3.0 TAH of Big Game Ungulates

3.1 Musk ox (*Ovibos moschatus*)

3.1.1 Populations

The recommended TAH for Nunavut's 19 musk ox populations (Fig 3.1, Table 3.1), 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 3.1) 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).

A dominating influence on biogeography is climate and arctic climate is strongly regionalized (Maxwell 1981). Western Devon (MX/07) is in a separate region (I, Northwestern Region) from north and south Devon (MX/05 and MX/06). As well, the two management areas on Ellesmere (MX/04 and MX/03) largely correspond to the two climate regions IV and V. In the absence of information to the contrary, it is prudent and reasonable to accept the range disjunction and biogeographic areas as affecting musk ox population structuring. Additional support for the use of climate regions comes from Inuit hunters. Their knowledge indicates that musk ox numbers fluctuate less on Ellesmere and Devon islands than on Prince of Wales, Somerset and Bathurst Islands (Taylor 2005). Ellesmere and Devon Islands are largely in climate regions that are colder and drier and less subject to incursions of maritime air masses (Maxwell 1981) which can be associated with rain in winter and heavier snowfall. Climate seems likely to affect demographic productivity, which is another strong reason to identify TAH by climatic region.

3.1.2 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.

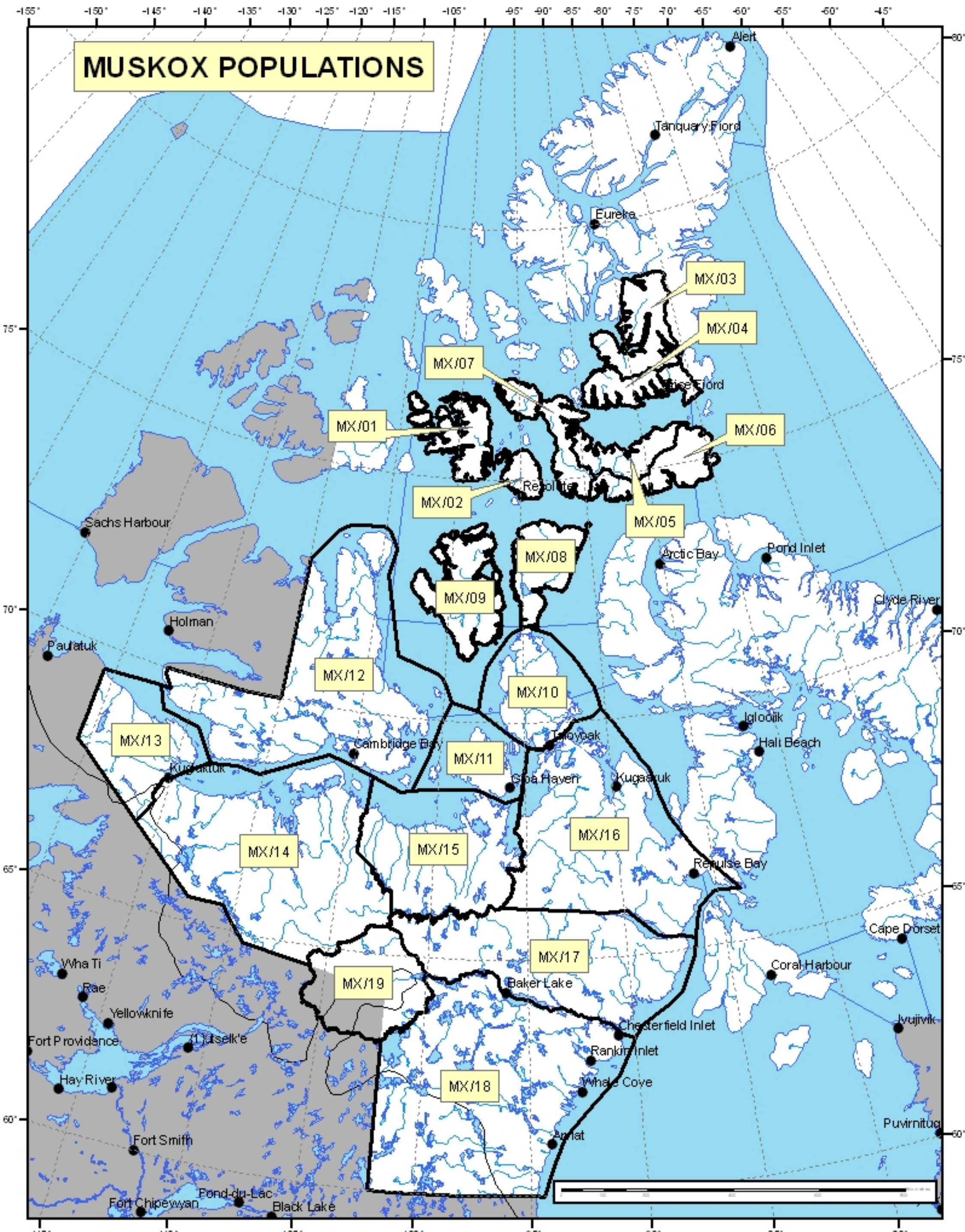

Figure 3.1. Musk ox populations in Nunavut.

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 .

3.1.3 Boundary Justifications

MX/01

The designation of Bathurst and its satellite islands is based on IQ (Taylor 2005), survey results and movements of radio-collared musk oxen. Musk ox seasonal movements remain within Bathurst Island (for example; preliminary location data for 4 musk oxen fitted with satellite-collars in 2003 indicates that movements are limited to Bathurst Island). Only during severe winters have Inuit hunters and biologists reported occasional desperation movements on to the sea ice (Taylor 2005, Gray 1987, Miller 1998).

MX/02

