MUSKOX (*Ovibos moschatus*) DISTRIBUTION AND ABUNDANCE, MUSKOX MANAGEMENT UNITS MX-10 SUBDIVISION, KING WILLIAM ISLAND, SEPTEMBER 2013.

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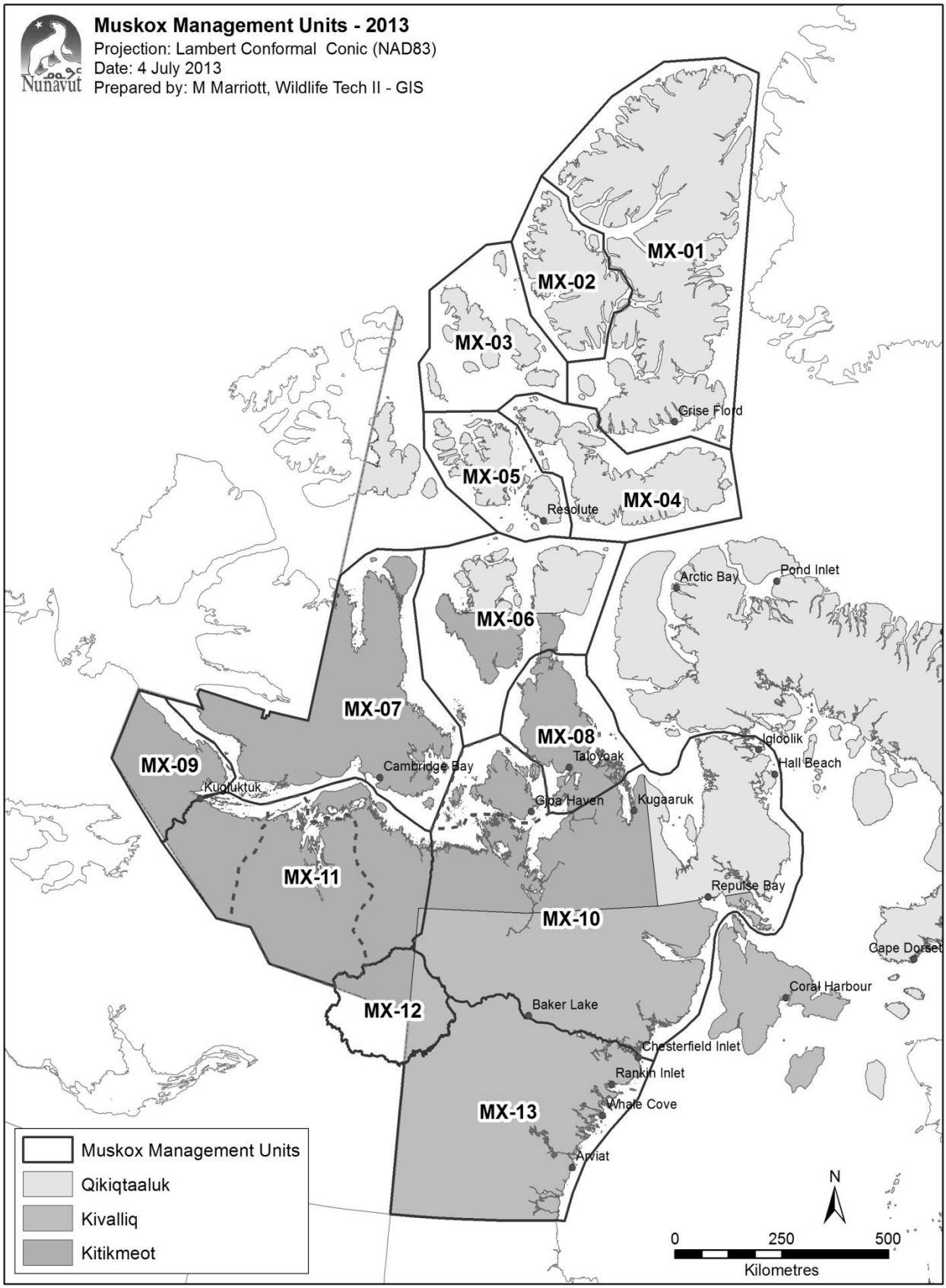
Muskox Management Units - 2013
Projection: Lambert Conformal Conic (NAD83)
Date: 4 July 2013
Prepared by: M Marriott, Wildlife Tech II - GIS
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Grise Fiord
Resolute
Arctic Bay
Pond Inlet
Igloolik
Hall Beach
Taloyoak
Gjoa Haven
Kugaaruk
Cambridge Bay
Kugluktuk
Repulse Bay
Cape Dorset
Coral Harbour
Baker Lake
Chesterfield Inlet
Rankin Inlet
Whale Cove
Arviat
Muskox Management Units
Qikiqtaaluk
Kivalliq
Kitikmeot
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Kilometres

