



SPECIES STATUS REPORT
(Traditional and Community
Knowledge Component)
for Muskoxen (*Ovibos moschatus*)
in the
Northwest Territories

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EXECUTIVE SUMMARY

Muskoxen are found in many regions in the Northwest Territories (NWT) and for this reason there is Traditional Knowledge (TK) and Community Knowledge (CK) about them from many parts of the territory. Over recent history, Inuit regions and communities have for the most part had a more consistent and stronger cultural connection to muskoxen than areas further south, where the animals were scarce for an extended period of time. A management history of localized extirpation, harvest restrictions, and muskox re-introductions and re-colonizations in some areas makes knowledge and use of these animals outside of the Inuit regions more complex.

Distribution

In regions where there is continuous TK about muskoxen (i.e., areas not experiencing extirpation) there are indications of periodic shifts or pronounced cycles in abundance and distribution.

Muskoxen are found in the Inuvialuit Settlement Region (ISR) and across the Arctic Archipelago, in the western portion of the Gwich'in Settlement Area (GSA), across much of the Sahtú Settlement Area (SSA), and in the eastern portions of the North Slave and the South Slave regions, including the far-east portion of Wek'èezhì (Tłı̨chǫ lands). Populations in the western mountainous parts of the Gwich'in Settlement Area and Inuvialuit Settlement Region, including the Yukon North Slope, resulted from a re-introduction to the Alaskan North Slope and expansion of those muskoxen into Yukon and NWT.

Over the last 20 years, muskoxen have been expanding their range into the South Slave Region; members of the Łutsel K'e Dene First Nation increasingly see them around the East Arm of Great Slave Lake at the boreal forest/tundra edge. However, while it is likely that many NWT knowledge holders have good information on muskox distribution, this information was not well-covered in the sources available at the time this report was prepared. This is particularly true for current distribution information, which could be considered an information gap for some regions.

Biology and Behaviour

It is also likely that many NWT knowledge holders have good information on muskox behaviour, health, and biology, but this information was also not covered in-depth in the sources that were available and reviewed for this report.

Muskoxen do not migrate as much as caribou do, although they may move between different habitat types seasonally and at times crossing ice to do so. They can move quickly when needed and are able to run long distances. They are not found consistently across their habitat; and some areas are known to be better habitat for them than others. They live

in small herds, which can grow quickly if conditions are right. Bulls leave to form new herds, dispersing larger herds. Muskoxen eat many types of plants and live in many different ecotypes: coastal, mountainous, wooded, and mossy tundra. They have large guts for their size and dig out food as needed in the winter. They run from predators, but also form a circle or front facing out towards a threat, to protect calves. Calves are born in early spring, and cows mature between two and four years of age. Muskoxen can get a variety of diseases including parasites. Muskoxen interact in complex and regionally specific ways with their competitors, and this topic in particular needs further study. They are preyed upon by wolves and bears, especially the calves.

Population

Muskox population information was not well-covered in the TKCK sources available for many regions and is often a topic best understood through western science. Oral histories strongly indicate population fluctuations, especially on the more southerly of the islands in the Arctic Archipelago. Overall, the muskox population decreased in much of the NWT before 1900 and has been growing since; this population growth includes a small immigration of animals eastward into the Yukon and NWT following a re-introduction of muskoxen in Alaska. Increases in abundance and distribution were noted for the ISR, GSA, SSA and Akaitcho/South Slave region, approximately over the last 20 years.

Very recent information indicates population declines in some areas. Decreases in abundance in some western parts of the Canadian subarctic are being described for Inuit areas. In both the NWT and Nunavut, populations may have peaked around 2005 and then started to decline.

Habitat

Although it is likely that NWT knowledge holders have good information on muskox habitat requirements, as well as changes to muskox habitat and distribution, this information was not well-covered in the sources available and reviewed for this report.

Muskox herds re-introduced to the Alaskan North Slope have expanded into the Richardson Mountains area from Alaska. Endemic populations have also spread south into the Sahtú Region from populations to the north and from the Thelon region. As a result, they are being seen in areas they were not found in for several decades and in some cases, nearly 100 years.

Threats and Limiting Factors

Although it is likely that NWT knowledge holders have good information on threats to muskoxen, this information was not well-covered in the sources available. Threats seem to be focal and regional, and include: a lack of recorded TKCK, unchecked population growth,

disease, and changes to body condition, climate change, predation (including hunting, commercial harvest for hides, etc.), and industrial activities.

Positive Influences

Although it is likely that NWT knowledge holders have information on positive influences on muskoxen, this information was not well-covered in the sources available. Traditional management practices and knowledge, along with increased tourism, can be seen as positive influences. Conservation planning and wildlife management can also influence muskox populations positively.

TECHNICAL SUMMARY

Population Trends

Generation time (average age of parents in the population) (indicate years, months, days, etc.)	Between two and four years.
Number of mature individuals in the NWT (or give a range of estimates)	Information not available in sources.
Amount of change in numbers in the recent past	Information not available in sources, large changes over the last 100 years.
Amount of change in numbers predicted in the near future	Information not available in sources.
Amount of change happening now	Information not available in sources.
If there is a decline, is the decline likely to continue if nothing is done?	Information not available in sources.
If there is a decline, are the causes of the decline reversible?	Information not available in sources.
If there is a decline, are the causes of the decline clearly understood?	Information not available in sources, but they suggest not.
If there is a decline, have the causes of the decline been removed?	Information not available in sources.
If there are fluctuations or declines, are they within, or outside of, natural cycles?	Information not available in sources.
Are there 'extreme fluctuations' (ups and downs) in the number of mature individuals?	Yes, although only some of this may be natural.

Distribution Trends

Where is the species found in the NWT?	In the ISR, GSA, SSA, North Slave, and South Slave.
How much of its range is suitable habitat?	Information not available in sources.
How many populations are there? To what degree would the different populations be likely to be impacted by a single threat?	Information not available in sources.
Is the distribution, habitat or habitat quality showing a decline that is likely to continue if nothing is done?	Information not available in sources.
Is the number of populations or amount of occupied area showing a decline that is likely to continue if nothing is done?	Information not available in sources.
Are there 'extreme fluctuations' (ups and downs) in the range or the number of populations?	Information not available in sources.
Is the NWT population 'severely fragmented'? (Most individuals found within small and isolated populations)?	Information not available in sources.

Immigration from Populations Elsewhere

Does the species exist elsewhere?	Yes.
Status of the outside population(s)	Information not available in sources.
Is immigration known or possible?	Bulls travel, and populations have been trans-located.
Would immigrants be adapted to survive and reproduce in the NWT?	Yes, demonstrably so.
Is there enough good habitat for immigrants in the NWT?	Information not available in sources.
Is the NWT population self-sustaining or does it depend on immigration for long-term survival?	Information not available in sources.

Threats and Limiting Factors

Briefly summarize the threats and limiting factors. For each one, indicate how imminent it is and what the degree/scale of the impact is.	Threats are regional and poorly understood. They may include disease, harvest, industry, and climate change.
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Positive Influences

Briefly summarize the positive influences. For each one, indicate how imminent it is and what the degree/scale of the impact is.	Positive influences are poorly understood, but may include conservation, traditional hunting rules, and muskoxen's ability to adapt.
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TRADITIONAL KNOWLEDGE AND CULTURAL PREAMBLE

A Brief History of Muskox Management in North America

Prior to 1900, muskoxen were widely distributed and traditionally harvested for food, clothing, and tools in many areas of what are now the Northwest Territories (NWT) and Nunavut (NU). They were found from the Anderson River valley in what are now the Gwich'in Settlement Area (GSA) and the Inuvialuit Settlement Region (ISR) in the west, right across the NWT, and south to Churchill, Manitoba. They were also found across the Arctic Archipelago (Barr 1991). With increasing commercial activities starting in the mid-1800s, muskoxen were extirpated from many parts of their range by the early 20th century; this was primarily due to over-hunting that was driven by trade with fur traders and whalers (Barr 1991; Lent 1999). Over half of the thousands of muskox hides traded at the numerous fur trade posts were traded in the region of the Mackenzie River, including the delta and further upstream.¹ These areas are far from the tundra where the muskoxen were probably being hunted (Barr 1991). Although the numbers of hides from various fur trade posts were covered by historian Barr (1991), Tener (1965) indicates that the number of muskoxen taken for meat for whalers' ships is not known but is probably in the thousands (Tener 1965; Barr 1991).

A strong southern demand for muskox hides after the near extirpation of bison led to heavy harvesting across the Canadian mainland (Barr 1991). These factors (and possibly others, including climate events) led to their extirpation in the mainland portion of what is now NWT and NU during the late 1800s and up to about 1915 (Tener 1965; Berger Inquiry Volume 41 Holman Island 1976; Barr 1991). In addition to the increased harvest on the mainland, the ease of harvesting muskoxen and their similarity in taste to beef made them a favourite of explorers, whalers, and early non-Inuit migrants into the Arctic Archipelago (Tener 1965; Lent 1999). As a result, abundance of muskoxen on many of the Arctic Islands, including Banks Island, was also low in the early 1900s (Tener 1965; Lent 1999).

The decline in muskox populations across the north prompted various regulations and laws to prevent further decline, starting in the 1890s. These were not seen as successful, and harvest continued (Barr 1991). Increasing concern with the diminishing population led to the 1917 decision to ban all hunting of muskoxen by Indigenous, Inuit, and Métis hunters, except in the instance of starvation, through the *Northwest Game Act* (Barr 1991;

¹ Although the number of hides likely passing through the various fur trade posts in the 1800s and early 1900s is included in Barr 1991, this information is outside the scope of this TKCK report. In addition to the thousands of hides harvested on the mainland for the robe trade, Tener indicated that well over a thousand muskoxen were harvested by Norwegian and American explorers on Ellesmere Island alone, between 1880 and 1917 (Tener 1965; Barr 1991).

Lent 1999; Taylor 2005). Around this time, federal biologists recommended that permanent muskox reserves should be declared on Victoria, Banks, and Melville islands. In 1924, these regulations were amended based on reports that the starvation clause was being misused by northerners who 'wantonly' hunted muskoxen. At this point, hunting muskoxen, and even possessing muskox meat or hides, was made illegal (Barr 1991). The hunting ban was in place until the Government of the NWT took responsibility for the management of game with the *Northwest Territories Act of 1967*. At this time, it was felt that muskoxen had re-colonized much of their previous range across the mainland and islands (Barr 1991). Soon after, the Government of the NWT began considering proposals for muskox hunting (Lent 1999).

Some historians suggest that the 1917 decision was taken at least in part due to establishing sovereignty through sending enforcement patrols, and indeed, muskoxen continued to play an important and interesting role in Canada's federal sovereignty conversation across the Arctic for many years (Barr 1991; Nagy 2004; Sandlos 2011). This includes sovereignty in relation to non-Canadians, as well as the emerging relationships between Inuit, Indigenous, and Métis nations and the federal government (Barr 1991).

“A recurring theme in the history of the interaction of muskox and man in the Northwest Territories is the intertwining of concerns about conservation of the muskox and about protection of Canada's sovereignty. On one occasion a representative of the Canadian government stationed in the Arctic to assert Canadian sovereignty took it upon himself to introduce a ban on the trade in muskox hides, long before the species received complete protection. And on two other occasions, perceived threats to Canadian muskoxen led to the establishment of a Canadian presence in the High Arctic and to legislation to control the activities of foreign scientists and explorers,” (Barr 1991:xii).

The declines in the mainland populations were blamed on the export of hides as carriage robes by non-Indigenous northerners (Sandlos 2011). On the Arctic islands, harvest of muskoxen was more for meat to supply exploration expeditions (Barr 1991).

Muskox populations were either recovering or had persisted in the Thelon-Hanbury watersheds in the 1920s, according to explorers' reports (Barr 1991). The relative abundance here led to the establishment of the Thelon Game Sanctuary in 1927 (Barr 1991). Hunting pressure on the muskoxen in the sanctuary was possibly reduced in early years due to healthy populations of caribou and furbearers, at least as reported by a collection of ten Indigenous families camping on the outskirts of Artillery Lake in 1928 (Hoare 1930). The muskox population of the Sanctuary was estimated to be in the hundreds of animals by the 1950s, and by the 1970s, the borders of the Sanctuary were changed to allow more prospecting (Barr 1991).

A small population north of Sahtú (Great Bear Lake) had also persisted into the 1920s, and while sightings were initially rare between Sahtú and Paulatuk (ISR) on the Arctic Coast, the population was estimated to be in the hundreds by the 1970s, and between 4,000 and 5,000 animals by the mid-1980s (Barr 1991). Changes in muskox distribution patterns and population size are covered in more detail in the **State and Trends** section of this report.

In the mid-1930s muskoxen were re-introduced to Alaska after being extirpated in the late 1800s, and one of these re-introduced populations has since spread into the western portion of the NWT.² The first time these muskoxen were seen in the NWT by Gwich'in hunters was in the late 1980s. A small herd seen along the NWT/Yukon border grew into a larger herd and eventually dispersed (McLeod 2018 personal communication). Protections were enacted for this small population via the *Yukon Wildlife Act* of 1981 with little consultation with the appropriate NWT communities of Fort McPherson and Aklavik (muskox is considered a “Specially Protected Wildlife Species”, Wishart 2004). One historian has argued that the federal government was interested in the protection of the muskoxen in part as they considered domesticating the animal and imposing an agrarian model on the north (Sandlos 2011).

The politics and history of muskox conservation in Canada have strongly influenced current perceptions and use in most Indigenous communities in the NWT and continue to shape Traditional and Community Knowledge (TKCK) of the species today.

Walter Bezha described how the history of muskox management in the Sahtú Region has had long term effects on Dene relationships with and knowledge of the animal. He stressed that the population declines had a huge impact on Sahtú Dene practices, and it continues to be a challenge to remind hunters that muskoxen are indeed a traditionally harvested animal.

² In 1930, 34 muskoxen were captured in Greenland and shipped to Alaska (Lent 1999). These muskoxen were the Arctic island subspecies *Ovibos moschatus wardi* and not the continental subspecies *Ovibos moschatus moschatus* that are currently found in other areas of mainland NWT and Nunavut. In 1935 and 1936, all of the surviving muskoxen that were brought to Alaska from Greenland, and those born in captivity, were released on Nunivak Island, Alaska (Lent 1999). The population of muskoxen on Nunivak Island was used as a source of animals for re-introductions of muskoxen to various areas in Alaska.

In 1969 and 1970, a total of 64 muskoxen were introduced to two areas in and near the Arctic National Wildlife Refuge. The population initially experienced a period of high mortality, and then a period of rapid growth, doubling every three to four years (Lent 1999; Wildlife Management Advisory Council (North Slope) 2017). The population had stabilized by 1986 as muskoxen dispersed out of the refuge to adjacent areas to the west in Alaska and to the east to the Yukon North Slope. Sightings of muskoxen on the Yukon North Slope were first reported in the early 1970s. Mixed sex groups eventually expanded their range into the Yukon in 1985, with a large dispersal occurring in 1986 and 1987 (Wildlife Management Advisory Council (North Slope) 2017). The original population on the Alaskan North Slope has since declined to very low numbers (Afema et al. 2017).

“It’s been a huge challenge to get people to harvest muskox again. Colonization affected all of it, including myself – as a wildlife officer I used to promote almost everything the government wanted and didn’t spend much time reading about my own history... we haven’t done a great job with muskox, in fact we’ve separated Dene people from muskox. My own sons would never come to me and ask how grandfather hunted muskox; they don’t even seem to appreciate it. But what about the meat, the hide, the Dene people and the ecosystem of Great Bear Lake? Our Dene history, our knowledge of food and harvesting, animal biology and ecology – those are all a big part of the Dene way of life... But there aren’t many people in Délı̨ne that want to harvest muskox because we lost that part of our hunting traditions. Alphonse Takazo used to say when ENR showed up is when the harvesting patterns changed so much – we had to live by laws. We have a lot to ‘re-learn’; if we can re-establish our relationship with muskox we might be getting somewhere,” (Bezha 2018 personal communication).

In his exhaustive search of available materials on the archaeology and the ethnohistory of muskox use in the circumpolar north, Peter C. Lent summarized the situation towards the end of the 20th century as follows:

“In North America [the native peoples’] mythology and oral history tell of a long relationship between people and muskoxen. In most cases these northern peoples have treated the animal pragmatically as a living resource in a region with a limited array of such resources, and where options and alternatives for sustenance and income are few. More recently, in a few places aboriginal people have come to view the muskox as a threat to existing livelihoods, a species that may compete with caribou and domestic reindeer,” (1999:7).

Nonetheless, muskoxen continue to play a valuable role “as a source of income and jobs, as food, and as a link to the land for practicing and preserving traditional skills and intergenerational knowledge,” (Kutz et al. 2017:226). They continue to be considered an integral component of northern ecosystems and emblematic of the Arctic in many regions (Kutz et al. 2017).

Cultural Background

Inuit (including the ISR in the NWT and Yukon, and the Kitikmeot and Qikiqtaaluk Regions of NU)

In the northernmost areas of the NWT, including the northern coast of the Mackenzie Delta region and the islands of the Arctic Archipelago, muskoxen are encountered and used by Inuit communities in the ISR and Yukon North Slope; they are also used in the Kitikmeot

and Qikiqtaaluk (or “Baffin”) Regions of NU. The Inuvialuit are culturally and linguistically related but diverse and speak at least three dialects in the ISR. Historically and into modern times, they make use of the tundra and taiga, and are settled into a number of small communities. Many of the communities are fly-in only.

Oral history and archaeological sources indicate that muskoxen have been an important food source for Inuit communities for generations, and that the importance of muskoxen to Arctic inhabitants went far beyond meat consumption alone. There is also ample documentation indicating that Inuit dependence on muskox as a source of food has varied greatly over geography and over time. A particular group of Inuit, the Utkuhikhalingmuit, lived in the Kitikmeot Region and were so dependent on muskoxen that their annual cycle of movements was to a large extent tied to the seasonal harvest of that species. Generally, hunters sought muskoxen primarily in winter months when caribou were scarce or in poor condition, but the meat became a staple in the Inuit diet as caribou declined in the 1830s and 1840s (Lent 1999).

Although muskoxen were used mainly as a food source, they were also harvested for their hides for tents and clothing, for thread, for horns for arrow points, and for cultural reasons such as songs (Nagy 1999; Fawcett et al. 2018). “Long ago, people called the muskox *hatuganik*... the muskox were the major resource exploited by people in Banks Island,” (Helen Kalvak *in* Nagy 1999:18). Muskoxen were also viewed as wise in some Inuit stories, having the ability to understand human language (Lent 1999). There were times when muskoxen and caribou were plentiful enough that dried muskox and caribou meat lasted the year round, and some Inuit recalled that their ancestors would only eat muskox meat through the winter and summer (Nagy 1999). Oral histories indicate that Inuit families would cross the sea ice between Banks Island and Victoria Island to hunt muskoxen. Shamans would travel across first and scout for muskoxen (Nagy 1999). Muskoxen were also hunted on the safer shore ice in the late winter, while waiting for the geese to arrive (Nagy 1999). A comprehensive description of how muskoxen have figured in Inuit societies and economies over time is provided by Lent (1999).

The West Kitikmeot and Slave area crosses the border between the NWT and NU, and includes communities of Dene, Chipewyan, Métis, Inuit, and other peoples. In these regions, muskox is still considered one of the most important traditional foods in both summer and winter (SENES 2008). However, as with many other parts of the NWT, muskoxen were extirpated from the entire area during the first half of the century, influencing current knowledge and use (SENES 2008). Further information on the traditional knowledge (TK) and cultures of the West Kitikmeot and Slave area is included in the Wek’èezhì (Tłı̨chǝ) subsection.

In 2003, muskoxen were not used by the communities of Aklavik, Inuvik, and Tuktoyaktuk, although interviewees from a TK study indicated that in recent times, some hunters would go to Ikaahuk (Sachs Harbour, Banks Island) to assist with the commercial harvests there. Muskox wool was kept from that harvest and the meat sold commercially (ICC et al. 2006). Muskoxen have excellent wool (qiviut), which they shed every spring and summer. Qiviut collection at places such as Sachs Harbour and Ulukhaktuk is well known; the yarn made from the qiviut is knit into scarves and sweaters and sold. It can also be found on willows or on the ground (ICC et al. 2006).

Muskox meat is not as lean as caribou meat, and some Inuvialuit feel that muskoxen make good dry meat because of the fat in the meat. Muskoxen were an excellent source of fat for arctic inhabitants, especially during winter, when an old male in good condition could provide up to 75 pounds of fat (Lent 1999). The meat was said to be superior for conditioning dogs for this reason. Muskox tallow could be used in lamps and the marrow was also used extensively. Muskox bones were used for heating and cooking fuel, as well as made into needle cases, skin stretchers, shafts, tips, and mouthpieces for bow drills (Lent 1999). Muskox skins were used for almost all items of clothing from boot soles to parkas in the past, as well as sled covers, and tents (Lent 1999), but like those of caribou, are “mainly sleeping skin nowadays,” (ICC et al. 2006:11-72). In more recent times, people have also sport hunted muskoxen, for the skin and the head (ICC et al. 2006).

Following the long-term ban on hunting in the early 1900s, muskoxen were not actively harvested by Ulukhaktok (formerly Holman) hunters until the early 1990s (Pearce et al. 2011). In more recent times, Inuvialuit harvesters in that community have indicated a strong reliance on muskoxen for food, especially in winter (Weshe and Chan 2010). There tend to be muskox hunts both in the fall and spring, but due to the close proximity of muskoxen to the community, day trips for hunting muskoxen can be made throughout the year (Pearce et al. 2011). When muskox availability increased in the vicinity of Aklavik, Tuktoyaktuk, Paulatuk, and Ulukhaktok, Paulatuk and Ulukhaktok increased their muskox harvest to compensate for declines in availability of caribou. Despite increased access across the four ISR communities, Ulukhaktok was the only community showing a high frequency of consumption in the early 2000s (Pearce et al. 2011). With increased availability, residents of Ulukhaktok embraced the use of muskoxen beyond subsistence, and new economic activities resulted, such as various forms of wage employment, including sports hunting, fur sales, and meat sales (Nickels et al. 2005; Weshe and Chan 2010).

In contrast, some Inuit in Aklavik reported negative feelings toward muskoxen because they scare away the caribou and people are not interested in eating the meat (Weshe and Chan 2010). Indeed, it is reported in several sources that muskox is not generally a preferred meat for Inuit, especially if it was frozen or had not been consumed for a long

stretch – at those points, caribou meat was preferred (Nagy 1999). The preference for eating meat other than muskox (among both Inuit and non-Inuit) was documented even by the earliest European traders who mentioned muskoxen, around 1700 (Barr 1991). Switching from caribou meat to muskox is at times considered a downgrade (Nickels et al. 2005; Weshe and Chan 2010). Again, a ban on hunting muskoxen in Nunavut (formerly part of the NWT) from 1917-1969 likely influenced harvesting behaviour well after the ban was lifted.

As with other regions, muskoxen are an alternative food source when caribou are scarce near Iqaluktutiaq (Cambridge Bay, south-east Victoria Island, Kitikmeot Region), NU. Caribou are generally preferred over muskoxen for several reasons, including personal preference, but also because they are easier to butcher, transport, and process than muskoxen (Tomaselli et al. 2018b). However, muskoxen were particularly important historically as a source of food to this community, and they remain so today. They are an important part of Inuit culture in NU, contributing to the traditional subsistence economy by providing food, tools, clothing and shelter, as well as to social life by inspiring art and games. Sharing meat with family networks and community members is a practice deeply connected to Inuit culture and tradition, and muskoxen were historically considered a reliable food resource to harvest and share, possibly because of their sedentary nature (Tomaselli et al. 2018b).

Iqaluktutiaq residents recognized muskoxen for their contribution to biodiversity as well (Kutz et al. 2017; Tomaselli et al. 2018b); however, muskoxen may have been feared, even by shamans.

