REVIEW OF MUSKOX POPULATIONS STATUS IN THE KITIKMEOT REGION OF NUNAVUT

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Photo: Mathieu Dumond

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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, muskox populations have increased on the Arctic Island, and, after a sharp increase, 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.

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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). A summary of muskox populations throughout Nunavut is found in Fournier and Gunn (1998). This document was prepared using available reports, files, and papers.

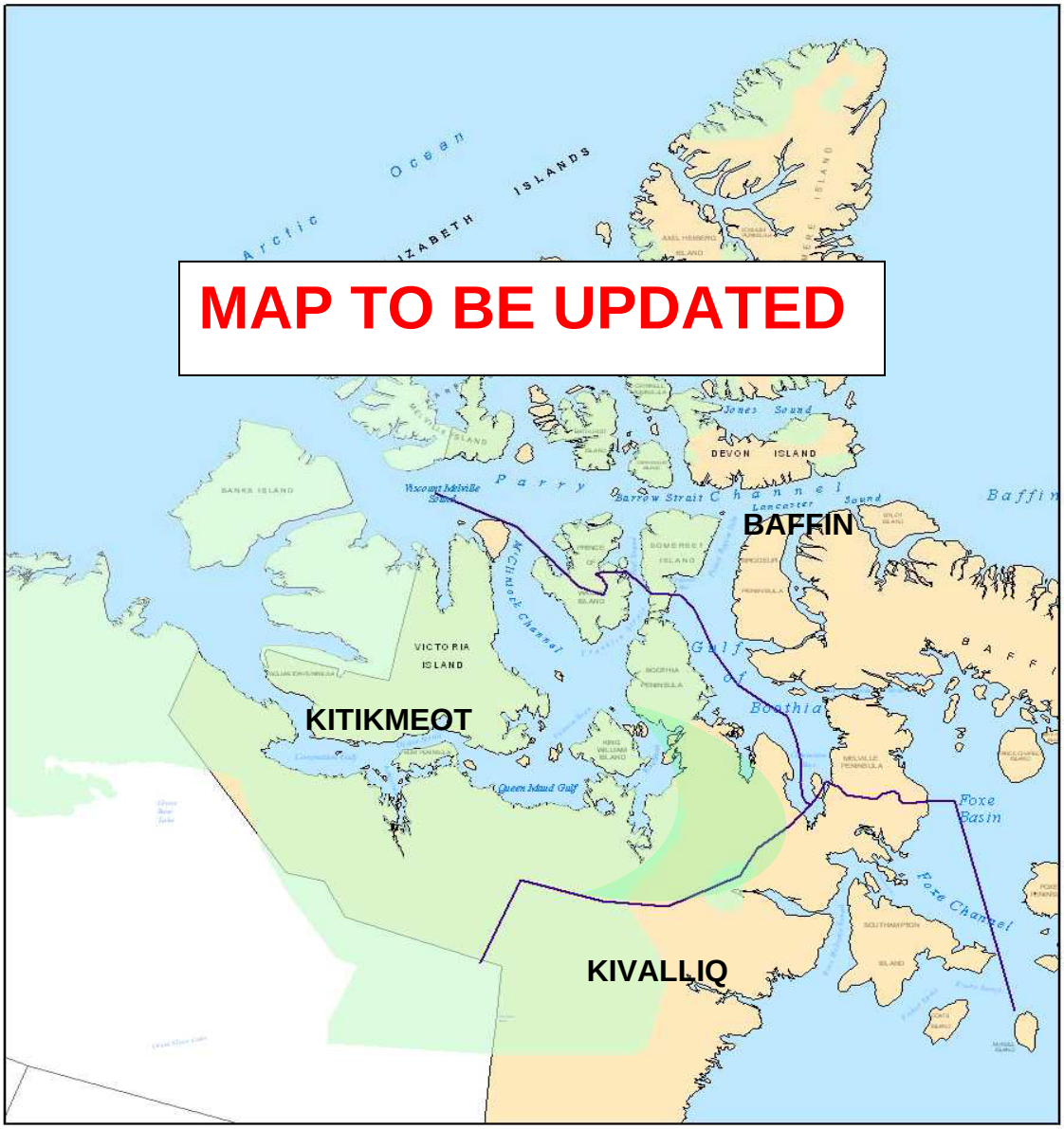


Figure 1.1: Known muskox distribution in Nunavut as of 1997 (Source: Fournier and Gunn 1998) and updated where new information was available.

