



FRAMEWORK FOR THE MANAGEMENT OF **Yukon North Slope Muskox**

PREPARED AND RECOMMENDED BY
The Wildlife Management Advisory Council (North Slope)

ENDORSED BY
The Wildlife Management Advisory Council (Northwest Territories)

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PURPOSE

This framework is intended to provide guidance for the management of Yukon North Slope muskox. While this framework references and is informed by management conditions that apply to muskoxen in jurisdictions and areas adjacent to the Yukon North Slope, strategic directions within this framework are aimed more narrowly at the Yukon North Slope and those with direct management responsibilities in the area: Environment Yukon, Parks Canada, the Wildlife Management Advisory Council (North Slope) and the Aklavik Hunters and Trappers Committee.

HISTORY AND CURRENT STATUS OF NORTH SLOPE MUSKOXEN

Skeletal findings and local knowledge indicate that muskoxen formerly occurred, in unknown numbers, along the Yukon and Alaska coastal plains (Allen 1912, Barr 1991, Hone 1934, Youngman 1975). Muskoxen disappeared from the North Slope of Alaska by the mid 1800s, most likely due to a combination of hunting by indigenous residents and changes in weather, such as increasing snow depth. By the time Europeans arrived, muskoxen were extremely rare in northern Alaska (Lent 1999). The last muskoxen seen in Alaska were killed on the south side of the Brooks Range in the 1890s. It is likely that the disappearance of muskoxen from the Yukon North Slope mirrored occurrences on the Alaska North Slope.

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 Northwest Territories (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 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 (Arctic 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, Jingfors and Klien 1982, Reynolds 1989). In the Arctic Refuge, the population had stabilized by 1986 as muskoxen dispersed out of the Arctic Refuge to adjacent areas to the west in Alaska and to the east to the Yukon North Slope (Reynolds 1998, Garner and Reynolds 1986). 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 (Reynolds 1998).

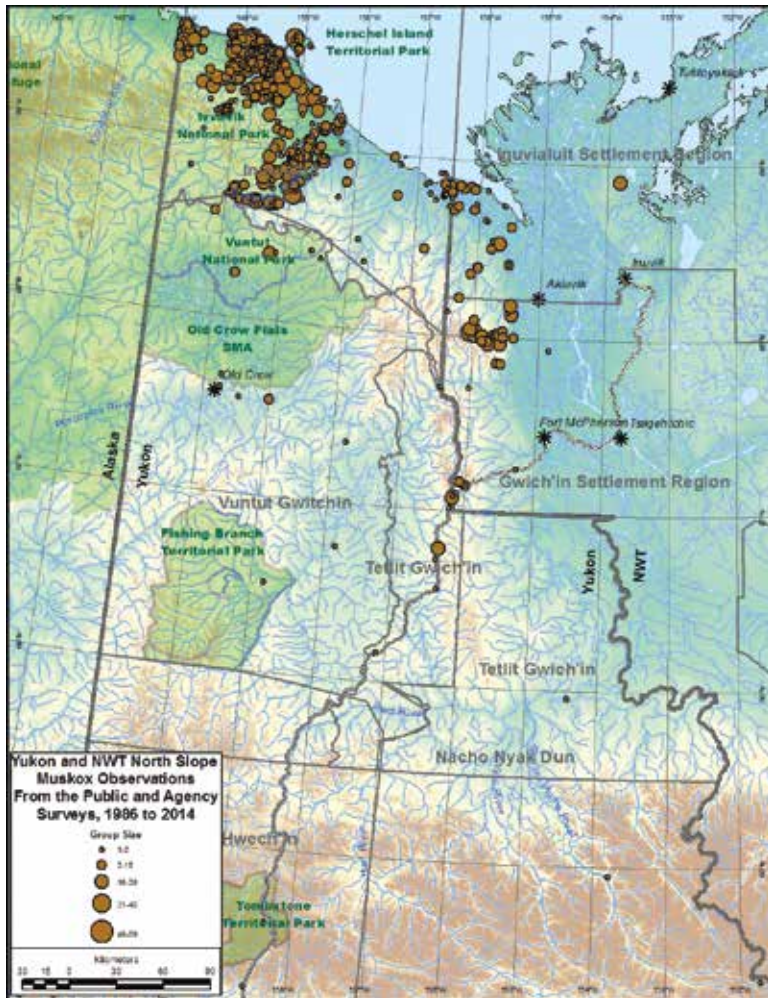


Figure 1 Distribution and group size of muskoxen, 1886 to 2014, in northern Yukon and Mackenzie Delta Region of the Northwest Territories.