“People were scared of this muskox, that man was scared of that muskox too. That man was a medicine man and was going to try to use his medicine on him. He blinded that muskox. Something was wrong with the eyes of that muskox. After he blinded him, they killed that muskox. After he blinded this muskox, he made a song,” (William Kuptana *in* Nagy 1999:21).

Muskoxen are important at both the individual and community level. They are bigger and heavier than caribou and provide more meat per hunting effort, and the community of Iqaluktutiaq had been harvesting muskoxen for commercial purposes since the 1980s. The last commercial harvest of muskoxen took place in Iqaluktutiaq in 2012; after that, commercial harvesting was suspended because of the decline in muskox numbers in the permitted hunting area (Tomaselli et al. 2018b). More detail on commercial hunting of muskoxen is included in **Guided Hunting, Sport Hunting, and Commercial Hunting**.

In recent years, the simultaneous declines of both caribou and muskoxen around Iqaluktutiaq have been of great concern to the community’s residents, as the declines affect both the food harvest and commercial guides’ income-generating potential. Declining food

harvest and declining incomes are both drivers of food insecurity, which is compounded by reduced opportunities in crafting and collecting qiviut (Kutz et al. 2017). Reduced numbers of muskoxen have negative economic consequences, significant implications for food security, and negative effects on the social and cultural system (Tomaselli et al. 2018b). Furthermore, the absence of muskoxen is considered a barrier to the connection and flow of knowledge among generations, especially between elders and youth. Beyond their significant economic value, muskoxen are valued culturally as a “catalyst for intergenerational learning to reinforce cultural identity,” (Kutz et al. 2017:227). Muskoxen are important for traditional use, community identity, and psychophysical well-being (Tomaselli et al. 2018b). In fact, the muskox is considered to be a unique, iconic animal; it is an integral part of the landscape and connected to Inuit culture and identity (Kutz et al. 2017).

Gwich'in

Many Gwich'in sources seem to point at the lack of valuation of muskoxen by modern community members (Wishart 2004; Benson 2011, 2015; McLeod 2018 personal communication). This may be in part due to perceived or real effects on caribou. The extirpation of muskoxen in recent history may have caused their traditional value to be lost, and for any knowledge to similarly be lost. After muskoxen were re-introduced in Alaska, hunting regulations were enacted without consultation. This, along with a focus on protecting muskoxen for non-Indigenous values such as tourism and guided hunts, may be exacerbating this perception (Wishart 2004). Muskoxen are being harvested around the community of Aklavik – in part to sell the hides to taxidermists. A renewed appreciation of the meat is being fostered by this activity, to some degree (McLeod 2018 personal communication).

Sahtú Dene and Métis

As previously mentioned the 1917 ban on muskox hunting also had a significant impact on Sahtú Dene and Métis³ TK and harvesting. The extirpation and ban effectively separated people from muskoxen, and because of that there is little TK about muskox in this area today, and it's been a challenge to get people to harvest again (Bezha 2018 pers. comm.).

Despite the fact that muskoxen haven't been available to Sahtúot'ine for several generations, and the subsequent interruption of TK transmission, there is evidence that they were important in the past, with harvest levels fluctuating based on abundance and availability (Bezha 2018 personal communication). The *Sahtú Atlas* identifies the Great

³ For the purposes of this report, people of multiple ancestries (sometimes known as “Métis”) who identify as either Gwich'in or Sahtú Dene, and those who identify as Métis within these two areas, are included as Gwich'in or Sahtú Dene. In other areas where Métis communities exist and there is TKCK information recorded separately, their information is included separately. This is due to the organization of the source material.

Bear River as a Sahtú Dene travel route to Great Bear Lake, where people would sometimes travel to hunt for muskoxen (Auld and Kershaw 2005). Neregah – the north shore of Great Bear Lake from McGill Bay east to Greenhorn River – is also noted in several Sahtú sources as an important traditional use area, that included muskox hunting (Andrews 2000; Auld and Kershaw 2005; Sahtú Land Use Planning Board 2013). T’echo Cho Deh T’a T’aa (Fort Confidence) is also an important area for Sahtú Dene and Métis, as there is a trail located there that leads from the head of Dease Arm to barrenland hunting areas for muskoxen (Andrews 2000).

“We do have stories about muskox – one we always used to hear was during the rut. You have to be very careful that you don’t get yourself into an unsafe position; the saying was ‘If a bird flew past muskox during the rut, it would end up on their horns’. I think they mean they’re very quick and their horns are sharp. Then also about how caribou don’t like the smell of muskox; I think this is in the old stories.

The danger is part of the reason we don’t hunt muskox anymore... if you don’t know much about it, why would you harvest it? If other ungulates are available, why would you hunt something you don’t know very much about?” (Bezha 2018 personal communication).

Walter Bezha states that muskox was an important species for Sahtúot’ine for food and clothing prior to contact. Members of his family said that muskox hides made excellent sled covers, as they are very resistant to wear from travel; this quality likely also made them good for clothing, footwear, snares, and snowshoes (Bezha 2018 personal communication).

Dehcho First Nations

Kát’odeeche First Nation harvesters and TK holders report that there are no observations, historically or presently, of muskoxen being near or within the Kát’odeeche First Nation traditional territory (Redvers 2018 personal communication). As a result, no information was included for this region in this report.

Wek’èezhì (Tìchq)

The Fort Rae post, at the location of the modern community of Behchokò, was first established in 1852 on a prominent peninsula on the north shore of the north arm of Great Slave Lake as a wintering provision post for the Hudson's Bay Company (HBC). It became an important trading post and meeting place for the Tìchq people and an important caribou meat provisioning centre for traders. The Fort Rae post was also a major station in the trade of muskox robes (SENES 2008).

Muskoxen used to be of considerable economic value to North Slave Métis trappers and one of the main resources that attracted trappers to the central NWT near Lac de Gras in the

past (NSMA 2001). Because the HBC trader at Fort Rae encouraged the winter hunting of muskoxen, it became an important center of trade for all hunters, Métis and Tłıchǫ alike (NSMA 2001).

In the 1870s, the HBC lost its monopoly in the fur trade, and in the mid-1880s the steamboat was introduced to reduce transportation costs. These developments had a major impact on the fur trade, and particularly the Métis teams who had formerly manoeuvred the York boats along the rivers (SENES 2008). The reduction of the number of fort employees significantly reduced the need for caribou meat, so Métis and Tłıchǫ were encouraged to trap and later to harvest muskoxen for robes (NSMA 1999).

Akaitcho Dene First Nations

The Akaitcho Dene First Nation represents people who are indigenous to Dettah, Ndılo, Łutsel K'e, and Fort Resolution. Akaitcho people also live in the NWT communities of Fort Resolution, Fort Smith, and Yellowknife. Ndılo and Dettah are two main communities of the Yellowknives Dene First Nation. Languages spoken in this area can include Chipewyan, Tłıchǫ, Dene Zhatie, North Slavey, Michif, and English.⁴

Written sources indicate that in general, Chipewyan people mostly harvested muskoxen early in summer when caribou were less available; while there are some discrepancies regarding the amount of muskox harvested, sources indicate that caribou was the preferred meat (Lent 1999). More culturally specific details are included below where available; however, very few sources were found for this region of the NWT.

Łutsel K'e Dene

Łutsel K'e Dene First Nation (LKDFN) elders that travelled and lived throughout the Na Yaghe Kue (Snap Lake) Region reported that they travelled along the eskers from historic Denésǫhíné villages and muskoxen were one of the animals that they killed on the barrens (LKDFN 2001a).

Yellowknives Dene

Very little information regarding the cultural importance of muskoxen to Yellowknives Dene was found in the sources reviewed for this report. Fred Sangris mentioned his own family's traditional reliance on muskoxen during a presentation as follows:

“My grandfather David Sangris was born on the Coppermine River around 1865. He was born there, living on the land in nomadic times. Nothing came from stores or from the European trade. They lived mostly by themselves in the

⁴ The information in this report is organized variably by political and cultural boundaries, as well as by muskox subspecies as appropriate. Generally, information in each subsection is presented from north to south.

traditional way on the Coppermine River, surviving on muskox and ekwò. Clothing, everything came from there,” (2012:75).

Deninu K’ue First Nation

Little documented TKCK was found for the South Slave region; however there are indications that the Deninu K’ue consider muskoxen to be of particular importance as a traditional food source (DeBeers Canada 2012).

Communities and Indigenous areas occurring within muskoxen range in the NWT are shown in Figure 2.

Source Summary and Discussion of Gaps and Omissions

This report was constrained by the lack of TK and CK sources that were recent, NWT-focussed, and specifically about muskoxen. Much of the information came from sources that were not recent. It is important to understand that the complicated management scenario of muskox extirpation, hunting bans, and re-introductions, continues to influence how people understand current trends in muskox population levels, distribution, and interactions. Many sources were not focussed on muskoxen so only had a small amount of relevant information, often included only tangentially, and the information did not result from accepted TKCK research methods.

With the intent of providing as up to date TKCK as possible, short telephone interviews were conducted with three knowledge holders in the Sahtú and Gwich’in Regions. The participants included two Indigenous wildlife resource professionals and one commercial hunting guide. The interviews were semi-structured and focussed on topics provided by the TKCK Guidelines. Information was recorded in as verbatim notes as possible and has been included here as personal communications.

While this work was intended to focus on information in the NWT, several recent and comprehensive sources of muskoxen TKCK became available from outside of the NWT, especially Nunavut. Research conducted in Iqaluktuq (Cambridge Bay, south-east Victoria Island, and Kitikmeot Region) was considered relevant due to proximity, the fact that Nunavut was part of the NWT until 1999, and the endemic population of muskoxen (in the NWT in the eastern part of the ISR, the Sahtú region and further south) is shared with NU. These NU sources (e.g. Tomaselli et al. 2018a and b) were publicly available and had undergone appropriate community verification. Generally, information from NU is included in its own sub-section.

While researching sources for this report, the preparers were made aware of relevant research being conducted by Postdoctoral Fellow Fabien Mavrot at the University of Calgary. Mavrot’s team has recently completed interviews and mapping with local knowledge holders in the community of Ulukhaktok, with the intent of better

understanding the health of the muskox population in that area. Research questions include:

- How is the muskox population doing? How has it changed in the past year?
- What factors have an impact on the population/individual health?
- What are the disease/symptoms observed in muskoxen?
- What health indicators could be used to effectively monitor the population?
- What information is available on factors important for disease transmission (sympatric species, animal movements, landscape preferences)?

This information would be extremely valuable to this assessment but is not currently available.

A muskox health monitoring program was initiated in Ulukhaktok in 2016 under a partnership between the Kutz Research Group (University of Calgary) and the Olokhaktomiut Hunters and Trappers Committee. The program aims to improve the timely detection of changes in local muskox population health and trends through a hunter-based sampling and data collection scheme (Mavrot 2019 pers. comm.). Samples are analyzed for different health traits (e.g. stress hormones, parasite burden, minerals) and tested for exposure to diseases such as brucellosis. Harvesters also fill out a questionnaire with information such as age class, sex, body condition, herd size, and number of young animals in the herd. Early results from that program are included in this report.

Northwest Territories

Inuvialuit Settlement Region (ISR)

Muskox TKCK sources from the ISR were the most numerous and the most focussed, and include:

Fawcett et al. 2018: Data were collected through semi-structured interviews and participant observation over a ten-week period in Ulukhaktok between June and August 2016. Thirty-two respondents, including both men and women, of varying ages were recruited. While the study primarily focussed on an economic assessment of changes in harvesting patterns correlated with climate change, the interview data include many observations about trends in muskox distribution and abundance on Victoria Island and Banks Island.

Lent 1999: This book is a rich source of background information regarding the long relationship between humans and muskoxen. It provides a comprehensive and detailed history of muskoxen in North America as well as other parts of the world, spanning both

TKCK and scientific knowledge (SK). Information has been included here when it was thought to shed light on patterns of muskox harvest/use, distribution, and abundance over time and space. However, this source could not be reviewed in detail and contains much information that could not be included here due to time constraints and a desire to focus limited resources on information sources that could be more directly relevant to determining the current status of muskox.

Nagy 1999: From 1995-1999 the Aulavik Oral History Project was undertaken by the Inuvialuit Social Development Program. The main objective of the project was to document Inuvialuit land use and knowledge of Banks Island. During the winter and summer of 1996, interviews were conducted with Inuvialuit elders in Banks Island, Aklavik, Holman, Inuvik, Sachs Harbour, and Tuktoyaktuk in the NWT. Information collected from archival material and interviews included topics such as seasons of land occupation, means of subsistence, habitation structures, trapping activities, and social life.

Yukon North Slope

While no “key” or “major” sources were found here, it should be noted that information for this region has been included under the ISR heading due to the fact that the Yukon North Slope (YNS) is a part of the ISR, and has been and remains a core hunting territory for Inuvialuit of the Western Arctic. Inuvialuit from Aklavik and Inuvik travel by boat, foot, all-terrain vehicle or skidoo to hunt, trap and fish along the coast, foothills and mountains of the YNS. The *Inuvialuit Final Agreement* finalized in 1984 legislated and confirmed that the management priority for the YNS is the conservation of the land, waters, wildlife, and Inuvialuit traditional use (Tyson and Heinemeyer 2017).

However, it is also important to note that the muskox population on the North Slope is distinct from other areas of the ISR and is a distinct subspecies also; for this reason, the information is often included under its own sub-heading.

All Other Areas, Including Gwich'in, Sahtú, Akaitcho Dene First Nation, Salt River First Nation

For the Gwich'in and Sahtú areas, sources did not include comprehensive or focussed TKCK about muskox. Most references were from reports about other topics. The Wildlife, Lands, and Environment Department Manager of the Łutsel K'e Dene First Nation is preparing a document about muskoxen, which was unavailable at the time of writing.

Alex Hall's '*Muskox Observations on Thelon River*' were provided by the contract monitor to the preparers of the SK report as well as this TKCK component. The information in this source includes a river guide's detailed accounting of muskox sightings from 1971-2016 within the Thelon Sanctuary, and tends to span scientific and local knowledge categories. Data up to 2004 have previously been published in Gunn et al. 2009. Because recent data are currently being compiled and analyzed at Environment and Natural Resources (ENR),

information from that source is expected to be included in the scientific component and has not been included here.

To supplement the Indigenous TK sources and the modern land-based knowledge from outfitters, several historical or overview level sources were reviewed for this report. In addition to Lent (1999), the sources include Barr (1991), Hoare (1930), and Tener (1965). These sources rely primarily on a western framework of scholarship, historical research from primary and secondary sources, and observations made while travelling or working in the NWT. Although these types of sources are not typically considered TK or CK, the specific management context of muskoxen means that historical sources are of particular interest in assessing status for this species.

Nunavut

Taylor 2005: The researcher documented Inuit knowledge (*Inuit Qaujimagatuqangit*) regarding patterns in population characteristics in Peary caribou (*Rangifer tarandus pearyi*) and muskoxen (*Ovibos moschatus*) in the High Arctic of NU as a means of understanding severe population fluctuations over the past 40 years. Local experts from Resolute Bay and Grise Fiord shared understandings of factors contributing to changes in abundance, and information concerning muskox ecology. Because the islands of the High Arctic are geographically quite distant from the area of focus, only summary details have been included in this report. However, this source contains a lot of very detailed information that could help inform understandings of muskox population cycles throughout the north.

Tomaselli et al. 2018a: The authors conducted community research about knowledge of muskoxen in the area of Iqaluktutiaq (Cambridge Bay, south-east Victoria Island, Kitikmeot Region, NU) in 2014. Thirty-eight participants took part in the study; semi-structured interviews were designed to gather local knowledge about muskox topics including muskox distribution, abundance, health, and diseases. Observations made by participants allowed inference of possible mechanisms for the recent population declines, including poor recruitment, poor body condition, and increased morbidity and mortality (including endemic and emerging diseases). The study was initiated based on community concerns about declining populations and increasing parasites. Much of the information came from the area immediately around the community although some knowledge did extend many hundreds of kilometers away.

Tomaselli et al. 2018b: Researchers explored themes such as the importance of muskoxen, their relevance for local food security, and the relationships and interactions between residents of the community of Iqaluktutiaq (Cambridge Bay) on Victoria Island, NU and muskoxen, with the goal of informing a community-based participatory muskox health surveillance system. Individual interviews were done with 30 community members

identified as muskox experts by local organizations, including 28 year-round community residents, of whom 23 were Inuit (nine elders and 14 adults) and five non-Inuit, and two summer residents (commercial float plane pilots). Results were finalized and refined with 26 interviewees in feedback sessions.

SPECIES OVERVIEW

Names and Classification (What names are used for the animal or plant?)

Common Name - English: Muskox (singular), Muskoxen (plural)

Common Name - French: Bœuf musqué

Scientific Name: *Ovibos moschatus*⁵

Inuktitut: Umingmak⁶ (Siglitun, Uummarmiutun, Kangiryuarmiutun)

Gwich'in: Dachan tat gwa'aak'ii (Teet'it Gwich'in dialect, needs verification⁷)

Dachan tat gwa'aak'ii (Gwichyah Gwich'in dialect, needs verification)

Sahtú: Gokw'i ejiré (Sahtúot'ine – Délıne)

Gop'iejiré (Shúhtaot'ine – Tulít'a)

ʔəjireyóné (K'ahshógot'ine – Radıłh Kóé / Fort Good Hope)

Description (What are muskoxen like; what do they look like?)

Muskoxen are completely covered by hair, except for the horns, hooves, lips, and nose. They have an under layer of short fine wool of exceptional warmth, known as qiviut, covered by a dark brown or black shaggy coat (Auld and Kershaw 2005). Bulls are slightly larger than cows and darker in colour. The horns of muskoxen are large, swoop down beside their heads, and meet in the middle of their heads (Barr 1991). Muskox herds can be detected by their distinctive smell — a large group of animals is said to have a foul smell to it, “You could smell them from a mile away,” (ICC et al. 2006:11-70). Muskoxen live in small

⁵ The 34 muskoxen that were captured in Greenland and shipped to Alaska were the Arctic island subspecies *Ovibos moschatus wardi* and not the continental subspecies *Ovibos moschatus moschatus* that are currently found in other areas of mainland NWT and Nunavut (WMAC(NS) 2017). For the purposes of this report, we use the terms muskox (singular)/muskoxen (plural) for both types of animal but differentiate between the two populations geographically.

⁶ Umingmak is singular; Umingmaak is two muskoxen and Umingmait three or more. Umingmak has been interpreted as “the one with hair like a beard” (Lent 1999:3) or “the animal with skin like a beard” (Inuvialuit Communications Society n.d.).

⁷ Tsiigehtchic elders Hyacinthe Andre and Gabe Andre (Gwichya Gwich'in dialect) indicate that there is some confusion over the words used to indicate muskoxen vs. wood bison in traditional stories and place names. Traditionally, however, a hand signal accompanied the spoken name which easily distinguished bison from muskoxen (Benson 2014).

herds up to about 80 animals in size. Once herds get bigger, they disperse (McLeod 2018 personal communication).



Figure 1. A small muskox herd photographed from the air, with animals of different ages visible. Photo credit: Kristen Olesen, Hoarfrost River Huskies Ltd.

Distribution (Where can we find muskoxen?)

NWT Distribution

Muskoxen are found in the ISR and across the Arctic Archipelago, in the western portion of the GSA, across much of the Sahtú Settlement Area, and in the eastern portions of the North Slave and the South Slave regions, including the far-east portion of Wek'èezhì. Populations in the western mountainous parts of GSA and ISR, including the YNS, resulted from a re-introduction to the Alaskan North Slope and expansion of those muskoxen into Yukon and NWT. Current SK of muskox distribution in the NWT is shown in Figure 2, as no spatial information was available in the TKCK sources reviewed for this report.

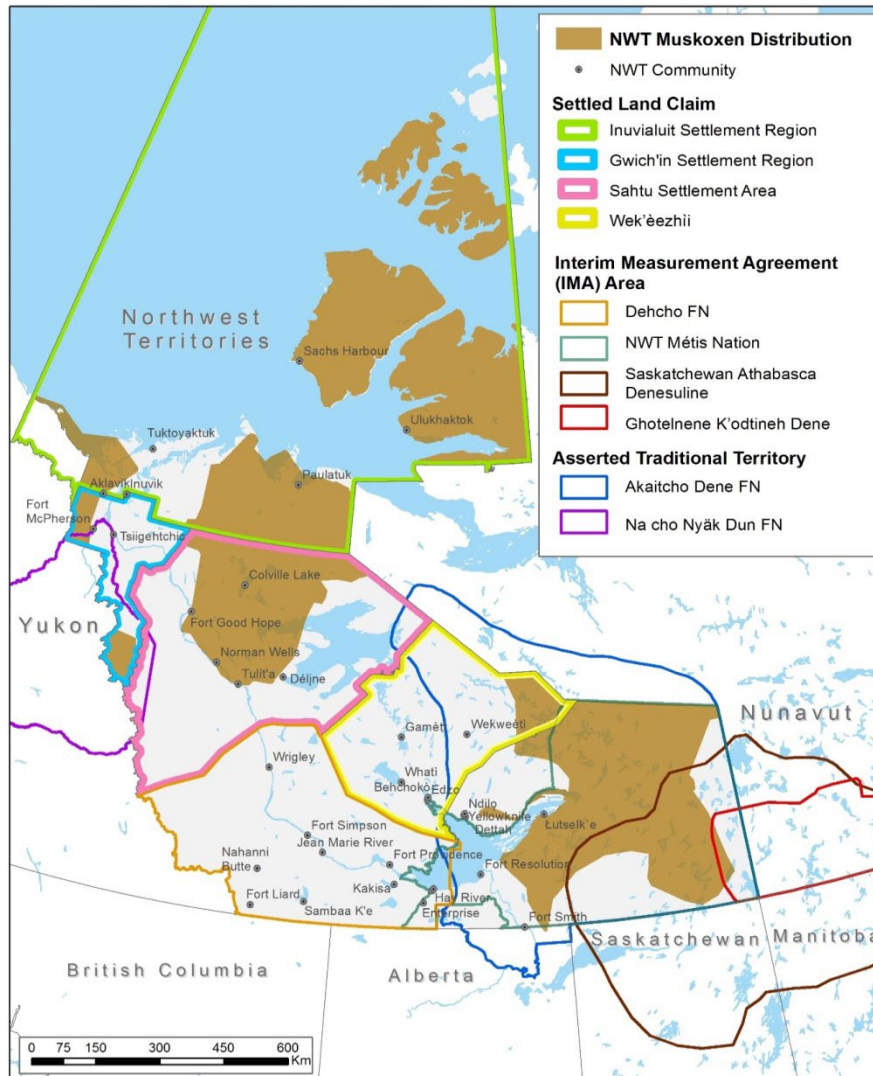


Figure 2. Map showing communities, land claim and Indigenous use areas within muskoxen range in the NWT. Distribution information is based on scientific survey data and incidental records from the GNWT Wildlife Management Information System (1967–2018) as no spatial information was available in the TKCK sources reviewed for this report. Map provided courtesy of Government of the Northwest Territories (GNWT), ENR.

Muskoxen are present throughout the West Kitikmeot/Slave Study area (eastern NWT mainland) (SENES 2008), including large portions of what is now NU (but was formerly NWT). This is the same population as found in the northeastern ISR, and older sources include the TKCK as NWT information. For those reasons, information has been included from NU when relevant. However, it is important to reiterate that no specific search was done for NU information sources and the information provided here should not be considered complete. No spatial information on the distribution of muskoxen in NU or Yukon was available for use in this report.

The actual southern extent of muskox range is currently not well defined (Adamczewski 2019 personal communication). In July 2019, a muskox (likely a young bull) was harvested near Fort Chipewyan, Alberta (Canadian Broadcasting Corporation 2019). While there are rare but reliable sightings on both the Saskatchewan/NWT and Alberta/NWT border, this is the furthest south record reported to date (Adamczewski 2019 personal communication).

While some details regarding distribution and range are included in the sections below, this topic is generally better addressed by available SK, and the authors direct readers to the SK component for this information. This is particularly true for muskoxen, due to the extirpation and re-introductions, and a generations-old hunting ban throughout their Canadian range otherwise. However, TKCK does provide a few spot locations and general distribution for muskoxen which appear to confirm the range map currently in use by the GNWT.