The designation of Cornwallis as a musk ox population is new and is based on IQ (Taylor 2005), survey results, and movements of radio-collared animals. The unit is an island large enough to encompass seasonal home ranges although the amount of suitable habitat is low (Tener 1965). The 2 musk oxen radio-collared on Cornwallis Island demonstrate no inter-island migration during their yearly cycle. Some movements from Bathurst Island have occurred during exceptionally severe winters (1973 and 1994) when Inuit hunters reported more musk oxen on Cornwallis (Taylor 2005).

MX/03 and MX/04

Ellesmere is one of the largest High Arctic Islands with high mountains, glaciers and fiords creating likely barriers to movements. The original populations are being recommended for change at the request of the Grise Fiord HTO.

The climate is strongly regionalized (Maxwell 1981) and the two musk ox areas on Ellesmere (MX/03 and MX/04) largely correspond to the two climate regions IV and V. The regional climate is considered to influence biogeographic zoning which likely affects musk ox demography through local climate and its effects on vegetation. The regular hunting area is south Ellesmere although hunters occasionally charter planes for hunting beyond this area (Taylor 2005). There is no information that suggests that musk oxen migrate from north to south.

MX/05, MX/06 and MX/07

North Devon (MX/05) is within a separate climate region from the rest of the island (Maxwell 1981) and is also separated by rugged terrain from the other two musk ox populations on the Island. The other two populations occupy a string of small lowlands along the north and south coast, respectively. The two areas are also separated by rugged terrain and glaciers. These three areas are a rationalization of the previous two populations which owed more to historical patterns. The previous population MX/05 included the central and eastern portion of Devon Island and is now divided into MX/05 (north Devon) and MX/06 (south Devon). MX/07 is a newly identified population for western Devon. Six musk oxen were radio-collared in 2003 and preliminary analysis of location data indicates fidelity to the island and no movement from western Devon island to the east.