The total population of this contiguous re-introduced population had increased to over 700 animals by 1993. However, muskoxen in the Arctic Refuge started to decline in 1998. By 2002, muskoxen had almost disappeared from the Refuge (Reynolds 2009). Since 2004, muskoxen in Alaska west of the Arctic Refuge have been stable but at a low population of just under 200. Recent surveys in March 2016 indicate this number has recently increased slightly to 228. East of the Arctic Refuge, muskox numbers have increased but the current trend is unclear, as population surveys have generally occurred every 5 years but the extent of surveys has not covered the whole sub-population east of Alaska. For brevity in this framework, muskoxen from the Alaska border to the Mackenzie River are collectively referred to as North Slope muskoxen.

In April 2016 a survey was completed along the Yukon North Slope including the portions of the Richardson Mountains north of the Rat River and found 287 muskox, 98 of which were in the Richardsons. A survey of Ivvavik National Park and parts of the eastern North Slope in 2011 found 101 muskox. The additional search area, the introduction of 8 collars in 2015, and other past sightings all likely contributed to the larger number found in 2016.

Muskoxen are seen regularly in Vuntut National Park and occasionally along the Dempster Highway, Old Crow and elsewhere in northern Yukon. Sightings have also been reported east of the Mackenzie River but well west of the typical range of mainland NWT muskoxen (Figure 1).

Developing this framework

In June of 1994, the Aklavik Hunters and Trappers Committee (HTC) expressed an interest to hunt North Slope muskoxen to the Inuvialuit Game Council (IGC). The IGC forwarded this request to the Wildlife Management Advisory Council (North Slope) (WMAC (NS)) to recommend a quota for North Slope muskoxen in Canada according to the procedures established in the IFA. In response to this request, the WMAC (NS), the Aklavik HTC, Parks Canada and the Yukon Department of Environment began a research program to determine the status of the North Slope muskoxen in preparation for the development of a management plan.

A series of studies were conducted on the Canadian portion of the range to coordinate with Alaskan muskox research. The studies were intended to estimate the population size and recruitment rates, document movement patterns and characterize parasite loads and genetic relationships between North Slope muskoxen and other populations (Dehn 1996, Hoberg et al 1995, 1999, 2002, Kienzler 2011, Kutz et al 2000, 2001, Paetkau 2010, Reynolds 2011, Smits 1989).

Special efforts were made to use the knowledge of biologists, hunters and community members who have experience with muskoxen in Canada and Alaska through numerous discussions between communities, Inuvialuit, Inupiat and Gwich'in organizations, and co-management organizations and government agency biologists from Alaska, Yukon and NWT. A trip was also organized to Paulatuk, NWT where Inuvialuit hunters from Aklavik were provided with field experience in muskoxen hunting practices and information on muskoxen and caribou interactions.

The WMAC (NS) has assumed a facilitating and coordinating role in the development of this framework and future reviews. However, its mandate is confined to the Yukon North Slope. On the basis of the many discussions and meetings that it has facilitated, the WMAC (NS) has drafted a framework that references the interests, rights and concerns that have been advanced by governments, communities and organizations who have participated in the management planning process for North Slope muskoxen.

A list of reports from the numerous engagement meetings is included in Appendix 1 while the list of organizations who may participate in or have an interest in the management of North Slope muskoxen is included in Appendix 2. A list of management plans with potential implications to North Slope muskox management is attached as Appendix 3.



Legislative context and management across the range of North Slope muskox

In Alaska, the first hunting season for muskoxen was established in the Arctic Refuge in 1982. As the population expanded to the west, a hunting season was opened west of the Arctic Refuge in 1990. In 1996 the North Slope Borough and state and federal agencies began a planning initiative in response to local community concerns about muskox-caribou interactions and future management of the muskox population. Hunting was managed through the [Alaska] North Slope Muskox Harvest Plan (1999) until 2006 when the season was closed due to the declining sub-population in Alaska. As a result, a research program occurred from 2007-2011 that resulted in the current Operational Plan for Unit 26B Muskox Recovery, 2012-2018. This current plan is now guiding recovery actions in Alaska.

Muskox hunting in the NWT was restricted in 1917 by the *Northwest Game Act* because of concern that hunting was endangering muskoxen (Barr 1991). There was no need for similar restrictions on the Yukon North Slope at this time, as there were no muskoxen there. In 1960 the government of Canada declared muskoxen to be a species in danger of becoming extinct under the Canada Wildlife Act. When muskoxen returned to the Yukon North Slope in the 1970s, they were recognized as game in danger of becoming extinct by S. 19(3) of the *Yukon Act* and subsequently as specially protected wildlife under the *Yukon Wildlife Act* (1981). This prohibited all hunting of muskoxen in the Yukon, including subsistence hunting. With the 2002 amendments to the *Yukon Wildlife Act*, provisions for “specially protected wildlife” were “scheduled” in the Yukon Wildlife Regulations. Following discussions with the WMAC(NS) and as part of the early Muskox Management Planning process, the Regulations were amended in 2003 to designate muskox as a “big game” species. The intention was to complete the planning process and have a plan in place to enable a managed hunt and that gives effect to the Inuvialuit preferential right to harvest muskoxen.