Inuvialuit Settlement Region and Yukon North Slope

Inuvialuit oral history and TK indicate that muskoxen were consistently found across islands in the Arctic Archipelago such as Banks Island and Victoria Island for many generations. Evidence of a significant subsistence reliance on muskox is found at numerous archaeological sites described in sources like Fawcett et al. (2018) and Nagy 1999, among other sources (e.g. Berger Inquiry V42 Sachs Harbour 1976). The archaeological record provides no evidence of past peaks of great abundance on Victoria Island, and explorers' accounts suggest that muskoxen existed in small numbers only on parts of the island (Lent 1999).

Banks Island is thought to have served as a refugium for muskoxen; "Perhaps no place in the north has exhibited such ups and downs in muskox numbers, such periods of feast or famine, as has Banks Island," (Lent 1999:75). Despite seeing abundant skeletal remains on the island, explorers here in 1851 saw no muskoxen on the island's coasts, and only saw four living muskoxen during an extended stay (Lent 1999). Muskox numbers on Banks Island were estimated as very low in the 1930s, 1950s, and at the time of the first systematic survey in 1961 (Tener 1965, Lent 1999, and other sources therein).

When placing a number of trial "muskombs" (devices to passively collect qiviut from muskoxen rubbing on them), Kellet Valley near Sachs Harbour was chosen as muskoxen were regularly seen there (Katz 2007).

The Paulatuk Community Conservation Plan outlines important subsistence and sports hunting areas for muskox, such as a spring harvesting area "[e]xtending from Cape Parry, west to the mouth of the Horton River, south to the ISR boundary, east to the Horton River, and north to the Brock Lagoon," and a winter harvesting location at "Cape Parry, west to the mouth of the Horton River, following southward along the west side of the Horton

River, to the south side of Tadenet Lake, east to the Horton River, northeast to Brock Lagoon,” (Paulatuk Hunters and Trappers Committee et al. 2016:33 and 49). The Sachs Harbour Community Conservation Plan also has numerous important areas identified for harvesting muskox, as well as descriptions of muskox habitat needs and use; for example, muskoxen are harvested south of Rufus River from October to April and are known to congregate in Aulavik National Park all year (Sachs Harbour Hunters and Trappers Committee et al. 2016).

The Olohaktomiut Community Conservation Plan (Olohaktomiut Hunters and Trappers Committee et al. 2016) identified many areas as important for muskoxen:

- the Kangikhokyoak Gulf (Liddon Gulf) coastline
- Richard Collinson Inlet and Glenelg Bay
- Tahioyak (Safety Channel), Tahikyuak Lakes (South, East) and Kangikihnik Lake, and Kaglokyuak, Engaloak Rivers
- Kuukyuak (Kuujjua) River and Diamond Jenness Peninsula Coastal Zone
- Ibbett Bay to McCormick Inlet
- Tahikpalok Lake Region and North Shore of Prince Albert Sound
- Habitat / Harvesting Areas south of Wynniatt Bay
- Habitat / Harvesting Areas around Minto Inlet
- Prince Albert Peninsula Wildlife Area of Special Interest (wintering area) (Olohaktomiut Hunters and Trappers Committee 2016).

In particular, the plan notes that Bailey Point Wildlife Area of Special Interest is “[a]mong the best habitats for muskoxen in the Canadian High Arctic” and is a “Refugium for muskoxen during periods of extreme climatic conditions November to March,” (Olohaktomiut Hunters and Trappers Committee 2016:36).

Sightings of muskoxen on the YNS were first reported in the early 1970s. The majority of the North Slope muskox population currently occurs within the ISR, particularly in Ivvavik National Park. However, in recent years, small groups of muskoxen have been reported as far east as the Mackenzie River, as far south as Old Crow, the Wind River, Tombstone Territorial Park, and the Bonnet Plume River north of Mayo (Wildlife Management Advisory Council (North Slope) (WMAAC(NS)) 2017).

Some Inuvialuit feel that muskoxen are not native to the North Slope or Richardson Mountain area; “... we never ever had muskox in our hills before, quite a few years back in ... Alaska, some white people around there transplanted some muskox,” (ICC et al. 2006:11-69).

Gwich'in Lands and Adjacent Areas in the Yukon

Although generally understood to be found in the northern extent of the Richardson Mountains or along the Arctic coast, Gwich'in harvesters and travellers have seen muskoxen outside of this area as well (Wishart 2004; Benson 2011, 2014, 2015; ABEKC 2014, 2015). Long in the past, oral history indicates that muskoxen were also found in Gwich'in lands north of the Mackenzie River. When muskoxen returned to the area in the late 1980s or early 1990s, the Gwich'in of Aklavik saw them first around the Yukon/NWT border at Police Cabin, and then around Bonnetplume Creek, up from Willow River/Jurassic Butte. This small herd grew and then dispersed. Smaller herds from this dispersal went to Canoe Lake, Still Lake, and other places nearby (McLeod 2018 personal communication).

Muskoxen are seen regularly in Vuntut National Park and occasionally along the Dempster Highway, near Old Crow, and elsewhere in northern Yukon. Sightings have also been reported east of the Mackenzie River but are well west of the typical range of mainland NWT muskoxen (WMAC(NS) 2017).

Recent specific observations of muskoxen include (Benson 2015; McLeod 2018 personal communication):

- 11 muskoxen on a lake near the Yukon/NWT border on the Dempster highway, in 2002 or 2003. A muskox was harvested here by a Gwich'in elder in 2000.
- Several around Rengleng River on the Dempster Highway, north of Tsiigehtchic.
- Two seen at James Creek on the Dempster Highway, in the Yukon.
- Police Cabin on the NWT/Yukon border, in the late 1980s, which were the first muskoxen to be seen in the GSA (i.e., the NWT part of the Gwich'in Settlement Region).
- Late 1980s or early 1990s, the mountains around Bonnetplume Creek, just up from Willow River/Jurassic Butte.
- For a short time in the 1990s, a few muskoxen may have been present in the Mackenzie Delta around Knut Lang Camp.
- A few animals were seen around Tent Island in the Peel River but may have drowned.

In 2001, a Fort McPherson resident reported that there had been a group of muskoxen near that community for many years (WMAC (NS) 2001).

Sahtú Settlement Area (SSA)

As mentioned, muskoxen have been largely unavailable to Sahtú Dene hunters for several generations due to their earlier extirpation from parts of the region. In more recent times, hunters have been reporting muskoxen in some parts of the Sahtú, such as Great Bear Lake

(Bezha 2018 personal communication; Coulter 2018 personal communication). Recently, they have expanded into the Franklin Range (Auld and Kershaw 2005).

The Sahtú Land Use Plan identified the following areas as muskox habitat, or otherwise important for muskoxen (or muskox harvest):

- Ts'ude Niline Tu'eyeta (Ramparts River and Wetlands) Proposed Conservation Initiative
- Maunoir Dome/Lac Maunoir Conservation Zone
- Dene Di Gon'e Conservation Zone
- Lac Des Bois Conservation Zone
- Lac Belot Conservation Zone
- Anderson River Conservation Zone
- Hare Indian River Special Management Zone
- Underground River Special Management Zone
- Tunago Lake Conservation Zone
- Nerehtene Conservation Zone
- Great Bear Lake Watershed (GBLW) Special Management Zone
- Horton Lake Special Management Zone
- Neregah (North Shore) Special Management Zone
- Norman Range Special Management Zone
- Lac a Jacques Conservation Zone (Sahtú Land Use Planning Board 2013).

Akaitcho Dene First Nations – Łutsel K'e Dene First Nation (LKDFN)

Denésq̄hné hunters have familiarity with muskoxen and have traditionally found them in barrenland regions (LKDFN 2003 and 2005).

“The K'asba Nēne land region encompasses the big lakes of K'asba Tué (Ptarmigan Lake) and Łudaghe Tué (Clinton-Colden Lake), and the barrenlands that surround them. Elders define this land region as an area that was used extensively in earlier times by Denésq̄hné white fox trappers. This land region also contains the headwaters of the Hanbury River, used by the Denésq̄hné to travel east towards the Thelon River valley. Muskoxen are known to be abundant in K'asba Nēne, and many a Denésq̄hné trapper has managed to overwinter in the area by hunting these resilient animals,” (LKDFN 2003:26; LKDFN 2005).

“Another land region to the east of K'asba Nēne shares the name Na Yaghé Tué. This region is renowned for its rockiness, cited as virtually impassable by all but the most experienced and competent Denésq̄hné. This region, described by Elders as a “forest of sharp, tall rocks”, is said to be traversable by only one

tortuous route. However, those who make the journey are rewarded by lands to the northeast rich in muskox and migratory birds,” (LKDFN 2003:26-27; LKDFN 2005).

There were few sources found for this region, but of those reviewed, each indicated that muskox distribution was observed to be changing by the 1980s (see **Distribution Trends**).

Search Effort (How do people know about them?)

ISR and Yukon North Slope

Oral histories and archaeological evidence indicate Inuvialuit people have hunted muskoxen for subsistence for many generations, however relatively little is known about past Aboriginal hunting practices (Lent 1999).

Although a question about search effort was not posed in any available source, oral history indicates that muskoxen on Banks Island were historically easy to find. People would make dry meat all summer and eat the meat all winter, along with oil made from the fat. Historically, it appears that hunters would kill a whole muskox herd to put the meat up for the year. The archaeological remains around Banks Island support this, with a lot of evidence of piles of muskox horns and other remains in different places (for example, 170 skulls were found in one location) (Nagy 1999; Fawcett et al. 2018). There is also a residential site on Banks Island consisting of 15 stone tent rings overlooking a narrow river valley with steep walls where Inuit hunters likely conducted muskox drives in the fall, stampeding the animals (Lent 1999). There are several other examples of Indigenous hunters driving muskoxen to get them closer to encampments or run them over cliffs in northern Canada and Alaska (Lent 1999). Based on archaeological and historical sources, it appears that muskoxen were used at least intermittently across Banks Island by Inuit for thousands of years. There are numerous caches of muskox skulls numbering in the tens or hundreds. Some historians suggest that Inuit hunters were responsible for a drastic near extirpation of muskoxen on Banks Island in the last half of the 19th century, possibly relating to access to iron from an abandoned ship. Other historians deny that the evidence supports this (Barr 1991).

While muskoxen may have a reputation as being easy to hunt in some of the sources reviewed for this report, there is also some observational and oral history evidence that speaks to the contrary – there are stories from Inuit and from Arctic explorers alike that muskoxen will often flee, whether together as a herd or individuals splitting from the herd, and be difficult to pursue, even out-running dogs at times (Lent 1999).

Muskoxen were not known to be traditionally used by the communities of Aklavik, Inuvik, and Tuktoyaktuk, but there was large scale harvesting at Ikaahuk (Sachs Harbour) and the animals are said to be easy to domesticate (ICC et al. 2006). Some sources say that

harvesting usually happens in the spring or in the early fall before the muskoxen start rutting (ICC et al. 2006), however Lent (1999) reports that Inuit hunters generally sought muskoxen in winter months when caribou were scarce or in poor condition.

Hunters and other land users have reported seeing muskoxen all over the YNS, from tundra habitat to coastal plains (WMAC(NS) 2018).

Gwich'in and Sahtú

Muskoxen had not been actively hunted for a hundred years in these areas, due to extirpation and government policy. Indeed, any hunting would have resulted in fines or worse, which likely drove any oral history or TK further into secrecy (Wishart 2004). For these reasons, search effort is undocumented and likely unknown.

“Because muskoxen haven’t been available to Sahtúot’ine for several generations, people are no longer accustomed to eating them or have much TK because they haven’t been part of the landscape for so long. I didn’t hear about muskox from my grandfather...” (Bezha 2018 pers. comm.).

Starting in recent years, a few muskoxen have been harvested by hunters in the community of Aklavik, primarily for their value to taxidermists. Hunters have trouble finding the animals, as they are spread far and wide and stay in small herds (McLeod 2018 personal communication).

In the Sahtú, Plummer’s Great Bear Lake Lodge guests and staff encounter muskoxen in two main ways: they conduct muskox hunts during the last week or two of August and they make over-flights in the region of the lodge. Guides fly around the Great Bear Lake area a lot all summer, but also have observations from travel during other times of the year (Coulter 2018 personal communication).

Akaiicho Dene First Nations

The Yellowknives Dene would hunt for caribou and muskoxen in the summer, “[t]he people often joined their T’satsaot’ine relatives to hunt in lands from Aylmer Lake to Artillery Lake, sometimes as far east as the Thelon River. In warmer months, they followed summer trails by canoe to hunt caribou and muskox,” (Yellowknives Dene First Nation 1997:12). Łutsel K’e Dene First Nation members have travelled to the barrenlands to hunt muskoxen for many generations. Elders indicated that “[w]hen there was no caribou people would go for muskox on the Thelon River,” (Madeline Drybones in Dokis-Jansen 2015:78).

Biology and Behaviour

Habitat Requirements (What kind of land and food do they need to survive?)

Inuit knowledge holders in the High Arctic observed that muskoxen tend to use grassy valleys (Taylor 2005). A Sachs Harbour trapper noted that muskoxen moving into the

southern part of Banks Island were found where there was higher land (Berger Inquiry V42 Sachs Harbour 1976).

The following seasonal habitat use has been noted for muskoxen around Sachs Harbour (ISR):

- Winter – feed in valleys and drainages
- Spring (May) – use valleys and particularly side hills
- Summer – they are widespread
- Fall (August, September) – use tops and sides of hills to loaf, and feed in valleys (Sachs Harbour Hunters and Trappers Committee et al. 2016).

The northern part of Banks Island was considered an important breeding area for muskoxen prior to the 1970s.

“The trappers can use the whole island for trapping or hunting if they want. But what we [Trapper’s Association in Sachs Harbour] used to say was we’re saving the north end of the Banks Island for breeding area. That’s for foxes, caribou, muskoxen, all the caribou and the muskox they all calve at the north end. Muskox don’t move around too much but the caribous they go in the spring up to the north end and in the fall time they go by the east part and come to the southern part of the island,” (Andy Carpenter, Berger Inquiry V42 Sachs Harbour 1976:4120).

As mentioned in **Distribution**, Banks Island is thought to have served as a refugium for muskoxen (Lent 1999).

According to Inuvialuit TK on the YNS, muskoxen use similar habitats as caribou and can be found “all over” (Tyson and Heinemeyer 2017:24). They are found in tundra ecosystems and along the coast, in hillside or mountain ecosystems, and near rivers in valleys.

Land users of the YNS also indicated that muskoxen are found in mossy, wet areas – the type of land where your “feet sink in as you walk”. The ground may be wet, but bodies of open water aren’t seen. These areas can have grassy vegetation, many different types of berries including cranberries, akpiks and blueberries, and willow stands. Muskoxen share these areas with geese, swans, other waterfowl, grizzly bears, caribou, and moose (Tyson and Heinemeyer 2017).

In the winters, Richardson Mountain muskoxen prefer wind-swept areas which are rocky and elevated – “Real long and flat, almost airport grade – all gravel, no willows”; they strip these areas of vegetation over the winter (McLeod 2018 personal communication). Unlike caribou, muskoxen do not “crater” or dig through the snow for food frequently, except for possibly in the spring when food is more scarce (McLeod 2018 personal communication).

Muskoxen have not dispersed further south into the Rat River area, perhaps because the area doesn't have large enough wind-swept areas to support a herd over the winter; this is also sheep habitat (McLeod 2018 personal communication).

Photographs showing the type of rocky and wind-swept habitat where muskoxen are found during the winter months are included in Figures 3-5.



Figure 3. Muskoxen in the Richardson Mountains in winter. Photo credit GNWT.



Figure 4. Aklavik hunters butchering a muskox in the type of rocky, elevated habitat they tend to be found in during winter months. Photo credit GNWT.



Figure 5. Muskoxen are found in open rocky habitat of the Richardson Mountains during the winter months. Photo credit GNWT.

Observations in the Sahtú region indicate that muskoxen don't move around as much as caribou and tend to stick to a smaller area of habitat (Coulter 2018 personal communication). This is perhaps because they are able to eat a more varied diet, including all the grasses (Bezha 2018 personal communication). Muskoxen have also recently shifted from staying in the barrenlands to being found below the tree line in the Sahtú (ACCWM 2014).

Around Great Bear Lake, muskoxen are seen on the shore during summer, but move back into the trees in fall where they are harder to see. While on the shore, they are usually observed travelling; it is thought that the consistent ground surface may make travel easier for them than in the bush (Coulter 2018 personal communication). They also are seen in a valley nearby; “[r]ight around McGill Bay – there are hills and streams, a fertile valley, and they’re in that valley a fair bit. It’s quite open in there and we always see them in there,” (Coulter 2018 personal communication).

Deninu K’ue hunters indicated that unlike animals which migrate or use both the barrenlands and treed areas in their territory, muskoxen are only found in the barrenlands (DeBeers Canada 2012). Explorers into the Thelon-Hanbury watersheds in the 1920s noted that muskoxen use brushy willow flats to rub insects off themselves, by pushing forward and backwards through the dense brush to physically remove them (Barr 1991).

Wilson and Haas (2012) defined and mapped Important Wildlife Areas for several species – including muskoxen – in the ISR, GSA, Sahtú Settlement Area (SSA), and Dehcho Territory.

The authors identified seven areas for muskoxen (described in Table 1 and mapped in Figure 6), based on local observations, TKCK, and scientific information.⁸

Table 1. Important Wildlife Areas for muskoxen, reproduced with permission from Wilson and Haas 2012. References in table and footnotes are quoted directly from Wilson and Haas and the full citations are in that report.

ID#	Criterion Satisfied	Size	Substantiation
45	Ibbett Bay to McCormick Inlet⁹		
	#2 (place where animals consistently occur in relatively large numbers)	2,490 km ²	<ul style="list-style-type: none"> • This area on Melville Island has high muskox densities in the eastern part around McCormick Inlet. Sedge meadows occur locally within the area, making it important muskox habitat year-round (Community of Holman, Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000; Nettleship and Smith 1975). • The reported high muskox densities are based on surveys in the 1970s; more recent information on muskoxen in the area is lacking (Gunn 2009 personal communication).
46	Bailey Point¹⁰		
	#3 (area that animals repeatedly use under adverse conditions as a refugium)	941 km ²	<ul style="list-style-type: none"> • The peninsula on Melville Island has been identified as a refugium for muskoxen during extreme climatic conditions. When muskox numbers on most of Melville Island and Bathurst Island were decimated due to a severe winter in 1973-1974, the population in the Bailey Point area appeared to remain unaffected. It was believed that the area served as a reservoir for Melville Island's muskox population and a source of muskoxen for repopulating other areas in the western Queen Elizabeth Islands (Community of Holman,

⁸ Information in the 2012 report was based on discussions between 2006 and 2009 with communities, co-management boards, departmental staff and others as well as reviews of available reports. Wilson and Haas noted that some unique areas considered to be important for multiple wildlife species were also mapped, including warm and hot springs and mineral licks – but were not included in the figure as they were considered sensitive areas.

⁹ This area is also a unique landscape important to multiple species (see ID: 92). Experts initially recommending inclusion: ENR staff (Branigan 2008 personal communication), based on identification in Inuvialuit Community Conservation Plans (Community of Holman, Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000).

¹⁰ Experts initially recommending inclusion: Wildlife consultant (Gunn 2009 personal communication).

			<p>Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000; Ferguson 1987; Fournier and Gunn 1998; Gunn 2009 personal communication; Nettleship and Smith 1975; Thomas et al. 1981).</p> <ul style="list-style-type: none"> • The Bailey Point area is considered to be excellent muskox habitat because of a combination of factors including low precipitation, lack of rain and snow melt during winter, protection from winds, and productive and fertile lands (Ferguson 1987; Nettleship and Smith 1975; Thomas et al. 1981). This particular microclimate and vegetation make this area quite different than any other area on Melville Island (Gunn 2009 personal communication). • Estimated muskox densities for the area were consistently high in 16 aerial surveys from 1972-1983 (average 53/100km²), leading to the conclusion that Bailey Point has one of the highest densities of muskoxen in the Canadian Arctic (Ferguson 1987). • A survey in 1987 found an estimated muskox density of 30/100km² for the portion of southwestern Melville Island that includes Bailey Point (Miller 1988). • Not all sources support the importance of Bailey Point for muskoxen. The most recent aerial survey in 1997 counted only one muskox herd on Bailey Point, with an estimated density of 6.3/100km² for the larger area that includes Bailey Point (Gunn and Dragon 2002).¹¹
47	Southwest Banks Island¹²		
	#2 (place where animals consistently occur in relatively large numbers)	16,809 km ²	<ul style="list-style-type: none"> • Periodic aerial surveys of Banks Island have shown that this area consistently has relatively high densities of muskoxen. Aerial surveys from 1985-1998 estimated densities of non-calf muskoxen ranging from 0.50-1.92/km² for the Egg River area and from 0.68-2.91/km² for the Masik River area (Larter and Nagy 1999). Aerial surveys in 2001 and 2005 also recorded densities of non-calf muskoxen

¹¹ Note that not all recent sources support this observation. During sex and age composition surveys of Bailey Point in 1997 and 1998 only a single lone bull was observed in 1997 (Gunn and Dragon 2002).

¹² Experts initially recommending inclusion: Staff of Inuvialuit Game Council, Joint Secretariat and ENR (Meeting with Staff of Inuvialuit Game Council, Joint Secretariat and ENR 2008; Nagy 2008 personal communication).

			<p>>1/km² for southwest Banks Island (Nagy et al. 2007b; Nagy et al. 2007a).</p> <ul style="list-style-type: none"> • Portions of this area are important for muskox harvesting (Community of Sachs Harbour, Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000).
48	Aulavik National Park¹³		
	#2 (place where animals consistently occur in relatively large numbers)	12,381 km ²	<ul style="list-style-type: none"> • High densities of muskoxen are found year-round in this area, which includes the Thomsen and Muskox Rivers (Community of Sachs Harbour, Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000; Ferguson 1987). • Aerial surveys from 1985-1998 estimated densities of non-calf muskoxen ranging from 1.32-2.66/km² for the area (Larter and Nagy 1999). An aerial survey in 2001 also recorded a density of non-calf muskoxen >1/km² for the Thomsen River drainage (Nagy et al. 2007b). • The area is believed to be among the best year-round habitats for muskoxen on Banks Island (Ferguson 1987) and includes calving, grazing, and sheltering areas (Nettleship and Smith 1975).
49	Parker River¹⁴		
	#2 (place where animals consistently occur in relatively large numbers)	4,348 km ²	<ul style="list-style-type: none"> • The Parker River area has been identified as a high-density muskox area and one of the best year-round habitats for muskoxen on Banks Island (Ferguson 1987). • Aerial surveys from 1985-1998 estimated densities of non-calf muskoxen ranging from 0.63-1.62/km² for the area (Larter and Nagy 1999). Relatively high densities were also seen in this area in 2001 and 2005 (Nagy et al. 2007b; Nagy et al. 2007a).

¹³ Experts initially recommending inclusion: ENR staff (Branigan 2008 personal communication), based on identification in Inuvialuit Community Conservation Plans (Community of Sachs Harbour, Wildlife Management Advisory Council (NWT) and Joint Secretariat 2000).

¹⁴ Experts initially recommending inclusion: Staff of Inuvialuit Game Council, Joint Secretariat and ENR (Meeting with Staff of Inuvialuit Game Council, Joint Secretariat and ENR 2008).