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, local inhabitants and foreign expeditions, and a key component of the ecosystem (vegetation dynamics, 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 sub-species *Ovibos moschatus moschatus* on the mainland and *Ovibos moschatus wardi* in the Arctic Islands (except Baffin Island). Genetic findings confirm differences between Arctic Islands and Mainland muskoxen (Van Coeverden de Groot 2001). However, Van Coeverden de Groot (2001), through the comparison of 14 microsatellites loci, determined that 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 populations 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 muskoxen population in Nunavut and Northwest Territories was estimated at 9,896 (1,500 on the mainland and 8,396 on the Arctic Archipelago) (Urquhart 1980). Banfield (1977) reported the Muskoxen population in Canada to be approximately 10,000 with a reported 1,500 on the mainland (approx. 33% within the Thelon Game Sanctuary) and 8,500 on the Arctic Archipelago. Thirteen years later (1980), the NWT muskoxen population was estimated to be 45,055 individuals (Urquhart 1980). The muskoxen population in Canada was estimated to be 108,600 animals in 1991 (Ferguson and Gauthier 1992).
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.

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 would be Bathurst Inlet cluster, Rae-Richardson cluster, Victoria Island cluster, Queen Maud Gulf cluster and Prince of Wales - Somerset Island cluster. By the end of the 1980s/ early 1990s, these clusters were estimated to be 3420, 1800, 30650, 7600, and 1130 muskoxen respectively (Ferguson and Gauthier 1992). These “populations” totaled approximately 45 000 muskoxen. However, some of the 30 650 muskoxen on Victoria Island are not distributed in Nunavut but are found in the NWT. All these populations were defined as increasing, except for Prince of Wales - Somerset Island population that was believed to be stable.

In the Kitikmeot, all island muskox populations have increased in size. On the mainland however, after reaching a high, most of the muskox populations are experiencing a decline. West of the Coppermine, the decline and lacke of apparent recovery is believed to be associated to the presence of a parasite: *Umingmakstrongylus pallikuukensis* (Gunn and Wobeser 1993, Hoberg et al. 1995, **REFERENCE IMPLICATIONS**). In other areas, the causes of decline are unknown and explanations are mainly speculative. The various clumps of muskoxen distribution seem to go through periodic fluctuations from low to high abundance. A common pattern seems to be a sharp increase of the muskox population followed by a drastic decline and a slow recovery. This type of dynamic 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 populations, in part due to an extensive fur trade.
In 1969, quotas were allocated for some of the muskox populations or clusters. However, most of the quotas in the Kitikmeot region were first established in 1976. See Urquhart (1980) for details. 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

