0. INTRODUCTION

Musk-ox (*Ovibos moschatus*) is an emblematic figure of the Arctic. It has been able to survive the toughest arctic conditions and has been a key species for the survival of carnivores, Inuit and occasionallly foreign expeditions, and a key component of the ecosystem (vegetation dynamics, Smith 1996, Kjell et al. 2002). Muskoxen have been the focus of an intense fur trade at the end of the nineteenth century up to the early 1900s (Barr 1991). This intensive harvest was a major factor in the decline of the muskox population but certainly not the only one and climatic variations and natural cycles played probably an important role in the decline and subsequent recovery (Gunn 1990a).

From phenotypic characteristics, Tener (1965 *in Gunn 1982*) described two incipient sub-species *Ovibos moschatus moschatus* on the mainland and *Ovibos moschatus wardi* in the Arctic Islands (except Baffin Island). Subsequently, Van Coeverden de Groot (2001) using the comparison of 14 microsatellites loci, determined that muskoxen had extremely low levels of genetic variation. However, Northern Arctic Islands, Southern Arctic Island and Mainland muskoxen differed genetically and that mainland muskoxen had the highest genetic variability. Nevertheless, the measured genetic difference is not enough to grant these muskox types the designation of subspecies (Gunn and Adamczewski, 2003).

3.0. MUSKOXEN HISTORY AND STATUS IN THE KITIKMEOT:

Since the major decline in muskoxen populations during the 1800s and early 1900s over the Arctic and subarctic, and the subsequent protection of the species (1917), muskoxen have recovered in most of their Canadian range and are progressively re-colonizing the eastern and southern parts of their historic range (Barr 1991). In 1967, the muskox numbers in Nunavut and Northwest Territories were estimated at 9,896 (1,500 on the mainland and 8,396 on the Arctic Archipelago) (Tener 1958 cited in Urquhart 1980). Banfield (1977), based on Tener’s work, mentioned that approximately 33% of the mainland muskoxen were in the Thelon Game Sanctuary. By 1980, muskox numbers were estimated to be 45,055 individuals (Urquhart 1980) and then 10 years later, estimated to be 108,600 animals in 1991 (Ferguson and Gauthier 1992). The increase was mostly due to a large increase in the areas surveyd for muskoxen.

In 2001, the estimate population size in NWT and Nunavut combined was 134,000 to 144,000 animals (Nunavut Mammal Committee 2001). Currently, the muskoxen population in the Kitikmeot region alone is estimated to be somewhat around 50,000 animals.

Muskoxen are present on most of Nunavut mainland except northeastern and western areas, and on most Arctic islands except Baffin and Southampton Islands (see figure 1.1). Local oral history suggests that muskoxen disappeared from Baffin Island during the fifteenth century (Barr 1991). The only recent record of muskoxen on Baffin is a herd of eight observed south of Clyde River in 1968 (Barr 1991). Because no other sighting has been recorded since then, it is believed that these muskoxen came from a neighboring arctic island and have since perished or moved from Baffin.

By the early 1900s, muskox distribution on the mainland had contracted to a few isolated sots which included north of Great Bear Lake, the Thelon-Hanbury river basins and west of Bathurst Inlet. As well there likely scattered muskox herds north of the Back River and around Wager Bay. Those remmant herds became the basis for the recolonization of the mainland.

Based on distribution clusters, Ferguson and Gauthier (1992) identified 17 populations of muskoxen in Canada. Fourteen of the 17 population described are partially or totally within Nunavut. Due to the lack of available information, these populations are currently in question. In the Kitikmeot, these “populations” or clusters (and their estimates) would be Bathurst Inlet (3420 muskoxen), Rae-Richardson 1800 muskoxen), Victoria Island 30 650 muskoxen), Queen Maud Gulf 7600 muskoxen) and Prince of Wales – Somerset (1130 muskoxen) which totaled approximately 45 000 muskoxen. However, some of the 30 650 muskoxen on Victoria Island are within the NWT as the Nunavut NWT border cuts through Victoria Island. Ferguson and Gauthier (1992) rated the cluster as increasing, except for Prince of Wales - Somerset Island which was stable.

More recently, In the Kitikmeot, all island muskoxen have increased. On the mainland however, after reaching a high, most muskox populations are declining. West of the Coppermine, the decline and lack of apparent recovery is believed to be the direct and indirect effects of a lungworm : *Umingmakstrongylus pallikuukensis* (Gunn and Wobeser 1993, Hoberg et al. 1995, Gunn and Fournier 2000 **REFERENCE IMPLICATIONS**). In other areas, the causes of decline are unknown and explanations are speculative. A common pattern seems to be a sharp increase of the muskox population followed by a drastic decline and a slow recovery. This pattern has also been documented in Alaska (Reynolds 1998).

4.0. MANAGEMENT HISTORY:

The active management of muskoxen really started in 1917 with the moratorium of the harvest following a major decline of the muskox numbers and a contraction of their distribution across the mainland, in part due to an extensive fur trade. This trade was not as active or absent from the Arctic Islands.

In 1969, a few quotas were established to allow muskox harvesting in the High Arctic. The first quotas in the Kitikmeot region were established in 1976 (Urquhart 1980) after local reports of increases in muskox sightings. Those sightings led to relatively unsystematic aerial surveys. By the early 1980s, the aerial surveys became more standardized (Graf and Case 1989). The first management zones in the Kitikmeot are presented on Figure 4.1. Except when otherwise mentioned, I used the current (as per May 2006) names for the muskox management zones (Figure 4.2). The boundaries differed sometime slightly from the older management zones but I found less confusing to use the current names.