50	Sahtú Muskox Areas¹⁵		
	#2 (place where animals consistently occur in relatively large numbers)	9,900 km ²	<ul style="list-style-type: none"> • These are places in the Sahtú region where one can consistently find large numbers of muskoxen (Popko and Veitch 2006 personal communication; Veitch 1997). With the exception of the area at the base of Smith Arm (off the western end of Great Bear Lake), they are upland areas such as ridgelines and eskers. • The easternmost areas, near Horton Lake, are the places in the Sahtú where muskoxen have historically been present the longest. Their importance for muskoxen is confirmed by published aerial survey reports and TK (Case and Poole 1985; Ferguson 1987; Fournier and Gunn 1998; McLean 1992; Sahtú Heritage Places and Sites
51	Hare Indian River¹⁶		
	#2 (place where animals consistently occur in relatively large numbers)	253 km ²	<ul style="list-style-type: none"> • In spring, when the water is high, muskoxen are concentrated along the stretch of the Hare Indian River between Lac à Jacques and Fort Good Hope (Sahtú Renewable Resources Board Meeting 2007; Sahtú Renewable Resources Board Meeting 2008).

¹⁵ Experts initially recommending inclusion: ENR staff (Popko and Veitch 2006 personal communication)

¹⁶ Experts initially recommending inclusion: Participants in Sahtú Renewable Resources Board meetings (Sahtú Renewable Resources Board Meeting 2007; Sahtú Renewable Resources Board Meeting 2008).

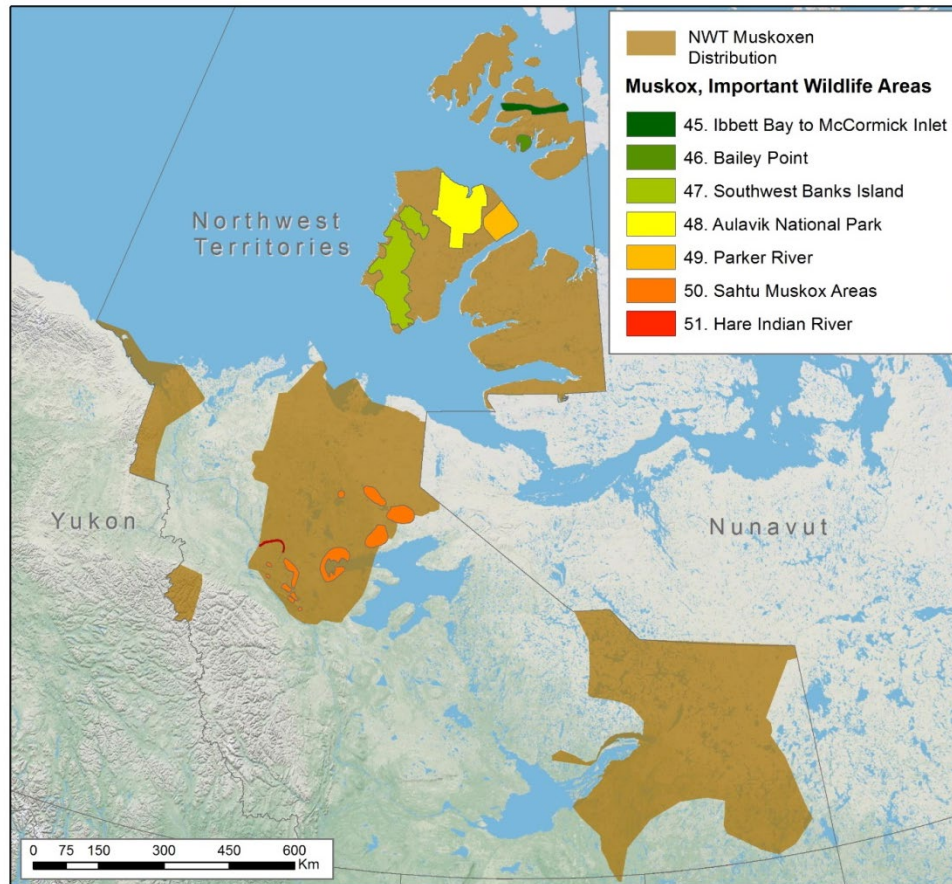


Figure 6. Important Wildlife Areas identified for muskoxen in the NWT, shown in relation to known SK of distribution. Reproduced with permission from Wilson and Haas 2012. Map provided courtesy of ENR (GNWT).

Movements

Overall, muskoxen do not seem to migrate or move around as much as caribou (Berger Inquiry V42 Sachs Harbour 1976; Bezha 2018 personal communication; Coulter 2018 personal communication); “Muskox are not travelers... They don’t migrate,” (David Nasogaluak *in* Nagy 1999:158). However, they will move seasonally or for other reasons, and herds will disperse as well.

While muskoxen are not migratory in the same way as Porcupine caribou, the animals on the YNS are observed to move between different types of habitat depending on food, weather, and time of year (WMAC(NS) 2018). Close to Aklavik, some of the muskoxen move to higher and steeper areas in the winter, while some stay in the same area in which they spent the summer. In the summer, the muskoxen who wintered high in the mountains head to lower areas in the ISR, including above Joseph’s Mountain and Myer’s Lake close to the delta (McLeod 2018 personal communication).

Community members in Kaktovik, Alaska reported to the Aklavik Hunters and Trappers Committee (HTC) that ‘explorer’ muskox (lone males) go out to find new places and come back to their groups to lead a smaller mixed sex group away with them (WMAC(NS) 2001). A herd near Aklavik grew to about 100 animals and then dispersed in this way, to form many smaller herds. The bulls in the larger herd chase out the younger, smaller bulls, who then start new herds (McLeod 2018 personal communication).

Muskoxen are capable of moving between islands in the Arctic Archipelago over winter ice (Nagy 2004). Kugluktuk hunters indicated that they can move between the mainland and Victoria Island, in NU (Golder 2003). Muskoxen will also expand their range as their population grows and have been seen south of the treeline in recent years when they previously were only known in the barrenlands (ACCWM 2014). Inuvialuit on Banks Island recalled them moving from their breeding grounds on the north of the island further south (Nagy 1999). However, it is reported that muskoxen around Paulatuk won’t travel south because their legs are too short, and they don’t like to go in the trees when the snow is deep. Instead, they will stay in one place for a long time, especially if no one is bothering them (WMAC(NS) 2001).

As mentioned, muskoxen around Great Bear Lake seem to be present and travelling along the lake shore during the summer months, but then move inland into the trees in the fall time, where they are harder to see and hunt (Coulter 2018 personal communication).

In an assessment of the Snap Lake Project, elders of the Łutsel K’e Dene First Nation showed muskox tracks in the area and indicated that both muskoxen and barren-ground caribou always move along eskers when they are travelling through rough rocky landscapes (LKDFN 2001a).

During a technical workshop of the West Kitikmeot Slave Study Society, Aboriginal land users and government wildlife biologists discussed the westward shift in muskoxen distribution during past years.

“Some elders explained that this shift in distribution mirrored a similar shift in the Denésǫhné (Chipewyan) people over the past 50 years and that the muskoxen were following the people because they missed them and wanted their company. This was a conclusion that would never be reached through conventional scientific means, and it completely baffled the participating scientific experts. Ultimately, the scientific experts ignored the elders’ interpretation without further dialogue and proceeded to devise an explanation for the distribution shift using standard principles of population ecology,” (Ellis 2005:73).

Life Cycle and Reproduction

Muskoxen can become sexually mature at two years of age or perhaps as old as four (Nagy 2004). Muskoxen calve in the early spring, in May. The calves are helpless and easily hunted, so the herds use behavioural strategies to protect calves from predation and hunting (Nagy 1999; Coulter 2018 personal communication).

Interviewees in Aklavik observed that muskoxen calve on their annual movement to the barren-grounds in mid-April and into early May, and usually have a single calf. One interviewee noted, "You can't shoot muskox after June 15, because they have young ones already, or June 10 anyways. June 15 is cut-off date for muskox because they have young already inside," (ICC et al. 2006:11-70).

As mentioned in **Habitat Requirements**, the northern part of Banks Island was considered an important breeding area for muskoxen prior to the 1970s.

Physiology and Adaptability

Muskoxen are able to eat a varied diet, including many grasses; their hooves may be adapted to digging and their short legs as well (Bezha 2018 personal communication). A muskox's stomach is very, very large compared to the size of their body, which allows them to eat 'anything' (McLeod 2018 personal communication).

Muskox live in herds (ICC et al. 2006) although as noted above, lone bulls are also observed at times (Coulter 2018 personal communication). The herds can be up to about 80 animals (McLeod 2018 personal communication). Some muskoxen are larger than others, and this appears to be regionally mediated. Albino muskoxen have been seen in NU (Golder 2003).

Muskoxen can move much more quickly than they appear. A hunter from Tuktoyaktuk spotted a muskox on a lake one time and tried to catch up to it. He said even though the muskox was only walking, and the hunter was running, he could not catch up to the muskox (ICC et al. 2006). Even if muskoxen start to run to escape hunters, they will stop and form a circle, even a group as small as six animals (Berger Inquiry V42 Sachs Harbour 1976).

There seems to be a broad range of responses that muskoxen have to being approached by people. Before there was any hunting pressure, muskoxen near Aklavik would allow people to approach very, very closely. One skidooer had a calf approach his skidoo and bunt his bag. Even during calving times, Aklavik residents could approach the herds to within just a few feet to watch them. With hunting pressure starting in the last few years, they have become more wary of people (McLeod 2018 personal communication). In other areas, muskoxen are scared of humans and predators, including dogs. They can show two reactions to being threatened. Muskoxen will stand in a circle with their heads and horns

facing out, and their calves protected inside the circle. At other times, muskoxen will run if threatened. Once they start running, they are known to run for a long time (Nagy 1999).

Health/Disease

Inuvialuit Settlement Region and Yukon North Slope

It must be remembered that the muskox population on the North Slope is distinct from muskoxen in other areas of the ISR, as these muskoxen were part of a re-introduction to the Alaskan North Slope from muskoxen of Greenland stock used for re-introductions across Alaska. Other muskox populations in the ISR are from endemic stocks that have expanded over about 100 years. There may be distinct health/disease issues that have resulted from that re-introduction to the Alaskan North Slope and expansion into the NWT.

In general, muskoxen tend to have more internal parasites than other species; according to one hunter from Tuktoyaktuk, “[m]uskox are usually pretty loaded... in the lungs... Don’t notice it too much in the caribou, not like muskox,” (ICC et al. 2006:11-70). Nonetheless, muskoxen had been observed to multiply in the years before 2005 (ICC et al. 2006). In the mid-2000s, a Paulatuk harvester reported that caribou are sick more often than muskoxen (Kutz 2007).

In 2016, a muskox health monitoring program based on hunter samples and data collection was initiated in Ulukhaktok and is ongoing (Mavrot 2019 pers. comm.). Harvesters use sample kits to contribute information that can be analyzed for different health traits (e.g. stress hormones, parasite burden, minerals) and tested for exposure to diseases such as brucellosis. They are also encouraged to collect any abnormalities found while butchering muskoxen, and to fill out a questionnaire with information such as age class, sex, body condition, herd size, and number of young animals in the herd. So far, 72 sample kits have been collected since October 2016 (Mavrot 2019 personal communication).

Data collected through the questionnaire will be used to gain insight into the health and population trends of muskoxen around Ulukhaktok. Body condition is a reliable indicator of food availability and general health; location provides information on how far harvesters must travel to find a muskox and can serve as a proxy for abundance; numbers of young observed is comparable to the cow:calf ratio used as a SK indicator of reproductive performance (Mavrot 2019 personal communication).

Early results from the health monitoring program are shown in Figure 7 and Figure 8. Note that similar work conducted in NU indicated that healthy populations of muskoxen around Iqaluklutiaq regularly had between five and eight centimeters of back fat when harvested (Tomaselli et al. 2018a).

SSA

Outfitter Chuk Coulter never sees any signs of sickness or disease in the muskox herd around Great Bear Lake (2018 personal communication). He has never seen a carcass, not even from an airplane, and reports that while people are always hoping to see muskox skulls, even pilots have never found one in the area. Coulter explains that the hunting lodge only targets the old, lone bulls they encounter on the shoreline:

“These are the big ones that get kicked out of the herd after they were challenged and lost, so they were ousted. Usually these are the biggest and oldest animals, but they are on their last legs,” (Coulter 2018 personal communication).

Coulter states that even those older, lone animals don’t show any sign of disease (Coulter 2018 personal communication).

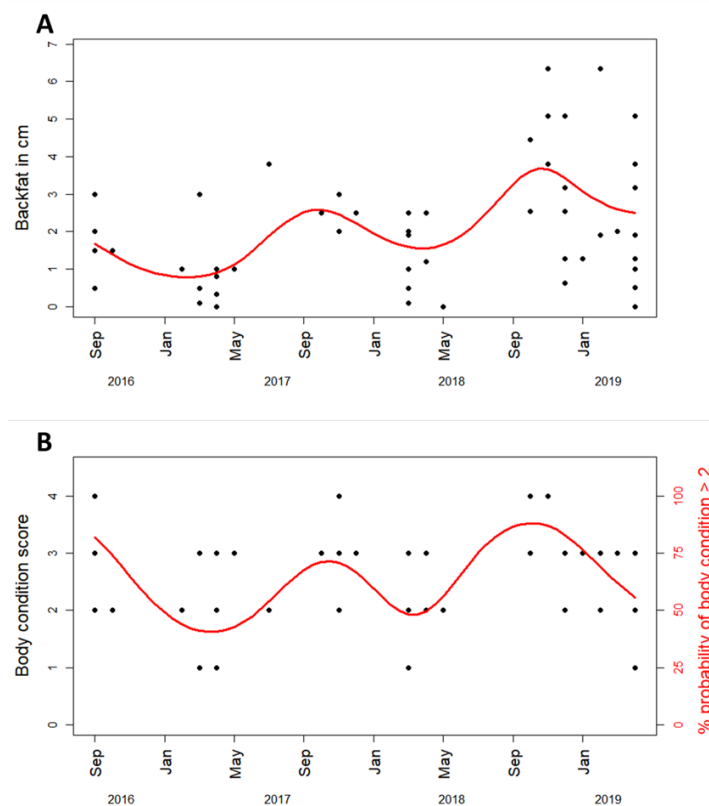


Figure 7. A) Backfat thickness (cm) recorded by Ulukhaktok harvesters on muskoxen sampled between 2016 and 2019 ($n=67$). A prediction line (in red) was fitted with a general additive model and a quasi-poisson link. **B)** Categorical body condition score of the same animals assessed by the harvesters ($n=70$). Body condition scores were 1: Skinny, 2: Not too bad, 3: Fat, 4: Really fat. The red line was fitted with a general additive model for ordered categorical data and shows the predicted probability of an animal having a body condition score over 2 (fat or really fat). Data provided by Fabien Mavrot.

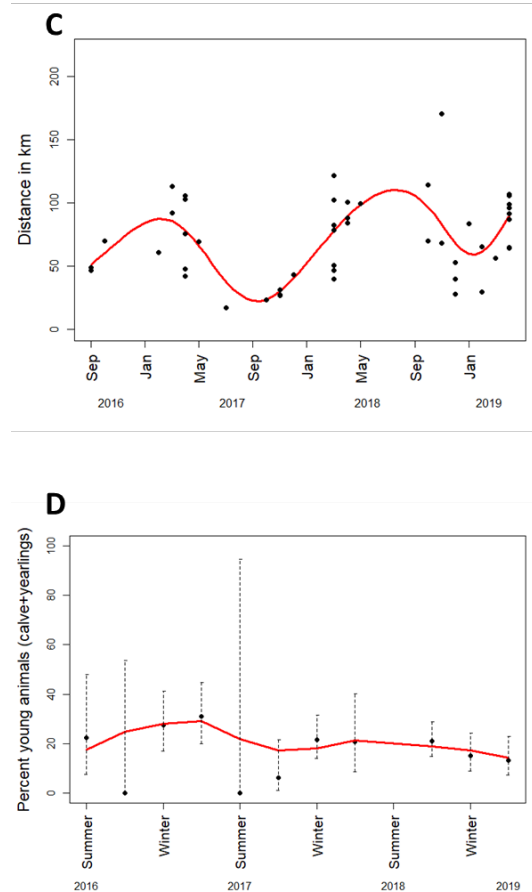


Figure 8. C) Distance (in km) from Ulukhaktok of muskoxen sampled between 2016 and 2019 (n=64). A prediction line (in red) was fitted with a general additive model and a gaussian link. **D)** Proportion of young animals (calves and yearlings) observed by harvesters in the herds around Ulukhaktok. Observations of individual harvesters (n=40) were aggregated by seasons. The proportion of young animals for each season was expressed as the total number of young animals observed by all harvesters during this season divided by the total number of animals observed in the same season. The red trend line was fitted using a moving average approach. Data provided by Fabien Mavrot.

Nunavut

NU harvesters have made detailed epidemiological observations such as presence of lesions, which correspond to approximately two dozen infections and illnesses that affect muskoxen. Healthy populations of muskoxen around Iqaluktutiaq regularly have between five and eight centimeters of back fat when harvested (Tomaselli et al. 2018a).

Causes of mortality

Causes of mortality for muskoxen and caribou described during 2014 interviews in Iqaluktutiaq included predation, ‘acute death’, and a variety of other causes that were categorized afterward as ‘other causes’ – these ranged from unknown causes (when partial

remains of carcasses were observed), injuries due to both natural and anthropogenic causes, starvation (e.g. muskoxen stranded on islands and reported primarily before a recent population decline), and “old muskoxen” (Tomaselli et al. 2018a). Most (95%) of the muskoxen perishing by ‘acute death’ were adults, only a few (5%) were juveniles, although juvenile remains may disappear more quickly and be under-reported (Tomaselli et al. 2018a).

Further information about sickness, disease, and causes of mortality in muskoxen in NU is included in **Threats and Limiting Factors**, including recent patterns of acute mortalities in muskoxen starting in 2010. Analyses indicate that high numbers of dead muskoxen reported from 2010-2014 are indicative of acute infectious disease (Tomaselli et al. 2018a).

Diet and Feeding Behaviour

Muskoxen are large animals with large guts and can eat two or four times as much as a small caribou (Nagy 2004). They are generally observed eating similar vegetation as caribou, with some interview respondents specifying either lichen or grass as preferred forage (Golder 2003; ICC et al. 2006; Tyson and Heinemeyer 2017).

Muskoxen are powerful animals and can tamp down or dig through the snow to access winter feed, although they do prefer to use wind-blown areas in the winter (Barr 1991). They easily pull whole plants from the ground (Berger Inquiry V42 Sachs Harbour 1976). On Banks Island, Inuvialuit hunters have noticed muskoxen prefer to eat in the valleys where there is grass, but also observe them feeding up the slopes and in different vegetation/forage types as well (Nagy 2004). In general, they eat sedges, grasses, and willows (Barr 1991). In the Sahtú their diet consists of willows, sedges, rushes, grasses, and willow herbs during the summer, and graminoids, crowberries, bilberries, and willows in the winter (Auld and Kershaw 2005).

One Aklavik harvester shared the following observation during TK interviews conducted for the Mackenzie Gas Project, “I think [muskox] just eat anything, they could maybe mix it with lichen and grass willows, but then again muskox is an implanted animal,” (ICC et al. 2006:11-69). In the winter, some of the muskoxen near Aklavik head to high, wind-swept rocky plains; here, they eat everything in sight, including dryas (shrubby plants related to roses) (McLeod 2018 personal communication). Photographs of vegetation found at muskox feeding sites on the YNS are included in Figures 9-11.



Figure 9. Feces and vegetation at a muskox feeding site. Photo credit: GNWT.



Figure 10. Willow shoots and other plants at a muskox feeding site near Aklavik. Photo credit: GNWT.



Figure 11. Photograph showing vegetation chewed down by muskoxen at a feeding site. Photo credit: GNWT.

Interactions

Competitors

Understandings of muskox interactions with other animals in the TK literature are generally limited to caribou, a species of special importance to all the communities in muskox range.

Caribou

The information available about muskoxen and caribou interactions can generally be separated into four themes: in some cases caribou and muskoxen compete for feed and space; caribou are threatened by muskoxen presence; in some cases caribou and muskoxen may *not* compete for food and space; and there are complex interactions with caribou, muskoxen, and their shared predators. The dual theme of caribou and muskoxen compete, and caribou and muskoxen do not compete can even be found in the same studies. For example, a TK study about boreal woodland caribou conducted in 2001 with Gwich'in, Sahtú, and Inuvialuit found the following:

“Some people claimed that muskox cause boreal caribou to abandon areas because of their hair, the noise they make, or because of parasites they transmit in their feces. Other people said they have seen boreal woodland caribou and muskox feeding on the same plants in the same places without competition or exclusion” (Auriat et al. 2002:16).

Local knowledge experts in the High Arctic of NU also observe that a large presence of muskoxen often results in the decline in the population of caribou in a specific area (Taylor 2005). By the late 1980s hunters around Resolute Bay and Grise Fiord observed a decrease in the abundance of caribou, and that areas previously occupied by caribou on the northwest and central areas of Somerset Island were now occupied by muskoxen. One interviewee described the changes they were seeing in muskox distribution in the 1990s as follows:

“The caribou are hardly around that area anymore [inland along west side of island]. Because of the muskox being in the area, the caribou don’t stay in the area, they only pass through it. The caribou were here, mostly all in this area [along the west coast]. The caribou are moving down that way [south along west coast and north of Creswell Bay], where they never use to be at, because the muskox has taken over the area that the caribou use to roam. This area [around Stanwell-Fletcher Bay] is where the caribou use to be at, and there’s hardly any now. They are moving to the coastal areas. These islands are loaded with caribous. Once you got around here, you started to see muskox and the caribou started to disappear from the area and the muskox started to roam the area,” (SI *in* Taylor 2005:40).

Also, in the 1980s, as observed on Somerset Island, hunters became concerned with the growing number of caribou on the island. Some participants believed that there were ‘too many’ caribou around Back Bay and Browne Bay (Prince of Wales and Russell Islands) (Taylor 2005).

While this negative correlation was noted between caribou and muskoxen abundance, residents in Resolute Bay and Grise Fiord did not cite competition or any other factor.

“...muskox and caribou kind of take turns in numbers. Like for some period it will be the muskox’s turn to multiply but then when they begin to die-off or disappear the caribous turn will come. They never multiply in large numbers at the same time,” (TM *in* Taylor 2005)

According to Inuit Knowledge of Somerset Island and Prince of Wales Island the trend may be so extreme that the growth of muskoxen on an island has been accompanied by the complete disappearance of caribou on the island. Some interviewees stated that caribou and muskoxen feed on different vegetation and therefore do not compete directly for forage. The author concluded this would suggest that there is indirect competition through displacement or avoidance. However, the animals tend to inhabit different habitats; generally, caribou forage in higher areas and muskoxen in lower valleys (Taylor 2005).

The four prevailing themes in the literature regarding how caribou and muskoxen interact are explored in more detail below.

Caribou and Muskoxen Compete for Feed and Space

Many Indigenous harvesters, interviewees, workshop participants, elders, and others indicate that muskoxen compete with caribou for food. This was found in multiple sources, across multiple regions.

Generally, sources report that muskoxen will move into an area and eat all the food that caribou eat, causing the caribou to be displaced and move to find other areas with suitable feed. This was described by some Inuvialuit elders as *umingmait* “taking over grazing areas from caribou and moose”; people expressed concern that this was going to occur in the northern Yukon (ICC et al. 2006:11-69). One participant in the study said that muskoxen drove caribou off an island in the 1970s and 1980s, when the caribou had returned to the Tuktoyaktuk area. The muskoxen had eaten all the caribou food (ICC et al. 2006). A similar pattern was also reported for Banks Island when muskoxen became numerous there and started to compete for the same food niche as caribou (Nagy 1999).

“The caribou herds kept declining all the time. Then gradually the muskox moved from the northern part of the island. That's when they were breeding, on the northern part of the island. They gradually came down. They kept pushing the caribou herds down and finally in the end we had hardly any caribou left. The caribou used to migrate up to the northern part of the island during the summer months, and they migrated back down towards the fall. In the end we had nothing coming back. Hardly nothing coming back and there, caribou were sort of going, staying along the coastline. ...there was hardly anything on the inland,” (Agnes Carpenter *in* Nagy 1999:161).