Executive Summary

A systematic strip transect survey of King William Island and its satellite islands (MX-10, subdivision King William Island) were conducted on September 4 and 5th, 2013 to determine the abundance and distribution of muskox on King William Island and its satellite islands. Some muskox observations were made on adjacent Matty Island with one group of five muskoxen. A total of 2,496km^2 were flown, representing 20% coverage of the study area of 13,935km^2. During the survey, 280 adult muskoxen were recorded on transect resulting in an estimated muskox number of 1,564 ±182 (S.E.) for the study area. The majority of observations were concentrated in the middle portion of King William Island. Calves represented 20% of the adults muskox seen and the average adult per group was 13 ± 8.40 (S.D.). The muskox number increased from about 384 in 2002 to 1,564 ±182 (S.E.) in 2013. The muskox density, 0.1123 muskox/ km^2, encountered in the study area, in addition to the recent appearance of predators and the lack of caribou in the area might suggest a change in ecosystem dynamics. A recommended harvest rate of 5% is suggested to support the stabilization of the muskox on King William Island. In addition, increase in population, health and harvest monitoring should be implemented. The next survey of this area should be undertaken no later than 2018, so harvest rates on this group can be reviewed.

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Introduction

For thousands of years, Inuit survival was directly linked to the use of available animals, such as Muskox (*Ovibos moschatus*). Inuit developed traditional management strategies to assure their subsistence off the land was sustainable. However, in the wake of whalers, fur-traders, explorers and scientists, muskox were hunted for their meat and hides (Spencer 1976; Gunn 1984). This hunting pressure and others possible contributing factors, reduced muskox numbers to near extinction levels and considerably changed their natural distribution and range, as some Arctic islands saw virtual extirpation (Spencer 1976; Gunn 1984).

Complete protection for close to 59 years Nunavut wide, allowed the muskox to re-colonize their former habitats and its population dynamics are now more prone to respond to environmental factors. Fluctuation in population numbers has management concerns especially when muskox constitutes an important source of food for Inuit communities in the Kitikmeot Region.

In July 2013, new muskox management units were established in Nunavut to better represent muskox population *boundaries*. The management units in Nunavut have been expanded and reviewed to match new population boundaries reflecting the expanding muskox range, characteristic of the natural population dynamic (Gunn, 1984). Since migration and genetic exchange with the mainland muskox has occurred, the muskox on King William Island are considered part of the east mainland population. For this reasons, the new muskox management unit MX-10 was created in July 2013 to incorporate King William Island, referred as the old MX-22 (Dumond 2006, 2010).

Nevertheless, no aerial or ground survey has been conducted since 2002 to provide the quantitative data needed to review the current muskox harvesting rate. In addition, the Gjoa Haven Hunter and Trapper Organization (HTO) have expressed conservation concerns about the over harvest on the Island if quotas are set for the entire east mainland population. Thus, they suggested a subdivision, King William Island, to closely monitor and distribute the harvest on the Island to avoid the risk of local depletion and the survey of this unit was requested. This research project aims to determine muskox abundance and distribution of MX-10, subdivision King William Island. According to hunter observations, muskox numbers are still increasing and therefore community members have requested to re-evaluate their Island quotas (Willie Aglukkak pers.com. 2013).

This study aims to provide essential inventory information required to review existing management strategies and promote the conservation of the muskox group, so that future generations of Inuit may continue to harvest this resource. To do so, the relative muskox numbers, distribution, and calf crops will be assessed. Natural population oscillations may bring different management strategies, thus, conservative management harvest levels were

maintained and the harvesting rate has been adjusted in function of the number of muskox estimate in the management units (Gunn, 1984).

