Wildlife Management Advisory Council
North Slope

Yukon North Slope Wildlife Conservation and Management Plan 2021

Companion Report 14: Muskox / Umingmak

Publication Information

Cover photo: Jay Frandsen, ©Parks Canada/Jay Frandsen, 2019

Citation: Wildlife Management Advisory Council (North Slope). (2021). *Yukon North Slope Wildlife Conservation and Management Plan – Companion Report*. Whitehorse, Yukon: Wildlife Management Advisory Council (North Slope).

Available from: Wildlife Management Advisory Council (North Slope)
P.O. Box 31539
Whitehorse, Yukon,
Y1A 6K8, Canada

Download link: https://wmacns.ca/what-we-do/conservation-plan/companion

Acknowledgements

Many individuals and organizations have contributed to the preparation of the *Yukon North Slope Wildlife Conservation and Management Plan – Companion Report*. Much of the Western science and traditional knowledge research that is the evidentiary basis for this plan reaches back several decades.

Critical reviews by Environment Yukon, Parks Canada, the Canadian Wildlife Service, Fisheries and Oceans Canada have been helpful in addressing a wide-range of terrestrial, aquatic and marine conditions that inform the conservation requirements of the Yukon North Slope.

The principal writers of the Companion Report are Kim Heinemeyer and Joan Eamer. Kim is a conservation biologist with Round River Conservation Studies. She was ably supported by Julia O'Keefe, Maggie Triska, and Will Tyson. Joan is a former Council member, science writer, and environmental consultant. They were assisted with strong support from Mike Suitor - Environment Yukon biologist, Dave Tavares – Parks Canada science advisor, Craig Machtans – Environment and Climate Change Canada manager, and Tyler Kuhn – Environment Yukon biologist. Allison Thompson and Kaitlin Wilson – Council biologists, and Lindsay Staples – past chair – participated in all stages of report design, drafting and editing. Kirsten Madsen provided invaluable editing support.

The Aklavik Hunters and Trappers Committee assisted with and contributed to a substantial body of traditional knowledge of the wildlife and habitat, and traditional use mapping, of the Yukon North Slope that informs the report.

Jennifer Smith, Council chair, Council members and alternates, Tyler Kuhn, Matt Clarke, Craig Machtans, Billy Storr, Evelyn Storr, Colleen Arnison, and Michelle Gruben, and Council staff Allison Thompson and Kaitlin Wilson reviewed the final draft of the report.

Companion Report to the Yukon North Slope Wildlife Conservation and Management Plan Number 14: Muskox / Umingmak

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About the Companion Report

This report is a companion document to the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022). The *Yukon North Slope Wildlife Conservation and Management Plan* (the Plan) is grounded in traditional knowledge and Western science. It addresses traditional use and wildlife conservation and management issues affecting the Yukon North Slope. Strategies in the Plan align with actions underway or planned by a range of agencies and organizations with jurisdiction on the Yukon North Slope.

This companion report summarizes the information that was used to support the objectives and strategies in the Plan, and provides references for the studies used in its development. The companion report draws from authoritative works, reports that synthesize knowledge and issues, and presentations of recent research findings. Sources include traditional knowledge and traditional use, scientific reports and journal articles, and management and conservation reports.

Companion Report Table of Contents

Each chapter is available for download at https://wmacns.ca/what-we-do/conservation-plan/companion.

There are fourteen companion reports, addressing four selected topics of key interest as well as ten wildlife species featured in the Plan. The featured species were selected by participants at a workshop held in Aklavik. The wildlife species in the companion reports:

- Have high cultural or economic value or are important as food for Inuvialuit;
- Have similar habitat needs to other wildlife species, so that conserving their habitat is key to conserving habitat for other species; and/or
- Are important for healthy ecosystems, including species that are main food items for top predators.

The Plan identifies key conservation requirements on the Yukon North Slope for each featured wildlife species. The Plan's objectives and strategies are designed to meet these conservation requirements. This companion report summarizes the information that guides the objectives, strategies and conservation requirements in the *Yukon North Slope Wildlife Conservation and Management Plan*.

Companion Report: Muskox / Umingmak

This companion report provides information on the conservation requirements for muskox as identified in the *Yukon North Slope Wildlife Conservation and Management Plan*. It summarizes the information that guides the objectives, strategies and conservation requirements in the Plan. It includes information on traditional use, population status and trends, important habitat types and locations, threats to muskox, programs and measures for conservation and management, and selected studies and research relevant to the Yukon North Slope.

Conservation requirements for muskox on the Yukon North Slope

1. Conservation of a diverse landscape of lowlands and hills with moist vegetation, from sedge swamps to windblown ridges.
2. Investigation of potential interactions in seasonal habitat use by muskox and caribou to evaluate effects of the reintroduced muskox population on caribou.
3. Research and monitoring to help understand the status and vulnerability of this small muskox population.

From the *Yukon North Slope Wildlife Conservation and Management Plan* (WMAC (NS), 2022)

Muskox on the Yukon North Slope

Muskox (Umingmak, *Ovibos moschatus*) crossed the Bering land bridge to North America about 200,000 years ago and survived the ice age, alongside caribou, residing in ice-free Beringia. After the ice age ended, they remained and extended their range in the Yukon and Alaska and beyond but eventually declined in the 1800s and early 1900s to the edge of extinction. Muskox disappeared from the Yukon and Alaska North Slope in the mid 1800s (WMAC (NS), 2012). There is little information on past populations and use of muskox in this region, though northern people have an ancient relationship with muskox, including harvesting for their meat, hide, hair, and horns (WMAC (NS), 2020). Records of local knowledge from Alaska and the discovery of remains of muskox provide evidence of their presence (Lent, 1998).

Thirty-one muskox were brought from Greenland to Nunivak Island, Alaska in the 1930s. This herd grew to over 700 animals by the late 1960s (Alaska Department of Fish and Game, n.d.; WMAC (NS), 2020). Two groups totalling 64 muskox from the Nunivak herd were released in 1969 and 1970 in two areas in and adjacent to the Arctic National Wildlife Refuge in Alaska. This reintroduced population has slowly increased and extended its range. Groups of muskox began to be seen on the Yukon North Slope in the 1980s with the first breeding group established around 1985. The range now extends east to the Mackenzie River and south into Vuntut National Park (WMAC (NS), 2017). There are approximately 400 muskox currently residing as part of the Yukon North Slope population including in the Richardson Mountains, although

survey work is ongoing and the estimate will be confirmed in 2022 (M. Suitor, personal communication, August 11, 2021).

Muskox move among feeding areas within their range, but they are not migratory animals. Bulls may travel considerable distances during summer (WMAC (NS), 2012) with sightings occurring in the Peel watershed on an almost annual basis now. Calving is from mid-April to mid-May, with cows normally giving birth to one calf each year (Aklavik HTC, Aklavik Community Corporation, WMAC (NWT), FJMC, & Joint Secretariat, 2016).