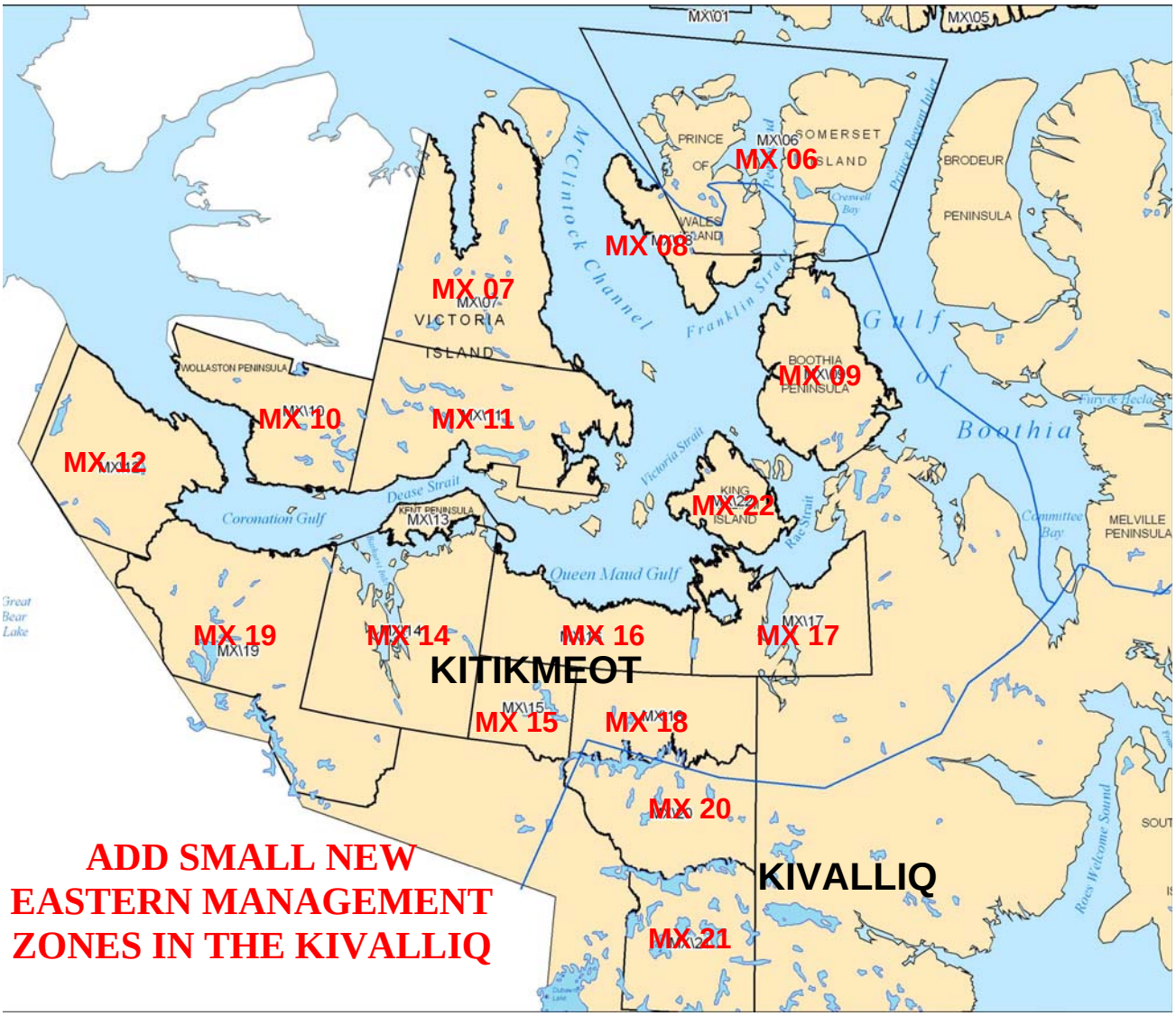
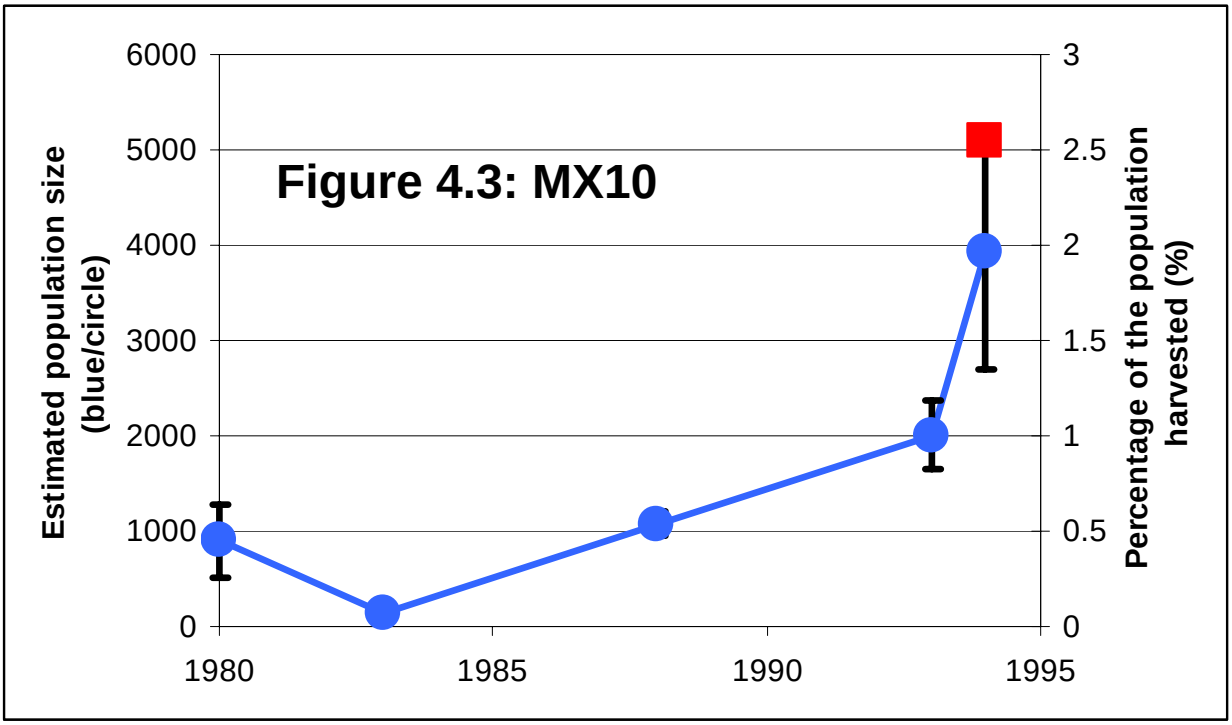