FIGURE 4.1: Map of the initial muskox management zones

TO BE ADDED

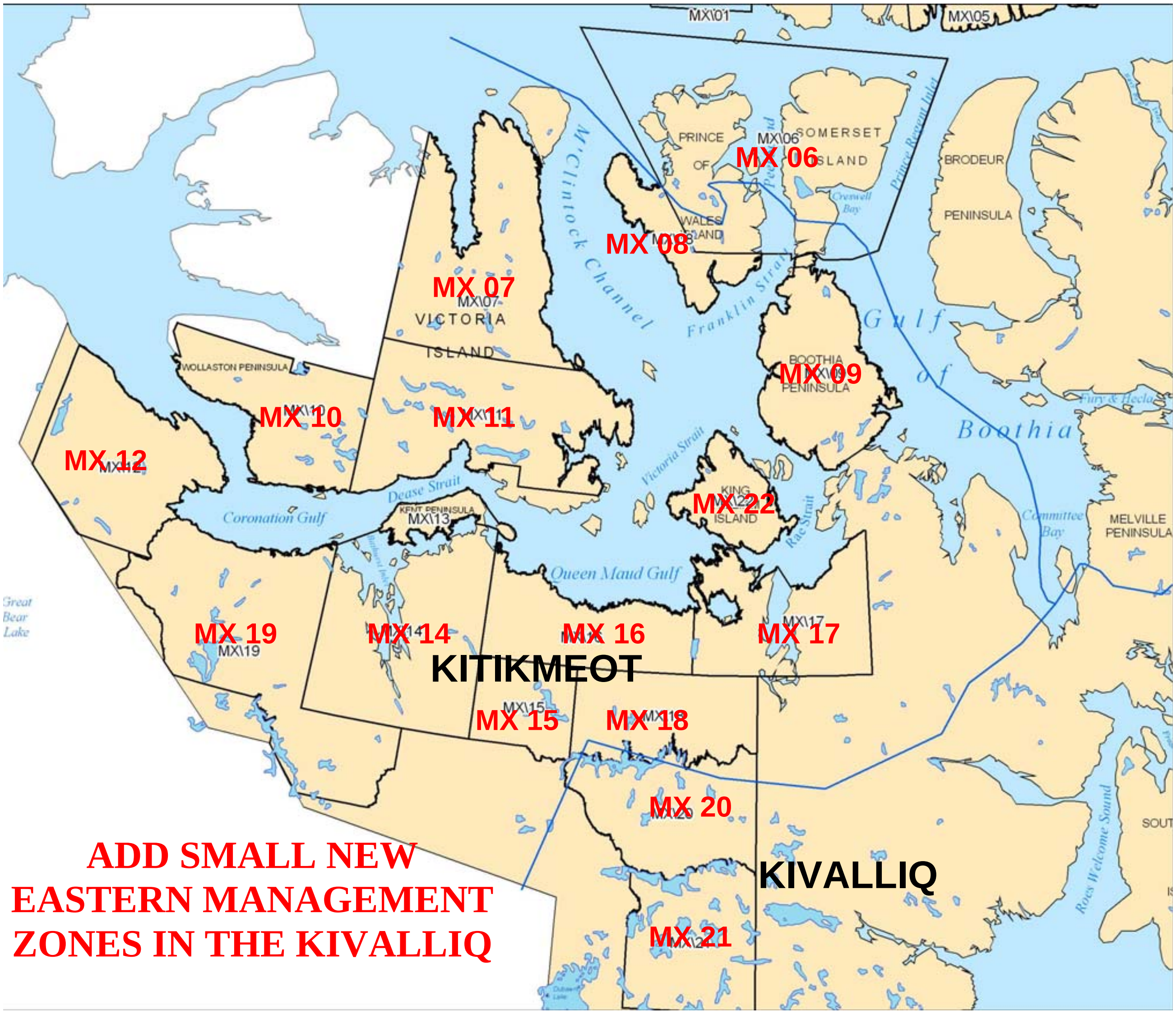
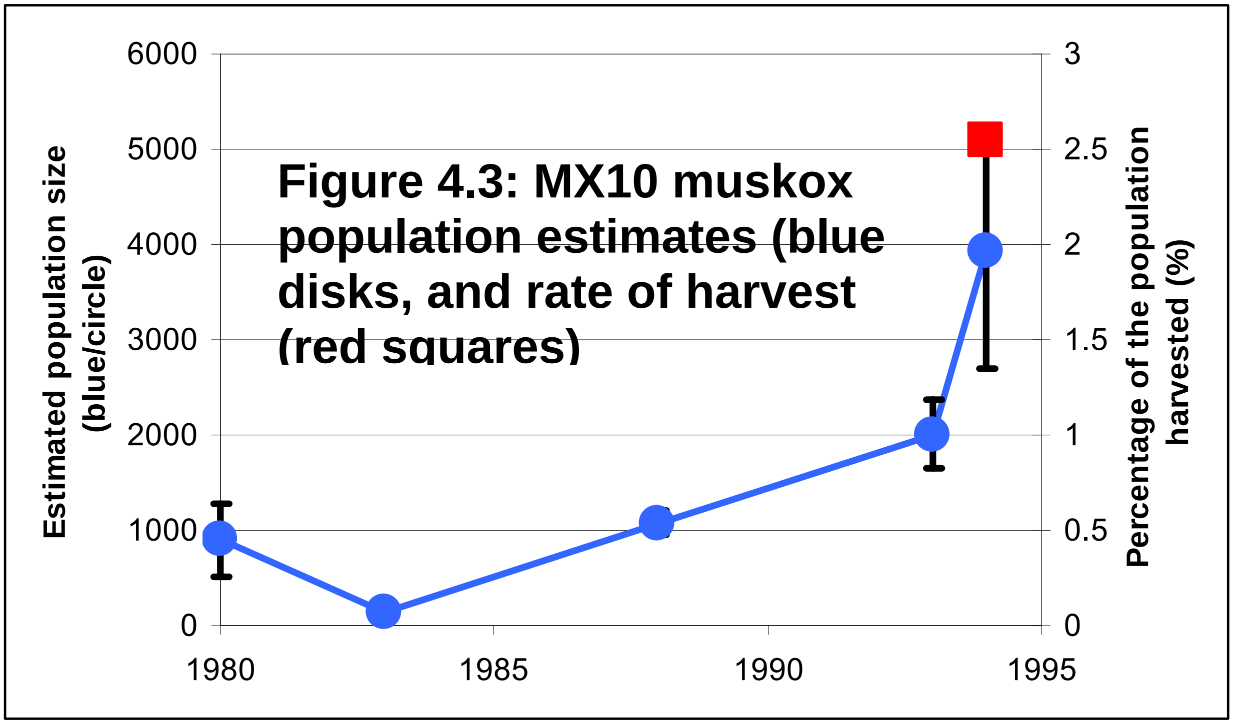
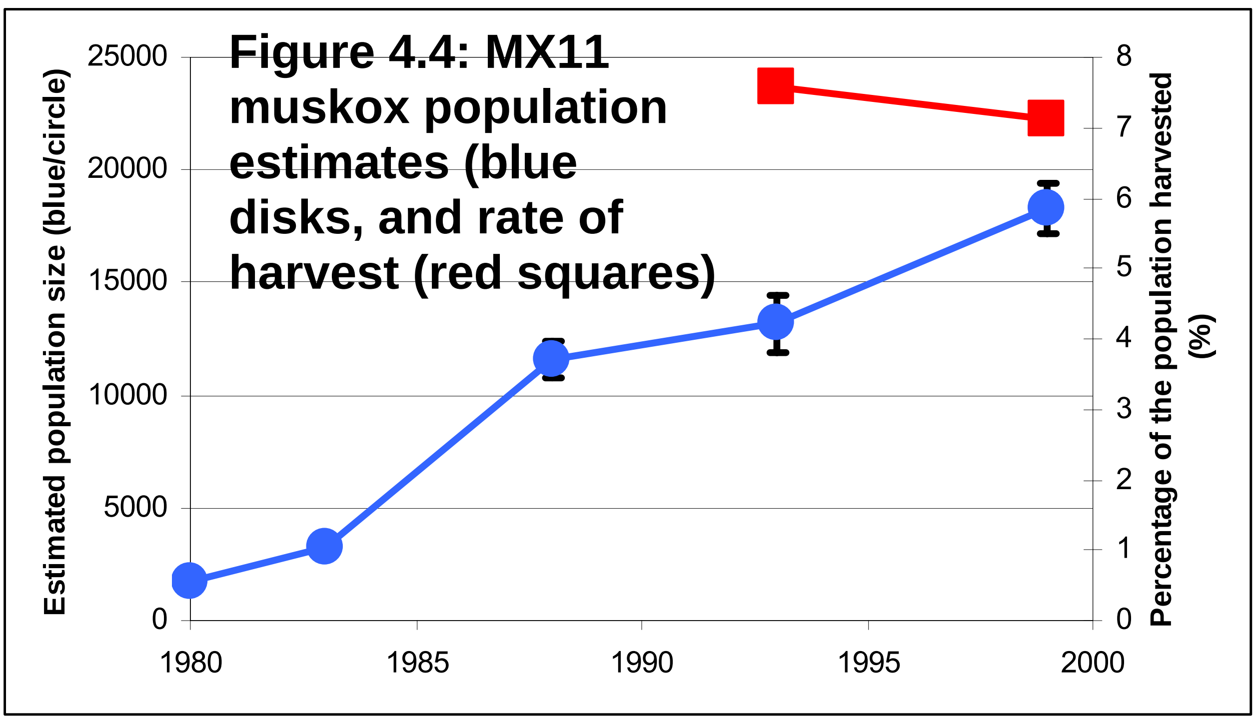


Figure 4.2: Muskox Management Zones in the Kitikmeot and Kivalliq regions as of May 2006.

Victoria Island was allocated a quota in 1976. The population was described as increasing. This quota was shared by Holman and Cambridge Bay (8 males and 4 females, and 9 males and 7 females respectively). In 1983, Poole (1985) surveyed the south-west part of the island. In 1984, the quota was 13 for the west of the island and 65 for the east of the island with no sex selective harvest. In 1992, the North-east of Victoria Island (MX07) was assigned a quota of a hundred following the 1990 survey results (Gunn and Lee 2000). In 1993, MX11 (South-East) was surveyed (Gunn and Patterson 2000) and the quota was raised to 1000. Following the results of the 1999 aerial survey (Gunn and Patterson 2000), the quota in MX11 was raised again in 2000 to reach 1300 tags. The quota in MX10 (south-west) has been 100 tags at least since 1994. See Figure 4.3 and Figure 4.4.