Traditional Use

The relationship between northern people and muskox (Umingmak, the bearded one) is ancient. Historically, the animals were hunted with dogs, using bow and arrow. Not only were muskox harvested for meat, but their thick hair and hide was used for sleeping robes and their horns were used to make tools. The utilization of muskox by northern people has waxed and waned, driven by changing economic and cultural realities and opportunities (for further context, see the Traditional Use companion report) (WMAC (NS), 2020).

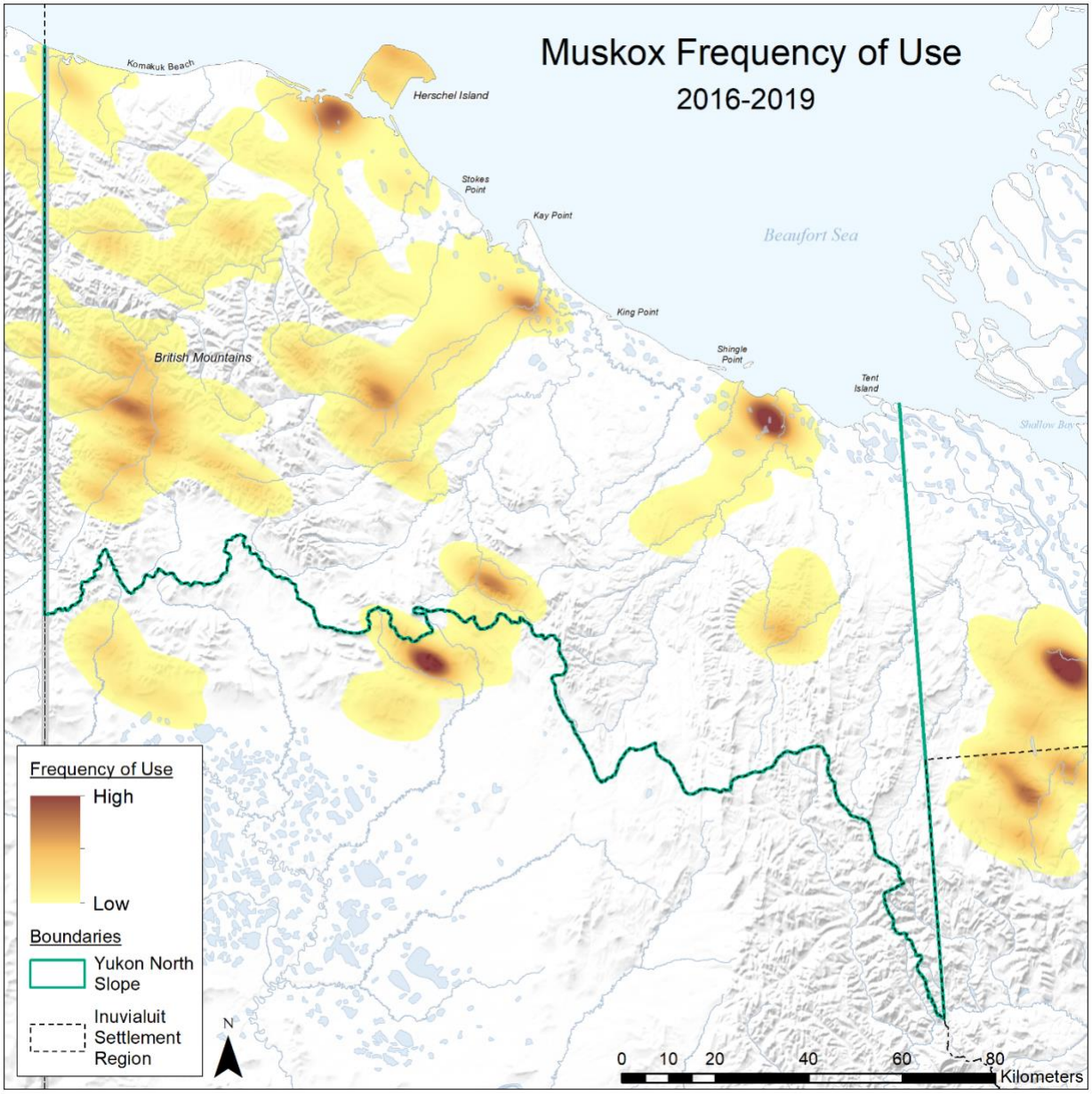
Muskox remain an important source of meat and other resources for many Arctic communities. The underhair of the muskox, called qiviut, may be the finest wool in the world: finer and softer than cashmere, stronger and warmer than sheep wool (WMAC (NS), 2020).

Muskox were extirpated from the Yukon North Slope for more than a century, severing the relationship between the Inuvialuit who use the Yukon North Slope and this species. Currently, there is some harvesting and use of muskox but little reliance on this species for traditional use. The *Aklavik Inuvialuit Community Conservation Plan* (Aklavik HTC et al., 2016, p. 110) refers to muskox as a "Traditional Use Food source. Also used for tools, bedding, and clothing." Aklavik Inuvialuit hunters reported harvesting an average of 6 muskox annually from 2016 to 2018 (IRC, 2019). Other Inuvialuit may access and harvest from the YNS muskox population in addition to Gwich'in harvesters. The *Yukon North Slope Inuvialuit Traditional Use Study* (WMAC (NS) & Aklavik HTC, 2018b), while noting that muskox are harvested, does not have location-specific information on this species. Other sources indicate that harvesting of muskox primarily takes place in the Richardson Mountains (M. Suitor, personal communication, March 30, 2021).

Habitat for Muskox

Muskox are widely distributed (Map 14- 1) on the Yukon North Slope.

Map 14- 1. Muskox observations, based on Inuvialuit traditional knowledge and surveys



This map is from the Plan (WMAC (NS), 2022, Appendix 1) and shows the distribution of satellite locations collected from 25 collared muskox monitored 2016-2019 (Carter, 2020). The darker (brown) areas indicate the highest density of locations and therefore the most intensely used areas.

Muskox have different habitat needs over the seasons. In most regions where muskox diets have been studied, sedge and willow are consistently common components (Carter, 2020). In summer they make use of a range of habitats, including river valleys and meadows, and in these areas they eat sedges and willows along with a diversity of arctic shrubs, grasses and leafy plants (WMAC (NS), 2020). In fall they also spread into shrubbier areas to feed on willows. In winter they favour hillsides and ridges that have strong winds to blow away the snow, making food

more accessible (WMAC (NS), 2012). In areas of deep snow, taller shrubs like willow are important (WMAC (NS), 2020). Recent research has identified that muskox strongly prefer riparian herb-willow, hydric sedge fen and some low-medium shrub ecotypes year-round (Carter, 2020).

Muskox habitat use and diet on the Yukon North Slope

An earlier study of muskox with radio collars was completed between 1999 and 2005. That study involved an analysis that compared where muskox were located relative to available land.