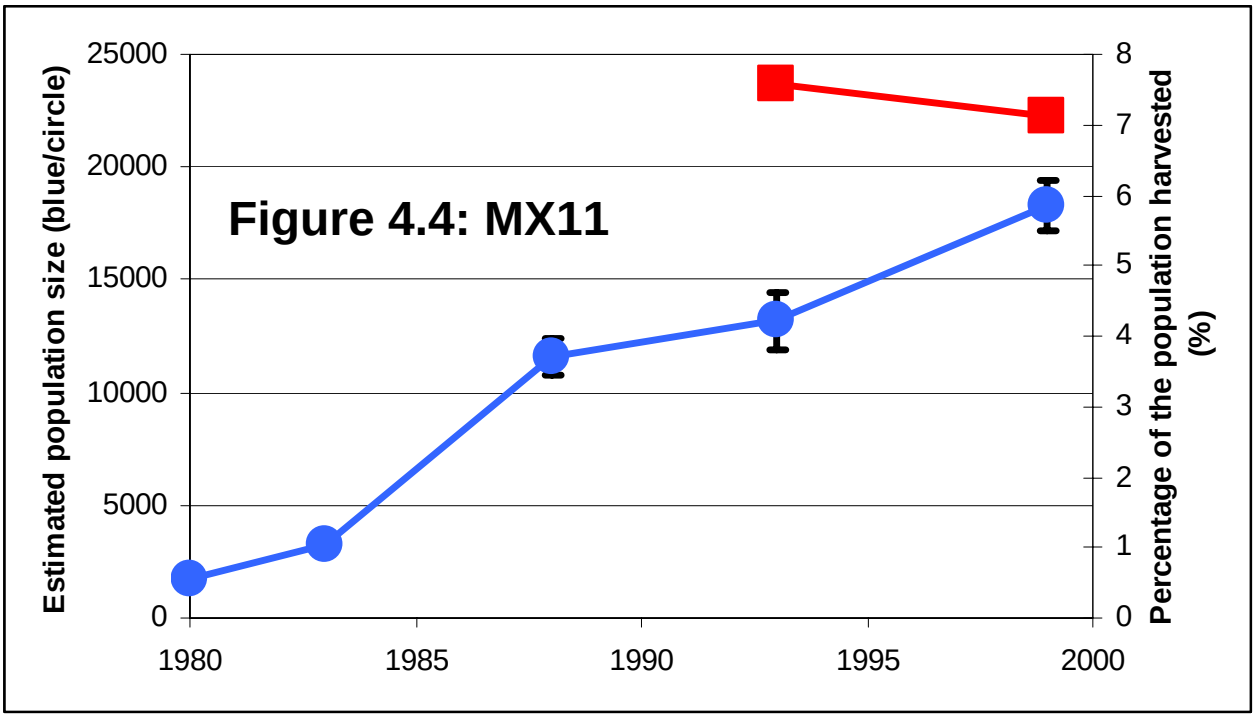