This knowledge of competition between the two species is not newly gained. Prior to the mid-1900s, Inuvialuit communities kept muskoxen populations low on islands in the Arctic Archipelago in order to allow caribou, in particular Peary caribou, to proliferate (Nagy 2004). Inuvialuit recognized that the 1917 law prohibiting muskox harvest would affect caribou populations when it was enacted. Indeed, there is evidence that Inuit in both the eastern and western Arctic would historically purposefully manage the population of muskoxen in order to promote caribou populations.

“When the Qangmalit (eastern Arctic people) first shot off the muskox, a few [years] after, caribou started coming back. Three years [later]. Well, they say that Tittaliq often said that three years after the caribou started returning. They never saw any more muskox; they cleaned them right out that time. The muskox, they had been killing them all that time because there was going to be no more caribou...” (Michael Amos *in* Nagy 1999:18).

The mountains to the west of Aklavik are another well-known site for muskoxen and caribou interactions which are considered negative for the caribou (e.g. ABEKC 2014, 2013, 2015, 2017b). The same phenomenon was also reported in areas where the endemic muskox population is expanding, and caribou numbers are declining, or caribou are moving to other parts of their range. For example, this type of interaction is reported at Mahoney Lake in the SSA, where people have noticed that since muskoxen have moved in, there are no caribou (ACCWM 2014).

In part, this competition and the caribou's inability to compete may be related to muskox biology. Walter Bezha surmised that because muskoxen don't move around as much as caribou and are able to eat a more varied diet, including all the grasses, they may be a stronger competitor in some areas (2018 pers. comm.). This was also indicated in the High Arctic, where muskox is known to eat a wider variety of vegetation, and caribou have been described as "picky eaters" (Taylor 2005).

Muskoxen also have a different feeding habit than caribou that dislodges some plants at the root, or they may paw the lichen into the ground, disturbing the soil and causing damage to delicate caribou habitat. Overall, a decrease in habitat quality for caribou, especially fodder/vegetation, results after an area is used by muskoxen (Nagy 1999; Wishart 2004; ABEKC 2014, 2013, 2015, and 2017b; ACCWM 2014; Tyson and Heinemeyer 2017).

When the population of muskoxen first expands into new ranges, they may use habitat which is not preferred by caribou, such as the flat bottom and lower slopes of grassy valleys. However, as their population continues to grow, muskoxen will start to use areas which are preferred by caribou, such as further up the valley slopes. This increases interactions and causes caribou to move or decline (Nagy 1999).

When representatives of the Aklavik HTC travelled to Kaktovik, Alaska to talk to community members there, they learned that it was only five years after the muskoxen were re-introduced that people in Kaktovik began to see a change in caribou migration routes; they warned Aklavik they would need a plan to do something about the muskoxen and protect the caribou. However, they specified that the issue was not that the muskoxen were affecting the caribou population numbers, but that they were disturbing the caribou migration (WMAC(NS) 2001). Many Aklavik community members feel that the Porcupine Caribou Herd overwintering in Alaska in 2014 may have related to increasing numbers of muskoxen in the eastern part of the herd's range, or that the migration routes of caribou more generally are being affected by muskoxen (ABEKC 2015; Tyson and Heinemeyer 2017).

A number of NWT communities throughout the range of the North Slope muskox population are concerned about potential negative effects of muskoxen on the Porcupine Caribou Herd; the two main stated concerns are that muskoxen will displace caribou from

their preferred habitats and divert caribou from migration routes that have historically provided hunters with good access to caribou – an important traditional food for users of the herd (WMA(NS) 2017). This concern was expressed in a 2006 Muskox Management Workshop in Aklavik; on the mainland it was noted that the caribou avoid muskoxen and move onto ridges when there are muskoxen in the valley (WMA(NS) 2006). Specific concerns that were documented for North Slope residents about muskoxen during the meeting included:

- Muskoxen frighten and displace caribou. Many hunters have seen caribou run from muskoxen. People from several villages have reported that when muskoxen have moved into their hunting areas caribou have become scarce. Most people greatly prefer caribou.
- Caribou no longer use some areas that muskoxen now occupy. The odour, hair, and feces of muskoxen have caused caribou to abandon areas that caribou used in the past.
- People are concerned that the two species will compete for food and that more muskoxen could mean fewer caribou. Residents have described the situation on Banks Island where the muskox population has greatly increased, and caribou have decreased.
- Some people are concerned that if the muskox population expands it could divert the caribou migration at such places as Anaktuvuk Pass. Some Point Hope people feel that caribou no longer migrate near the village because of muskoxen residing in the area.
- Muskoxen have trampled habitat and have ruined berry picking areas. In addition, the muskoxen have taken up residence in berry patches and people cannot pick berries there for fear of being attacked.
- Some people don't like the aggressive behaviour of muskoxen. Some people have been bothered and chased by muskoxen while camping. Some trapping areas cannot be used because muskoxen occupy those areas now.
- People from most villages are resentful they cannot hunt muskoxen. People fear that a preferred subsistence animal (caribou) will be reduced in number or displaced from their areas by one that it is against the regulations to hunt.
- People fear that when there is a hunt it will be a sports hunt with a drawing and a high fee. They feel that it will bring sports hunters into the area that they don't want there (WMA(NS) 2006).

There is also a sense among knowledge holders that wildlife managers do not put credence in their knowledge of this phenomenon; "We keep telling that there's competition between caribou and muskox. They still didn't believe us," (Andy Carpenter *in* Nagy 1999:163).

There was just one account found in the sources reviewed for this report, where muskoxen were observed to move to avoid interactions with barren-ground caribou:

“There are herds where you can fly for five minutes with an airplane at 100 miles an hour over a [barren-ground caribou] herd and look in amazement at it. North Contwoyto is the biggest herd up in here in the Mara-Hackett River area and they'd be about 200,000 strong. They'd come through for days right past the tent. Of course, the muskox disappears because they know that the caribou are there, that means the wolves are there. After the caribou have gone through the muskox shows up again,” (D'Arcy Mercredi *in* NSMA 2001:106-107).

Muskoxen Scare Caribou Away due to Their Shape, Behaviour, and Scent

Some knowledge holders stated that muskoxen scare caribou away due to their shape, which caribou find threatening (Tyson and Heinemeyer 2017). It may be that muskoxen look like a grizzly bear to caribou (ICC et al. 2006; ABEKC 2013). At least one person, a Paulatuk resident, has also seen a muskox charge a caribou, on a beach (ACCWM 2014).

Many observers feel that part of the reason caribou avoid both muskoxen and the areas where muskoxen have been feeding relates to scent. Muskoxen smell strongly, as does their urine, which mars the environment (Nagy 1999; Wishart 2004; Taylor 2005; Tyson and Heinemeyer 2017). The scent they leave on the landscape is persistent, “you can smell them even a week after they have gone by and maybe that's keeping caribou away,” (Fort Good Hope resident, ACCWM 2014:55). This effect is compounded by caribou's powerful sense of smell (ACCWM 2014; Benson 2015; SARC 2017).

“There was nothing around here, but we used to hear that further up, like Storkerson, Bemard River, they used to tell stories about muskox. Well, from the north, apparently, they came to Sachs Harbour. Now they took over the caribou area. They have an awful smell. When they come on the south side, they smell strong. Even stronger than dogs. They smell like sweat,” (Frank Cockney *in* Nagy 1999:164).

Caribou and Muskoxen Do Not Compete for Feed and Space and/or Experience Similar Threats/Cycles

Ulukhaktuk harvesters indicated that caribou and muskoxen do not compete. They noted a decrease in caribou and muskoxen population and an increase in muskoxen; all of which was considered standard population cycles (Gunn 2005). Similar information has been recorded on the YNS, where Inuvialuit have observed that good muskox habitat can also be good caribou habitat and, as the population has recovered, muskoxen are increasingly spotted foraging in places people would expect to see caribou, like Herschel Island (WMAC(NS) 2018).

Outfitter Chuk Coulter has observed that for the most part, muskoxen and barren-ground caribou do not share habitat or seem to compete for resources.

“There aren’t any caribou around anymore so this is all past knowledge, but if you look at a map of Great Bear Lake, we were hunting the Bluenose-East herd, but we hunted caribou that we considered lost – these ones would hug the shore on their way to Caribou Point and then eventually turn back. We wouldn’t see the migration, so used to target these ones. And there aren’t a lot of muskox in that area – you never see muskox at Caribou Point. However, we would see caribou get sort of off-track up on the north shore too, and that was the same area as muskox... they don’t seem to be damaging the habitat because you can see muskox in the same area at the same time as caribou. As far as hunting and guiding go, we used to have hunts for both muskox and caribou at the same time; we wouldn’t hunt them as if they were found in different zones,” (Coulter 2018 pers. comm.).

Based on his observations, Coulter suggested that there is no correlation between what he has observed as steady but small numbers of muskoxen over the last 12-13 years, and declining numbers of caribou in the Sahtú region; “The caribou numbers have changed but muskox numbers haven’t, so I don’t think they’re correlated,” (2018 personal communication).

Others report that there does not appear to be a relationship between increasing observations of muskoxen in recent decades and the abundance of caribou bulls, bears or wolves, which may imply that muskoxen or muskoxen-induced predation are not being observed on the land (Nguyen 2016; ABEKC 2017a).

While many interview participants quoted in Nagy 1999 said they felt muskoxen and caribou compete for foraging habitat, at least one person mentioned that the decline of caribou on Banks Island might not be due to competition, but to natural population growth cycles.

“The people figure that muskox are probably chasing the caribou away. But I don't think it's that way. I think it's probably what they call a 30 years cycle that they have the caribou. Because, eventually I think they'd probably going to come back. Maybe it's just a downfall,” (John Lucas *in* Nagy 1999:165).

Other interviewees in the same report also reported that the disappearance of some caribou on Banks Island could be linked to weather conditions instead of muskox presence. A fall weather pattern of freezing temperatures, followed by a warm-up and rain, covered the animal’s forage with ice in the 1970s. This caused the caribou to try and leave the

island, including via the ocean. One particularly bad year there were no caribou calves due to this effect, which happened just before the rutting season (Nagy 1999).

Recent work in Nunavut supports this theme, describing a correlative relationship between caribou and muskox cycles of abundance and distribution in which the populations have peaked and declined similarly over time (Tomaselli 2018a and 2018b).

Muskoxen, Caribou, and Their Predators Interact in Complex Ways

Wolves are an important predator of muskoxen and can influence muskox population numbers. They are known to prey upon even adult muskoxen; it is said that a pack of wolves can 'easily' hunt an adult muskox (Golder 2003). Banks Island Inuvialuit explained that part of the reason that muskoxen increased so dramatically there during the last half of the 20th century was that wolves had been extirpated or nearly extirpated by game wardens and trappers seeking more foxes in their traps (Nagy 2004). In the High Arctic, some Inuit interviewees stated that wolves follow muskoxen when they shift their range, and that wolves prefer muskoxen over caribou (Taylor 2005).

Other sources indicate that wolves switch to muskoxen when caribou numbers are low.

“Those muskoxen now, even on our land (Victoria Island), there's too many of them now. Then the caribou there's fewer of them now. And then there's the wolves, there's lots of them now. Lots of them would get together and kill a caribou and eat it. That's why the caribou are depleting. Maybe it is because they don't have much to eat. So, they are now killing muskox now too. This winter when my son-in-law was travelling, he saw a muskox that wolves had just killed. The muskox was big, and the wolves had killed it,” (Sam Oliktoak *in* Nagy 1999:163).

Iqaluktutiaq (NU) interviewees also noted that an increase in the presence of wolves, near the community and further inland in Victoria Island, added another hunting pressure for muskoxen (Fawcett et al. 2018).

Increasing muskox populations are blamed for an increased presence of wolves and bears by many TK holders, which is complicated by reduced fur-bearer harvest and changing moose populations. This effect has been noted in the Inuvialuit, Gwich'in, and Sahtú regions, from the YNS to near Délı̄nę (ACCWM 2014; SARC 2017).

An increase of wolf numbers associated with the presence of muskoxen may deter caribou from using areas they previously used (ACCWM 2014). Muskoxen may also be influencing the normal predator-prey relationship typically found in barren-ground caribou population fluctuations; an influx of muskoxen into an area allows for the wolf population to survive

and possibly grow even during a shortage of caribou. In the past, low caribou numbers would lead to a decrease in the number of wolves (ACCWM 2014).

It has been reported by harvesters from Tuktoyaktuk that grizzlies are turning up on Banks and Victoria islands, where they kill muskoxen (Joint Secretariat 2015). Polar bears are also seen scavenging muskox carcasses in some shoreline locations (Joint Secretariat 2015).

Several Aklavik Inuvialuit suggested that grizzly bears increasingly follow muskox herds, especially on Herschel Island and especially when the muskoxen have calves (Tyson and Heinemeyer 2017). Four interviewees gave detailed accounts of grizzly bears traveling to areas with large muskox populations in the spring, when access to and from the Herschel Island muskox population is easier and muskoxen are having their young. Muskox has become an important food source for these bears although grizzly-muskox interactions on Herschel Island were not known in the past; one interviewee suggested that this might be becoming more common, as the muskox population increases. Interviewees also said that food sources determined fall grizzly bear locations, and observations of grizzly bear foraging and hunting in the fall included hunting and scavenging caribou, moose, and muskoxen among other activities (Tyson and Heinemeyer 2017).

Similarly, Inuvialuit TK recorded on the YNS indicates that grizzlies have been increasingly following muskox herds; this activity has been particularly prevalent in springtime, when muskoxen have more vulnerable young ones (WMAC(NS) 2018). Aklavik harvesters indicated that both grizzly bears and wolves eat muskoxen in the Richardson Mountains (Lambert-Koizumi 2012) but hunters haven't mentioned seeing many wolf-killed or bear-killed muskox carcasses in their hunting areas; it is likely that at least the skulls would be found if this were happening frequently. This may be due to the relatively recent appearance of muskoxen in the area (McLeod 2018 personal communication).

In a North Slave Métis Alliance report about the Diavik Diamonds Project, one observer explained the complex interactions between barren-ground caribou, muskox, and wolves as follows:

“It all depends I guess on where the food is. The wolves aren't just going to hang around here, when the caribou have all moved off. They have to be able to move with the caribou. During denning time... I think that we might see them in and around the camp, right in the camp potentially, but if there's really that many people, bad smells, explosions and stuff, then they'll hardly be staying there. ...I think they're probably fairly adaptable in that sense [human activity]. If there's something that attracts them and holds them there, getting hand-outs from people working at the mine, or if there's something they can access from the garbage, or if any animals are held there because of other things -- I'm thinking

increased growth or some kind of forage, caribou or musk-ox that hang around there -- most wolves would tend to capitalize on that,” (Adrian D’Hont *in* NSMA 2001:144).

In regard to caribou abundance, participants observed low numbers of animals in the 1960s and 1970s and noted that they were not close to the community. Caribou started migrating within a few miles of the community in the mid-1980s, and in the autumn it was typical to observe big herds gathered on the shoreline both to the east and west side of the community, waiting for the sea ice to freeze. The abundance curves generated during group interviews identified ‘pre-decline’ (from the 1990s to mid-2000s) and ‘decline’ (from mid-2000s to the end of 2014) periods (Tomaselli et al. 2018a and b).

Iqaluktutiaq participants reported an 85% decrease of muskoxen and 80% decrease of caribou, from the pre-decline period to the end of 2014 (Tomaselli et al. 2018a). Increases in predators, changes in migratory routes (caribou) or emigration events (muskoxen), as well as human disturbance, environmental changes, and changes in the health status of the animals were among the factors that participants associated with the decline of both species. During feedback sessions in 2015, participants emphasized that they were still observing a declining trend for both species (Tomaselli et al. 2018a).

The report authors summarized their findings as follows:

“The data that we gathered highlighted significant population declines for both muskoxen and the Dolphin and Union caribou herd. These were characterized by poor recruitment, deterioration of body condition status, and increased observations of morbidity for both species, as well as unusual mortality events in muskoxen. These collective observations suggest declining population health of muskoxen and caribou in the study area,” (Tomaselli et al. 2018a:342).

Overall, local knowledge confirmed major population declines for muskoxen and caribou, beginning in the mid-2000s, and that the body condition of both muskoxen and caribou had deteriorated over that time period (Tomaselli et al. 2018a).

Nunavut

NU interviewees have reported the occurrence of new species of wildlife and increases in the population of some predators since 2005. There were documented observations and successful hunts of grizzly bears and hybrid ‘grolar’ bears on Victoria Island, which is partly in the NWT and partly in NU. Grizzly bears are thought to be competing with polar bears for food, and there are observations of kill sites where it is believed a grizzly killed several muskoxen but only ate specific pieces of select animals (Fawcett et al. 2018). Iqaluktutiaq harvesters indicated that grizzlies have learned to chase muskoxen long enough that they’ll

leave their calves behind (Dumond 2007). Kugluktuk harvesters noted that muskox and caribou calves were the main food source for grizzlies (Golder 2003).

Other Competitors/Interactions

Several interview participants in Nagy 1999 linked the scattering or disappearance of geese to the fact that they might not like being around muskox. Goose-muskox interactions were also noted on Banks Island, where there were concerns about the effects of large numbers of snow geese – because geese eat the same foods as muskoxen, high numbers of geese may push muskoxen to other food that is also preferred by caribou (WMAC (NS) 2001). Some Norman Wells elders have mentioned that muskoxen are bad for all resident animals (ACCWM 2014).

Snowshoe hares may take advantage of an area where muskoxen have grazed when snow conditions are severe (Olohaktomiut Hunters and Trappers Committee et al. 2016).

Predation by Humans

Muskoxen have been hunted in High Arctic latitudes for thousands of years, according to archaeological evidence. For example, on Victoria Island they were harvested using bow and arrow technology in sites dating to about 4,000 years ago (Pelly 2002). In modern times, consumption patterns and preferences vary. By 2000, data for Inuvialuit communities were showing an intergenerational trend in the consumption of muskox meat that could indicate increasing acceptance by younger generations. While people older than 61 years reported zero average intake, younger adults reported an intake of roughly 30 g of muskox per person per day (Kuhnlein et al. 2000 *in* Weshe and Chan 2010).

As stated previously, use of muskoxen for food and other materials has been interrupted through extirpation, reintroduction, and hunting bans. This interruption and introduced policy have altered and reduced knowledge of muskoxen including how to harvest, prepare, and use the skin and wool, and likely preference for the meat of muskoxen as well. However, in even the recent past (when elders alive around 1999 were children), muskox was considered a major resource exploited by people on Banks Island (Nagy 1999). The muskox meat was made into drymeat, and the skins, especially the smaller skins, were used for clothing. The drymeat was cached for consumption all winter. Their fat was rendered into oil. It seems that muskoxen were harvested in relatively large numbers in the past, by killing a whole herd. The hunters and their families would then make drymeat ‘all summer’. To harvest so many animals at once, one person would go out behind the herd and make noise to chase them. Other people would join in, directing the herd to go by the camp. The whole herd would be killed near the camp this way, to reduce the amount of travel needed between the kill site and the camp. This hunting style made use of one of the aspects of muskoxen behaviour: once a herd of muskoxen starts running, they won’t stop (Nagy 1999).

Muskoxen were also hunted using dogs. The dogs were released, which would cause the muskoxen to group up in a circle around the calves in an anti-predator stance. The entire herd could then be killed and skinned (Nagy 1999). The calves are easy to kill and were hunted in early May when they were just born; they could be hunted without weapons (Nagy 1999).

Early explorers to the NWT area found that chasing muskoxen onto frozen lakes was another common hunting technique (Barr 1991).

Due to their behaviour, muskoxen are known to be easy animals for hunters with guns to kill. Hunters in the past didn't have to stalk and chase them like other game species (Berger Inquiry Volume 41 Holman Island 1976).

Muskoxen are harvested by Paulatuk hunters in November and December (Paulatuk HTC et al. 2016). On Banks Island, Sachs Harbour residents harvest muskox year-round, with the exception of late May and June (Sachs Harbour HTC et al. 2016). In Tuktoyaktuk, harvesters take muskox in April and May (Tuktoyaktuk HTC et al. 2016). Olohaktomiut harvesters also take muskox year-round (Olohaktomiut HTC et al. 20016).

Aklavik Gwich'in harvesters indicate that the taste of muskox meat is not preferred for food. In fact, during starvation times in the late 1960s, muskox meat was brought into Aklavik by Ward Air and the meat was fed to dogs (ABEKC 2013). However, things may be changing. In the last few years, Aklavik hunters are hunting muskoxen as they are valued by taxidermists. Even a single skull may be worth \$300. As they are being hunted for their skins, people are starting to eat the meat more often as well, and it is starting to be accepted as a good food source. This is particularly the case as the Porcupine caribou herd has not been close to the community for the last three or four years, and a herd of about 50 muskoxen calved near Joseph's Lake, about half an hour from the community (McLeod 2018 personal communication).

Community Hunts

In Iqalukutiaq (NU) community-sponsored hunts of mainly muskoxen had been organized in times of abundance to provide country foods for community members who do not otherwise have access.

“Thirty-two muskox were hunted over the course of two community hunts in 2015/2016 and the meat was distributed to households throughout the community. The hunts have been well received by community members, many who would not otherwise have had access to country foods at those times of the year. Some respondents, however, emphasized that it is important to consider the health of the wildlife species being hunted, and to not deplete a population that is already stressed,” (Fawcett et al. 2018:23).

Guided Hunting, Sport Hunting, and Commercial Hunting

Muskoxen have also been the target of guided hunts, sport hunting, and tourism, but mostly in the far north (Nagy 1999; Wishart 2004; Kutz et al. 2017; Fawcett et al. 2018). Sport hunting of muskoxen on Banks Island began in the mid-1970s, at first by dog sled but then by skidoo (Nagy 1999). Prior to 2008, the polar bear sport hunt provided important financial resources to the community of Ulukhaktok through income for Inuit guides and helpers. However, when the United States Fish and Wildlife Service banned the importation of polar bear trophies under the Endangered Species Act, the number of polar bear sport hunts in the community dropped and guided muskox hunts became more prevalent, despite decreasing muskoxen populations around the community (Fawcett et al. 2018).

A commercial harvest of muskoxen operated on Banks Island for at least 20 years. Both the meat and the hides were used (Inuvialuit Communications Society n.d.). The quota set for that harvest is currently 10,000 animals; however there is no evidence that quota was ever reached, and muskoxen have not been harvested every year. In 2012 the harvest target was for 2,000 animals (Inuvialuit Communications Society n.d.). In more recent years harvesting declined as the abundance and proximity of muskoxen to Sachs Harbour declined (Adamczewski 2019 personal communication). The SK component of this status report includes more information on that commercial harvest, including reported harvests between 2000 and 2011 (Gunn et al. 2018).

In recent years in Iqaluktutiaq sport hunting of muskoxen has provided numerous sources of economic benefit through both the guided hunt and the selling of the hides (Kutz et al. 2017). In addition, some commercial establishments in Iqaluktutiaq buy muskox meat, and some hunters are using social media for direct sales of the meat. The commercialization of hunting and sharing networks has important implications for the sharing economy in the community (Fawcett et al. 2018).

Participants in the Tomaselli study explained that the community of Iqaluktutiaq has been harvesting muskoxen for commercial purposes since the 1980s (Tomaselli et al. 2018b). The annual commercial muskox harvest was suspended in that community in 2012 because of local declines of muskoxen in the permitted hunting area (Tomaselli et al. 2018b).

There is currently one outfitting company guiding sport hunts for muskoxen in the Sahtú region; they receive a total of six tags but usually only harvest two to four animals per year (Coulter 2018 personal communication).

STATE AND TRENDS

Despite evidence of long-standing reliance on muskoxen in TK and oral histories from areas where the populations are endemic, to say nothing of the evidence of substantial use at many archaeological sites, TK also tells of periodic shifts in abundance and distribution of these animals. Most of the TKCK sources reviewed for this report indicate that there are not high densities and close proximities of both muskoxen and caribou at the same time. Instead, there may be one or the other, and the reason for the cycles might relate to changes with their forage (Taylor 2005). However, recent work in NU contradicts this information, describing a different correlative relationship between caribou and muskox cycles of abundance and distribution in which the populations have peaked and declined similarly over time (Tomaselli 2018a and 2018b).