Muskox:

- Use areas to the west of Babbage more than to the east;
- Favour low elevation areas;
- In late winter, prefer areas with moist vegetation;
- In spring, prefer wet graminoid/low shrub and low shrub tundra vegetation types and avoid moist cotton-grass tussock;
- In summer, are highly selective for the moist non-tussock sedge land class;
- In fall, prefer shrub thickets and wet barrens.

Their main food sources, based on fecal analyses, are willow, cotton-grass, sedges, and horsetail.

Source: *Yukon North Slope and Richardson Mountains Muskox Research Plan* (WMAC (NS), 2019b), based on Cooley and McDonald, 2010

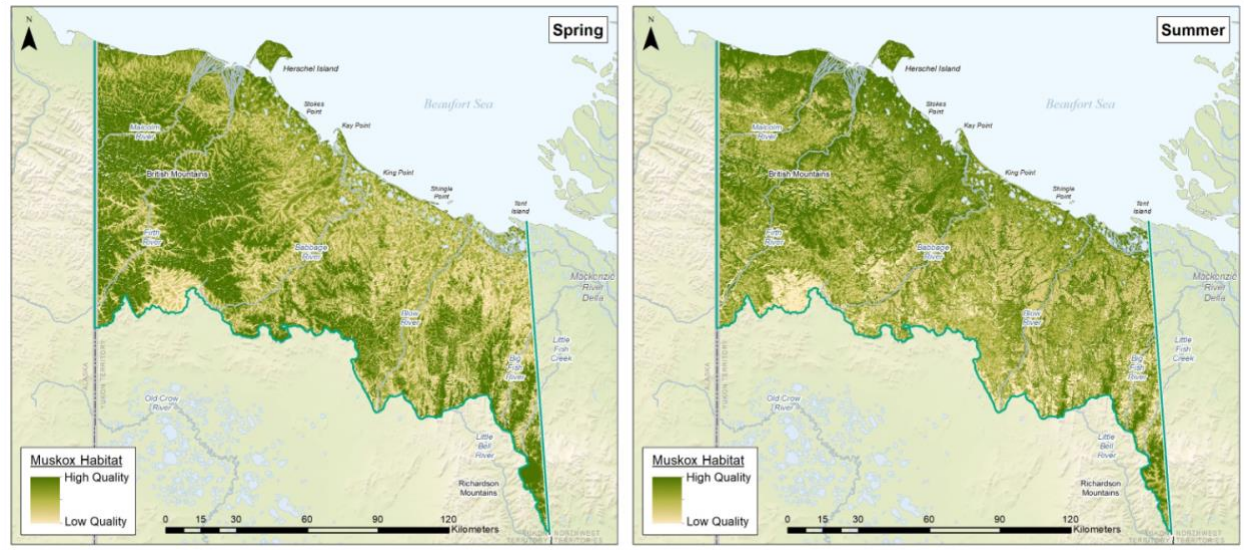
Habitat Model

Models predicting muskox spring and summer habitats were developed using the locations of 25 satellite-collared animals that were monitored from 2016 to 2019. A large portion of muskox groups across the Yukon North Slope included a collared animal that was monitored. The habitat models (resource selection functions) evaluated the relative habitat use of muskox, as indicated by the animal locations, to the relative availability of different kinds of ecosystems across the Yukon North Slope.

Predictive Ecosystem Mapping (PEM) uses knowledge about ecosystem patterns and relationships to predict locations of ecosystems on the landscape (Environment Yukon, 2016). The result is maps showing PEM classes. Each PEM class integrates many features, including vegetation, elevation, water, terrain, soils, and aspect.

In the spring, the analysis found that muskox are more likely to use drier habitats, such as those that occur in the foothills and mountains of Ivvavik National Park and the southern portions of the eastern Yukon North Slope. During summer, preferred habitats are broadly distributed and include habitats across the Yukon North Slope including on the coastal plains (Map 14- 2).

Map 14- 2. Predicted muskox habitat during spring (May 1 – June 30) and summer (July 1 – August 31) based on the locations of satellite collared muskox