Prince of Wales Island (PWI) was allocated a quota in 1976 as muskox numbers were believed to be increasing which was confirmed during an island-wide survey in 1980 (Gunn and Decker no date).This quota was shared by Resolute and Taloyoak (4males and 3 females, and 2 males and 1 female, respectively). The current management zone

MX06 includes Somerset Island and the eastern portion of PWI, and MX08 is covering the western portion of PWI (Figure 4.1.). The changes in the zones for these two islands are not clear in the 1980s'. In 1995, MX06 was assigned a quota of 20 tags and MX06 12 tags based on the increase documented during an aerial survey in 1995 (Gunn and Dragon 1998). A ground and an aerial survey were conducted in April 2004 (Ferguson 2005), but no new quota recommendation has been provided yet.

The Queen Maud Gulf Bird Sanctuary was established in 1961. Queen Maud Gulf area was allocated a quota in 1976. The population was described as increasing. This quota was shared by Cambridge Bay, Perry River & Ellice River, Baker Lake, and Gjoa Haven (5males and 3 females, 5males and 3 females, 2males and 1 female, and 6 males and 4 females respectively). In the early 1980s', the quota was increased to 65 and then 80 in 1986. In 1991, following an aerial survey the quota was increased to 170. After the 1996 survey reporting a decline in the muskox population, the quota was reduced to 90 and has remained 90 since then.

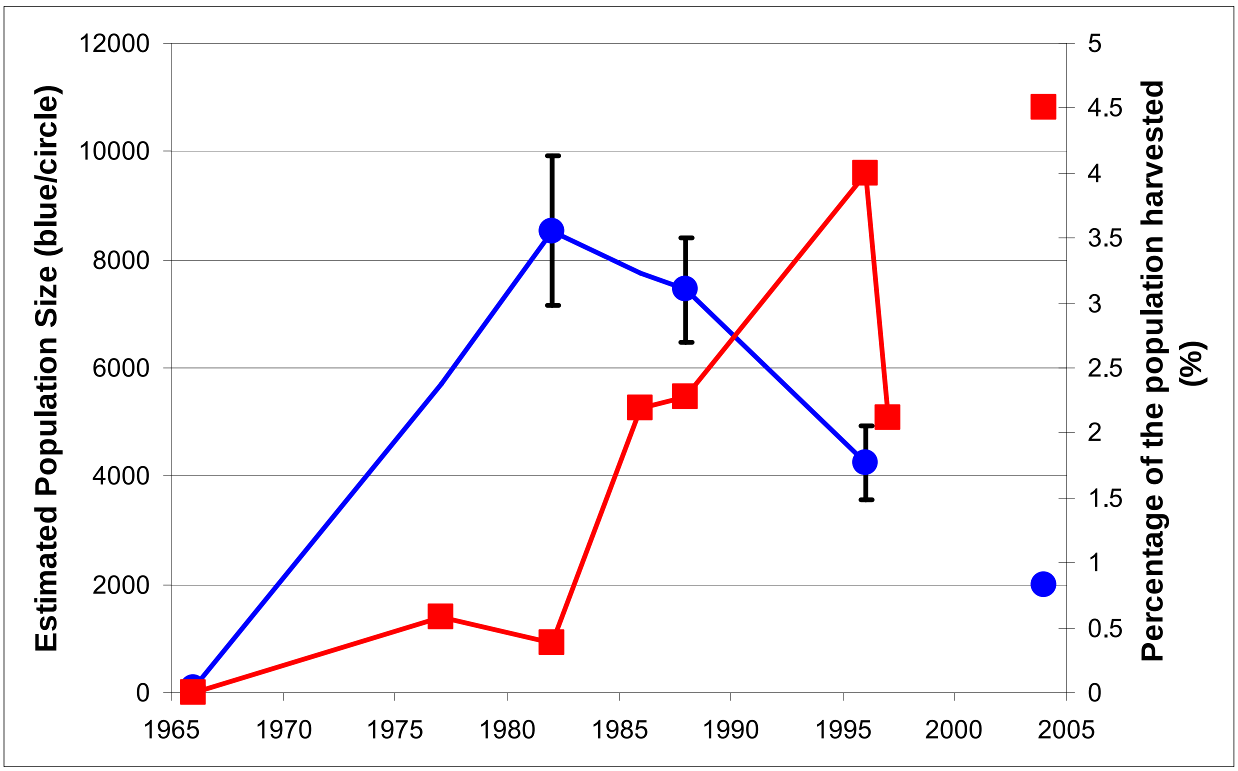


Figure 4.5: MX16 muskox population estimates (blue disks, and rate of harvest (red squares). Figures for 2004 are projected figures based on trends.

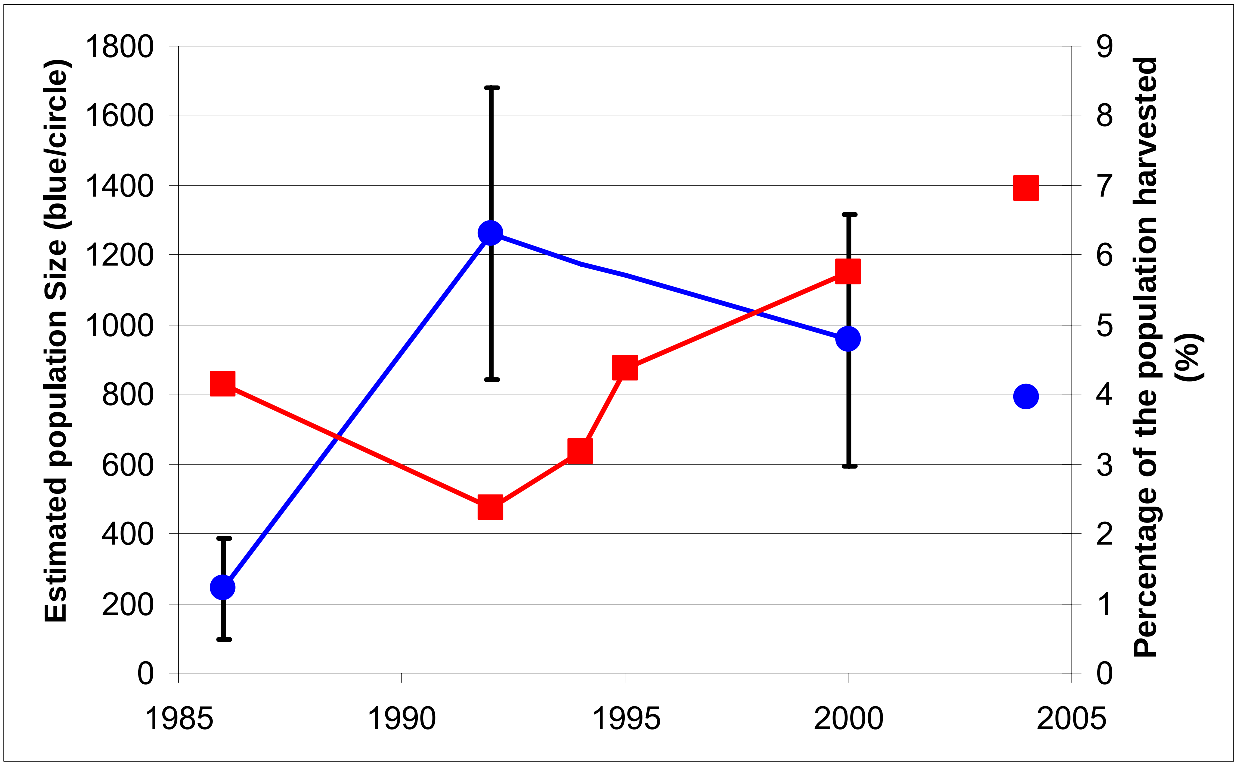


Figure 4.6: MX17 muskox population estimates (blue disks, and rate of harvest (red squares). Figures for 2004 are projected figures based on trends.