Population

Abundance

By 1917 muskoxen were completely protected in Canada, except for emergency subsistence use. In 1930, Anderson estimated there were 500 muskoxen left on the Canadian mainland, and in the early 1960s Tener (1965) estimated 1,500 on the Canadian mainland and 8,500 on the Arctic Islands.

Historical sources (see **A Brief History of Muskox Management in North America**) document the growth of muskoxen numbers in the mainland area of the NWT after the hunting and sales bans of around 1915. The population of muskoxen grow slowly for several decades after 1915, but the population started to rebound in the 1960s (Barr 1991).

As mentioned, information regarding many aspects of muskox biology in the NWT based on TKCK is complicated by the recent history of extirpation, hunting bans, and reintroduction. However, the lack of directed research into muskox TKCK in any relevant communities or regions other than the ISR and NU is likely the most limiting factor regarding information on current abundance levels and distribution. This is particularly true for the regions in which muskoxen are currently rumoured to be expanding their range and numbers. Until TKCK research is done in these regions, the authors would caution against drawing conclusions from the information presented here, and in fact identify the topic of current abundance as an information gap in those regions.

Populations of muskoxen in the Gwich'in and Sahtú regions suffered the same fate as in other areas at the time of the fur trade.

“Basically, muskox was almost wiped out due to the fur trade demand for hides, and incentive prices. During the depression there were a lot of trappers up here trying to make a few dollars. So, muskox were almost wiped out due to the high price of the hides. And because of the biology of muskox – they don’t run away but try to protect themselves – it’s very easy to wipe them out. That comes from the Hudson Bay Company; the market demand for muskox, beaver was the same – huge. Overharvesting can happen very quickly,” (Bezha 2018 personal communication).

Overall, people in the Sahtú Region say they didn’t see many muskoxen when caribou numbers were high; “I think the saying is true – that muskox prefer to be away from caribou – and I think it has to do with the food. When caribou numbers are that high, I don’t think the muskox can compete for food,” (Bezha 2018 personal communication).

Aklavik residents are also reporting that after increasing for a few decades, the population in the last few years may be decreasing around Aklavik. It is difficult to tell, because snow conditions have not supported a lot of winter travel (McLeod 2018 personal communication).

Through the fur trade, Akaitcho hunters provided hundreds of muskox pelts to traders for their use as robes, especially for the European markets. As with other areas to the north and west, and due to over-harvest for robes, muskoxen declined dramatically in the region around modern-day Łutsel K’e in the decades just before and after the turn of the 20th century. For almost thirty years after 1830 the trade in muskox hides lapsed completely, but then in the early 1860s it revived, increasing steadily to a dramatic peak around 1890, before tapering off very sharply as stocks became depleted (Barr 1991). Łutsel K’e hunters had to travel further and further (as far as 400 km) to harvest the animals for their furs. Akaitcho harvesters also noted that Arctic fox pelts increased dramatically in value as muskox populations declined and their hides were unavailable (Lent 1999; DeBeers 2012). The decline in muskoxen was one of the reasons the Thelon Game Sanctuary was created in 1927, that is, to protect remnant muskox populations, as a relatively large portion of the remaining muskoxen on the Canadian mainland could be found along the Thelon River at the time (Lent 1999).

There are very detailed Inuit observations available in the community of Resolute Bay regarding muskox and Peary caribou relative abundance and population fluctuations dating back to the early 1900s (Taylor 2005). Overall, information documented from interviews with Inuit knowledge holders in 2003 indicates that caribou and muskoxen have experienced the largest population fluctuations on the more southerly islands of the High Arctic, especially Bathurst, Somerset, and Prince of Wales islands, where few caribou were known to range during the most recent time period (i.e., 2000-2003) (Taylor 2005).

In comparison, caribou and muskoxen experienced smaller, local fluctuations on the northern islands of Devon and Ellesmere, where caribou and muskoxen exhibit greater abundance.

The author concluded that overall, the populations of muskoxen on Ellesmere and Devon Islands appeared to be stable in 2003, and that population fluctuations observed by interviewees were considered normal (Taylor 2005).

While Baffin Island has not supported a muskox population historically, Inuit oral tradition, early written accounts, and sparse archaeological evidence all hint that muskoxen were formerly present, at least in small numbers (Lent 1999).

Trends and Fluctuations (Have numbers gone up and down in the past; are they going up or down now?)

NU officially separated from the NWT to become Canada's newest territory on April 1, 1999. Because information predating this time cannot be separated by territory, and because the historical sources used to inform this report provided an abundance of information regarding trends dating back to the 1850s in the far north, population trend information has been divided into two time periods for this region: before and after 1999.

Inuvialuit Settlement Region and Nunavut

Population Trends from 1850 to 1999

Historical sources indicate that muskox populations varied quite drastically and over a relatively short period of time on Banks Island. The population was quite low just after 1850, but then may have increased noticeably. With hunting pressure relating to complex factors including exploration and fur trade, along with climate events, muskoxen were extirpated from the island by 1915 (Barr 1991). There are caches of hundreds, or even thousands of muskox skulls and skeletal elements found on Banks Island. It is unclear exactly when these muskoxen may have died, and how. Some historians suggest that Copper Inuit, enabled by ready and new access to iron from abandoned explorers' ships, killed hundreds of muskoxen. However, other historians indicate that it is more likely to be climate events, such as icing, that killed groups of muskoxen, due to the largely intact nature of the skeletons (Barr 1991).

The population on Victoria Island has also fluctuated drastically in the last several hundred years, although without the hunting pressure seen on Banks Island. It is unclear if the population on Victoria Island was ever as high historically as it was after 1950, although muskoxen were commonly harvested on the northwest and northeast portions of the island before 1920 (Barr 1991). The muskox population was low in the mid-1800s, then they were near extirpation when a remnant herd was hunted near Gateshead Island around 1915. The population became re-established and grew after 1950 (Barr 1991).

During the winter and summer of 1996, the Aulavik Oral History project conducted interviews with Inuvialuit elders on Banks Island, and in Aklavik, Holman, Inuvik, Sachs Harbour, and Tuktoyaktuk (Nagy 1999). TK documented during those interviews provides ample evidence that muskoxen have cycled in abundance in the past.

“Tiittaliq often talked about them. She said there used to be a lot of muskox long ago. And they really died off and there was no more muskox. She said they decreased when they get too many of them, they started dying off. She talked about that,” (Peter Esau: Aulavik-24A:13 *in* Nagy 1999:158).

“It was at that time when there was no muskox there too. We did not see any muskox tracks that summer when my parents were walking the land. There was no muskox for a long time and when the muskox population wanted to go up, it went up. They must have crossed from somewhere. Now, there's muskox again,” (Susie Tiktalik *in* Nagy 1999:154).

“They'll die again just like long ago. Right here, at Kellett River, there are muskox horns piled up all over. If it iced up, you'll lose them all in one season. Muskox are not travelers; they'll be weaker and weaker before they reach anywhere. They don't migrate. They say when there's too many in one place, they die off. They will do that. [There's about] 70,000 anyway,” (David Nasogaluak *in* Nagy 1999:158).

Ice events which decimate ungulate populations including muskoxen were known to happen in the past. An Inuvialuit elder, Jimmy Memoganak, recalled a die-off of muskoxen and caribou from his youth on Victoria Island. After the die-off, the caribou and muskoxen populations did rebound (Berger Inquiry Volume 41 Holman Island 1976). Inuvialuit elders on Banks Island knew of a time when the muskox population was too high and there was a large die-off. When the population was very high again in the last half of the 20th century, they predicted another die-off was possible (Nagy 2004). Arctic explorer Stefansson also reported oral traditions shared with him that indicated Inuit on Banks Island used to be well-off, killing so many muskoxen and caribou that the meat would last year-round (1913, see Lent 1999). This period of wealth was followed by a period of scarcity; Stefansson implied that famine occurred roughly around the 1890s (Lent 1999).

Banks Island's rich archaeological record provides ample evidence of times when Inuit use of muskox was very high; at close to 200 sites identified there in the 1960s and 1970s, the remains represented a minimum of 2,657 muskoxen (as compared with only 142 caribou) (Will 1984 *in* Lent 1999). However, there is also evidence that there may have been significant changes in muskox availability throughout history (Lent 1999).

Interestingly, other researchers have documented TK about Inuit actions intended to limit muskox herd numbers in order to avoid massive die-offs or habitat deterioration. This suggests knowledge of previous and extreme cycles of abundance and scarcity on Banks Island.

“There's too many on the island. Before the resources die, use them. Before the resources go, take advantage of it. I mean, I don't think this island ever did have that much muskox in its entire existence. I'm sure there was a lot of muskox long ago from what you hear in this area, Thomsen River, but not like what it is now,” (Lawrence Amos *in* Nagy 1999:164).

More information is provided on Inuit suggestions for managing muskoxen in **Positive Influences**.

As noted elsewhere, hunting muskoxen for trade caused population declines across the NWT and contributed to population declines on Banks and Victoria islands. This hunting pressure was variable over time, “For almost thirty years after 1830 the trade in muskox hides lapsed completely, but then in the early 1860s it revived, increasing steadily to a dramatic peak around 1890, before tapering off very sharply as stocks became depleted,” (Barr 1991:15). After the extirpation of muskoxen during the late 1800s and early 1900s, residents of Ulukhaktok (Victoria Island) were seeing muskoxen back in their traditional lands by at least the 1970s. The muskoxen returning in ever-growing numbers was seen to be at odds with the restricted hunting quota allowed by Inuit harvesters (Berger Inquiry Volume 41 Holman Island 1976). A Berger Inquiry participant speaking in 1976 indicated that the muskox population was growing rapidly after about 1965 in the more southern areas of Banks Island (Berger Inquiry V42 Sachs Harbour 1976).

Inuvialuit interviewees in Nagy (1999) also presented evidence of a much longer timeline of fluctuations in muskox abundance and management efforts, reporting that by 1890 the muskox population had disappeared and people had returned to Victoria Island and to the southeastern coast of Banks Island; some oral history indicates that people used to hunt out a whole population of muskoxen and/or caribou (Nagy 1999).

“[My husband Kuptana] said they were like that, long ago they finished the muskox by doing that. The Qangmalit would surround big herds and kill them. Then, there was no more muskox, but the herds grew again,” (Sarah Kuptana: Aulavik-60A:5 *in* Nagy 1999:21).

Stefansson (1969 [1921]:241) was convinced that the Inuinnait had overhunted the muskox of Banks Island during their summer visits to Mercy Bay in the 1850s... However,... numerous archaeological sites ... in northern Banks Island ... do not support Stefansson's conclusion (Toews 1998:141-

144). In 1915 when Kullak (the father of Susie Tiktalik) was asked by Stefansson if muskox had been extinguished by hunters, he was told that muskox had moved away (Stefansson 1969 [1921]:370). Asked the same question in 1996, David Nasogaluak answered, "I don't think so. Not enough people to hunt them and when Nature put ice on the ground [...], they starve right away" (DN: Aulavik-47 A:5). However, Susie Tiktalik is said to have warned people that muskox population should be kept low in order to have caribou on Banks Island. It is thus possible that in the 1800s, and possibly before, people tried to keep some control over the muskox population (*in* Nagy 1999:18).

Further details describing pre-2000 population trends in Nagy 1999 are included in **Appendix A**; the remainder of the information about abundance presented here focuses on the period following the formation of NU.

Population Trends Since 1999

Over the long term, it appears that muskoxen populations grow and then crash. On a shorter timescale, the trend prior to 2000 was for muskoxen to be seen more frequently in the High Arctic, possibly relating to longer-term trends or, more likely, the near extirpation and subsequent re-growth of the herds after the hunting ban. After 1999, the TKCK literature indicates growing numbers and range expansion in some areas, but declining numbers of muskoxen in the High Arctic and some other areas.

In 2005, Aklavik, Inuvik, and Tuktoyaktuk interviewees reported that muskoxen were increasing in population and taking over caribou areas, at least for the several years preceding the interviews; "1989 when I worked at Firth River... fly along and you counted 33 [muskoxen] a couple of years ago there is 200... so now they are multiplying and chasing caribou away," (ICC et al. 2006:11-70). Muskox populations were said to be increasing all along the coastal areas of the ISR in the early 2000s (ICC et al. 2006).

In July 2016 one respondent from Ulukhaktok reported travelling 120 km by ATV one day without seeing any muskoxen (Fawcett et al. 2018). Respondents attributed the decline to natural cycles, the presence of more wolves, grolar and grizzly bears, and increased harvest pressure as muskoxen became a focal point of subsistence hunting and income (e.g. sport hunting, meat resale, and the sale of horns and hides) (Fawcett et al. 2018).

Population fluctuations seem to be regional in scope. According to Gwich'in/Inuvialuit harvesters working with the Arctic Borderlands Ecological Knowledge Co-op, there was a lower than normal abundance of muskoxen before 2004. Since then, however, there has been more than normal. This doesn't seem to relate to interactions but may relate to climate change and other changes seen on the land (ABEKC 2017a). Numbers are again moderating or reducing, after about 2015 (McLeod 2018 personal communication).

Participants in individual and group interviews in 2014 in Iqaluktutiaq all reported a substantial decline in muskox and caribou numbers (Tomaselli et al. 2018a and b). In a drawing exercise that characterized the relative abundance of muskoxen and caribou over time, participants indicated that for both species populations peaked and then began to decline around the mid-2000s, with a major decline after 2010 (Tomaselli et al. 2018a and b).

Over the longer-term decreases in muskoxen, bears, and caribou were seen by Iqaluktutiaq harvesters on Victoria Island as early as the 1950s; the animals were all considered more abundant by 2007 (Dumond 2007). Participants in the 2014 Iqaluktutiaq study reported that in the 1960s and 1970s it was rare to see muskoxen, but from the 1980s to the early 2000s, muskox numbers increased and it was common to see herds in the vicinity of the community, in numbers large enough to make it unnecessary to go further away to hunt them for personal consumption (Tomaselli et al. 2018a and b).

Sex and Age Structure

Ikaluqtutiak residents indicated that there are fewer calves than there used to be. The proportion of adult muskoxen increased from 75% in the pre-decline to 90% in the decline period (Tomaselli et al. 2018a).¹⁷ All interviewed groups reported a decrease in the observed proportion of juveniles from 25 to 10% over this period. Four of seven groups reported a relative increase in adult females from 47.5 to 65%, whereas the proportion of males remained similar across periods. Three groups did not feel confident in providing the relative proportion of adult muskoxen divided by gender (Tomaselli et al. 2018a).

Similar observations were made by Ikaluqtutiak residents about caribou; interview groups reported an increase in the proportion of adults, from 65% in the pre-decline to 80% in the decline period and a concurrent decrease in the proportion of juveniles from 35% to 20% (Tomaselli et al. 2018a). Not all the groups felt confident in providing the proportions of adults by sex, but for those that did, the proportion of adult female caribou increased from 42% in the pre-decline to 50% in the decline, while the proportion of adult males did not vary between the two periods (Tomaselli et al. 2018a).

¹⁷ Participants were not directly asked about this in the NU study; the observation of fewer calves in declining muskox herds emerged as a theme from individual interviews (Tomaselli et al. 2018a). This was followed up in group interviews using a TK research technique known as a “proportional piling exercise” to determine sex and age structure of muskox and caribou herds. For calves, the aggregate observation throughout the year was reported (as opposed to attempting to estimate calving, survival, or recruitment rates). Because of this, possible misclassification between calves and yearling might have arisen (e.g. late winter calf mistakenly referred to as yearling), especially for muskoxen; therefore, ‘juveniles’ were reported as the sum of observations for calves plus yearlings (Tomaselli et al. 2018a).

Group Size

The size of muskox groups and the distance between groups changed over time (Tomaselli et al. 2018a).

“Within the last ten years is when it started to be more difficult to see herds [of muskoxen] and then more recently within the last 3-5 years I would say that it is extremely difficult to find certainly any larger, and if you do find muskox they are usually loners or very small herds,” (Interviewee 17; Tomaselli et al. 2018:340).

Through a categorization exercise, six of seven groups indicated that in the pre-decline period, the average size of a muskox herd was greater than 30 animals, with an average of five to ten miles (or 8-16 km) between herds. The authors reported that progressively, smaller and more scattered groups were observed and, by the end of 2014, interviewees observed fewer than ten muskoxen per herd, with more than 20 miles (32 km; n=4 groups), and often more than 50 miles (80 km; n=3 groups), between herds (Tomaselli et al. 2018a).

Contrary to TKCK documented in other regions, the NU study reported interviewee observations of a barren-ground caribou decline (mainly of the Dolphin and Union herd – *Rangifer tarandus groenlandicus x pearyi*) occurring at the same time as the decline in muskoxen (Tomaselli et al. 2018a). The observations of changes in caribou were similar to those seen in muskoxen – namely, that groups of caribou had fewer individuals, and groups were further apart. Participants reported that prior to the decline, during the fall migration from late October to mid-November; they used to see “hundreds of caribou gathered in a single herd” near the shoreline, waiting for the sea ice to freeze, before migrating to the mainland. Progressively, fewer caribou were noticed in the usual areas, and, by the end of 2014, participants observed “very small, very few, and very scattered herds” of caribou, ranging from three to 30–40 individuals, but more frequently less than ten caribou (Tomaselli et al. 2018a).

Note that Barr (1991) indicated that muskoxen typically live in groups of 6-12 individuals, but that these groups can both intermingle and disperse again.

Fawcett et al. (2018) documented a shift in harvesting patterns from caribou to muskoxen amongst Ulukhaktok harvesters based on interviews and participant observation in 2005 and 2016. Researchers found that in the late 1990s muskoxen had replaced caribou as the primary source of meat due to the scarcity of caribou and the close proximity and abundance of muskoxen. In 2005, interview respondents reported that they were starting to see a slight decline in muskoxen and had to travel a little further to hunt them. Eleven years later, respondents reported that there were even fewer muskoxen and they had moved progressively further away from the community.

Representatives from Vuntut Gwitchin Traditional Territory and Parks Canada reported that larger groups and bigger numbers of muskoxen were being noted in the park¹⁸ by the early 2000s; of two groups of muskoxen seen in the park, one had 29 animals and the other 21 (WMAC (NS) 2001).

Coulter did note that there was previously a small herd of muskoxen around Dease Arm/Sulky River – roughly 12 animals that he hasn't seen for a couple of years, however he also stated that because they are so difficult to see in the trees there, it is entirely possible that they are still there (2018 personal communication).

Gwich'in and Sahtú (including Vuntut Gwitch'in information)

There is not a lot of recent TKCK regarding muskoxen for the GSA at this time. Gwich'in harvesters interviewed in 2008 documented an increase near Aklavik of the Alaskan (i.e. re-introduced) population; “Muskox [in the Richardson Mountains near Aklavik] did increase over the years... From single numbers up to maybe 200,” (Eddie Greenland *in* Lambert-Koizumi 2012:185). Aklavik interviewees also commonly described increasing muskox populations in the nearby Richardson Mountains (Tyson and Heinemeyer 2017). Muskoxen showed up at the NWT/Yukon border in the late 1980s, and a small herd was established around Jurassic Butte. There were about 12 animals in the herd when it was first spotted by Aklavik residents. The herd grew over the next six or seven years to be around 100 animals and at that point it dispersed into smaller herds (McLeod 2018 personal communication).

In the Vuntut Gwitch'in community of Old Crow (YT), there has been a recent drop in muskoxen numbers close to the community (ABEKC 2013). An independent analysis of ABEKC data – namely, harvester observations about changes in muskox relative abundance on the North Slope from 1996 to 2015 – found the following:

“Harvesters tended to report less than normal muskox abundance before 2004, but more harvesters started seeing more than normal than those in other years after this date. This increase in number of muskox observations was not related to other changes observed on the land, specifically more than normal observations of bears and wolves and less/same than normal observations of caribou,” (Nguyen 2016:1).

Outfitter Chuk Coulter has been guiding muskox hunts in the Great Bear Lake area for 12-13 years and reports that the muskox numbers in that area are largely unchanged.

¹⁸ Unclear whether this is Ivvavik National Park or Vuntut National Park; not stated in the source.

“I started working with the muskox hunt in 2005 or 2006, and I really would not say there has been any change in the muskox herds, both in terms of sizes and locations. They seem exactly the same. Our hunters were consistently successful a decade ago, and they continue to be,” (Coulter 2018 personal communication).

Coulter says he has seen a small but steady population of muskoxen in the Sahtú around Great Bear Lake over the years he has been there; “it’s a little muskox population there – there’s not a lot, probably a couple hundred animals in the Sahtú – and they don’t roam around, they don’t seem to migrate, they stay in the same little area” (2018 personal communication). Coulter also reports that the muskox herds always seem fairly consistent in regard to sex and age structure, but he can’t report on ratios. In each herd, he usually observes roughly the same number of calves, cows, and bulls – including a couple of very big bulls (2018 personal communication).

Akaitcho Dene First Nations - Łutsel K’e

Muskoxen were still considered rare and unusual for a hunter to bring home in the 1970s, according to Łutsel K’e elder Georgina (Dolly) Simon, speaking of her grandfather, “I remember he came back with something that was out of the ordinary. It was a muskox,” (DeBeers 2012:261). However, muskoxen did increase over the 20th century in the sanctuary and outside of its borders; “In 1989, hunters began reporting increased sightings of muskoxen west of the Sanctuary, and in 1998, muskoxen were reported in the vicinity of the Łutsel K’e town site,” (DeBeers 2012:112). In 1998 the town’s muskox harvest quota increased from 14-34 based on the increase in population in the decade between 1989 and 1998 (DeBeers 2012).

Habitat

Habitat Availability (How much land is occupied by the animal or plant?)

There was no information on this topic in the sources reviewed for this report.

Habitat Fragmentation (How is the land available to the animal or plant being cut in pieces? Are the places they are found changing?)

There was no information on this topic in the sources reviewed for this report.

Habitat Trends (How is the land and food important to the animal or plant changing?)

TKCK suggests that muskoxen (along with other ungulates) themselves make changes to the land. Inuvialuit interviewees noted that muskoxen seem to be changing portions of the Herschel Island landscape from tundra to mud, a behavioural phenomenon which may also play a role in their population cycling (Tyson and Heinemeyer 2017).

Łutsel K'e elders indicated that muskoxen are using the land differently than in the past, perhaps due to climate change or noise pollution from mines. For hundreds of years, muskoxen were known to stay in the open areas, but recently elders have started to see them in the 'bush' or wooded areas (Dokis-Jansen 2015).

There was no other information in the sources reviewed on this topic, although this is a topic generally well-served by TKCK; in other words, TKCK likely exists but has not been recorded.

Distribution Trends (Are they found in fewer places than before?)

As noted in the **Interactions** section above, reintroduced muskox herds have expanded into the Richardson Mountains area from Alaska. Endemic populations have also spread south into the Sahtú Region from populations to the north. As a result, they are being seen in areas they were not found in, in the recent past. "People from Aklavik, Tulít'a, Fort Good Hope, and Déljine all talked about either an expansion of muskox range into new areas or an increase in numbers of muskoxen in recent years," (ACCWM 2014:53).

A small population of muskoxen north of Sahtú (Great Bear Lake) persisted into the 1920s, and rare sightings were seen between Sahtú and Paulatuk (ISR) on the Arctic coast. Groups of between 10 and 100 muskoxen were seen in the 1930s to the late 1960s and these populations seemed to be expanding geographically by the 1980s (Barr 1991). Barr reports that populations in what is now NU have declined and grown more variable in part due to harvest (for example, in the Chesterfield Inlet area) (1991).

Lent argues that over many parts of the Arctic, hunting by Aboriginal people was the principal factor controlling distribution and numbers of muskoxen, including long before western influences and hunting technologies arrived (1999).

Based on information contained in Barr (1991), the pre-1860 range of muskoxen in the NWT and NU is approximated in Figure 12.