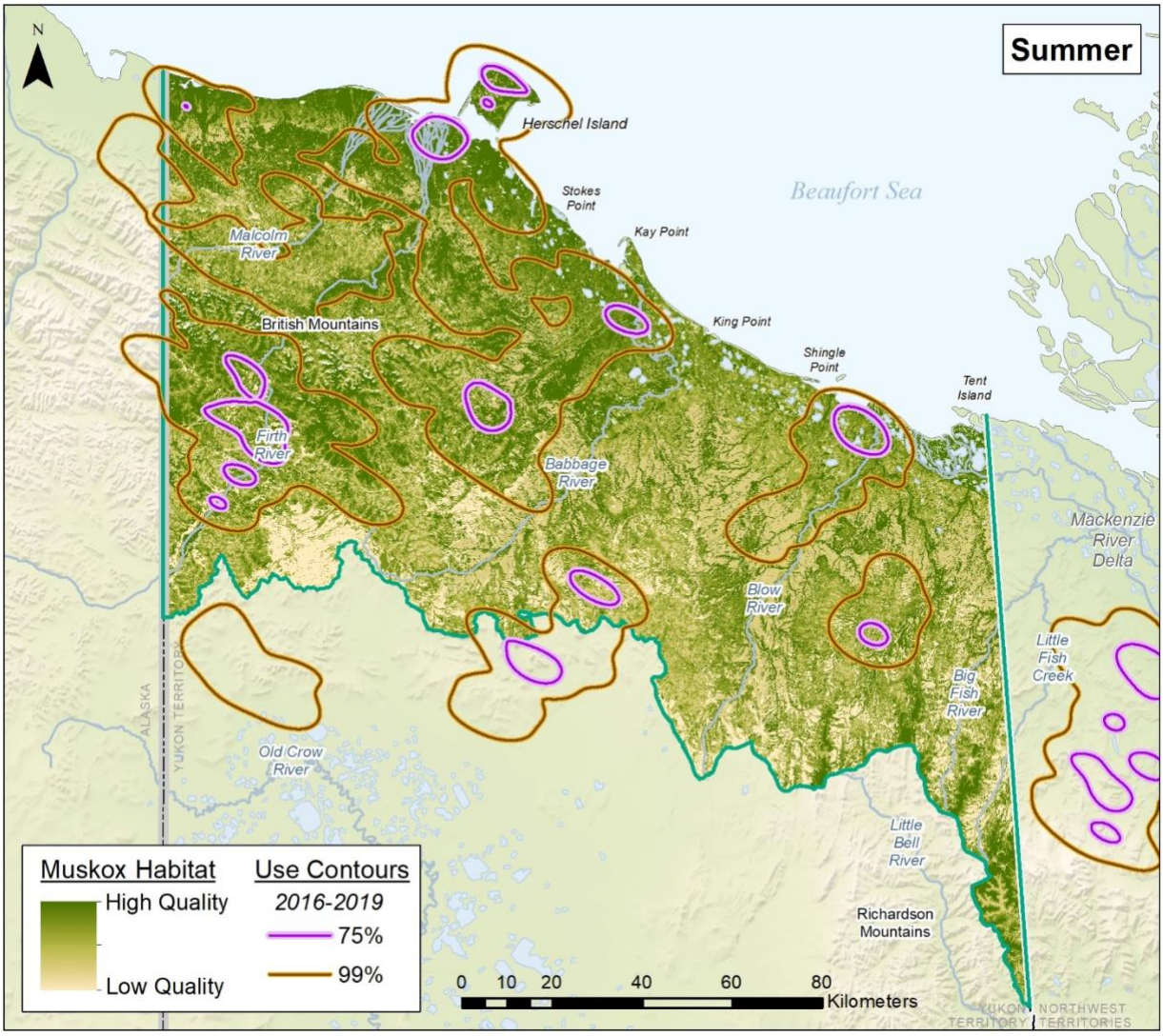


This map shows the results of a Resource Selection Function habitat model based on the GPS collar locations of 25 muskox monitored between 2016 and 2019. The predicted distribution and relative quality of spring and summer habitats are shown, with darker green colors where the model predicts there is a higher probability of muskox use of the area, compared to lighter beige areas that are predicted to have a lower probability of muskox use.

Habitat Occupancy: Comparing Predicted Habitat Distribution with Observations

The habitat models presented in the previous section predict areas that may be preferred muskox habitats, but they do not identify where muskox are actually found. Map 14- 3 shows the summer habitat model as well as the distribution of muskox based on satellite collar locations of 25 animals monitored between 2016 and 2019. This map suggests that much of the higher quality muskox habitats in the western portion of the Yukon North Slope receive some use by muskox, based on the 99% frequency of use contours. The eastern North Slope shows both a pattern of relatively lower amounts of higher quality habitat and a more restricted distribution of muskox. Additionally, the highest levels of use as indicated by the 75% use contours (where 75% of all the locations occur) suggests that the majority of time, muskox use very limited areas that are widely distributed across the Yukon North Slope.

Map 14- 3. Muskox habitat use contours, 75% and 99% based on GPS collar locations



This map shows distribution of satellite locations collected from 25 collared muskox (monitored 2016-2019) layered over predicted summer habitats. The distribution of muskox is based on collar data in which most muskox groups had a collared individual. The distribution is shown as circles with the smaller magenta circles showing where animals spent 75% of their time and the brown circles showing where animals spent 99% of their time. The habitat model shows darker green colors where the model predicts there is a higher probability of muskox using that area, as compared to lighter beige areas that are predicted to have a lower probability of muskox use. Areas outside the brown circles indicate areas where relatively few muskox currently occur. Some of these areas include potentially suitable habitat for muskox, areas that the population may expand or shift into in the future.

Muskox Populations

Species Conservation Status

Table 14- 1. Muskox conservation status

Status assigned by	Applies to	Status	References
Species at Risk Act (SARA)	Canada	Not listed	(Canada, n.d.)
Committee on the Status of Endangered Wildlife in Canada (COSEWIC)	Canada	No COSEWIC assessment; not a candidate species for assessment	(Canada, n.d.; COSEWIC, n.d.)
Canadian Endangered Species Conservation Council (General Status of Species in Canada)	Canada	N3N4: Vulnerable to Apparently Secure*; 2015 status	(Canadian Endangered Species Conservation Council, 2016)
Yukon	Yukon	S1S2: Critically Imperiled to Imperiled*	(Yukon Government, n.d.)
NatureServe	Global	G5: Secure*; last reviewed 2016	(NatureServe, n.d.-b)

*Following the ranking system developed by NatureServe, an international network of conservation data centres (NatureServe, n.d.-a). G=Global; N=National; S=Subnational.

Population Trends on the Yukon North Slope

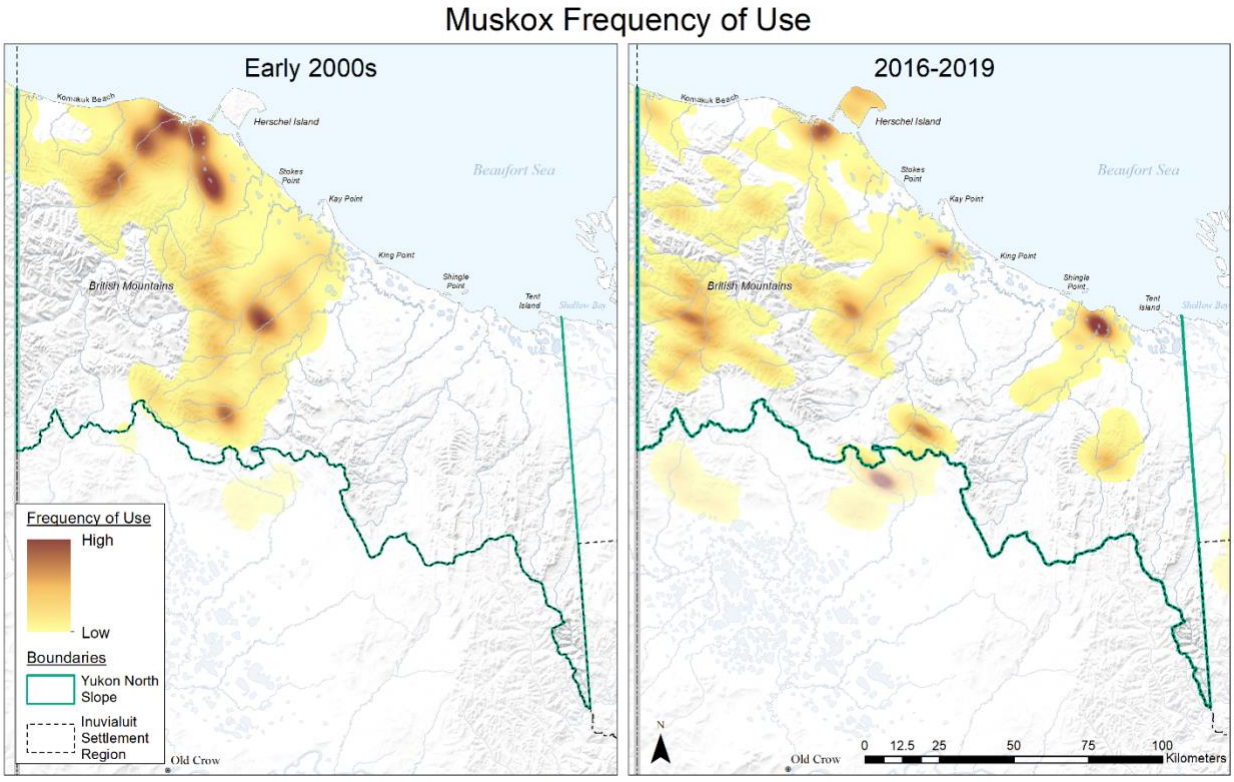
Groups of muskox began to be seen on the Yukon North Slope in the mid-1980s. The first mixed sex and age group was observed in 1985, indicating a breeding herd. Although their range has expanded since then, the population remains relatively small. In 2019, 2020 and 2021, summer composition surveys in the Yukon and adjacent portion of the NWT west of the Mackenzie Delta have found 373, 336, and 319 muskox respectively. These numbers are minimum counts and are part of a larger effort to produce a population estimate in 2022 with confidence intervals (Environment Yukon, unpublished data, 2020 and M. Suitor, personal communication, August 11, 2021). The population has likely increased by about 50% since the early 2000s. A population count in July 2002 recorded 145 muskox between the Alaska border and Shingle Point (WMAC (NS), n.d.). Recent surveys (2013 to 2020) show high calf productivity, indicating that the population is increasing (Environment Yukon unpublished data, 2020)