A muskox harvesting zone was created in the Central Arctic (Bathurst Inlet, Upper Back River) in 1977 with a quota of 5 (3 males and 2 females) allocated to Bathurst Inlet (Kingaut) and Bay Chimo (Umingmaktok). In 1984, the quota is increased to 10, to 30 in 1987 and 40 in 1988. A quota of 20 was set for MX15 in 1993 and in 2000, MX13 was assigned a quota of 20. There is still some information to gather to establish the exact management history in this area.

Great Bear Lake North was allocated a quota in 1976. The population was described as increasing. This quota was shared by Paulatuk and Kugluktuk (4males and 4females, and 3males and 3 females respectively). Muskoxen were nearly extinct from the area from 1918 to 1930. In 1984, the quota increased to 40, and in 1988 to 50. Following a drastic decline of the muskox population in the area, the quota was reduced to 20 and has remained 20 since then.

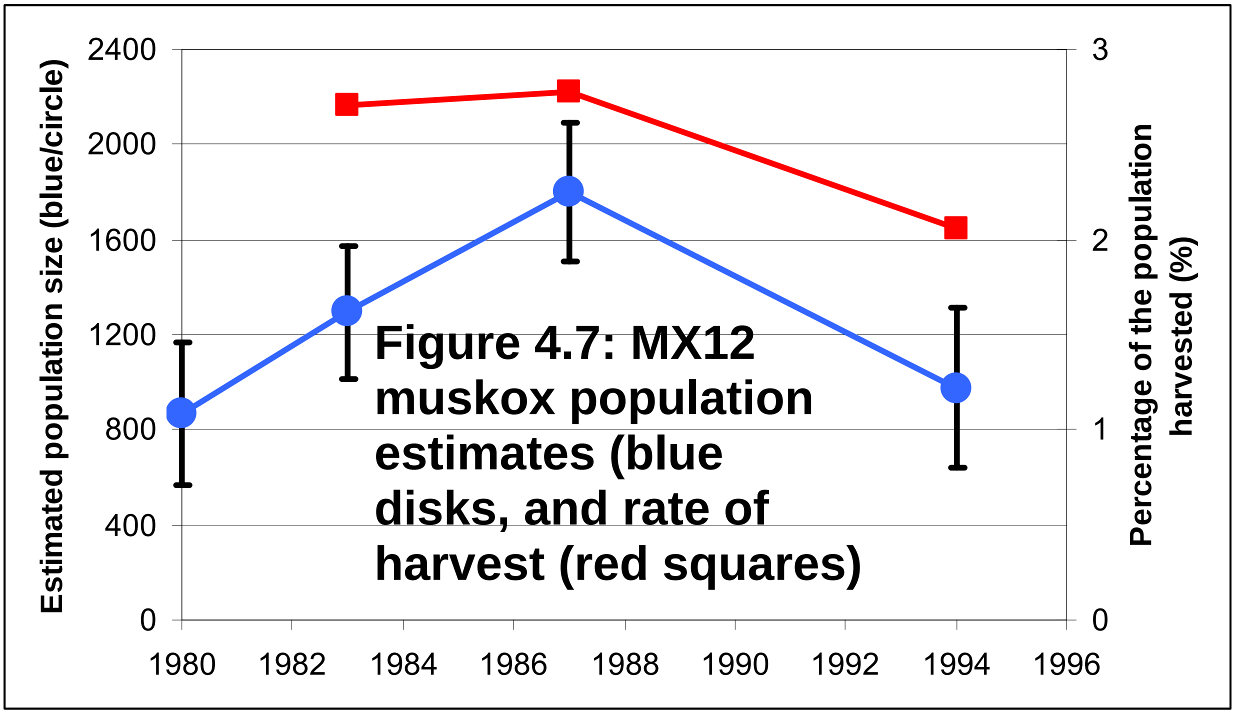


Figure 4.7: MX12 muskox population estimates (blue disks, and rate of harvest (red squares)

5.0. CURRENT MANAGEMENT:

The muskoxen quota system in the Northwest Territories and Nunavut started in 1969. To facilitate the quota system, management units were established to reflect traditional hunting patterns by local residents and known muskoxen distribution (Gunn 1984, Figure 5.1.). Muskoxen are harvested for subsistence use, although in many areas, caribou meat is generally preferred. However, commercial harvest project are also taking place for sport hunts, meat plants and qiviut industry.

Under the Nunavut Land Claim Agreement, the Nunavut Wildlife Management Board (NWMB) "…*shall have sole authority to establish, modify or remove, from time to time and as circumstances require levels of total allowable harvest* [TAH] *or harvesting in the Nunavut Settlement Area*" (Nunavut Land Claims Agreement (NLCA) Article 5.6.16). The NWMB also has sole authority for non-quota limitations (*e.g.*, harvesting seasons) on wildlife in the Nunavut Settlement Area (NLCA 5.6.48). Muskox harvesting in Nunavut is managed using quotas (to become TAHs) and seasons for each of the management areas (Figure 4.2). The quotas and seasons that the NWMB establishes are typically based on recommendations from Government of Nunavut (GN) biologists and stake-holder communities, and the final approval of management actions is the responsibility of the Minister of Environment (Minister of Sustainable Development prior to April 2004). For that reason, muskoxen fall under the mandate of the Nunavut Department of Environment.

Current quotas and population estimates are shown in Table 5.1 for each management zone in the Kitikmeot (status in 2005). The muskox populations in the Kitikmeot total approximately 50,000 animals allowing a total quota of 1965 tags, representing a harvest level of approximately 4%. For the management zones where at least two surveys were conducted, 8 showed an overall increase (MX06, MX08, MX09, MX10, MX11, MX14, MX19 and MX22) while 3 showed a recent decrease (MX12, MX16, and MX17). The three other zones (MX07, MX13, and MX15) were never surveyed or only once. Overall there is no significant difference between harvest rates (based on quotas but not on actual harvest data) in areas where muskoxen increased or declined ($t=-0.384$, $df=8$, $p=0.7$). Nevertheless, if other factors are the main driving force in muskox population dynamics, harvest is certainly cumulative. Muskox demography and population dynamics should be a research priority to ensure a sustainable management of muskoxen populations.

All the declining populations are located on the mainland and several factors could be responsible for these decline: weather/climate, food quality/availability, diseases, predation, human activities and harvest. Unfortunately, especially following the near extirpation of the species, we do not have a long enough experience to know if muskoxen tend to follow natural cycles similar to caribou. We lack a detailed understanding of the interactions between muskoxen, their forage and the effects of weather on plant growth and availability to muskoxen. We also lack an understanding of how carnivores limit muskox numbers. Another factor to consider is dispersal of muskoxen from an area to another. At least in some areas, local knowledge identified shift in distribution rather than actual decline in the population.

Although there is a whole theory to setting harvest levels(Caughley and Sinclair 1994, Milner-Gulland and Mace 1998), in practice we have taken a simpler more conservative approach. In the absence of understanding fully muskox ecology, a pragmatic approach has been applied while recognizing its limitations. The pragmatic approach has been to simply recommend harvesting a fixed proportion of the most recent population estimate (Gunn 1998).

The last update of the *Big Game Hunting Regulation* was R-118-98 (14 August, 1998) and should be the reference for quotas, seasons, and the delineation of management zones. However, since the creation of Nunavut in April 1999, new quotas have been established without changes to the *Wildlife Act* regulations. Currently a Nunavut Wildlife Act has been implemented and regulations are currently being updated.

Overall, communities have been requesting quota increases, mainly to develop or increase economic activities such as meat and qiviut industry or sport hunting. In general, the Government of Nunavut Department of Environment (GNDoE) has taken a conservative approach to these requests considering the near extirpation of muskoxen during the early 1900s. The conservative or precautionary approach includes using the lower confidence limit from the survey results as the population estimate, and rarely suggesting quotas that exceed 3% of that population estimate.