Figure 4.2: Muskox Management Zones in the Kitikmeot and Kivalliq regions as of May 2006.

Victoria Island was allocated a quota in 1976. The population was described as increasing. This quota was shared by Holman and Cambridge Bay (8males 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.

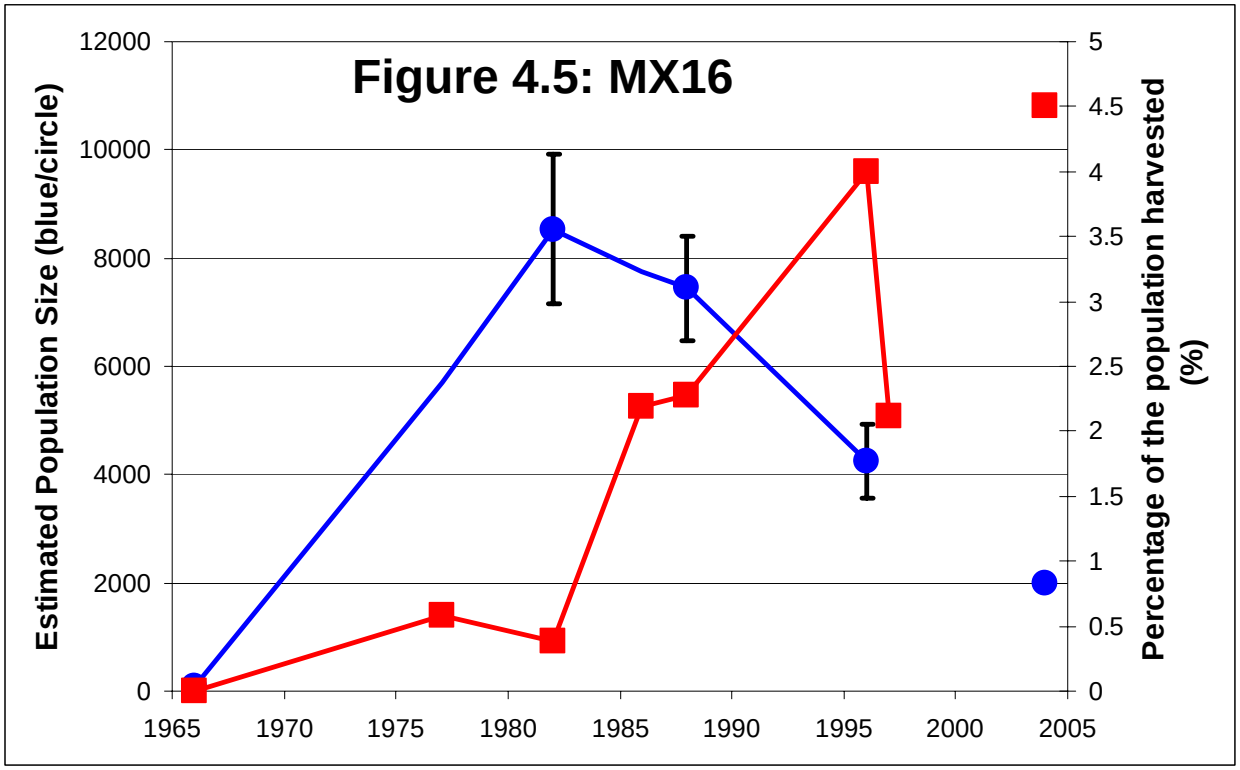


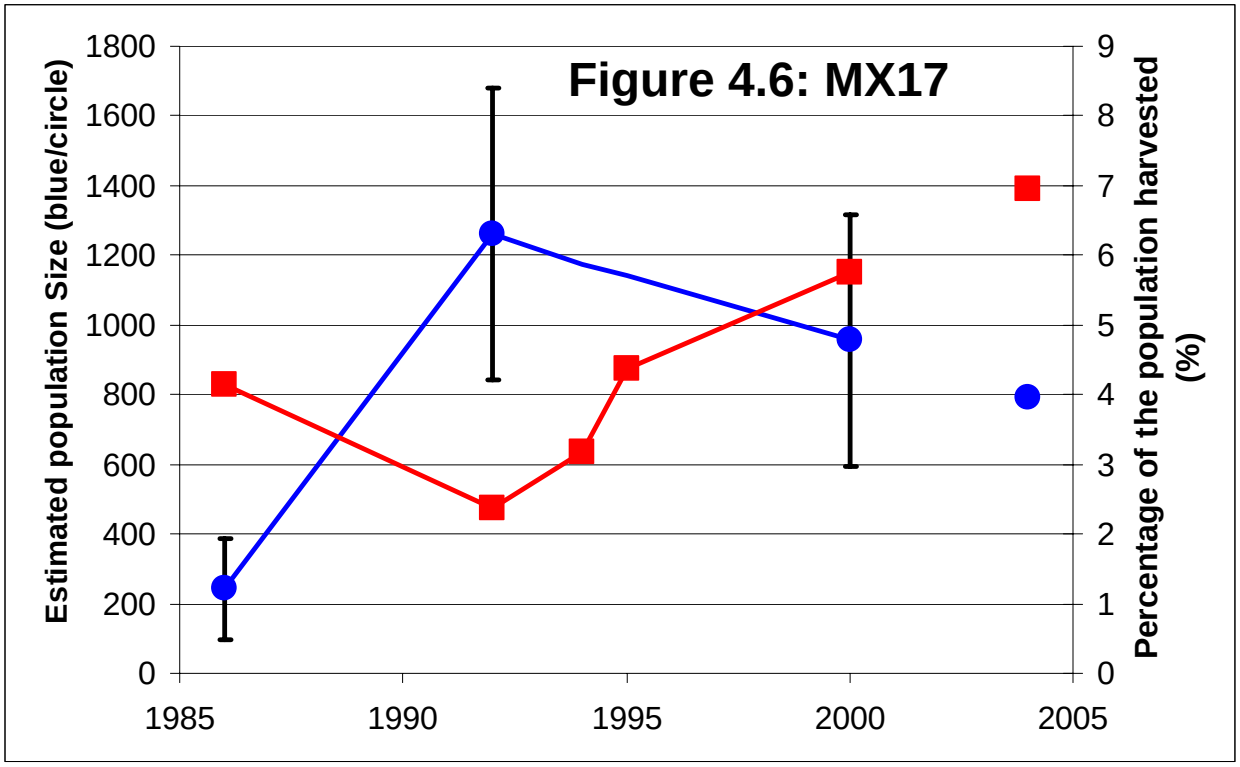


Prince of Wales Island (PWI) was allocated a quota in 1976. The trend was unknown. This quota was shared by Resolute and Taloyoak (4males and 3 females, and 2males and 1 female respectively). The current management zone MX06 is including Somerset Island and the eastern portion of PWI, and MX08 is covering the western portion of PWI