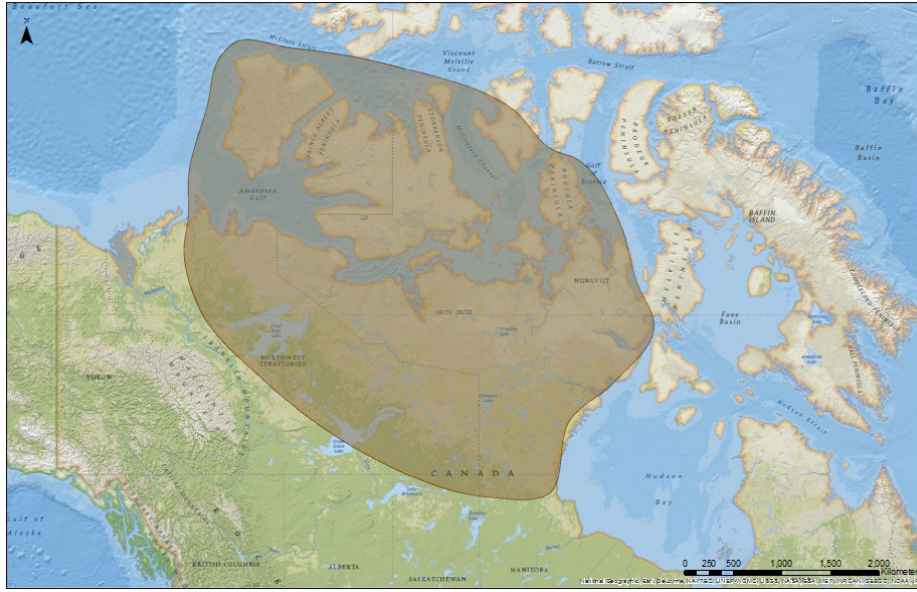


Figure 12. Approximate range of muskoxen in the NWT/NU, pre-1860 (from descriptions in Barr 1991). Map provided courtesy of GNWT, ENR.

The mainland/endemic population in the Gwich'in and Sahtú was also increasing at that time. In 2014, people from Aklavik, Tulít'a, Fort Good Hope, and Délı̄ne all talked about either an expansion of muskox range into new areas or an increase in numbers of muskoxen in recent years (ACCWM 2014).

Dene hunters in the Sahtú have been reporting increases in numbers of muskoxen, as well as increases in the extent of their range (Auld and Kershaw 2005).

“People have talked about how the caribou numbers are going down, so muskox are going up and it’s happening. There was a sighting in Fort Providence¹⁹ two years ago. Its common knowledge they’re on the ridge and across the lake. People saw five casually standing on the point – they don’t care we’re here. If it was my grandfather, we would thank the creator and go hunt. But there aren’t many people in Délı̄ne that want to harvest because we lost that part of hunting muskox,” (Bezha 2018 personal communication).

Inuvialuit Settlement Region and Nunavut

The cycling of muskox populations strongly influences muskox distribution trends. Inuvialuit interviewees remembered, for example, a time when there were no muskoxen around De Salis Bay (Kangiᑭᑭualuk) (Nagy 1999). An earlier reference may help to

¹⁹ W. Bezha confirmed this observation when requested by email. At time of finalizing this report (2020) there were no other known observations of muskoxen in the Fort Providence area.

pinpoint the timeline: Mrs. Susie Tiktalik of Sachs Harbour, speaking in 1976, recalled her parents moving into the De Salis Bay and Egg River area, to use the abundant geese and muskoxen in that region. However, at one point in her childhood, Tiktalik recalled that there were no more caribou or muskoxen to be found there, and her family stopped going to that area for that reason (Berger Inquiry V42 Sachs Harbour 1976). Historical sources agree with these observations.

The decrease in population on the Arctic Archipelago in the pre-1915 period also caused drastic changes in distribution.

“On Banks Island there were relatively few muskoxen at the time of M'Clure's sojourn in the area (1850-53), but there is some evidence that the population increased significantly shortly thereafter. This increase was followed by a drastic decline, caused probably by a combination of unusually heavy hunting pressure by Inuit visiting the abandoned Investigator and possibly also by environmental stress and/or disease. By 1914-16 the island was reported to be entirely devoid of muskoxen. It was not until the early 1950s that muskoxen were again seen, in small numbers, on Banks Island,” (Barr 1991:98-99).

A similar distribution pattern was seen on Victoria Island (Barr 1991).

Also speaking in 1976, trapper Peter Esau indicated that muskoxen were not commonly seen on his trapline around Masik Pass and De Salis Bay when he started trapping. At that point (perhaps around 1965, it is unclear), muskoxen were seen only in the northern parts of Banks Island. Over the following ten years, they became more and more common in southern areas including around his trapline, increasing at a rapid rate (Berger Inquiry V42 Sachs Harbour 1976).

On Victoria Island, Fawcett et al. (2018) documented a shift in harvest patterns from caribou to muskoxen amongst Ulukhaktok harvesters based on interviews and participant observation done in 2005 and 2016. Researchers found that in the late 1990s muskoxen had replaced caribou as the primary source of meat due to the scarcity of caribou and the close proximity and abundance of muskoxen. In 2005, interview respondents reported that they were starting to see a slight decline in muskox numbers and had to travel a little further to hunt them. Eleven years later, respondents reported that there were even fewer muskox and they had moved progressively further away from the community.

As mentioned previously, one respondent reported travelling 120 km by ATV one day in July 2016 without seeing any muskoxen (Adam Kudlak *in* Fawcett et al. 2018).

On the mainland, the Thelon River muskoxen population has spread to adjacent areas, especially southward (Barr 1991). According to Barr's interpretation of explorers' reports,

muskox populations were either recovering or had persisted in the Thelon-Hanbury watersheds in the 1920s (Barr 1991). As mentioned previously, the relative abundance in that area led to the establishment of the Thelon Game Sanctuary in 1927 (Barr 1991).

Gwich'in and Yukon North Slope

In the far west of the NWT, muskoxen are expanding their distribution from the west to the east. They have been seen in the Richards Island area (Aklavik HTC et al. 20016) and Parson's Lake (Community of Paulatuk et al. 2008). There have also been sightings of muskoxen in the various locations in the Richardson Mountains north of about the Rat River area, along the Porcupine River, northwest of Mayo, and near Old Crow (WMAC (NS) 2001; McLeod 2018 personal communication).

For the YNS, the WMAC reports that for a number of years, muskox expanded from northeast Alaska into the northern Yukon and NWT west of the Mackenzie River (WMAC(NS) 2001).

There are also reports of muskox around the Old Crow Flats as early as the 1920s-1930s, as well as old stories of muskox being in the mountains north of the flats (WMAC(NS) 2001). These muskoxen spread into the NWT to the mountains around Aklavik after about the 1970s (McLeod 2018 personal communication).

Sahtú Settlement Area

Historical sources indicate that after their near extirpation before 1915, mainland muskox populations started to grow more rapidly after about 1960; during this time, they expanded their range (Barr 1991).

Hunting guide Chuk Coulter has been working in the area of Great Bear Lake for the last 12 years, and reports seeing muskoxen in the same areas consistently over that time period. He said he has observed no change in distribution in the Sahtú Region. The only distribution change he is aware of is around Great Slave Lake, where people started seeing muskoxen there about five years ago, and they were not previously known to be in that area (Coulter 2018 personal communication).

Akaiicho Dene First Nations – Łutsel K'e Dene

Denésqłíné TK of muskox distribution in the Kache Tué region indicates that there is a change in muskox distribution there as well:

“We lived this land for about 40 years growing up around Artillery Lake [northeast of the community of Łutsel K'e]. We used to trap a lot around Fletcher Lake and Cook Lake, but we didn't come here [Aylmer Lake] that often because we didn't have to. But we came here to keep up the practice of living on the land. We lived all around - all the way east of the Thelon. ...I've never seen

musk ox around here just farther east. In Artillery too, only in the past 20 years musk ox have been found around there,” (MD 19 08 01 *in* LKDFN 2002:23, see also Dokis-Jansen 2013).

To the north of Kache Tué and ?edacho Tué is a region known as Bedaghé Tué. This region features one of the main routes used by Denésǫłiné to access the barrenlands, and then move off in different directions towards their traplines and hunting grounds. In the springtime, families would regroup here for the journey back to Tu Nedhe (LKDFN 2005).

“Central to this land region are the lakes called Tué Cho (Fletcher Lake), Datthi Tué (Walmsley Lake), and K’ezus Tué (Cook Lake). ...Many great caribou crossings are found on the bigger lakes in the region, with which are associated many Denésǫłiné camps and travel routes. In recent times, muskox have begun to be spotted making heavy use of the area, representing a westward shift from the traditional distribution,” (LKDFN 2003:25).

Nunavut – High Arctic

More detailed information on population and distribution trends for muskoxen is provided in Taylor 2005 for the following areas:

- Somerset, Prince of Wales and Russell Islands, and Boothia Peninsula
- Cornwallis and Bathurst Islands
- Devon Island
- Southern, Central and Northern Ellesmere Island.

As noted above in the population trends section, both caribou and muskoxen experienced the largest fluctuations on the more southerly of the islands in the Arctic Archipelago. Smaller, local fluctuations are seen on the northern islands of Devon and Ellesmere Islands where both species are found in greater abundance. Distribution and population changes were due to population cycles, weather, and human disturbances (Taylor 2005).

Threats and Limiting Factors

The lack of recorded knowledge and lack of funding to conduct research (including TK research) is a threat to muskoxen. Knowledge gaps include long-term population trends, regionally focussed threat assessments, and others (Kutz et al. 2017). This report found information gaps for many topics and in most regions. A lack of appreciation of muskoxen due to historical management decisions and the absence of muskoxen from many areas for decades, and perhaps a lack of good public awareness is also a threat to muskoxen (Kutz et al. 2017).

Threats seem to be focal and regional. In the High Arctic, it is possible that extreme fluctuations in muskox abundance and distribution over time are part of a normal cycle

(Taylor 2005). The idea that a large increase in muskox numbers may be a threat to their long-term survival was also raised by Inuvialuit knowledge holders in the NWT.

“The muskox had overpopulated into thousands. Into thousands! ...they're afraid that if they don't [kill part of the muskox population], there's going to be a disease broke among them and they'll die of starvation by themselves. It'll take years and years and years for the caribou to come back,” (Agnes Carpenter *in* Nagy 1999:161).

Muskoxen are not facing any unusual threats in the Sahtú Region. Wolves are a usual predator, but muskoxen have a strategy for protecting their calves (Coulter 2018 personal communication). Currently, there are no roads nor industrial developments that are impacting the population (Coulter 2018 personal communication).

Poor Body Condition and Disease in Nunavut Populations

Iqaluktutiaq community members provided insights into possible mechanisms for changing demographics. These include poor body condition and increased burdens of disease, including syndromes consistent with brucellosis and orf. Both may have played a role in the decreased trend of juveniles reported by interviewees (Tomaselli et al. 2018a and b). Increases in predators, changes in emigration events, as well as human disturbance, environmental changes, and changes in the health status of the animals were among the factors that participants associated with the decline of muskoxen in interviews conducted with Iqaluktutiaq community members in 2014 (Tomaselli et al. 2018a). Participants in that study provided detailed epidemiological observations that correspond to approximately two dozen infections and illnesses. They also consistently identified grizzly bears as new predators for muskoxen on Victoria Island during the decline (Tomaselli et al. 2018a; Kutz et al. 2017).

The authors discussed the direct link between cow body condition, conception and calf survival rates, as well as pathogens like *Brucella spp.* and the orf virus being linked to reduced pregnancy rates and increased calf mortality, acknowledging that poor condition and a high burden of disease can lead to increased direct mortality and susceptibility to predation (Tomaselli et al. 2018a). Working together, these mechanisms are all likely influencing key demographic rates and ultimately, the dynamics of the declining muskox and caribou populations on Victoria Island (Tomaselli et al. 2018a). However, it is likely that the magnitude of muskox body condition decline was actually underestimated. Some of the information resulting from specific health-related topics covered in the Iqaluktutiaq interviews is summarized below.

Muskox Body Condition

During interviews in Iqaluktutiaq in 2014, changes in the body condition of muskoxen emerged (unprompted) as a theme in the individual interviews (Tomaselli et al. 2018a).

This was explored further in group interviews where participants did an exercise to indicate the proportion of animals observed in different body condition classes (excellent, good, fairly good and poor). Overall, from the pre-decline to decline period, fewer animals were classified in excellent condition and more in fairly good and poor condition (Tomaselli et al. 2018a). Narratives supported these findings, with many participants in group interviews reporting that it was common to hunt both muskoxen and caribou with 5 to 8 cm of back fat during the pre-decline; whereas at the time of the interview, “you would be very lucky to get an animal with 3 cm of back fat, but usually they have 1 cm or nothing,” (Tomaselli et al. 2018a:341).

Overall, local knowledge confirmed major population declines for muskoxen and caribou, beginning in the mid-2000s, and that the body condition of both muskoxen and caribou had deteriorated over that time period (Tomaselli et al. 2018a).

Muskox and Caribou Morbidity and Mortality

Among the themes that consistently arose from community work in Iqaluktutiaq were the following: increased observations of abnormalities in hunted and observed muskoxen and caribou, recent observations of muskox carcasses with attributes that were inferred to be suggestive of a disease outbreak, and increased observations of muskox and caribou mortality due to predators (Tomaselli et al. 2018a). For both muskoxen and caribou, from the pre-decline to the decline period, the proportion of animals observed healthy had decreased and the proportion of diseased had increased. For muskoxen, there was also an increase in the proportion of animals observed dead, but no change was observed in the proportion of dead caribou (Tomaselli et al. 2018a).

Relative Prevalence of Diseases

Participants in the Iqaluktutiaq study provided detailed epidemiological observations that correspond to approximately two dozen infections and illnesses, including a variety of lesions or more generic syndromes in hunted and observed muskoxen and caribou (Tomaselli et al. 2018a). Rarer, but more recent observations reported by individual participants included lesions described as “white eyes” consistent with corneal opacity in adult male muskoxen (attributed by participants to injuries incurred during the rut, however noticed only since 2010). Observations of yellow coloration of subcutaneous tissue associated with pale skeletal muscle were described in both muskoxen and caribou and in particular in individuals with poor body condition since 2008 (Tomaselli et al. 2018a).

Causes of Mortality

As noted above in **Physiology and Adaptability**, causes of mortality around Iqaluktutiaq included predation, ‘acute death’, and a variety of other causes that were categorized

afterward as 'other causes', ranging from unknown to deaths due to drowning, injuries due to both natural and anthropogenic causes, starvation, and old age (Tomaselli et al. 2018a).

For both muskox and caribou, from the pre-decline to the decline, there was an increase in mortalities attributable to predation, and although wolves were considered the primary predators of both species, the proportion of predation attributed to grizzly bears increased for muskoxen from 7% in the pre-decline to 25.5% during the decline (Tomaselli et al. 2018a).

Acute mortality was observed only in muskoxen during the decline period and by six of the seven groups interviewed; it was considered to contribute to the 25% of the total muskox mortality (Tomaselli et al. 2018a). One Inuk hunter described: "There was a bunch of dead muskoxen ...They looked like they just fell down and die, it's almost like somebody came and went bang, bang, bang. But they weren't shot they just died," (Tomaselli et al. 2018a: 342).

Patterns of Acute Mortalities in Muskoxen

Twenty-six of 38 interviewees in Iqaluktuiaq had observed acute deaths of muskoxen. The first reported case was from the early 1980s (Tomaselli et al. 2018a). From the early 1980s until 2005, six participants reported observing a total of 9-12 cases. Beginning in 2010, observations of acute mortality increased, peaking in 2012. These observations were confirmed by individual narratives. A pilot reported,

"In a normal year during the summer we would see on average a dozen carcasses, but scattered...in that big area we fly in...But then, all of the sudden, in those years '10, '11, '12, we saw a lot more [carcasses] and concentrated in a smaller area ... In [Sussex] Hills and Surrey Lake, there was at least the double of what you would see in a normal year," (*In*: Tomaselli et al. 2018a:342).

The interviews documented at minimum 120 more dead muskoxen from 2010-2014, with the peak in 2012, and descriptions of the mortalities (entire carcasses, various age classes, and no evidence of predation) indicative of acute infectious disease (Tomaselli et al. 2018a). Among all the muskoxen observed dead, 95% were adults and 5% were juveniles. The authors suggested that mortality during this time period was underestimated because of limitations in search techniques, carcass removal by scavengers, misclassification of mortalities as primary predatory events because carcasses were scavenged, and predator removal of diseased and weak animals. Additionally, carcasses of juveniles would likely be more difficult to detect and would disappear more rapidly, thus disproportionately underestimating juvenile mortality (Tomaselli et al. 2018a).

Human Predation

Muskoxen are said to be easy to harvest; this was likely a contributing factor for the historic decline in their population and the subsequent hunting ban. Figure 13 shows how “tame” muskoxen were in the Richardson Mountains when they had not experienced hunting pressure.



Figure 13. Aklavik hunters have been able to approach muskoxen in the Richardson Mountains. They are described as "tame" when they haven't experienced hunting pressure. Photo credit: GNWT.

It has also been acknowledged that it was the commercial exploitation of muskoxen that had the greatest impact on most populations, especially across the Canadian mainland (Lent 1999). One estimate puts the number of hides coming from the Canadian mainland between 1860 and 1915 at roughly 23,000; this number is thought to be conservative, as it does not include hides lost to waste, those that didn't make it to market, or those passing through independent traders (Lent 1999). Lent argues that over past millennia humans have extirpated muskoxen in certain areas, in other areas held muskox numbers to low levels, or checked muskox dispersal into otherwise suitable habitat; “[i]n short, human hunting was a major influence on the numbers and distribution of muskoxen around the circumpolar north prior to the introduction of firearms,” (Lent 1999:216).

Following considerable analysis of trends in muskox abundance/distribution and Inuit exploitation over time, Lent concluded:

“I cannot absolutely establish a cause-and-effect relationship between the presence of Inuit and the absence or diminished numbers of muskoxen in any specific case. Nevertheless, the overall pattern leads me to conclude that

hunting by Inuit was a principal factor influencing the distribution and density of muskox populations prior to western influences and technology,” (Lent 1999:215).

Muskoxen may be particularly sensitive to hunting at certain times, such as calving (Golder 2003) and when they are young; “[l]ong ago, in early May when they are just born, people used to hunt young muskox with no weapons,” (Helen Kalvak *in* Nagy 1999:19).

Some community members in Ulukhaktok are undertaking traditional subsistence activities less often than in the past due to financial and time constraints.

“This has serious implications for the generation and transmission of TEK and the capacity of these hunters to safely travel and ultimately deal with changing conditions on the land. Other hunters tend to be relying heavily on a few species, or even specializing on one or two species (e.g. wolves, muskox) as a flexible response to changing wildlife quality and availability and as an opportunistic source of income. This focussed pressure, in turn, could have negative consequences for the population health of the targeted species,” (Fawcett et al. 2018:32).

Targeted species include muskoxen.

Plummer’s Great Bear Lake Lodge is the only outfitter conducting guided hunts for muskoxen around Great Bear Lake in the NWT. They get six tags a year, but usually only harvest two to four animals; they target the older, larger, lone bulls that they see on the shore of the lake and give the meat to the community of Délı̄ne. Most of these bulls are expected to die of natural causes before the end of winter. Generally, hunters in the community are not harvesting muskoxen, as they tend to prefer harvesting and eating other animals (Coulter 2018 personal communication).

Industrial Activities

There was little information regarding the reaction of muskoxen to industrial development in the sources reviewed for this report, and little environmental research conducted in the past to assess the impact of activities such as increased mining and drilling on muskoxen or the surrounding ecosystems in general (Taylor 2005).

Within the NWT, there was one mention in a Diavik diamond mine environmental assessment document that muskoxen did not avoid mines or mining activity:

“I don't think [Diavik mine] at Lac De Gras will bother [barren-ground caribou]. The trucking camp has been there since the year that me and my uncles made that road to Lupin and they still go to Lupin. If you go to Lupin you see muskox grazing just a mile or two away, it hasn't affected them any and you see caribou

coming through there too in the fall time,” (D'Arcy Mercredi in NSMA 2001:109).

During research in the High Arctic, Taylor (2005) documented observations from local knowledge holders that muskoxen are disturbed by industrial activity. Beginning in the 1960s, some interviewees reported that caribou and muskoxen alike were moving away from exploratory work on northwestern Ellesmere Island. They said that the noise and smell of the explosions frightened the animals, and accompanying disturbances, such as aircraft and land vehicles, and residual materials, such as oil drums and garbage, also caused the animals to vacate these areas (Taylor 2005). Further, interviewees said that these activities frightened the muskoxen away from good grazing areas to poor grazing areas and possibly resulted in starvation; animals that did stay within the area of disturbance became physically unhealthy (Taylor 2005).

There were suggestions that a group of ten muskoxen had starved to death when they fled to a glacier because they were afraid of seismic work that had begun in the area. Based on these and other observations made in the late 1970s and into the early 1980s, interviewees believed that the abundance of muskoxen on the west side of Baad Fiord had decreased because of this work and because of increased helicopter traffic driving muskoxen away. These observations coincide with stated dates and locations of the exploration activities of Kenting Exploration and Panarctic Oils Limited (Taylor 2005).

Weather and Climate Change

By 1999, Inuvialuit hunters on Banks Island were observing that muskoxen were being born earlier than in the past due to climate change (Riedlinger 1999). Harvesters from Sachs Harbour indicated that climate change is a threat to muskoxen and in particular rain after snow, which causes a crust of ice. This is compounded if it happens across the whole island, leaving no fodder (Kutz 2007). Winter rains making winter feed unavailable to muskoxen was also mentioned as a threat by an Aklavik interviewee (Benson 2011). These events have been a threat to muskoxen since at least the late 1930s; “[a]lmost the only weather condition that can cause them severe stress (and in the worst cases, death) is the occurrence of freezing rain, which produces a thick ice crust on the snow, preventing them from reaching their fodder,” (Barr 1991:1). An icing event in that decade devastated the muskox population on Banks Island; ice covered the muskoxen’s feed, the grass, so they starved (Nagy 2004).

Interviewees in the High Arctic generally supported the idea that climate has an impact on caribou and muskoxen but did not mention global climate change as the primary factor influencing the fluctuations in animal numbers (Taylor 2005). The degree of influence that interviewees believed weather to have on caribou varied between individuals:

“I think that the caribou will slowly come back in the islands here as long as the weather doesn’t freeze up again. I think that is the thing that affects them more than anything else. If they can’t get at their food they can’t eat,” (TM *in* Taylor 2005:101).

“The snow, the weather, I don’t think it has any effect on the animals, it is their way of life, they are outside animals, they live in the snow... it is the movements of mining and oil explorations, high noises of airplanes, I think those are the things that effect the animal,” (LN *in* Taylor 2005:101).

Differences in opinion may be due to what individual interviewees have observed within their different hunting areas. For example, the residents of Resolute Bay have observed weather patterns that they believe have had a much more dramatic impact on caribou and muskoxen, while interviewees from Grise Fiord generally did not believe that weather has had the same impact on caribou on Ellesmere (Taylor 2005).

Whether a part of climate change or more usual weather patterns, many interviewees in the High Arctic felt that freezing rain over deep snow or the partial melting of snow in warm weather followed by cold temperatures that quickly freeze the wet snow had an impact on the ability of both caribou and muskoxen to access food (Taylor 2005). As a result, caribou and muskoxen would try and move to an area where they might be able to access food, and if unsuccessful they would starve to death. Many interviewees emphasized that the effects of icing over vegetation had the ability to cause caribou and muskoxen to starve but they did not believe that it killed all of the animals (Taylor 2005). In the mid-1990s, carcasses of muskoxen and caribou were being found on the south and southeast coasts of Prince of Wales Island and on Little Cornwallis Island, and interviewees correlated some of those mortalities with rain events during the winter of 1994/1995 (Taylor 2005).