Muskox population dynamics have an impact on management plan and decision making-related to harvest levels. The recommendations in this report are intended as short-term management options based on the 2013 survey results. From the scientific data, management recommendations included in this scientific report will be used with the community consultation report, as support documents to the Kitikmeot Muskox Management Plan.

Objectives

This project aims to address the concerns and requests of Inuit hunters, as well as to provide up to date scientific information. Therefore, the main objectives of this study are:

1. Determine the estimated number of muskox;
2. Determine muskox distribution and density;
3. Determine calf crop and group size .

By doing so, it will be possible to relatively compare the number of muskox on King William Island estimated during the ground survey in 2002 and more precisely their current abundance and distribution. Information on group structure, calf crop, group size and density, is essential to gain insight on the relation between these variables and population dynamic.

Materials and Methods

Study Area

The study area includes King William Island as well as its satellite islands; the Royal Geographical Society Island, Matty Island and Tennent Island. The elevation lies predominantly below 100 meters with the highest ridge having an altitude of 137 meters. The study area is part of the Northern Arctic Ecozone and has one distinct terrestrial ecoregion, the Victoria Island Lowlands. The vegetation cover is mainly dominated by arctic willow, alpine foxtail, wood rush and other saxifrage species, such as the purple saxifrage. The land is covered with numerous ponds and small lakes. Around the wet areas, sedges, cotton grass, saxifrage and moss are present (Environment Canada, 1995).

Survey Area

No reconnaissance survey was undertaken prior to maximize the coverage area investigated. Instead, anticipated muskox distribution patterns were obtained from past ground surveys, hunter observations, and Inuit Traditional Knowledge/*Inuit Qaujimajatuqangit* (IQ).

A tool within ESRI'S ArcGIS software was created to increase the precision of the survey areas. The tool allows managers to determine the precise number of transects and the distance between each transect line required to reach the predetermined percentage of cover in function of the transect strip width and the total area of each stratum within the management unit. Due to the small extent of King William Island, the entire Island was flown without stratification in addition to the Royal Geographical Society Island, Matty Island and Tennent Island (Figure 1).

The management unit MX-10, subdivision King William Island was surveyed at 20%, which is a consistent survey coverage that was done in 1986. Since the survey occurred in September, only the land mass was considered as part of the management unit area. Orientation of the transect lines within the study area was determined in function: 1) consistent orientation from the 1986 surveys 2) to have the most homogeneous and shorter transect line length and 3) the transect lines are perpendicular to the long axis of the coastline and the major rivers (Figure 1).

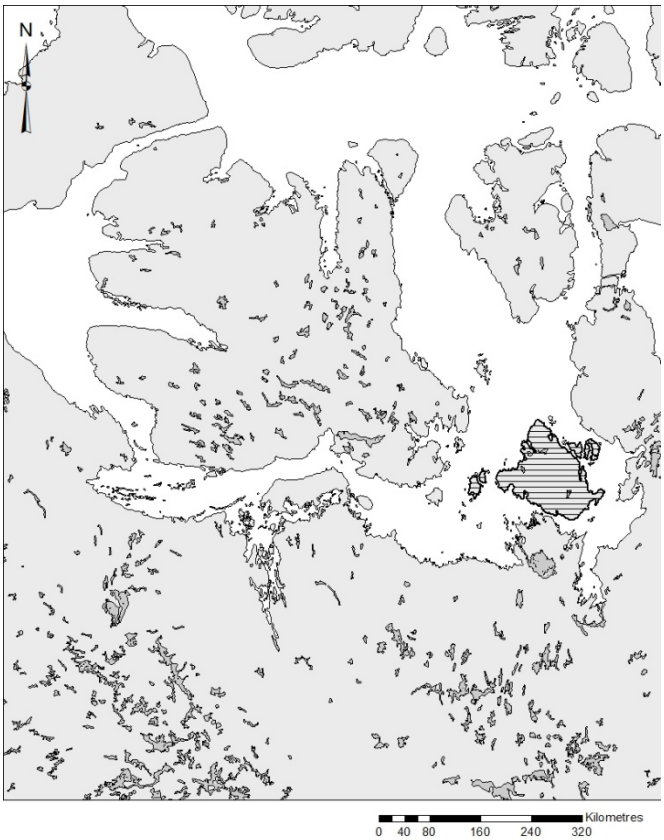

Figure 1: East-West transect lines covering 20% of the muskox management units MX-10, subdivision King William Island, during a muskox survey, September 4 and 5 2013.