(Figure 4.1.). The changes in the quotas for these two islands are not clear in the 1980s'. In 1995, MX06 was assigned a quota of 20 tags and MX06 twelve tags. A ground-aerial survey was conducted in April 2004 (Ferguson 2005), but no new quota recommendation has been provided yet.

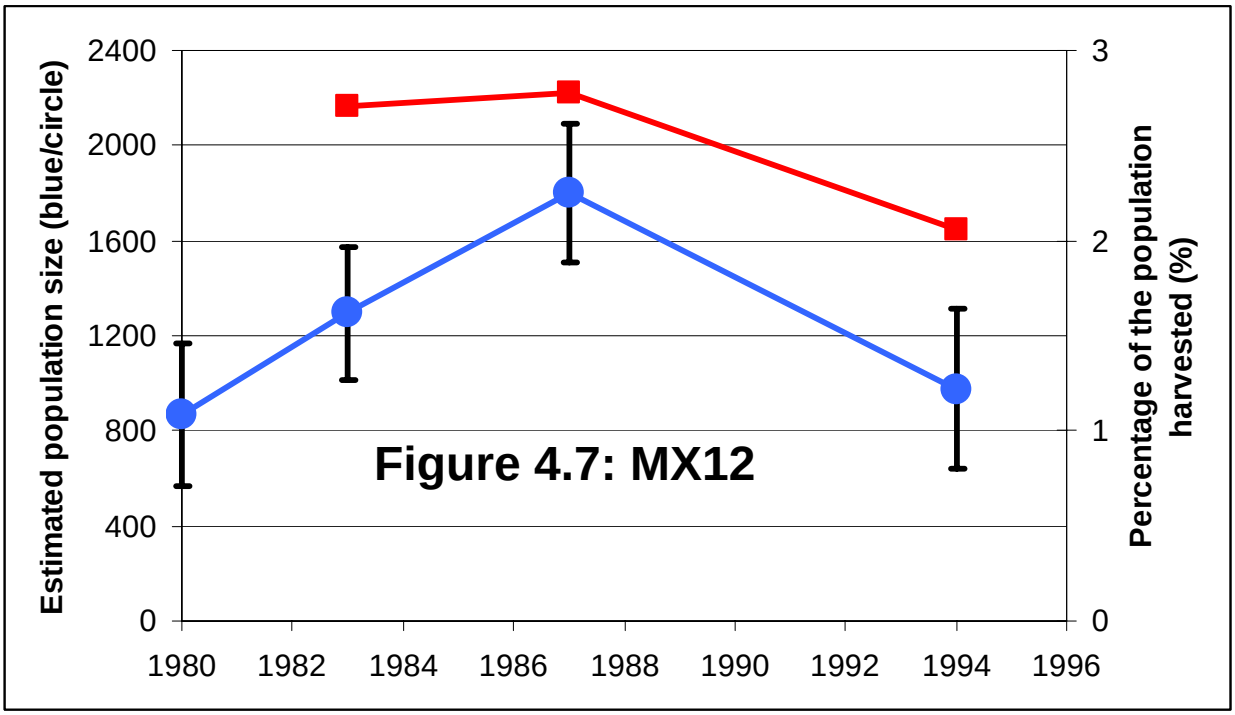
The Queen Maud Gulf Bird Sanctuary was established in 1961. Queen Maud Gulf area was allocated a quota in 1976. The population was described as increasing. This quota was shared by Cambridge Bay, Perry River & Ellice River, Baker Lake, and Gjoa Haven (5males and 3 females, 5males and 3 females, 2males 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.