Most information about this population is based on aerial survey data (WMAC (NS), 2019b), monitoring collared muskox and community observations (WMAC (NS), n.d.). Pre-calving surveys, conducted in March or April, provide the most accurate population counts. Summer surveys, conducted periodically since 1986, allow muskox to be accurately aged and sexed, resulting in estimates of population productivity, recruitment, and age/class structure. In

addition to allowing managers the ability to easily monitor the population, collars provide information on home range sizes, movement rates, and use of different habitat types.

Satellite collar monitoring is on-going, automatically recording locations year-around to learn more about where muskox are found at different times of the year (WMAC (NS), 2020). Monitoring of collared animals shows a more dispersed population from those monitored in the early 2000s (14 animals) to those monitored in the late 2000s (25 animals), although it is worth noting that collars are more representatively distributed amongst all muskox groups now than in the past. Muskox have become more common throughout Ivvavik National Park while densities along the coastal plain have reduced, have become common in places like Herschel Island, Shingle Point and the Barn Mountains (Map 14- 4). Though not shown on Map 14-4, the distribution in the Richardson Mountains has not increased dramatically although the number of groups and size of those groups have increased in time.

Map 14- 4. Frequency of use distributions of muskox, based on the locations of collared animals



Monitoring of 14 animals in early 2000s and 24 animals in late 2000s (2016-2019). The darker (brown) areas indicate the highest density of locations and therefore the most intensely used areas, and lighter areas show less-intensely used areas. While the two maps give a relative sense of density between periods, a direct comparison of densities between the two periods isn't appropriate as total numbers have fluctuated in time.

Predation by grizzly bears, health related issues, and relatively poor long term productivity, rather than a shortage of good habitat, likely keep Yukon North Slope muskox numbers low (WMAC (NS), 2019b). An objective of the muskox research plan is to determine the potential for population increase. This entails understanding the factors that currently limit this population and the roles of harvest and of grizzly bear predation in muskox population dynamics.

> Aklavik Inuvialuit land users have observed that bears are not preying on moose as much and that they have been seen following muskox.
>
> Source: *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a)

Population Trends in Northern Alaska

Muskox in Northern Alaska are monitored through precalving surveys, a long-term collar program, and through testing for diseases, parasites, and mineral deficiencies. Studies indicate that forage abundance may not be limiting, but that low trace nutrient content of forage during winter may be affecting muskox health and reproduction (Harper & McCarthy, 2017). A decline in muskox abundance from 2007 to 2011 may have been in part an increase in grizzly bear predation (Arthur & Del Vecchio, 2017). Increased impact from infectious disease is an additional potential cause of the decline (Afema et al., 2017). More recently the Alaskan North Slope population has increased at a similar rate to Yukon North Slope muskox although muskox continue to be rare in the Arctic National Wildlife Refuge, instead occupying habitats west of there (M. Suitor, personal communication, August 17, 2021). A history of population fluctuations in Alaska indicates that muskox numbers can climb quickly and crash quickly within a small population range (WMAC (NS), 2017).

Muskox and grizzly bear predation in Northern Alaska

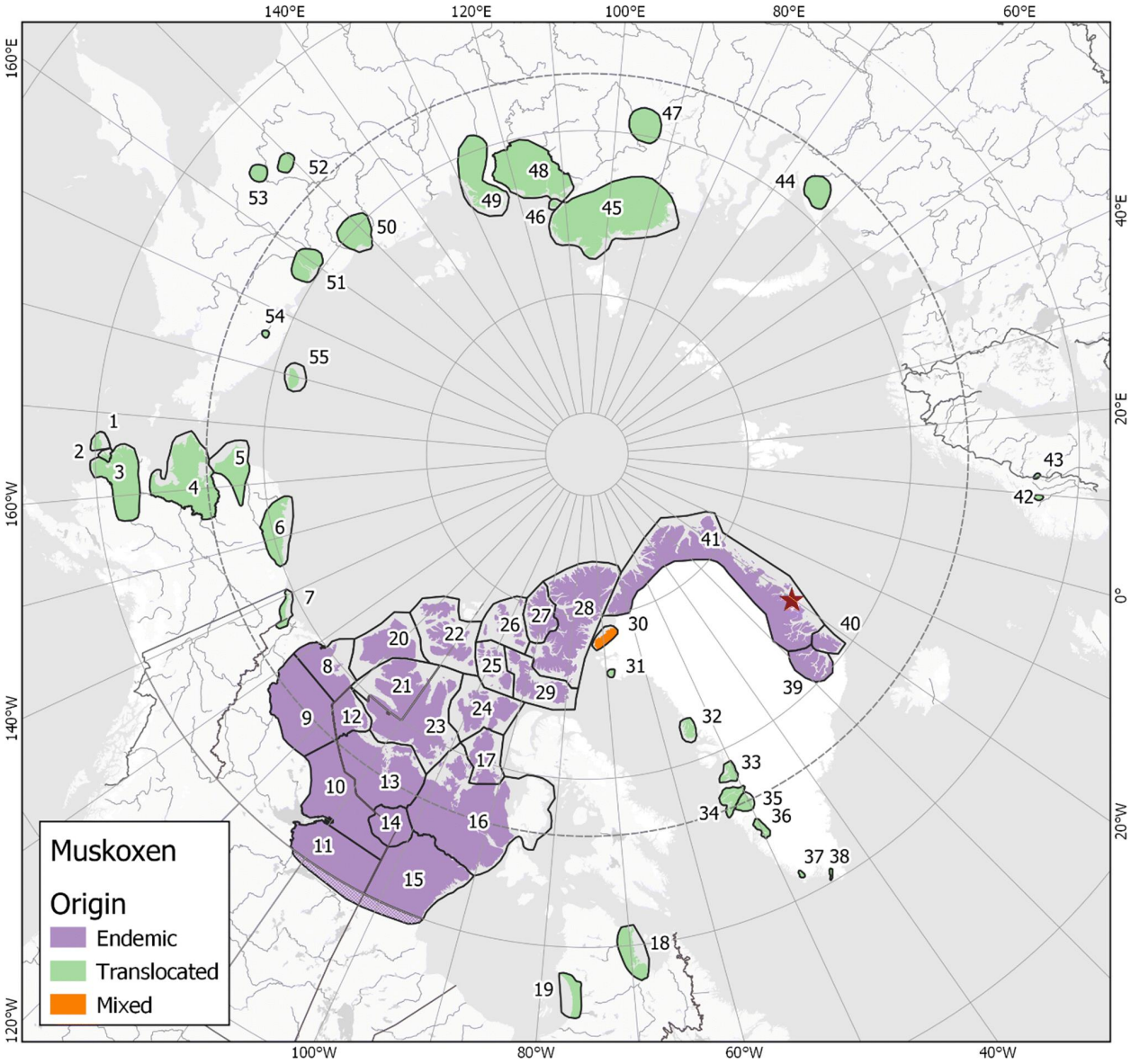
In Northern Alaska, counts indicated a steady decline in muskox from 2007 to 2011. Predation by grizzly bears was the most common cause of deaths during those years. Grizzlies killed muskox mainly in late winter and spring when little other food is available to the bears. There is no evidence that bear abundance changed over this period, but the abundance of moose and caribou declined in the area, suggesting that bears may have switched to muskox as a food source. Another factor in increased grizzly predation may have been the low levels of copper, which weaken animals and make them more prone to predation (Arthur & Del Vecchio, 2017).