Currently, the GNDoE recommend harvest quotas for muskoxen in the Kivalliq at approximately 3% of the population estimate (based on the lower confidence interval for the population estimates) from surveys conducted in 1999 and 2000 (Campbell and Setterington 2001). The justification of the "3% rule" is oriented towards recovering and re-colonizing populations. This limit is meant to promote muskoxen range expansion to historic boundaries which would allow harvesting closer to some communities. In areas where muskoxen are now well established, this regime may be too conservative and could be relaxed to allow greater proportional harvests. However, it has to be stressed that muskoxen populations seem to respond to various environmental factors which are for most of them independent of human harvest. Populations can decline rapidly, independent the harvest level (e.g. due to predation, parasites/diseases, and/or weather). In such a situation, a harvest level set too high could exacerbate the decline and negatively influence the recovery. Harvest levels should be adjusted rapidly when one of several conditions is reported and management objectives should be reassessed with the relevant communities. Those conditions need to be discussed with the communities but could include a severe decline in muskox abundance or calf productivity or a severe weather event and outbreaks of disease.

In the Kitikmeot, harvest levels have become variable due to the lack of a general management strategy (there was a management plan drafted in the 1980s but it seems to have been forgotten by all co-management partners) and various changes in the quotas that were not necessarily supported by standardized surveys. Although quotas are allocated for any muskoxen harvest, the actual harvest data need to be organized and analyzed. Currently much harvest data are archived mainly as hard copies and might be lost if no action is taken. The monitoring of the harvest, partnered with demographic studies, is a basic requirement to manage harvesting practices and set harvest limits at a sustainable level. However, harvest monitoring is not systematic and often only available as hard copies of raw data. Because some quotas are not filled, it is difficult to assess what level of harvest may be sustainable or contribute to a decline of the muskoxen population. Research regarding harvest thresholds should be undertaken to promote a full use of the resource while maintaining a sustainable harvest.

Table 5.1: Most recent population estimates and quotas for Muskoxen Kitikmeot Management Zones. The last column represents the quota as a percentage of the lowest muskox population estimates.

	Last survey	Previous	Estimates	Quotas		%of lowest
MX07	1992	none	6720±790	Cambridge Bay	100	1.69
MX08-MX06	1995[a]	1980, 1979, 1976, 1975, 1974	5259±414	Baffin	20	0.66
				Taloyoak	12	
MX09	1995	1985	555±205	Taloyoak	20	5.71
MX10	1994	1993, 1988, 1983, 1980	3934±1225	Kugluktuk	100	3.69
MX11	1999	1993, 1988, 1983, 1980, 1979, 1976	18290±1100	Cambridge Bay	1300	7.56
MX12	1994	1987-88, 1983, 1980, 1979	974±336	Kugluktuk	20	3.13
MX13	?	?		Umingmaktok	20	?
MX14	1986	1979, 1976, 1975, 1970	2192±494	Umingmaktok	20	2.36
				Kingaut	20	
MX15	None	?		Umingmaktok	10	?
				Kingaut	10	
				Cambridge Bay	70	
MX16	1996	1988, 1982, 1979, 1976, 1966	4255±680	Gjoa Haven	80	2.52
				Kugaaruk	5	
				Taloyoak	5	
MX17	2000	1992, 1986, 1979, 1957	956±361	Gjoa Haven	45	9.24
				Kugaaruk	5	
				Taloyoak	5	
MX19	1991 (partial)	1986 (partial)	1400	Umingmaktok	20	4.29
				Kingaut	20	
				Kugluktuk	20	
MX22	2002 (Ground)	1986	147	Gjoa Haven	8	5.44
Total			Approx. 50000		1965	Approx. 4%

[a] A survey was conducted in April 2004. 1070 and 1530 muskoxen were observed on Prince of Wales and Somerset Island respectively. The muskox population estimates for these two islands are not available at this time but observations suggest an increase since 1995.

<u>Table 5.2:</u> Known history of Muskox management in the Kitikmeot (based on NWMB minutes and DSD files) from 1917 to 2005. In bold are the modification in the management regime in a given management zone management zone. X refers to a management zone boundary change. Please note that the management zones changed during the 1980s and the 1990s. I used the current zones in all the chronology for clarity.

Year	MX07	MX10	MX11	MX06	MX08	MX09	MX12	MX13	MX14	MX15	MX16	MX17	MX19	MX22	Rational / Remark
Late 1980s	Closed season from March to October														
1917	Ban on trade and harvest except when faced with starvation														Muskox populations at very low densities
1924	Total protection														Harvest level was felt too high and muskox population decreasing (+ illegal trade)
1976	**Creation**				**Creation**		**Creation**				**Creation**				
1977	?				?		?		**Creation**		?				
1980	28				10		14		5		29				Quotas or recommendations?
1983		8	5	12	3		18		5		11	7			
1984		13?	65	12	3		40		**10**		65	10			Arbitrary change
1986							40		10		80	10			
1987							40		30		80	10	**Creation (20)**		Establishment of the management zone F2-2 (MX19)
1988							**50**		40		80	10	20		Survey1987 (MX12)
1989-1991	Extension of the hunting season in the spring from March 31 to April 15. in all the Kitikmeot management units.														
1991				**S**			50		40		170	10	20		Survey 1991
1992	**100**						50		40		170	10	20		
1993	100						50		40	**20**	170	**30**	20		Survey 1992

1993	100		**1000**				50		40		170	30	20		Survey 1993
1994	100	100	1000				50		40		170	**40**	20		Arbitrary change
1995	100	100	1000			**5**	50		40		170	40	20		Observations/Survey
1995?	100	100	1000			5	50		40		170	**Extended to east**	20		Survey 1992
1995	100	100	1000	**20**		5	50		40		170	40	20		Survey 1995
1995	100	100	1000	20	**12**	5	50		40		170	40	20		Survey 1995
1996	100	100	1000	20	12	**10**	50		40		170	40	20		HTO request
1996	100	100	1000	20	12	10	50		40		170	**55**	20		Survey 1992 and zone expansion
1996	100	100	1000	20	12	10	50		40		170	55	30		Observations
1996	100	100	1000	20	12	10	50		40		170	55	30	**Creation (5)**	Observations
1996	100	100	1000	20	12	10	**20**		40		170	55	30	5	Survey 1994
1997?	100	100	1000	20	12	10	20		40		**90**	55	**60?**	5	Survey 1996
2000	100	100	1000	20	12	**20**	20	20	40		90	55	60	5	HTO request
2000	100	100	**1300**	20	12	20	20	20	40		90	55	60	5	Survey 1999
2002	100	100	1300	20	12	20	20	20	40		90	55	60	**8**	Ground survey 2002
Current	**100**	**100**	**1300**	**20**	**12**	**20**	**20**	**20**	**40**	**90**	**90**	**55**	**60**	**8**	

Table 5.3: Current community quotas in the Kitikmeot (some communities share one management zone or harvest in more than one):

	Kugaaruk	Taloyoak	Gjoa H	Cambridge	Umingmaktok	Kingaut	Kugluktuk
Tags	10	42	13	1470	70	50	140

Current management zones (Figure 4.2) reflect known muskoxen clusters that seemed to have had independent fluctuations. Because these management zones are not based on actual population data and because muskoxen populations have been re-colonizing their historical range, these areas have changed over the years. As muskoxen have been re-colonizing the mainland and some of the arctic islands, new management zones were created (Table 5.2).

The community with the largest quota is Cambridge Bay (1470 tags). For several years, the community has been trying to get a commercial harvest going in order to produce meat and qiviut. However, so far, this commercial harvest has encountered many problems and is not yet developed to its full extent.

6.0. MANAGEMENT RECOMMENDATIONS FOR REGULATIONS ENACTING THE NUNAVUT WILDLIFE ACT

These recommendations are adapted from a wildlife management recommendations report resulting from meetings and correspondences among the Government of Nunavut Wildlife Biologists and Technicians as well as interactions with co-management partners.

6.1. Populations

The recommended TAH for Nunavut's 19 musk ox populations (Fig 6.1, Table 6.1), are based on a demographic definition of "population". We define musk ox populations as spatial units within which birth and death rates are believed to contribute more to population dynamics than rates of immigration and emigration. In most cases, these demographic units are defined based on the female component of the population because musk oxen are a polygynous species. For a polygynous species as long as there are enough males to mate available females, the growth rate of females will determine the population growth rate.