The study area of 13,935 km^2 , where King William Island accounts for 12,300 km^2, was surveyed at 20% with 1,560 kms of transects, which represented 29 transect lines of different length randomly distributed (Table 1, Figure 1). The transect lines varied from 2 km to the

longest at 139 km (mean 54 km, SD ±47 km). The resulting distance between each transect was 8.54 km.

Table 1: Characteristic of the study area and the transect lines in the Management Unit MX-10, subdivision King William Island.

Stratum	Total area (km^2)	Percentages (%)	Total transect lines (km)	Number of lines	Distance between transect line (km)	Orientation
MX-11 subdivision	13,935	20	1,560	29	8.54	East-West

Aircraft configuration

A systematic transects lines survey was flown with a fix-wing single engine turbine aircraft, a Turbo Beaver. The transect lines were surveyed at a speed of 160 km/hr and at an altitude of about 150 meters which was consistently maintained due the flat relief of the study area. Pre-determined transect width of 800 meters was set on the window based on calculation using the formula of Norton-Griffiths (1978) and others (Gunn and Patterson 2000; Howard 2011).

$$w= W*h/H$$

Where, W= the required strip width; h= the height of the observer's eye from the tarmac; and H= the required flying height.

The strip transect was 800 meters on each side of the aircraft, for a total transect width of 1.6 kilometers. The strip width calculations were confirmed by flying perpendicular over a known distance marked at 800 meters. Two observers in the rear continuously searched for and counted muskox, either as on or off-transect; the number of calves (5-6 months old) were counted when they were conspicuous. No sex and age classification count were systematically attempted. Photographs were taken of large groups (> 20 muskoxen). The data keeper recorded the number of muskox, GPS location and their distance from the transect line. Even if this survey focused on muskox, additional sightings of other species were recoded, such as caribou, grizzly bear, polar bear and wolf.

Analyses

As this survey focused mainly on obtaining an estimated number, only unambiguous classification criteria were used to determine the number of calves and adults. The group was then broken down into adults (female/male) and calves (Howard 2011). The flying height and speed did not allow for accurately distinguishing male from female muskox in a group from the sexual dimorphism of the horn. Therefore, the proportion of calves per female cow was not determined, and no information on the recruitment or productivity was generated. The group

structure was however described such as calf crop, mean group size and the number of single lone bulls encounter was also recorded.

To determine the number of muskox in the study area, only the adults muskox sightings recorded on transect were analyzed using Jolly's Method 2 for unequal sample sizes (Jolly 1969) using a coefficient limit of 95%. The count was automated by a script in ESRI'S ArcGIS software.

Density, the number of muskox per unit area (muskox/km^2), was determined using the number of adult muskox seen on transect divided by the total area of the study area. Lakes and streams areas were not subtracted from the total area calculations used in muskox density.

The area occupied by the muskox during this specific season within the study area was determined. Thus, the distribution was illustrated by plotting each muskox sighting on transect base on their precise geospatial position captured with a Global Positioning System (GPS) during the survey. In addition, the number of animal composing each group was highlighted using an increasing size of symbol to represent group of 1-5, 6-12, 13-20, 21-30, 31-45 and 46 to 91 animals.

Give the importance of predators, Grizzly Bear (*Ursus arctos horribilis*) and Arctic Wolf (*Canis lupus arctos*) in affecting muskox numbers and the difficulty of estimating their predation rates; we collected standardized information of predator sighting in the management units using the predator index (Heard, 1992). The predator index reports all predator sighting per species against the reported total number hours of flying, in this case also including the ferry time. This gives a way of comparisons between study areas, as the number of predators observed is expressed per 100 hours.