Muskox Populations Around the Arctic

Globally, muskox have seen dramatic declines in recent years. Although relatively small in size, the North Slope population will likely continue to play an important role in conserving the species globally.

A review of global muskox populations (Cuyler et al., 2019) provides an overview of origin and distribution of muskox. The 55 endemic or translocated populations are divided into two subspecies: *Ovibos moschatus moschatus* (barren-ground muskox) and *Ovibos moschatus wardi* (white-faced muskox). Genetic studies confirm that these are separate subspecies. The *wardi* subspecies is endemic to the High Arctic islands and Eastern Greenland. Muskox of this subspecies from Eastern Greenland were the original animals introduced to other areas. The Yukon and Alaskan mainland populations are of the *wardi* subspecies, as are the three populations of muskox on Banks Island, Victoria Island, and Melville Island. The populations on the NWT mainland, including the Inuvik area population, are the *moschatus* subspecies. Global abundance is about 170,000 muskox, with several of the larger populations in decline. Factors influencing muskox populations are further discussed in the section on Observations, Concerns, and Threats.

Map 14- 5. Global overview of distribution and origin of muskox populations



Translocated includes introduced and re-introduced. Mixed is translocation to an area with endemic muskox. The star marks Zackenberg Research Station in Greenland. Source: Cuyler et al. (2019)

Population Management

Muskox management has focused on population monitoring, managing harvest opportunities, and addressing questions about how muskox and caribou interact (see section on Effects of Muskox on other Wildlife).

Inuvialuit harvesters have exclusive rights to harvest muskox in Ivvavik and Herschel Island-Qikiqtaruk Parks. They have a preferential right to harvest muskox on the Eastern Yukon North Slope (WMAC (NS), 2008). Muskox is closed to recreational hunting (Yukon Government, 2019) throughout the Yukon. Muskox may also be harvested by Gwich'in beneficiaries in the

Richardson Mountains and by other First Nations when muskox are present in their Traditional Territories.

There are currently no restrictions (such as quotas) placed on Inuvialuit muskox harvest on the Yukon North Slope. However, the muskox management framework includes strategic directions to consider introducing measures to manage muskox harvest in all or part of the population's range, based on population assessments and other factors (WMAC (NS), 2017).

Transboundary Considerations

The muskox population originated through range expansion from Alaska. Until the population crash of muskox in the Arctic National Wildlife Refuge in the mid to late 2000s, WMAC (NS) coordinated international management of the population with Alaska. Muskox in the far west of the Yukon North Slope could act as a seed population to repopulate the former Alaskan range in the future (WMAC (NS), 2017), and recent studies have shown that some groups do spend time in the Refuge (M. Suitor, personal communication, August 17, 2021).

The current range of the approximately 400 muskox that use the Yukon North Slope includes the Yukon coastal plain, extending east to the Mackenzie River, and the northern Barn Mountains and Richardson Mountains in NWT and Yukon. The population's range includes parts of the Inuvialuit Settlement Region (ISR), Gwich'in Settlement Area, and Vuntut Gwitchin Traditional Territory. Muskox range over three parks: Herschel Island–Qikiqtaruk Territorial Park, Ivvavik National Park, and Vuntut National Park.

Observations, Concerns, and Threats

Overview of Threats to Muskox

Muskox population declines have been linked to health issues caused by diseases and parasites, and muskox are prone to die-offs from extreme weather events. Populations in other Arctic regions have declined recently. An improved understanding of pressures on the small Yukon North Slope muskox population will aid in managing the population to maintain its viability.

Overharvest was a contributor to past muskox declines across the Arctic.

Table 14- 2 summarizes some key characteristics of muskox that make them either vulnerable or resilient to change. This table is based on proceedings of an international symposium on muskox health, ecology, and sustainability (Kutz et al., 2017).

Table 14- 2. Vulnerability and resilience of muskox to changing climate and ecological conditions: Key points from the *Muskox Health Ecology Symposium 2016*

	What makes muskox vulnerable?	What makes muskox resilient?
Climate change	• Small, isolated populations that are not highly mobile • Limited ability to respond to extreme weather events, especially heat extremes • Low genetic diversity may limit adaptability to rapid ecosystem changes and emerging pathogens	• Have survived past shifts in climate • Can adapt to new kinds of food and feeding behaviour • Have low metabolism and large fat stores that allow them to survive temporary food crises
Infectious diseases and parasites	• Poor immune response--susceptible to new pathogens • Herd behavior may facilitate spread of pathogens • Heat stress may increase susceptibility	• Isolation of populations may act as a barrier to disease transmission • Historical evidence suggests they have survived similar events in the past
Interspecies interactions	• Decline of other food sources for people may increase harvest pressure on muskox • Encroachment of other herbivores may increase food competition, predator levels, and pathogens	• Isolated populations and wide distribution offer broad-scale species protection • Good at defense against traditional predators and can modify behaviour in response to other species

Source: Kutz et al. (2017), summarized from Table 3

Climate Change

Extreme weather events like heavy snowfalls and rain-on-snow events are natural occurrences that are predicted to happen more frequently and to greater extremes with climate change. Climate trends can also affect muskox access to food. For example, several years with deeper than average snow was linked to the decline of muskox on Bathurst Island in Nunavut (Cuyler et al., 2019). Adverse conditions can prevent muskox from accessing food or make feeding require more energy, which can lead to increased mortality or reproductive failure.

Climate change may also have positive effects on muskox populations, as increases in the length of the growing season and longer snow-free periods may improve food availability (Cuyler et al., 2019; Stern & Gaden, 2015).

The Yukon North Slope is undergoing enhanced vegetation growth as a result of changing climate conditions in the region, which may have a positive influence on muskox demographics. However, these benefits are confounded by other negative aspects of climate change such as changing snow depths and densities.