Geographic boundaries of Nunavut musk ox populations (Figure 6.1) have been previously identified from assessment of IQ, survey results, movements of radio-collared animals, and known physiographic barriers to movements (e.g., glaciers, sea, river and lake ice conditions, topography and forage availability).

All mainland population boundaries are based on survey results and/or hunter reports and observations showing discontinuities in musk ox distribution (e.g., low to nil densities, and/or geographic barriers). Also considered in population boundary designations are mean home range values measured in straight line distances for mainland musk ox populations (Gunn and Fournier, 2000).

For Island populations of musk ox, range disjunction at the scale of all except the largest islands reflects what we know about musk ox movements and probability of dispersal. Limited information from marked musk oxen does not reveal inter-island movements except during environmentally forced dispersal (i.e. severe winters). In addition there are few observations of musk oxen crossing sea ice (Taylor 2005) which suggests musk ox ranges are disjunct between islands.

In cases where one or more musk ox populations are adjacent to each other (i.e. MX/05, MX/06, MX/07), there is typically some cross boundary movements by individuals with home ranges near the boundaries. However, in the High Arctic, the norm is range disjunction imposed by terrain, glaciers and mountains. It is unusual for musk oxen to cross these features. Indeed, there are only rare observations of bull musk oxen crossing glaciers (Taylor 2005). Instead, musk oxen demonstrate fidelity to relatively small discrete patches of suitable habitat; lowlands and slopes with sedges, grasses and willows typically characterize their range on arctic islands (Gunn and Adamczewski 2003).

6.2. Musk oxen seasonal movements

There is little scientific information on musk oxen seasonal movements. The main studies that followed musk oxen movements over several years are Tener (1965), Reynolds (1998), and Gunn and Fournier (2000). These movements seem quite variable from one year to the other, though a pattern of non-migratory behavior is apparent due to the relatively small home ranges exhibited (Gunn and Fournier, 2000). The main movements are between the early spring (calving) range from late April to the end of May (rarely the first week of June) and their late summer early fall range a time that includes the rut. This movement is believed to be directly related to forage accessibility through snow in early spring and forage quality and quantity later in the summer and early fall. Complicating these findings are density dependant factors likely responsible for the greater movements less commonly observed. Seasonal movements are believed to be influenced by animal density, forage availability/accessibility, and predation. Therefore, these movement patterns can vary substantially from one area to another if snow conditions, vegetation, musk ox densities, and predator species and densities differ.

The maximum straight distance observed for musk ox cows was 114 km in Alaska and 140 km in the West Kitikmeot. Mean straight line values however suggest much smaller home ranges. In Alaska (*In* Gunn and Fournier 2000), seasonal ranges were on average 20-30km apart. In the West Kitikmeot, Gunn and Fournier (2000) reported mean straight line values of 75 to 85 km between winter and summer collar locations. In almost all cases seasonal ranges overlapped.

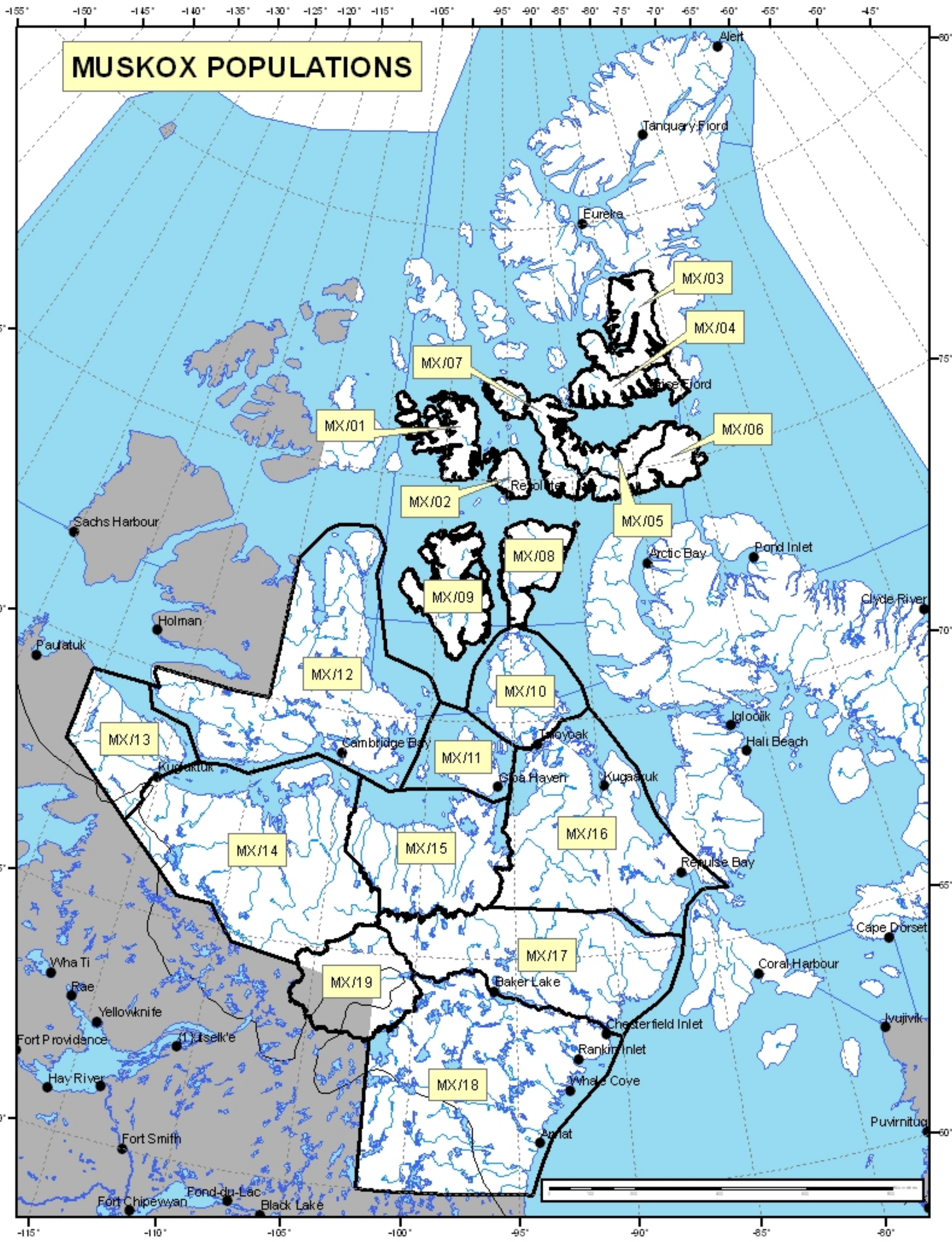


Figure 6.1. Musk ox populations in Nunavut.

Nevertheless, current studies suggest that seasonal movements are generally limited to less than 80 km on average and summer is usually the season with the longest movements and the most dispersion of musk ox breeding groups (Gunn and Fournier 2000). Moreover, seasonal ranges generally overlap. Therefore, the distribution of musk oxen, observed during surveys conducted during summer, is likely to represent the major part of the annual reproductive range with, on average, a 30 to 75 km buffer defining these areas. This means that musk ox clusters separated with a low (or nil) musk ox density area of a width ≥150km are unlikely to have regular demographic exchange, and thus can be considered as discrete populations in the current management context.

Some reports are contradictory regarding geographic barriers to musk ox populations but it seems that although they can, in general, musk oxen rarely swim (Tener 1965, Gunn and Adamczewski, 2003). Musk ox herds were found stranded on lake islands during the summer and did not swim to reach the mainland despite the lack of forage (*in* Gunn and Adamczewski 2003). Although, musk oxen have been observed crossing rivers on occasion (Mallory 1995), it is likely rare enough to suggest that large rivers could be considered a demographic barrier at the time scale we are managing musk oxen. During the winter when frozen rivers would allow movements across, musk oxen movements are limited to a relatively small area (Tener 1965, Gunn and Adamczewski, 2003). During breakup (Calving) and into the summer months (rut), when musk oxen movements are more extensive, large rivers and lakes/open ocean limit movements across these water bodies effectively reducing any demographic exchange .