Results

The survey was conducted from September 4 to September 5, 2013. The survey was not interrupted due to weather and the area was consecutively surveyed over the two days in 15 hours. This time includes time to fly the 1,560 km of transect lines and ferry from the Gjoa Haven airport to the transect lines.

Group Characteristic

During the survey, 22 groups of muskox were recorded on transect, with two being single lone bulls. A total of 57 calves and 280 adults where seen on transect. The lone bulls accounted for less than 1% and the calves represented 20% of the total number of muskox observed. The average adult per group was 13 ± 8.40 (S.D.). The highest number of adults counted in one group was 36. The majority of the groups (45%) were groups of 13 to 20 animals followed by groups of 6 to 12 animals (Figure 2). Only two groups with more than 21 adults were observed.

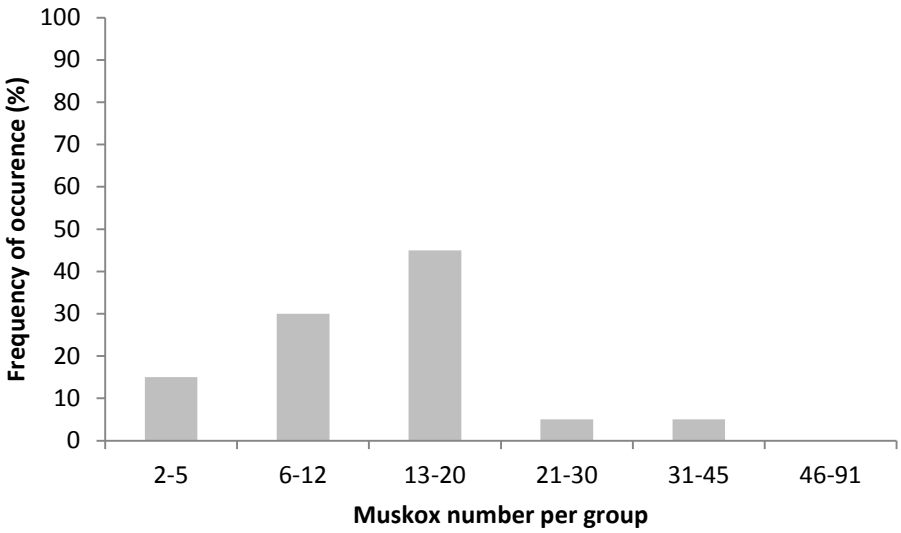

Figure 2: Frequency of occurrence (%) of the different muskox number per group, grouped as follow 2-5, 6-12, 13-20, 21-30, 31-45, and 46-91, during the survey of the management unit MX-10, subdivision King William Island.

Abundance Estimate

During the survey, 280 adult muskoxen on transect were recorded on the 2,496 km^2 of transect area representing 20% of the management unit. For this estimate, the total number of transects at 100% coverage is 78 (N) and 29 (n) of this number was surveyed. This corresponds to an estimated number for the total area (13,935) of 1,564 ± 182.2 (S.E.) muskox ($p<0.005$, $t = 2.048$, $N = 78$ and $n = 29$) (Table 2).

Table 2: Muskox estimate in the Muskox management Unit MX-10, subdivision King William Island.

Stratum	Area Survey (km^2)	Total area (km^2)	Muskox on Transect	Estimate	Standard error (S.E.)	95% CL (±)	CV
MX-10 Subdivision	2,496	13,935	280	1,564	182.26	373.27	0.116

*$p<0.005$, $t = 2.048$, $N = 78$ and $n = 29$

Distribution

When the survey occurred, no ice was recorded around King William Island linking it to its satellite islands. Most of the muskoxen on King William were concentrated in the middle portion of the island, from one side to the other (Figure 3). The largest group of muskox, 36 animals, was observed on the southern portion of the Island. Additional coverage of the

surrounding area of this group failed to detect any other larger groups in between the transect lines. One group of five muskoxen was seen on the west side of Matty Island. The survey revealed that no muskox were present 50 km around Gjoa Haven and on the Royal Geographical Society Island at that time.