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 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 3females 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 (Nishi et al. ????), the quota was reduced to 20 and has remained 20 since then.



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, but 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 count

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 lack information on potential natural cycles that could be density dependent. Another factor to consider is movements 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.

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 a

steep decline is reported and management objectives should be reassessed with the relevant communities.

In the Kitikmeot, harvest levels are variable due to the lack of a general management strategy and various changes in the quotas that were not supported by surveys. Although quotas are allocated for any muskoxen harvest, the harvest data need to be organized and analyzed. Currently much 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	?	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	?	?		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 Whales 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.

Table 5.2: 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 other than Native people														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. Not sure that it was applied to all management zones at that time.														
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	**Extension of the area eastward**	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 Haven	Cambridge Bay	Umingmaktok	Kingaut	Kugluktuk
Tags	10	42	133	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 problem and is not yet developed to its full extend.

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

We currently recognize 12 populations/clusters of musk ox that reside wholly or partially in Nunavut, 9 of which being totally or partially in the Kitikmeot (Figure 6.1.1, Table 6.2.1). Geographic boundaries of Kitikmeot musk ox populations (Figure 6.1) have been previously evaluated from assessment of IQ, survey results, movements of radio-collared animals, and known geographic barriers (e.g., glaciers) to musk ox movements. A genetic study is also on-going to refine population delineation.

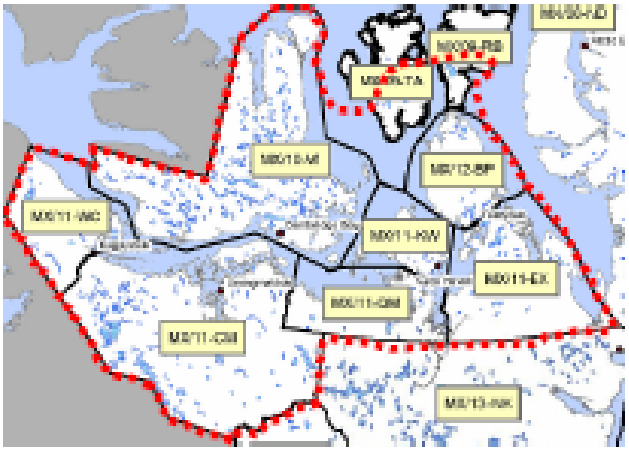


Figure 6.1.1: Proposed muskox management boundaries in the Kitikmeot.

6.2. Total Allowable Harvest

Recommended levels of TAH, recommended quotas within populations, and justification for levels of TAH and quotas are summarized in Table 6.2.1

6.3. Sex-Selectivity of Harvest

We recommend that for small populations of musk ox, females be conserved in order to mitigate the impact of harvesting on populations and encourage populations to attain and retain numbers. Nunavut's smallest musk ox populations occur in the north. In the Kitikmeot, implementing sex-selectivity in the harvest does not appear to be necessary at this point.

6.4. Seasons of Harvest

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). We believe there is a risk that the loss of bull males at this time may predispose females with calves to unknown, but likely higher levels of predation, given that bull males are thought to lead and coordinate harem defense against predators (Urquhart 1982). Further, bull males are believed to play an important role in leading females and calves to adequate forage during summer. Summer 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, Adamczewski et al 1998). During winter, the harem social structure dissolves and musk ox form larger, multi-male and multi-female congregations (Banfield 1977), at which time the loss of some males from the group is not thought to have an impact on predator defense or foraging behavior.
We believe implementing a harvest season to protect against disruption of musk ox groups during summer is a valid conservation strategy, and, to this end, we recommend a harvest season from 01 October–15 April for southern musk ox populations inhabiting central mainland Kitikmeot (proposed MX/11), the Boothia Peninsula (proposed MX/12), and mainland Kivalliq (proposed MX/13). Here, management is directed at increasing population growth rates and conserving expanding populations. An open season is recommended for Victoria Island (proposed MX/10), where the musk ox population is large and increasing under the current harvesting regimen. An open season is also recommended for all northern musk ox populations, where harvesters do not usually have access to musk ox herds during summer.

Table 6.2.1: Recommended levels of TAH, quotas, and basis of recommendations for managing Nunavut musk ox populations.