6.3. Boundary Justifications in the Kitikmeot

MX/08

The Somerset Island Population of Musk ox, MX/08 is considered a separate population based on the sea and ice conditions during spring, summer and fall and sea ice during winter and their effects as a barrier to adjacent Island and mainland populations. The available literature supports the ability of these barriers to effectively restricting reproductive exchange with adjacent populations.

MX/09

The Prince of Whales Island Population of Musk ox, MX/09, is considered a separate population based on the sea and ice conditions during spring, summer and fall and sea ice during winter and their effects as a barrier to adjacent Island and mainland populations. The available literature supports the ability of these barriers to effectively restricting reproductive exchange with adjacent populations.

MX/10

Although musk oxen have likely re-colonized the Boothia Peninsula from Somerset Island, the Boothia Peninsula Population of Musk ox, MX/10, should be considered as a separate population considering the changing ice conditions and human activities on the

Northwest Passage that is likely increasing the geographic barrier between Somerset and Boothia.

MX/11

The King William Island population, MX 11, is considered a separate population based on the sea and sea ice barrier to the mainland effectively restricting reproductive exchange. The Gjoa Haven HTO is also in agreement with the separation of the islands musk ox from mainland animals.

MX/12

Arctic Island musk oxen differ genetically from mainland musk oxen (De Groot 2001) therefore we recommend to separate Victoria Island musk oxen from mainland musk oxen. We do not know if the musk oxen on Victoria Island constitute one or several populations. However, considering the high musk oxen densities on the island, there is at this point no conservation issue and therefore we recommend treating the whole island as one population.

MX/13

The Western Kitikmeot Population of Musk ox, MX/13, population dynamic is considerably different then that of MX14 which justifies the treatment of these two populations as separate populations. The stagnating low densities of musk oxen in MX/13 compared to the high densities on the east side of the Coppermine (MX/14) seem to indicate that there is little movement from MX14 to MX13. Moreover, a reason for the decline of the musk ox population in MX12 is likely the presence of a parasite (*Umingmakstrongylus pallikuukensis*). The absence of reports of this parasite by local hunters on the east side of the Coppermine (MX14) further indicates that movements from MX13 to MX14 are extremely limited or nil.

MX/14

The Central Mainland Population, MX/14, has its western boundary following the Coppermine River that according to IQ represents a strong geographic barrier year round due to the Rivers uncertain ice conditions and cliff like banks along is length. The MX/14 population is separated from the MX/15 population along the Perry River connecting through to McAlpine Lake through to its confluence with the Thelon Sanctuary. According to Dumond (in prep) in addition to the geographic barrier poised by this watershed, densities along the north and northwestern portions of this boundary are extremely low to nil suggesting a break in reproductive exchange thus justifying a separate population.

MX/15

The Queen Maud Gulf Population of musk ox, MX/15 is separated from the MX/14 population along the Perry River connecting through to McAlpine Lake through to its confluence with the Thelon Sanctuary. According to Dumond (in prep) in addition to the geographic barrier poised by this watershed densities along the north and northwestern portions of this boundary are extremely low to nil suggesting a break in reproductive exchange thus justifying a separate population. The MX/15 western boundary with the MX/16 population is drawn based on moderate densities to the west of the boundary and very low to nil densities to the east suggesting restricted movements of animals between these populations.

MX/16

The Eastern Mainland Population, MX/16, shares its southern boundary with MX/17 running west through Wager where survey observations recorded extremely low to nil densities of musk ox along its length up to its confluence with the Back River (Campbell and Setterington, 2003). MX/16s northern boundary is drawn just north of Taloyoak separating zero densities to the south from low to moderate densities north of the boundary (Campbell and Setterington 2003, Dumond in prep). The MX/16 population has not re-colonized historic range last occupied in the early 1920's. It is currently considered an extirpated population with a management goal for the re-establishment of the population to restore the integrity of the ecosystem in the eastern mainland. Within this population extremely low densities of musk oxen exist mainly along its south western and northern most boundaries (Campbell and Setterington, 2003, Dumond 2006).

MX/19

Musk ox management zone 15 encompasses the Thelon Game Sanctuary. The population is bordered to the southeast and east by the Dubawnt River forming a geographic barrier to musk ox movements during the calving and rutting periods on most years. The northern boundary of this population showed zero densities between it and the MX/14 population. The available information suggests that reproductive flow outside of the sanctuary boundary is extremely low thus supporting its designation as a population.

6.4. Total Allowable Harvest

The total allowable harvest is essentially the maximum level of a particular harvest regime that can be sustained. How the harvest is taken can affect its impact on the population. For that reason, the TAH recommendations made herein depend on (assume) simultaneous acceptance of the suite of non-quota limitations (NQL's) that comprise the musk ox harvest management regulations. Any modification of the NQLs recommended herein would require a re-assessment (i.e., reduction) of the TAH levels to ensure the sustainability of the harvest for all populations.

Years of survey data and the monitoring of population trends of most musk ox populations in Nunavut has provided valuable information regarding the setting of harvesting rates now termed TAH. This long term data has shown that musk ox harvest rates of 3% fostered slow growth, 5% stability and 7% slow decline when factored over years of variable environmental conditions. These rates of harvest reflect empirical data collected by Tener (1965) over a number of years. Tener found survival rates for calves to vary between years, however, values of between 40% and 80% survival were observed suggesting that between 4% and 8% of the population in any one year was made up of yearlings. Factoring in adult survival through predation, disease and natural causes, the more common 24 month breeding cycle (36 months during times of environmental stress) of breeding cows, the values used to set TAHs above represent a medium risk to the long term sustainability of the harvest in most populations especially when applying the 5% harvesting levels to mean population estimates. Whether these values were drawn from the lower confidence interval of an estimate (generally 95% CI) or the mean estimate, has been effectively made by wildlife managers through the assessment of range quality as well as the monitoring of localized trends and assessment of adult survival between surveys. This being said managers must also consider that the persistence of populations may depend more on their rate of change than their absolute size (Caughley and Gunn 1996) and that harvesting rates may be specifically related to the trend between the two most recent population estimates and management objectives when those data exist.

Most contemporary musk ox populations in Nunavut are considered growing and/or stable compared to pre-1920 population levels, although repatriation of their former (pre-commercial exploitation) densities and distributions have yet to be achieved for all but a very few populations. The instance of dramatically growing populations are likely the result of the calculated TAH not being fully harvested and/or too long an interval between population estimates where interim growth estimates were not available to guide the estimate of TAH. Recommended levels of TAH and justification for levels of TAH are summarized in Table 3.1.

6.5. Sex-Selectivity of Harvest

No sex selective harvest is currently recommended for any of Nunavut's 19 musk ox populations.

6.6. Seasons of Harvest

During summer, musk ox form smaller groups led, usually, by a single bull (i.e., a male and harem of females with calves.) (Banfield 1974, Tener 1965). We believe there is a risk that the loss of bull at this time may predispose females with calves to unknown, but likely higher levels of predation, given that bulls are thought to lead and coordinate harem defense against predators (Urquhart 1982). Further, bulls are believed to play an important role in leading females and calves to adequate forage during summer. Summer and early fall is critical for musk ox nutrition (Tedesco et al. 1993): There is evidence that the likelihood of pregnancy and successful parturition is related to fat reserves, and most fat reserves are accumulated during the summer and early fall (Adamczewski et al. 1997). During winter, the harem social structure dissolves and musk ox form larger, multi-male and multi-female congregations (Banfield 1974), at which time the loss of some males from the group is not thought to have an large impact on predator defense or foraging behavior.

The DoE Wildlife Research group in consultation with the available literature and other northern ungulate biologists believe implementing a harvest season to protect against the disruption of musk ox groups during summer is a valid conservation strategy that allows the maximization of harvesting opportunities while maintaining healthy musk ox populations and, to this end, we recommend a harvest season from 01 October–15 April for all Nunavut populations with the exception of the Victoria Island Population (MX/12) due to an inability of harvesters to fulfill the TAH allowance for this population.