Parasites and Diseases

Parasites and diseases can affect muskox health, population dynamics, and the quantity and safety of meat for consumption by people (Kutz et al., 2012). The impact of disease on muskox populations is linked to past shifts in the climate and current rapid Arctic climate change. Muskox survived past major climate changes when many other species did not. But widely fluctuating muskox populations in the past have led to low genetic variability, which affects their ability to respond to infectious disease (Cuyler et al., 2019). Current climate warming is leading to shifts in ranges of some parasites and disease vectors, and the introduction of some wildlife diseases not previously seen in the Arctic (Kutz et al., 2012). Changes in vegetation, and related changes in nutrition may lower resistance to disease (Cuyler et al., 2019). Outbreaks of disease have coincided with sharp muskox population declines in Canada and Norway.

Banks Island and Victoria Island muskox populations declined by over 50% between 2000 and 2014 (Kutz et al., 2016). The decline coincided with range expansions of lungworms, likely due to changes in ecological conditions, and emergence of a disease-causing bacterium that was not previously known in Arctic wildlife. Monitoring showed overall deterioration in body condition, additional viral and bacterial infections, and increased signs of stress, indicating that there were likely multiple causes of the rapid population decline.

Orf virus

The Orf virus can be transmitted from one ungulate wildlife species, or livestock, to other ungulate species. It has different effects on Dall's sheep, mountain goats, deer, and muskox. The virus causes lesions on the eyes, nose, lips, muzzle, and legs of muskox. Orf is common in domestic animals globally; there have been severe outbreaks of this viral disease in captive muskox in Alaska and in free-ranging muskox in Norway. There were increased reports of Orf-type lesions on Banks Island muskox when that population was declining. The Orf virus is known to occur in Alaskan muskox populations and, as of 2020, it appears to be widespread in the Yukon North Slope muskox population. Orf is thought to be extremely rare in caribou.

Sources: Tryland et al. (2018), Kutz et al (2016), M. Suitor, personal communication, March 30, 2021

Effects of Muskox on other Wildlife

Caribou

Inuvialuit land users have raised concerns about how muskox affect caribou since the species first began to appear in the Yukon in the 1980s. The concern is partly about whether caribou avoid muskox or flee from them, but also about the potential for competition between the two species for food and habitat, and whether muskox damage vegetation that is important for caribou. These concerns are being investigated through research and monitoring with

community involvement, as set out in the *Yukon North Slope and Richardson Mountains Muskox Research Plan* (WMAC (NS), 2019b).

As part of this effort, Carter (2020) examined the overlap and interactions between collared muskox and collared caribou on the Yukon North Slope. Habitat models for spring and summer were developed for both species (see muskox habitat models, Map 14-2). The analyses showed that the two species select different kinds of habitats, with caribou favoring tussock habitats that are avoided by muskox but both favoring rock-lichen, wetland and floodplain habitats. Individual animals encountered each other less than 1% of the time.

Muskox and caribou

Eight interviewees (of 27 total) noted concern that increasing muskox populations were affecting caribou habitat. These observations focused on changes to the vegetation in areas with large muskox populations and on caribou's general avoidance of muskox. Interviewees noted that habitat in areas with large muskox populations has decreased in quality, particularly on Herschel Island. Interviewees also stated that caribou avoid muskox, either the animals themselves or the smell of areas with large muskox populations. Three interviewees suggested that the increased muskox population is contributing to the changing migration routes of caribou.

Excerpt from *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a), pp. 25-26

Carter (2020) also evaluated whether muskox impact vegetation biomass and community structure, and found little evidence of this. Muskox presence was associated with higher lichen, graminoid and willow biomass suggesting muskox select for areas with higher forage availability. Based on the results of this work, Carter (2020) suggests there is little evidence that muskox were competing for vegetation or modified significant quantities of vegetation used by caribou during her study period (2016-2019).

Predators

Grizzly bear predation on muskox

Responses also suggest that grizzly bears increasingly follow muskox herds. Four interviewees gave detailed accounts of grizzly bears travelling to areas with large muskox populations, particularly in the spring when access to and from the Herschel Island muskox population is easier and muskox are having their young.

Excerpt from *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a), p. 33

Muskox, as a relatively new prey species, may also affect predator-prey interactions. For example, there are indications that grizzly bears in Alaska and the Yukon are taking advantage

of this new source of food (Arthur & Del Vecchio, 2017; M. Suitor, personal communication, August 17, 2021).

Muskox abundance may also affect wolves on the Yukon North Slope. Wolves follow caribou annual migrations, roaming widely across the herd's range.

Links to Plans and Programs

This section lists plans and programs that link to the objectives and strategies of the *Yukon North Slope Wildlife Conservation and Management Plan*. These plans and programs informed the development of the Yukon North Slope Plan and are an integral part of its implementation.

Muskox Conservation and Management

- *Framework for the Management of Yukon North Slope Muskox* (WMAC (NS), 2017)

  This plan provides guidance for muskox management on the Yukon North Slope. The guiding principle is conservation of the muskox population, as established for all wildlife across the ISR. Management goals are to:

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

  > In developing this research plan, there was a strong desire expressed for muskox research that responds to community concerns and includes basic monitoring that can contribute to management decisions. Communication, education and outreach emerged as an overarching theme that should guide all research being undertaken on Yukon North Slope muskox.
  >
  > From *Yukon North Slope and Richardson Mountains Muskox Research Plan* (WMAC (NS), 2019b), p. 6

- *Aklavik Inuvialuit Community Conservation Plan* (Aklavik HTC et al., 2016)

  Identifies the eastern Yukon North Slope, Ivvavik National Park, and Herschel Island–Qikiqtaruk Territorial Park (Special Designated Lands Sites 725DE, 727E, and 730E, respectively), as muskox year-round habitat. The plan also notes that there is an interest in knowing more about muskox diets and the relationship between muskox and caribou.

- Park plans (Herschel Island-Qikiqtaruk Management Plan Review Committee, 2018; Parks Canada, 2018)

  Conservation and management of muskox is part of Ivvavik Park's strategy "to protect and conserve natural ecosystems, habitat, wildlife, cultural resources and Inuvialuit practices,

based on the best available scientific and traditional knowledge" (Parks Canada, 2018). Both parks record observations of muskox and participate in monitoring and research on muskox.

Research and Monitoring Programs

- *Yukon North Slope and Richardson Mountains Muskox Research Plan* (WMAC (NS), 2019b)
  The research plan is designed to accompany the *Framework for Co-management of Yukon North Slope Muskox* (WMAC (NS), 2017). The geographic scope of the plan crosses boundaries, encompassing the range of muskox across the Yukon North Slope and in the Richardson Mountains to the south and east. Partners and collaborators for developing and implementing the plan include Inuvialuit and Gwich'in organizations, co-management boards, government agencies, and other researchers. To aid in defining research priorities, a gap analysis was conducted, and a workshop was hosted by the WMAC (NS) and Aklavik HTC in 2017. Research planning is organized around three primary themes: 1) population dynamics; 2) habitat use and movement; 3) muskox-caribou interactions; and one secondary theme: health and genetics. Research objectives and actions are presented for each theme.