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/17

The Eastern Mainland Population of musk ox, MX/17, is thought to have been largely from the west and North West. Some movement out of the Thelon Game Sanctuary was also indicated in historic reports though the extent of this movement is unclear and occurred over a long period of time (Barr, 1991). The north eastern boundary of MX/17 running west through Wager Bay was drawn based on extremely low to nil densities of musk ox recorded along its length up to its confluence with the Back River (Campbell and Setterington, 2003). This boundary separates it from the MX/16 population. Directly north of the MX/17 boundary and its confluence with the Back River, musk ox densities increase in a northward progression as you proceed closer to Committee Bay. Northeast of this confluence musk ox densities drop off entirely (Campbell and Setterington, 2003). To the northwest of MX/17 a boundary is drawn along the course of the Back River to its confluence with the boundary of the Thelon Sanctuary separating it from the MX/15 geographically given the musk oxen's reluctance to cross major river systems during the reproductive seasons. Research findings and the available literature support the identification of this population as being reproductively isolated from adjacent populations. These findings support the suggestion that this population is reproductively isolated.

MX/18

The Southern Kivalliq Population of Musk ox, MX/18 is bounded in the south and west by the Nunavut border with Manitoba and the Nunavut/NWT border up until it contacts the Dubawnt River/Thelon Game Sanctuary boundary. The northern boundary separating MX/18 from MX/17 separates two distinct populations based on a zone of no to extremely low densities of musk ox present along this entire boundary effectively restricting reproductive exchange (Campbell and Setterington, 2003).

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.

3.1.4 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.

3.1.5 Sex-Selectivity of Harvest

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

3.1.6 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.

3.1.7 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 3.1 Recommended delineations of Nunavut musk ox populations and associated TAH.

Region	Population	TAH	Notes
Baffin	MX/01	3	***Bathurst Island Population.*** TAH based on 3% of the current minimum count (94) determined in 2001. The objective is to encourage population growth until the population is about half the peak sizes (1961, 1994) when the TAH should be re-examined. The population is relatively small and could be vulnerable to environmental variation. The sex and age structure is unknown (Gunn and Jenkins, in prep).
	MX/02	0	***Cornwallis Island Population***. Encourage population growth until the population is half the known peak (25 ind.) when TAH should be re-examined. The pop. is extremely small (based on 2002 survey) and could be vulnerable to environmental variation (Gunn and Jenkins, in prep).
	MX/03	20	***Central Ellesmere Island Population***. Recent aerial & ground survey of Ellesmere I found the majority of musk oxen distributed north of designated musk oxen populations (Fosheim Peninsula). The TAH = 5% of the upper CI of the pop. estimate (394) (Gunn and Jenkins, in prep).
	MX/04	4	***Southern Ellesmere Island Population***. A population estimate of 139 (95% CI 98 – 196) was calculated from 2005 survey results (Gunn & Jenkins, in prep). Given the poor condition of observed musk oxen in 2005, a harvest of 3% of the mean abundance estimate is recommended until new information on trends/recovery is available (Gunn and Jenkins, in prep).
	MX/05	14	***North Devon Island Population***. IQ suggests musk oxen are increasing. Recommend a TAH of 14 or 5% of the 1990 estimates (Gunn and Jenkins, in prep).
	MX/06	2	***South Devon Island Population***. Objective to maintain the population at a level to meet current Inuit needs. A TAH of 2 which is 3% of 1990 estimate is recommended as the population is small (72, 1990 survey) (Gunn and Jenkins, in prep).
	MX/07	5	***West Devon Island Population***. The population is small but appears to be increasing. . The objective is to maintain the population. A TAH of 5 or c. 5% of the 2002/03 estimate is recommended (Gunn and Jenkins, in prep).
	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).
Kitikmeot	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).
Kivalliq	MX/17	41	***Northern Kivalliq Population***. 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 MX/17 and MX/16 based on musk ox distribution and known movements and a geographic separation in excess of known movements between the 2 populations as identified in (Campbell & Setterington, 2003).
	MX/18	60	***Southern Kivalliq Population***. TAH based on survey results, approx. 3% of the lower confidence interval of survey means. TAH level set to promote population growth. Division between the North Kivalliq and South Kivalliq (SK) based on musk ox movements (being a non-migratory species) and a geographic separation in excess of known movements identified in (Campbell & Setterington, 2003).
	MX/19	0	***Thelon Game Sanctuary population*** (No harvest allowed)

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