6.7. Mandatory reporting and Sampling

We recommend that it be mandatory that harvesters report the harvesting of a musk ox through the filling out of hunter kill reports and the use of tags. Information collected on the reports should include date, location (Latitude and Longitude), hunters name, tag number, sex, approximate age, size of herd harvested from, and should also include a sample of skin with hair attached (equal or equivalent to a 2 by 2 inch square) from the harvested musk ox. The harvest reporting is essential to monitor the harvest and to be able to modify populations TAH when harvest figures are compared to survey findings. A skin sample is needed to increase our understanding of musk ox populations through genetic analysis as well as to monitor the sex ratio of the harvest in the instance of a reported decline and/or increase in a population’s growth rate. Harvesters should return any found radio telemetry transmitter or satellite collar to a conservation officer.

Table 6.1 Recommended delineations of Kitikmeot musk ox populations and associated TAH recommendation.

Region	Population	TAH	Notes
Kitikmeot	MX/08	117	***Somerset Island Population***. Objective is to encourage sustainable harvesting of musk oxen and foster the recovery of caribou. The average annual rate of increase (6%) is recommended as the TAH (Gunn and Jenkins, in prep) (Dumond 2006).
	MX/09	20	***Prince of Whales Island Population***. Since 1995 musk ox abundance has declined. The recommended TAH is a balance between allowing musk oxen to decline further (possibly foster caribou recovery) without accelerating the decline to the point of jeopardizing sustainable harvesting (Dumond 2006) .
	MX/10	20	***Boothia Peninsula Population***. Current recommendation based on the previous population estimate. The TAH will be reviewed to the light of the survey conducted in June 2006. Report should be available by March 2007 (Dumond 2006).
	MX/11	12	***King William Island Population***. Population estimate (adult musk oxen): 317 (extrapolation from ground survey 2002), current population status: increasing (HTO), recommended rate of harvest of 4% (TAH of 12) (Dumond 2006).
	MX/12	None	***Victoria Island Population***. The current harvest is far less than even conservative estimates of the TAH, so no TAH is required (Dumond 2006).
	MX/13	20	***Western Coppermine Population***. The population declined by over 50% and was estimated around 650 individuals in 1994. Since then local knowledge and reconnaissance flights or ground travels are consistent that the population hasn't recovered and is still at low density. The recommended harvest rate represents approximately 3% of the population (Dumond 2006).
	MX/14	240	***Central Mainland Population***. TAH of 240 based on 4% of population estimate (Dumond 2006).
	MX/15	66	***Queen Maud Gulf Population***. Population estimate (adult musk oxen): 2200 (projection from past aerial survey 1996 and 2000), current population status: decreasing (HTO, aerial surveys), recommended rate of harvest: 3% (TAH of 66) (Dumond 2006).
	MX/16	10	***Eastern Mainland Population***. Most recent estimate (adult musk oxen): 165 (aerial survey 2000), current population status: re-colonizing (HTO), recommended rate of harvest: 4% (but TAH of 10 to include un-surveyed areas until further information is gathered (Dumond 2006, Campbell & Setterington, 2003).
	MX/19	0	***Thelon Game Sanctuary population*** (No harvest allowed)

7.0. DISCUSSION AND RECOMMENDATIONS

(**Note:** The management zones used in this section are the one still in place in the Kitikmeot as per December 2006)

In general, muskoxen abundance has increased in the Kitikmeot during the past 30 years (Fournier and Gunn 1998). However, on the mainland, after an increase for several years, it seems that abundance is now declining and calf production is low. In MX12 and MX16, populations decreased substantially during the early 1990's. There is no current information for MX13 and MX15. Also, according to the most recent survey (2000), muskox abundance in MX17 has declined. Local knowledge confirms that the Queen Maud Gulf and Adelaide Peninsula muskox populations have been declining. The decline of muskoxen in some areas may be due to actual declines in the populations or shift in distribution. Traditional knowledge also mentions muskox movements between the mainland and Arctic Islands and Boothia Peninsula in the East Kitikmeot.

Based on the last survey in each muskoxen management zone, we can estimate that the muskoxen population in the Kitikmeot is in the order of 50,000 animals (including 25-30,000 on the Nunavut part of Victoria Island). However, as important if not more so is to determine the rates of increase or decrease – those determine population persistence not the size of the population. Further analysis are being conducted to add this aspect in this report.
The total quota is currently 465 on the Kitikmeot mainland and 1500 on Victoria Island representing approximately 3.5% and 5.8% of the lowest population estimates respectively. It represents an average harvest of 2.6% and 4.7% of the highest estimates on the mainland and on Victoria Island respectively (meaning that <u>at least</u> 2.6 to 4.7% of the muskoxen population is harvested each year -when quota is fulfilled-).

In general, there is variation in the level of harvest (variation from 0.7 to 9.2%) among the different management zones. To justify such a variation in the setting of quotas, there should be clear management objectives linked with each rate of harvest. Without clear management objectives, quotas are arbitrary and can be challenged at any time.

As demographic information is scarce for eastern arctic mainland muskoxen populations it is difficult to set quotas without recruitment data. The best information we currently have on recruitment exists as the population trends and the proportion of calves to adults observed on transect over the many years of line transect survey work.

In the east Kitikmeot and central Kivalliq, several examples support that, with a percentage of July calves in the population $\geq$ 15%, a harvest rate of 3% is sustainable and allow for a slow population increase (See Campbell and Setterington 2001).

Muskoxen are sensitive to unregulated over-harvest as discovered during the nineteenth and early twentieth century (Gunn 1998, 2001, Gunn et al. 1984, Barr 1991). However, subsequently as muskoxen recolonized their former ranges, the rate of increase was perceived as close to the maximum rate of increase (Jingfors and Klein 1982) and harvest levels could certainly be higher than 3% of the lowest estimate.

A Nunavut muskoxen management plan should be a priority to orient research and provide the necessary background and rational for management decisions and actions. The management plan should recognize the regional specificity in terms of environmental conditions, muskoxen behavior and ecology, and harvest practices.

Hunting seasons should be adapted for local conditions to accommodate for both muskox demographics as well as hunter's access to hunting grounds. It's during the summer and rut that females are increasing their fat reserves (White et al 1989, Adamczewski 1995). Reproduction success is positively related to the amount of fat breeding female is able to accumulate (Adamczewski *et al.* 1998). Quota and non-quota limitations are linked with each other and if harvest is allowed during the sensitive periods of a species biological cycle, then quotas should be more conservatives.

Also, for communities organizing musk ox sport hunts, there should be a clear understanding that removing the dominant bulls from the population may have consequences and that to sustain guided hunting, they should avoid the critical period of grouping (July) and rutting (August). During summer, musk ox form smaller groups led, usually, by a single bull male (i.e., a male and harem of females with calves; Banfield 1974). Muskox bulls' movements seem to be the main factor for colonizing new area and for re-colonizing historic range (Smith 1989). It seems that migratory or exploratory movements by bulls could be driven by the competition for harems (where bulls that cannot find a harem would colonize new area). This means that bulls' survival may play a critical role in the rate of re-colonization.

Currently, seasons vary among management zones and type of users. There is no clear background for this discrepancy and they are difficult to defend in a Territory wide muskox management strategy. Originally, in the Kitikmeot, the sport hunting season was 1 October to 31 March with the rational of minimize hunting pressure during the rut while allowing hunting during snowmachine season but not extending later to avoid the risk of muskox calves being abandoned during stampedes of hunted herds (Gunn 1984). At one time, for guided hunts, hunters had to approach the muskoxen on foot for 1 km to limiting disturbance to the herd. To my knowledge, this practice is not implemented anymore.

There is more and more pressure to develop commercial muskox harvest (meat, leather, qiviuq, sport hunts). This development will bring a new dimension (economic) to the management of muskox populations. Hunting that has an economic momentum (Caughley and Gunn 1995) can cause increased pressure on muskox population increases, the risk of decline may increase. The loss of habitat and effects of disturbance may also become an issue as industrial development increase in the territory.

Also, global climate changes are bringing new diseases northward and may pose a threat to arctic species including muskox.

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