- *Muskox (Ovibos moschatus) Habitat Associations and Interactions with Caribou (Rangifer tarandus)* (Carter, 2020)
  This thesis is an ecological assessment of competition potential and habitat segregation between muskox and caribou. Satellite collar data from muskox and caribou were used to analyze their spatial and habitat overlap through range overlap, encounter rates, and resource selection functions. Range overlap was at its highest in the spring and summer months, but less than 1% of collared caribou encountered a muskox during that period. Habitat overlap was minimized through differential selection of elevation, distance to water, and abundant tussock habitat. Ground-based vegetation sampling was used to characterize fine-scale muskox-vegetation associations. Positive associations were found between muskox use and lichen, willow, and graminoid abundance and presence, and research found the relationship between muskox use and vegetation is mostly driven by selection rather than by herbivory (i.e., muskox likely are not changing vegetation on the landscape but rather responding and moving to areas with selected vegetation). Collectively, this research reveals that in the Yukon North Slope and Richardson Mountains, the reintroduced and expanding population of muskox has low encounter rates and differential habitat use with caribou.

- Ongoing monitoring and research on Yukon North Slope muskox (summarized in WMAC (NS) annual and term reports (e.g., WMAC (NS), 2019a))
  Monitoring of muskox on the Yukon North Slope is led by the Yukon Government, in collaboration with the Gwich'in Renewable Resources Board, the Government of the NWT, and Parks Canada. Research and monitoring are guided by the research plan described above (WMAC (NS), 2019b). Muskox surveys to track abundance and collect information on the composition of the herd are carried out annually. Enough muskox are now equipped

with radio collars to enable locating groups of muskox across the population's distribution. Recent or current research projects in collaboration with university researchers include research on muskox genetics, diet, health, and population dynamics. Research to better understand community concerns and solutions for managing muskox is currently getting underway, working with Aklavik. Efforts are also underway to enhance the value of muskox in the community, through harvest activities and workshops with knowledgeable harvesters.

- Muskox Expert Network of the Circumpolar Biodiversity Monitoring Program (MOXNET) (Conservation of Arctic Flora and Fauna, n.d.)
  This circumpolar expert network collaborates and shares information on muskox populations around the circumpolar Arctic. The network helps to advance understanding of muskox ecology and develop and improve monitoring methods (Cuyler et al., 2019; Kutz et al., 2017).

- Harvest monitoring: Inuvialuit Harvest Study (IHS) (IRC, 2017, 2018, 2019)
  Annual harvest monitoring in the ISR was led by the Inuvialuit Game Council and the Inuvialuit Regional Corporation. This program included muskox harvest monitoring. The ISR Community-Based Monitoring Program was revised after 2014 to focus on harvest. Aklavik Inuvialuit Community Resource Technicians (CRTs) collected harvest information, including harvest locations, through annual interviews with active harvesters. This program built on previous harvest monitoring methods and data (Inuvialuit Harvest Study, 2003).

Selected Studies and Research Relevant to the Yukon North Slope

Because muskox on the North Slope is a reintroduced species, the knowledge base around this population is relatively recent. Research on muskox ecology, health, and causes of mortality has been conducted in Alaska and the Yukon. Knowledge about global muskox populations, including their vulnerability and adaptability to rapidly changing Arctic climate and ecosystem conditions, has been synthesized through initiatives of the Circumpolar Biodiversity Monitoring Program.

This section is an annotated listing of selected reports, scientific papers, and other resources that provide support to the *Yukon North Slope Wildlife Conservation and Management Plan* and highlight issues and research directions that will be important to consider during its implementation.

Traditional Knowledge Studies

There is little documented traditional knowledge about muskox on the Yukon North Slope. The species was not present in the region from some time in the 1800s until the 1980s and it is not known how abundant muskox were prior to their extirpation in the 1800s. However, the muskox

management framework and research plan were developed through extensive consultation with the community of Aklavik, and incorporate Inuvialuit knowledge and concerns about muskox on the Yukon North Slope.

- *Yukon North Slope Inuvialuit Traditional Use Study* (WMAC (NS) & Aklavik HTC, 2018b) and *Inuvialuit Traditional Knowledge of Wildlife Habitat, Yukon North Slope* (WMAC (NS) & Aklavik HTC, 2018a)
  These two studies were undertaken by the WMAC (NS) and the Aklavik HTC to document traditional use patterns and knowledge about wildlife habitat on the Yukon North Slope. Both studies were based on interviews with Aklavik Inuvialuit land users. The results were used in developing the Plan. The studies include references to muskox sightings and observations about interactions with caribou, but muskox are not included in the mapped data.

Assessments and Syntheses of Monitoring and Research Findings

The reports listed below summarize knowledge about muskox, identify strengths and gaps in the knowledge base, and include recommendations.

- *Muskox Health Ecology Symposium 2016: Gathering to Share Knowledge on Umingmak in a Time of Rapid Change* (Kutz et al., 2020) This report summarizes the 2016 Muskox Health Ecology Symposium, the first international conference on muskox in almost 30 years. Information was shared on muskox health, ecology, and sustainability.
- *Yukon North Slope and Richardson Mountains Muskox Research Plan* gap analysis (WMAC (NS), 2019b)
  The gap analysis conducted to inform the research plan is based on a review of relevant scientific literature, reports, presentations, and management tools. Results of this review are included in the plan (Table 1 and Appendix 2).
- *Summary of Wildlife-Related Research on the Coastal Plain of the Arctic National Wildlife Refuge, Alaska, 2002–17* (Pearce et al., 2018)
  This US government report includes a summary of the history of Alaskan muskox on the eastern Alaskan North Slope, a review of muskox biology and ecology in the area, and discussion of monitoring results and research on predation, disease, parasites, and nutrition.
- Muskox status, recent variation, and uncertain future (Cuyler et al., 2019)
  This review of global muskox populations includes information on muskox biology; the history, status, and trends of the 55 muskox populations around the circumpolar Arctic; and factors influencing muskox health and population dynamics.

- *Muskox Health Ecology Symposium 2016* (Kutz et al., 2017)
  The report from this international symposium summarizes presentations and discussions on muskox health, ecology, and sustainability. Contents include knowledge about causes of recent declines, gaps in knowledge about resilience of muskox to changes in climate and ecological conditions, and muskox diseases and parasites.
- *Parasites in Ungulates of Arctic North America and Greenland: A view of contemporary diversity, ecology, and impact in a world under change* (Kutz et al., 2012)
  This review paper provides information on the distribution and effects of Arctic ungulate parasites and the relationship of these parasites with muskox. It includes discussion of risks of parasite range shifts or expansions due to climate change, and the risks of transfer of parasites among ungulate species.

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