Region	TAH	TAH Code	Area Code	Quota	Notes
Baffin	5	MX/01	BI	5	Based on 3% of mean abundance estimate determined in 2001 (only 3% of mean because of marginal population growth since 1997). TAH allows for population growth.
	0	MX/02	CI	0	Subject to revision pending data analysis. In all likelihood the most appropriate TAH is 3% of mean abundance estimate.
	70	MX/03	SF	70	Likely one population since fiords does not appear to be barriers to movements. TAH based on 5% of total abundance estimate of 70. Recommend allowing carry forward of maximum of TAH due to long history of unused tags and evidence suggesting an increasing population.
	27	MX/05	GF	27	TAH based on 5% of mean abundance estimate and thought to be sustainable.
	14	MX/06	ND	14	TAH based on 5% of minimum count of musk ox presented in survey data.
	4	MX/07	SD	4	Musk ox occur only periodically along the coast; TAH based on 5% of minimum count of musk ox presented in survey data.
	0	MX/08	WD	0	TAH level set due to very low abundance; however, a small TAH may be recommended after survey calculations are complete.
Kitikmeot	32	MX/09	RB	20	Subject to revision; rationale for new TAH will be based on rates of population growth and the objective of Resolute Bay to reduce the population. Quota will likely increase. Recommend carry forward of unused tag for MX/09-RB.
			TA	12	
	No TAH	MX/10	VI	No TAH	The current total harvest is far less than even conservative estimates of the TAH, so no TAH is required.
	358	MX/11	CM	240	MX11-CM, TAH of 240 based on 4% of population estimate. MX11-QM, 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). MX11-KW, 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). MX11-EX, 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 unsurveyed areas until further information is gathered, e.g., through ground survey planned by Kugaaruk HTA). The allocation of tags among the different communities in MX11 is the responsibility of the KHTA.
			QM	66	
			KW	12	
			EX	10	
	20	MX/12	BP	20	
Kivalliq	101	MX/13	NK	41	TAH based on survey results, approximately 3% of the lower confidence interval of survey means. TAH level set to promote population growth. Division between the North Kivalliq (NK) and South Kivalliq (SK) based on muskox movements (being a non-migratory species) and a geographic separation in excess of known movements between NK and SK as identified in the 1999 muskox population survey.
			SK	60	
			TH	0	Thelon Game Sanctuary (no harvest allowed).

6.5. Additional Concerns or Recommendations

We recommend that it be mandatory that harvesters provide a sample of hair and tissue from harvested musk ox and evidence of sex if the total allowable harvest is sex specific. Harvesters should return any found radio telemetry transmitter or satellite collar to a conservation officer. Harvest information (date, location, sex and age class of the animal, number of animals in the herd, and presence of calves) should be systematically recorded for all musk ox kills.

7.0. DISCUSSION AND RECOMMENDATIONS:

In general, muskoxen populations have 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 population densities are now on the decline. 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 population 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).
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 at least 2.6 to 4.7% of the muskoxen population is harvested each year -when quota is fulfilled-).

In general, there is quite a discrepancy in the level of harvest (variation from 0.7 to 9.2%) among the different management zones. To justify such a discrepancy 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 detailed demographic information is not available 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 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 ≥ 15%, a harvest rate of 3% is sustainable and allow for a slow population increase (See Campbell and Setterington 2001).

Muskoxen populations are sensitive to over-harvest as discovered during the nineteenth and early twentieth century (Gunn et al. 1984, Barr 1991). However, some populations did or are increasing dramatically and harvest levels in these senario 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 to management decisions and actions. The management plan should recognize the regional specificity in terms of environmental conditions, muskoxen behavior and ecology, and harvest practices. Population delineation will be a necessary step to implement meaningful management zones.

Hunting seasons should be adapted for local conditions in order to accommodate for both musk ox 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 in order to sustain this activity, 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). The loss of bull males at this time may predispose females with calves to unknown, but likely higher levels of predation, given that bull males are thought to lead and coordinate harem defense against predators (Urquhart 1982). Further, bull males are believed to play an important role in leading females and calves to adequate forage during summer. Summer is critical for musk ox nutrition (Tedesco et al. 1993) and nutrition in breeding females is an important factor for successful pregnancy and parturition (Adamczewski et al. 1997, Adamczewski et al 1998). During winter, the harem social structure dissolves and musk ox form larger, multi-male and multi-female congregations (Banfield 1977), at which time the loss of some males from the group is not thought to have an impact on predator defense or foraging behavior. Moreover, 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 (Gunn 1984).

There is more and more pressure to develop commercial muskox harvest (meat, leather, qiviuq, sport hunts). This development will bring a new dimension to the management of muskox populations. As the 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 development increase in the territory. However the reduction of muskox population densities may also limit the impact of epizootics and overgrazing in some areas. Global climate changes are bringing new diseases northward and may pose a threat to arctic species including muskox.

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