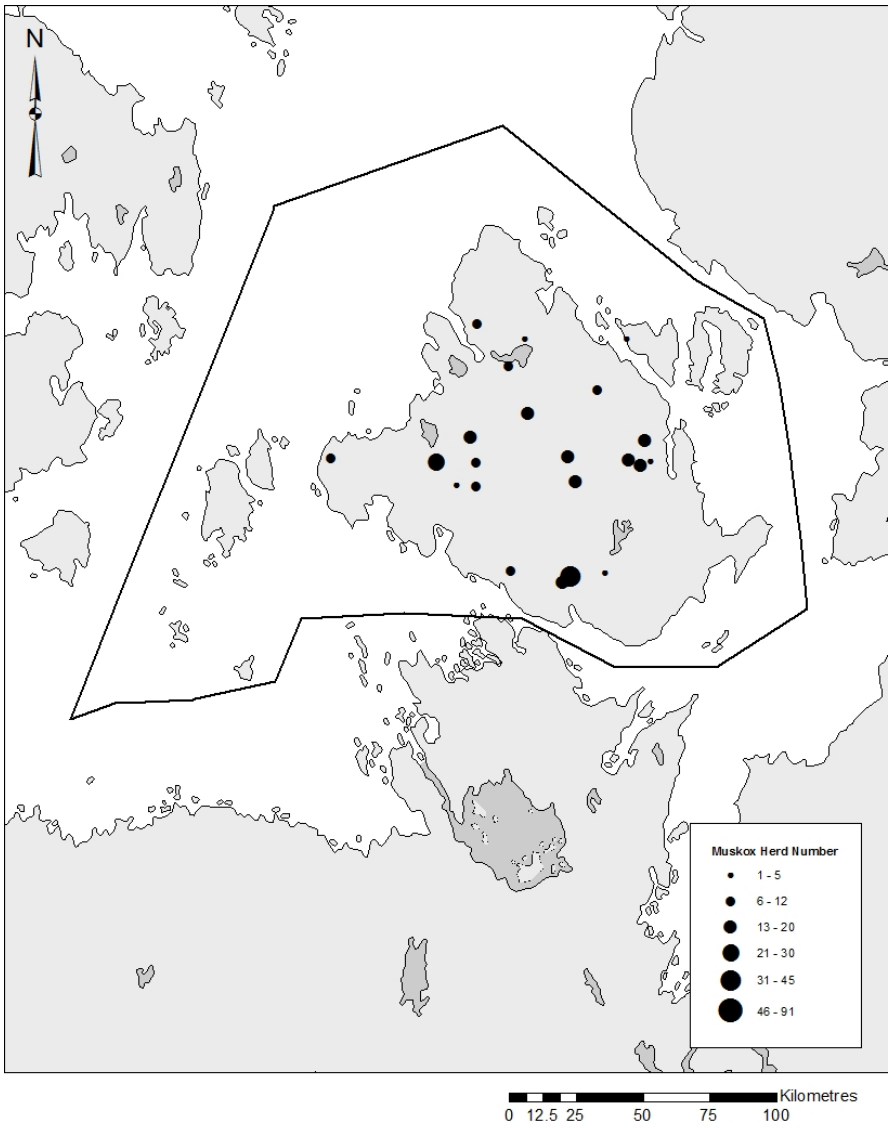

Figure 3: Muskox distribution and abundance recorded in the management unit MX-10 during the survey taking place on September 4 to 5, 2013, where the number of animal per group was grouped as 1-5, 6-12, 13-20, 21-30, 31-45, and 46-91.

Density

Since the management unit is restricted to the land mass in September, the muskox are then concentrated on the islands, mainly on King William Island. Although, there are numerous lakes

and ponds of different depths, the water bodies were not removed to calculate the muskox density. Within the management unit (13,935 km^2) and for an estimated of 1,564 ± 182.2 (S.E.) , the muskox density was 0.1123 muskox/ km^2.

Predator sighting (wolves, polar bear and grizzly bear)

During the 15 hours of flying within the study area, 1 wolf and 2 polar bear sightings were recorded. Two wolfs were observed in a single pack. Polar bears were encountered on the north part of King William Island, with one of the east shores and the other one the west shore. Predator sightings in the management unit, MX-10 using the predator index (Heard, 1992) revealed an approximate number of 7 wolfs / 100 hours and 13 polar bears / 100 hours.