Changes in weather patterns may be working together with human predation to function as a threat to muskoxen. During community workshops on climate change between 2002 and 2005, Inuit communities reported a general decrease in access to country foods. Changes in weather, snow, ice and water conditions, access to traditional hunting areas, and shifts in some animal migration routes and timing had all negatively affected access to some country foods. This can at times result in increased harvest pressure on muskoxen. For example, residents of Paulatuk stated that when the caribou move farther away from the community, they rely more on other animals that are more accessible; several communities in the ISR reported switching from caribou to muskoxen (Nickels et al. 2005).

Historic literature bears out this pattern. Icing events are particularly hard and can combine with other threats to cause population declines. Muskoxen are “quite susceptible to relatively warm conditions resulting in freezing rain and widespread ice crusts.

Catastrophically high mortality rates have been recorded among the muskoxen of East Greenland under such conditions on several occasions,” (Barr 1991:100); a similar effect was noted in the Canadian Arctic in the 1970s. When warm winters allowed for coastal waters to remain ice-free, the conditions made for icing events compounded with heavy snowfall that were particularly hard on older muskoxen and calves (Barr 1991).

Interviewees from both Grise Fiord and Resolute Bay indicated that fluctuations in population abundance and changes in distribution were influenced by regular population cycles, weather and human disturbances. Large die-offs of caribou on the southern islands were mainly attributed to a combination of population cycles and unusual weather, for example rain in fall or winter which created ice lensing on the ground surface. However, interviewees also indicated that seismic work on Bathurst Island may have also influenced changes in distribution there. On the northern islands significant changes in caribou and muskoxen distribution were attributed mainly to seismic activities (Taylor 2005).

Positive Influences

Some elders in the 2014 study in Iqaluktuiaq shared Inuit knowledge about traditional hunting management practices that can help to sustain muskox populations, such as not shooting animals when there are only a few in a herd, not shooting during calving season and not hunting pregnant cows (Tomaselli et al. 2018b). Other elders stated that when they were young, their families used to hunt no more than one muskox per season and then share (Tomaselli et al. 2018b). With one possible exception on Banks Island, Lent (1999) found no evidence of taboos or concerns for muskox conservation in the ethnographic literature other than Inuit hunters practicing selective harvesting.

There are suggestions in the literature that limiting the size of muskox populations in times of abundance could help to avoid massive die-offs and/or habitat deterioration.

“[Muskox], they're just like sheep, when they eat, they eat right to the roots and they don't leave anything. Well, then the best thing to do is to destroy them all, you know. Or get somebody to go in there and farm them. See, Banksland is big, but nobody lives in it, there's only guys that lives here (Sachs Harbour). They could have big muskox farm in here (showing the Aulavik National Park on the map),” (Sam Lennie *in* Nagy 1999:159).²⁰

“You know, the animals have their own ways too. By themselves, the muskox really increased in Banks Island. Today, it is pretty hard to try to do something about it, and there's hardly any more caribou too. Just like it's getting to be worrisome about it. The muskox, maybe they increased too much in Banks

²⁰ Note that Banks Island may also be referred to as “Banksland”, see Sachs Harbour HTC et al. 2016.

Island. ... Maybe for about five years over 8,000 muskoxen should be slaughtered [every year], that's the way we thought about them. If we try to decrease the muskox, if they decrease, it would be good. There are too many of them right now today. That's what our opinions were about them. We should do some slaughtering during a period of five years," (Albert Elias *in* Nagy 1999:159).

However, it is not clear as to whether these suggestions arise from Inuit TK or from SK and management perspectives shared with Inuit harvesters.

An Inuit interviewee in the High Arctic indicated that wolves may positively impact muskoxen because they generally kill the weak and sick animals (Taylor 2005).

Outfitter Chuk Coulter suggested that a potential positive influence for the muskox population could be the growing interest from tourism (2018 personal communication).

The ability of muskoxen to habituate to the noise of development may also be a positive influence. An Iqaluktuuttiaq interviewee mentioned that many years ago, industrial machinery would scare both muskoxen and caribou. In modern times, however, they have adjusted. Muskoxen also habituated to people's presence at the dump (Golder Associates 2003). The ability of muskoxen to habituate may be regional.

Conservation Planning and Wildlife Management

Several conservation initiatives include positive influences, based on TKCK, for muskoxen. The 2016 Sachs Harbour Community Conservation Plan includes some management actions that aim to sustain the Banks Island muskox population at a goal of 20,000 animals. Conservation measures included:

- Selectively harvest muskox from certain areas on a rotational basis.
- Use all parts of muskox (save heart and liver for dogs if not used for human consumption).
- Maintain population of muskox near Sachs Harbour for subsistence, tourism and trophy hunting.
- When shooting muskox take a neck shot to reduce meat wastage.
- Establish quota to maintain population goal.
- Below a population of 20,000 muskox on Banksland, review harvest strategy and reset quota.
- Continue regular population census (planned 2019).

- Identify and protect important habitats from disruptive land uses (Sachs Harbour HTC et al. 2016:75).

Guided by the *Inuvialuit Final Agreement*, the WMAC has been collaborating with a number of partners to create a framework to support the management of YNS muskoxen, as well as working to develop a research plan that will address key knowledge gaps and questions, including those raised by Inuvialuit. There are three main goals established under this framework (WMAC(NS) 2018):

1. Provide opportunities for Inuvialuit hunters to harvest muskoxen, while maintaining a healthy, productive, and sustainable population.
2. Minimize any detrimental effects that muskoxen may have on caribou and caribou habitat and harvesting.
3. Cooperate and share information about muskoxen among users to develop and implement management and research programs.

At the 2001 YNS Muskox Management Workshop in Aklavik, during a presentation on the draft YNS Muskox Management Plan, the following was stated to be the overall goal of the plan:

“The management priority is to maintain a stable population of muskox on the North Slope while preventing the expansion of muskox east into the Mackenzie River Delta. Muskox management will involve maintaining the current population level of muskox on the YNS, undertaking research and monitoring activities and providing opportunities for Inuvialuit to exercise their hunting rights for subsistence purposes subject to the principles of conservation,” (WMAC(NS) 2001:14).

However, there are currently no published management goals for North Slope muskoxen in the NWT. The muskox harvest that occurs in the NWT region adjacent to the YNS is not bounded by quota or other management tools. There is no desire for a quota on muskoxen on the NWT side of the ISR at this time (WMAC(NS) 2017).

INFORMATION SOURCES

Contributors to TKCK referenced in this report

Auriat 2002: Participants' identities are not revealed for confidentiality purposes.

Benson 2011: Tom Wright, Emma Kay, Richard Ross

Benson 2014: Hyacinthe Andre, Gabe Andre, Bob Norman

Benson 2015: John Jerome, James Firth, Julie-Ann Andre, Morris Blake

Berger Inquiry Volume 41 Holman Island 1976: Roy Goose, Jimmy Memoganak

Berger Inquiry Volume 42 Sach's Harbour 1976: Susie Tiktalik, Mrs. Albert, Unknown Participant, Peter Esau, David Nasagaluak, Andy Carpenter.

Dokis-Janson 2015: Joseph Catholique, Madeline Drybones

Dumond 2007: Bobby Algona, Charlie Bolt, Marion Bolt, John Ivarluk, Stanley Klengenber, Peter Taktogon, Colin Adjun, Gerry Atatahak, Allen Niptanatiak, Mitch Campbell, Luigi Torretti, Jack Himiak, Peter Taptuna, and Dustin Fredlund.

Lambert-Koizumi 2012: Abe Stewart Sr., Abraham Peterson, Alfred Semple, Archie Jerome, Billy Wilson, Charlie Stewart, Dale Semple, Donald Aviugana, Eddie Greenland, Ernest Vittrekwa, Freddie Greenland, Glen Alexie, Ian McLeod, John Carmichael, Johnnie Charlie, Lloyd Nerysoo, Mary Kendi, Patrick Gordon, Peter Francis, Peter James Kay, Robert Alexie Sr., Ryan McLeod, Woodie Elias

Katz 2007: Trevor Lucas, John Lucas Sr.

Golder 2003: Frank Analok, Mary Kaniak, Tommy Kilaodluk, Luke Kudlak, Luke Novoligak, Bessie Omilgoetok, Paul Omilgoetok, John Akana, Pillip Kadlun, Lena Kamoayok, Mary Kaniak, Allen Kapolak, Charlie Keyok, Clarence Klengenber, Moses Koihok, Luke Kudlak, Noah Kuptana, Joseph Niptanatiak, Luke Novilogak.

Gunn 2005: Alex Banksland, Jimmy Kudlak, Sam Oliktoak, Frank Kuptana, Jimmy Memogana, Agnes Goose, Morris Nigiyok, Harry Egotak, William Kagyut, Nickolas Aloakyuk.

Kutz 2007: Paulatuk: Garrett Ruben, Olga Ruben, David Ruben, Annie Illasiak, Marcus Ruben, Edward Ruben, Charlie Thrasher, Ray Ruben (Assistant). Fort McPherson (one participant's name not included): Abe Koe, Mary M Firth, Mary Teya, Tabitha Nerysoo, Abe Stewart, Elizabeth Colin, Peter Francis, Doris Koe (Assistant). Aklavik Inuvialuit: Annie B and Danny A Gordon, Donald Avirgana, Jacob Achie, Jonas Meyook, Thelma Gordon, Jerome Gordon (Assistant). Inuvik: Elizabeth Firth, Leslie Cardinal, William Francis, Lucy Adams, Colin Day, Fred Dick, Miles Dillon, William Day, Shawna

Kaglik (Assistant). Sachs Harbour: Geddes Woolki, Richard Carpenter, Peter Esau, Joe Apiana, Terrence Lennie (Assistant). Déliņę: Joe Blondin Jr., Peter Baton, Alfred Taniton, Leon Modeste, Johnny Tutcho. Aklavik Gwich'in: Steven C Bonnet Plume, Charlie Stewart, Alfred Semple, John Koe, Richard Ross Sr., Allen Koe, James McDonald, Sr. Robert Buckle (Assistant). Fort Good Hope: Michel Lafferty, George Voudrak, Joe Orlias, John McNeely, Adeline Pierrot, Monique Cotchilly, Stanley McNeely, Wilfred Jackson, Gabe Kochon. Colville Lake: Marie Kochon, Hyacinthe Kochon, Madeline Blancho, John Blancho, Philip Cadzi, John B Gully, Alexie Blancho. Tsiigehtchic: Irene and John Kendo, Dale Clark, Noel Andre, George Nيتدitchie Sr., James Cardinal, Jennifer Andre (Assistant). Tulít'a: Joe Bernarde, Wilfred Lennie, John Hotti, David Yallee, Victor Menacho, Boniface Ayah. Norman Wells: Edward Oudzi, Winter Lennie, Roger Odgaard, Dave Fowler.

Nagy 1999: Paul Adam, Beverly Amos, Lawrence Amos, Joe Apiana, Alec Banksland, Agnes Carpenter, Andy Carpenter, Frank Carpenter, Frank Cockney, Winnie Cockney, Collis Dick, Sam Dick, Albert Elias, Alexandria Elias, Peter Esau, Shirley Esau, Alice Felix, Emmanuel Felix, Helen Gruben, Persis Gruben, William Gruben, Edith Haogak, Jean Kagyut, William Kagyut, Agnes Kayotuk, Frank Kudlak, Martha Kudlak, Frank Kuptana, Philip Kuptana, Robert Kuptana, Sarah Kuptana, Sam Lennie, John Lucas Sr., Jimmy Memogana, Agnes Nanogak Goose, Agnes Nasogaluak, David Nasogaluak, Morris Nigiyok, Sam Oliktoak, Albert Oliver, Emma Raddi, David Roland, Olga Roland, Peter Sydney, Joe Teddy, Nicholas Uluariuk, Agnes White, Bessie Wolki, Geddes Wolki, Sandy Wolki. Also includes information from interviews done with William Kuptana in the late 1980s, and an interview with Fred Carpenter.

NSMA 2001: D'Arcy Mercredi, Adrian D'hont.

Tomaselli et al. 2018a: Tyson and Heinemeyer 2017: Danny C. Gordon, Annie C. Gordon, Renie Arey, Nellie Arey, Jordan McLeod, Sam McLeod, Edward McLeod, Andrew Archie, Colin Gordon, Dwanye Benoit, Deon Arey, Dean Arey, Patrick Gordon, Judy Selamio, Jerry Arey, Peter Archie, Robert Archie, Larry Arey, Billy Archie, Jonas Meyook Jr., Lee John Meyook, Danny Gordon Jr., Wilson Malegana, Sarah McLeod, Trent Arey, Andrew Gordon Sr., and Joe Arey.

WMAC(NS) 2017: David Ruben, Robert Bruce, Dennis Frost, Georgie Blake.

PERSONAL COMMUNICATION

Jan Adamczewski – personal communication via emails, March 9, 2018 through August 1, 2019.

Walter Bezha – personal communications based on a telephone interview conducted March 9, 2018.

Chuk Coulter – personal communications based on a telephone interview conducted March 29, 2018.

Ian McLeod – personal communications based on a telephone interview conducted June 28 2018.

Fabien Mavrot – personal communications based on emails in 2018 and 2019.

Peter Redvers – personal communication via email, Jun. 18, 2018.

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APPENDIX A: ADDITIONAL DETAILS

There are very rich and detailed observations regarding the increase of muskox that happened in the ISR within living memory (since the 1950s). These observations have not been included in the main body of the report, as they only refer to a very small portion of the NWT and provide a window into what is likely only one part of a trend.

Observations Regarding Pre-2000 Population Trends of Muskoxen on Banks Island

Nagy 1999: 154-158

The muskox population has been increasing steadily since the 1960s and there is now over 70,000 muskoxen on the island (DN: Aulavik-47A:5, see also Toews 1998:138). Yet, in 1915 when Stefansson was on Banks Island, there was very few muskox and caribou on the island, as recalled by Susie Tiktalik who was a young teenager at the time.

Frank Kuptana. Long ago, Banksland had muskox. Then land froze up, iced land. The muskox had nothing else for feeding. The muskox became less and less, just like the caribou. Then the herd grew back to large numbers. [...] People, long ago have said the caribou also may have travel close to Victoria Island, as well as herded out by muskox (FK: Aulavik-27 A:3).

Geddes Wolki. They say long time ago when there was no muskox; they say there were a lot of caribou. Before (Susie) Tiittaliq died, the muskox was really increasing. She said the muskox would push the caribou away. Maybe they don't like the smell of them or it's about their food. [Muskox] eat so much, maybe they take all the food and let [the caribou] get short of food, maybe. You know the big muskox can eat three times more than one caribou, or even four times as much. Big gut. She thought all the caribou were gonna be gone that time. While there were still quite a few caribou yet. When we started seeing more and more muskox. When I first got a skidoo, well later on we all started getting skidoos. I got to meet four of them up around Big River. I felt as if I'd seen a ghost when I saw them. Boy! They were big after you see caribou. And then I followed them for a while and then I just let them go. I never killed them at all. Well, I didn't have the idea to kill them (GW: Aulavik-26B:4).

Sam Lennie. Susie Tiktalik told hunters and trappers, "if any way you fellows could destroy all them muskox, do it." She said when she was a very young girl, she said

that old William Kuptana, she used to pack him around. She said, there were a lot of caribou and muskox migrated through there and chased all the caribou away. And they had big rainstorm, and muskox, everything died in Banksland, everything that lived of the ground, caribou, everything. She said in springtime, Banksland was so stinking they all went back to Victoria land. See, I got this from a person that knew. She'd seen it happen and if they had listened to her, it would never never have happened. [...] But they just protected them. Now in Banksland there's no more caribou (SL: Aulavik-13A:2-3).

Sam Oliktoak. Long ago the white man said we couldn't kill any muskox. Because the muskox wasn't being killed anymore, now there's really lots around. Even in the summer, the people don't walk the land anymore too that's why. They don't hunt those animals anymore. People are staying mostly in town, where there's houses (SO: Aulavik-35B:9).

Jimmy Memogana. [Natkusiaq] said there was lots of muskox! Real lots! When they returned, there had been a very big rain fall, the land froze and the muskox all died, there was no more of them. That's what happened to them, around there, all over around there (JM: Aulavik-33A:5). The quick overgrowth of muskox of Banks Island within the past 40 years and the reluctance of the Canadian government to change its law which forbade the hunting of muskox, show that although people warned that caribou might disappear from the island due to muskox expansion, oral history and Traditional Knowledge were not taken seriously. As explained by Andy Carpenter, the ban on muskox hunting was finally lifted in 1971 with a small quota system of 15 muskox for the community of Sachs Harbour.

Andy Carpenter. Around the 60s they'd seen about 200 in this area here (south of Mercy Bay). Then in the 70s that's when they started really increasing in 71, there was about 3,000 to 4,000 muskoxen. Lots of them, and then they started coming this way. We started seeing some around this area here. [...] We tried to tell when we saw the increase coming, we tried to tell the government so they would start taking some of them. And they gave us so small quota, when they first open the quota that was in 1971. They opened it for 15 muskoxen, and they had to be hunted here (in the Aulavik area). You get seven this side and eight from this side here. You had to get them on other side of Bernard River. Nothing close. Now, you can't travel all the way up here to get one muskox and that's all you could get, one muskox. [...] they couldn't take the quota anyway because this was too far (AC: Aulavik -20B:9-10).

Peter Esau. I travelled all this, but I never went with dog team [through] the whole thing. But this, when they first opened the hunt, we split it by there, around here, we had permission to get eight muskoxen. [...] Apian and I we were the first ones.

Straight across. There's a boundary here for muskox, were you could kill. When you go outside of it, it is eight, a quota of eight. Me and Apian we were the first ones to go down that way [...]. He just went ahead, when we went to hunt muskox, we got two. One each. We went by skidoo. Not too many [of us]. I don't know who else. David Nasogaluak I guess [and] Wallace (Lucas). [...] They had that quota till they started to come around. They tried to manage them; they were not managing right. That's why they overpopulated, we could have controlled them right from the beginning, you know. We could get hunters and everything up here, but they were "endangered species." They called them that for so long and, they never wrote me for sport hunting. Now there is too many. You know, the white people they overdo it sometimes (PE: Aulavik-24A:l2-13). At one time we got 11 muskoxen, there were five cows altogether. With Floyd Sydney [...] around where it's close by, long ago when we killed muskox, there were five cows. They all had young ones inside of them. The other five were small ones. They'd always be born one right after the other. We really found out good about them, we really wanted to find out really good about them, when a cow has a young one, we shoot the cow and she always had young one inside of her. I just wanted to find out myself. That's the way I found out myself, them white men talked, [but] I really proved it myself. We talked [with biologists but] they still don't believe in it now yet. When we started doing the killing, we saw a cow here that was two years old, we saw it, it had young one inside of her. It was gonna have a young. She was age of two [...] yet they were saying that they will not have youngs till they are four years old first. But it's so true, we saw it ourselves. When they are two years old, they have a lot of youngs. They really increased (PE: Aulavik-24B: 1).

In his article on Banks Island, Douglas (1964:710) mentioned that the people of Banks Island linked the disappearance of the wolf to the resurgence of the muskox. Peter Esau also thinks that the absence of predators has influenced the growth of muskox on the island.

Morris Nigiyok. There was hardly any muskox then in 1959. There was hardly any muskox right up to 61. We started seeing a few then when we were at Banks Island. Only a few. Mter we stayed there we moved to Holman, we lived here and in Minto Inlet. When we were living in Minto Inlet, we saw a muskox there. No wonder the muskox were starting to come (MN:Aulavik- 36A:6).

Joe Apiana. Sometimes too, the muskox always goes down to the ocean too. Last winter too, down at Kellett Point where there was straight ice, near the land they were going towards the ocean, they say they were quite a few of them. [...] When they started growing, they sure increase. That time when they were few muskoxen,

there used to be some caribou around here. The caribou keep getting fewer and fewer (JA: Aulavik-17B:l2).

Agnes Carpenter. About the muskox, I've known for years. Like we've known for years on the island that the hunters and trappers, when they first started seeing the muskox, the elders were talking about it from past experience. Especially we were going back to the elders in the community at that time. They used to talk about muskox that used to completely wipe out the caribou herd because they were competing for the same food when we saw the signs of muskox coming into Banks Island. I know the hunters and trappers had written out to the Game people and to Ottawa. That was [...] was right in the early '60s, I know we started writing about muskox. That was a species at that time that was prevented from being killed. It was outlawed to kill muskox. The government was protecting them so they could make a comeback. But the people were against it, that's what we wrote to tell the government, that we did not want the muskox to increase because from past experience, past history, of what the elders knew, that the muskox were competing for the same food that the caribou were eating. And that they were going to completely wipe out the caribou herds. There's been meetings galore, there's been writings about it, there's been tapes on it, there's been recordings on it, but the government would not budge. And by the time they open [the hunt] the government kept having surveyors going onto the northern part of the island, the muskox was breeding like nothing! In about two, just a few years, it went from almost a few, just a few hundred maybe not even that, up to 10,000 (AC: Aulavik-12A:7).

Robert Kuptana. When we were there long ago, there was no muskox around. ... Then after that, the muskox grew in numbers and then the muskox were everywhere (RK: Aulavik-42B:3).

David Nasogaluak. Muskox took over that whole island anyway. Before anybody knows it, long time ago muskox was, I don't know how much in the north side. Muskox multiply so fast and when there's no more room down there, they started going south. An average muskox eat 35 pounds of moss a day (DN:Aulavik:-47 A:5).

Berger Inquiry V42 Sach's Harbour 1976: 4121-4124

It's quite a long distance from here to go down to these zones here, and we tried it, the first year we went down. We went down here, we got four muskoxen, but that was costly. We went down in skidoo and then after that we talked more about muskox, we figure if we were hunting muskox on the south end would be better because that's where the caribou come up in the fall time. They go down this part for the summer, but they come up here in the wintertime when the weather is really cold. But muskox is different than caribou. When muskox is feeding and grazing on

the ground, they take everything and they're heavy enough that they trample all the snow, and then caribou can't go there and start feeding right where the muskox been through. That's why we said, "Why not take these off and get our muskox on this part?" We've got a quota of 25 now, so we get our muskox from any place close to Sachs. They start with muskox all right, but they only give us quota of 25. The guys that were studying told that at least 20% per year they increased, and said there's about 5,000 muskox, that's a couple of years ago. The way they are going right now the people that have the experience on the island since before the white man told us, said long ago there was lots of muskox and they figure they got over-populated and some of them died off. Right now, they keep saying this, there should be more killed because they're increasing too fast for the island. For the last couple of years, maybe more, every winter we see dead caribou now. That means there's something wrong some place. Maybe the island maybe not big enough; maybe that's why something is getting over-populated, like maybe muskox. Every time we go trapline we start seeing dead caribou. A few days ago, there was a guy came back, saw six right on his line, right only on his line. How about if we cover the whole island, I wonder how many dead caribou there would be? That's why right now we try to talk about we know the island pretty good. Sometimes we go to the government and say, "Look, I think they're getting over-populated," but they still don't understand. They wanted to study them more. (Peter Esau, Berger Inquiry V42 Sach's Harbour 1976: 4121-4122)

We had a quota that time of muskox there and there were getting so many up here that they started moving down here, and around Masik Pass there got to be a lot, and some on the traplines. We told the government that there were getting too many on the island. One year they say there's 3,000; next year they say there's over 4,000. So that's quite a bit of increase right there. They wanted to do a slaughter, kill about 250 and ship them out to different settlements. Down in the south they say, "No, don't kill the muskox." So, they couldn't do any slaughtering at that time. But in a few years, there might be so many that the caribous will be dying off more. Around 1950's there was hardly any caribou. We had to go way up here to get caribou in the fall. In the wintertime there was hardly any around here. We never used to see muskox at that time. In '54, I think, we seen the first muskox down by Lenin River there. I see some down on Sachs River. That time when they were up here, they couldn't do a slaughter. We told the government to move some off the island. They said they had no money. Well, if the people in the south are so concerned about a few muskoxen they can put up the money to move them out of the island. There was nothing come out of it. So that's about for the muskox, I guess (Andy Carpenter, Berger Inquiry V42 Sach's Harbour 1976: 4,123-4,124).