Discussion

Group Characteristic

During the survey, a total of 57 calves and 280 adult where seen on transect, calf crop representing 20% of the sighting. First records of calf crops occurred in May 2002, but the percentage of calves calculated in that study, 6%, is not representative of the total number of calves born as calving occurs at the time of the surveys and extend until late May (White 2002). It has been establish that a steady 10.5% of calf crops is necessary to keep the muskox population stable (Freeman 1971) as high variance in the rate of population increase and decreases in calf production have been found (Reynold, 1998).

Twenty-two groups of muskox were recorded, where two were single lone bulls. The lone bulls accounted for a negligible number. The average adult per group was 13 ± 8.40 (S.D.). This is consistent with Freeman's observation (Freeman, 1971). During the summer, muskoxen form smaller groups, usually led by a single bull and harem of females with calves (Banfield, 1977; Freeman, 1971). During the winter, the harem social structure dissolves and muskox form larger, multi-male and multi-female congregations (Banfield 1977; Freeman, 1971).

In winter time, herd are 1.2 to 2.3 larger than in the summer (Head, 1992). During the 2002 spring ground survey two groups with numbers higher than 60 in a group were found just north of Washington Bay. Group numbers of 20 to 60 or more individuals were frequently encountered in May by observers (White 2002). During the fall survey, the biggest group recorded constituted of 36 animals and the herd size will be expected to increase after the rut in October November (Gunn and Fournier, 2000).

Abundance Estimate

Documentation on muskox abundance on King William Island is scarce, but there is historic information that the area is within the historical range of muskox. Muskox bones (1650 ± 60

A.D.) were found at a Thule site near Gladman Point, on the south coast of King William Island (Savelle 1987). However, there is only one sighting dating back of 1919 by Simon Kernek, when two bull muskoxen alive were found and killed on the south coast of the island (Gunn 1996). According to local reports from community hunters, muskoxen began to recolonize King William Island 25 to 30 years ago (Dumond 2010). In 1980s, hunters reported sightings of muskoxen on the northeast and south coasts of King William Island (Gunn et al. 1996). However, the 1986 aerial survey failed to detect any muskox (Gunn et al. 1996). Sightings of muskox were rare to non-existent until 1992, and after they slowly start to increase in number (Gunn et al. 1996; White 2002). A conservation officer kept a log of muskox sightings around 1990, from which a population estimate of 100 individuals was derived.

In late spring 2002, 140 muskoxen were counted during a ground survey that covered approximately 36.5% of the Island (White 2002). This number brings the muskox number for the entire Island to a rough estimate of 384 muskoxen. During this 2013 survey, 280 adult muskoxen on transect were recorded on the 2,496 km^2 of transect area representing 20% of the sub-management management unit. This corresponds to an estimated number of 1,564 ± 182.2 (S.E.) muskoxen. This significant increase in muskox number from the 2002 estimate suggests that muskoxen are still recolonized their historic ranges and the habitat is adequate to support a population growth.

Frequently and equally spaced surveys from 1986 to 2015 would have allowed for tracking the re-colonization, expansion and increasing in muskox number, on King William Island. Different survey methodologies used and large gaps in survey frequency make it is impossible to arrive at any relevant conclusions on yearly increase in numbers. This emphasizes the importance of a consistent monitoring program.

Distribution

When the survey occurred, no ice was recorded around King William Island linking it to its satellite islands. Only one group of 5 muskoxen was seen on the west side of Matty Island. The vegetation on Matty Island was very scares where the ground was mostly constituted of sand patches deprive of vegetation than the lush wet meadow characteristic of King William Island. The group found on the west side of this Island, might suggest winter movement between these two areas, where they failed to cross back to King William Island before the ice-break up.

Most of the muskoxen on King William were concentrated in the middle portion of the island, from one side to the other (Figure 3). The survey revealed that no muskox was present 50 km around Gjoa Haven. Muskox might avoid this area due to the disturbance caused by inland traffic or the settlement. Similarly, it has been reported that generally no muskoxen were found 15 km around Gjoa Haven during the summer month. In winter time, this distance increased to the two third of the Island as this areas is heavily traveled by people by snowmobile (White 2002).

During the summer months, muskox occupies the southeast part of the island where travel inland is more limited (White 2002). The largest group of muskox, 36 animals, was observed on the southern portion of the Island. Additional coverage of the surrounding area of this group failed to detect any other larger groups between the transect lines. Seasonal and annual change in muskox distribution could be a strategy to access continuous source of vegetation or result of sensitivity to human disturbance. Tener (1965) suggested that muskox made a seasonal movement from a winter range to a summer range of around 50 km. The previous observation of muskox movements and the relatively small size of King William Island make this area ideal to better understand muskox seasonal movement.

Density

The model for erupting ungulate populations on islands is that herbivores experience great availability of foraging until they overgraze and the population declines. The assumption of this model is that that the erupting population inevitably follows a decline and that decline is density-dependent. In the case of muskox, Heard (1992) noted that group size in not generally related to muskox density and mechanism influencing muskox density is not well understood.

The density of muskox on King William Island is 0.112 muskox/km^2. This density is consistent with what has been seen in southern Ellesmere Island in 2015, 0.881 muskox/ km^2 and higher that the muskox density on the old management zone MX-17 with 0.03 muskox/km^2 (Anderson, unpublished and Campbell and Setterington, 2001). Muskox density has reached 0.6 muskox/km^2 in Scoresby Land and Jameson Land, Greenland, (Ferns, 1977). The relatively low densities encountered in King William Island compared to Southern part of Greenland, in addition to the number of muskox on the incline propose that the island might not have yet reached its carrying capacity yet.

Predator sighting (wolves, polar bear and grizzly bear)

In 2002, it was mentioned that carnivores feeding on muskox, such as wolves and grizzly bear, were absent from King William Island. During the surveys, a pack of two wolves were observed. Such observations correspond with the local hunter observations reporting an increase of predators around Gjoa Haven. Thus, the increase in muskox numbers on the Island has reached a number capable of upholding another trophic level. The presence of wolves and grizzly bear will also be a factor in shaping their distribution and abundance in the future. Note that polar bear were always observed in the northern part of King William Island and should not be excluded as source of mortality. In May 1967, a large male polar bear shot in Lancaster Sound had muskox hair in the feces (Freeman 1971). Considered a rare event, the muskox remains in feces can result either from scavenging as well as predatory activity.

Management Recommendations

When the management unit of King William Island was created in 1996, this management zone had a Total Allowable Harvest of five. The harvest was set at a level low enough to allow muskox numbers to increase and recolonize their historical range while allowing some harvest to take place. As the number of muskox remained relatively small on the Island until 2002, the harvesting rate has remained conservative to encourage the muskox number on King William Island to continue to increase. Based on the results of the 2002 ground survey, the increase of muskox numbers justified a rise of three tags from five to eight, which was reflective of a conservative harvest rate of 2% (White 2002).

Based on a growing numbers of muskox sightings from the community members, a Total Allowable Harvest of 12 was recommended and implemented in 2006. This represents a harvest rate of 4% (Dumond 2006). Such management is believed to foster slow growth (Tener 1965). This management recommendation was successful, as 2013 area survey shown that muskox increased in abundance which is also supported by local observations.

At the West Kitikmeot Workshop in October 2014, the Gjoa Haven HTO supported the survey results and requested that the number of muskox stabilize to 1,500 and recommended a harvest rate of 10% (Leclerc, 2015). Thus, more discussion would need to take place with the co-management partners as a harvest of 10% on the island would allow for a harvest of 69 muskox from MX11 (Northeastern Mainland population). The rate harvested in a population is based on long-term empirical data of muskox harvest from Tener (1965) whereas a harvest rate set a 5% resulted in stability of the group.

The results of this survey recommend a harvest rate of 5%, which based on a muskox numbers of 1,564 ± 182.2 (S.E.), representing a Total Allowable Harvest of 69 for King William Island. This conservative harvest rate should be implemented in the condition that continuous monitoring is effectuated on a five year basis. The next area survey should then be undertaken in 2018.

Acknowledgements

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