The majority of the North Slope muskoxen population currently occurs on the Yukon North Slope within the Inuvialuit Settlement Region, 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 (Figure 1). Consequently, muskoxen occur in areas covered by five land claimant groups: the Inuvialuit Settlement Region, the Gwich'in Settlement Area and the Traditional Territories of the Vuntut Gwitchin, Tr'ondëk Hwëch'in, and the Nacho Nyak Dun.

The intrinsic value of muskox as part of the diversity of species on the North Slope and the non-consumptive interest by residents and visitors are recognized by the management partners. Viewing opportunities of muskox are of high interest to visitors of the North Slope, and are likely to remain so through time.

In 1984, the *Inuvialuit Final Agreement* established the legal right for Inuvialuit beneficiaries to hunt muskoxen in the Yukon subject to the restrictions of conservation and public safety. Inuvialuit have an exclusive right to harvest muskoxen in Ivvavik National Park and a preferential right* to hunt muskoxen on the Yukon North Slope.

* “preferential right to harvest”, with respect to the Inuvialuit, includes the right to harvest wildlife for subsistence usage and to be allocated, subject to conservation, quantities of wildlife sufficient to fulfill Inuvialuit requirements for subsistence usage before there is any allocation for other purposes in areas where the Inuvialuit will have harvesting rights.



In response to a request for a quota, WMAC (NS) in 1998 facilitated the amendment of the Yukon Wildlife Act to allow for harvesting of muskoxen in the Yukon in order to accommodate Inuvialuit harvesting rights under the Inuvialuit Final Agreement.

In 2002, amendments to the *Canada National Parks Act* harmonized this legislation with modern day land claims

agreements. These amendments provided for the clear recognition of subsistence harvesting rights established within land claim agreements and enabled the Federal government to make regulations to allow subsistence harvesting by beneficiaries of land claims agreements in national parks, including the subsistence harvesting of muskoxen by Inuvialuit beneficiaries in Ivvavik National Park on the Yukon North Slope.

STRATEGIC DIRECTIONS FOR MANAGEMENT

Management principle

Muskoxen occur over a large area of northern coastal plain between the Colville River in Alaska and the Mackenzie River delta in the NWT. Across the Inuvialuit Settlement Region, including the Yukon North Slope, all wildlife is managed on the basis of conservation. The Inuvialuit Final Agreement (IFA) defines conservation to mean:

The management of the wildlife populations and habitat to ensure the maintenance of the quality, including the long term optimum productivity, of these resources and to ensure the efficient utilization of the available harvest.

Conservation is therefore the basic management principle that guides the goals and strategic directions in the framework. It established the key condition that Yukon North Slope muskoxen shall be managed on a population-basis. This requires that any management activities on the Yukon North Slope consider decisions and actions by others across the range of the whole population – in Alaska, the Northwest Territories and the remaining range in the Yukon.

Management goals

As of 2015, Alaska Department of Fish and Game's management goals were to: provide harvest opportunities while maintaining healthy, stable muskox populations; minimize any detrimental effects of muskoxen on caribou; cooperate and share information about muskox among users to develop and implement harvest, management and research programs; and, provide opportunities to view and photograph muskoxen (Lenart 2013).

There are currently no published management goals for North Slope muskoxen in the Northwest Territories. The harvest that occurs on muskox in the NWT region adjacent to the Yukon North Slope is not bounded by quota or other management tools. There is no desire for a quota on NWT muskoxen on the Northwest Territories side of the Inuvialuit Settlement Region at this time.

This framework establishes the following goals for the management of muskoxen on the Yukon North Slope:

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.





STRATEGIC DIRECTIONS

- Implement actions that support a sustainable Yukon North Slope muskox sub-population that is reflective of the range of variation observed in population estimates since 1993 and that fully respect Inuvialuit harvesting rights.
- Prior to initiating management activities (e.g. a large research program or a managed harvest), Environment Yukon, Parks Canada and the Wildlife Management Advisory Council (North Slope), in consultation with the Aklavik Hunters and Trappers Committee, should cooperatively determine the overall population and area-specific management objectives for the Yukon North Slope portion of the sub-population.
- Support ongoing engagement of the Aklavik HTC, Inuvialuit harvesters and the general public in the management of North Slope muskox and in the collection of local and traditional knowledge.

Harvest of muskox

In Alaska, the management objectives for muskox is to support the growth of the population to 300, and then harvest may occur at a rate of 1 to 3% of the pre-calving population (Lenart 2015). Given that the estimated population was below the threshold of 300, no permits have been issued since 2008/09. The U.S. Federal Subsistence Board will not issue any permits until a minimum of 36 muskoxen are recorded in the Arctic Refuge during pre-calving surveys. Once that threshold is reached, a 3% harvest of bulls only can be carried out within the harvest areas identified in Alaska (Lenart 2013).

Currently no quotas have been recommended or established and it remains legal for the beneficiaries of the Inuvialuit Final Agreement to harvest North Slope muskoxen in the Yukon and NWT.

STRATEGIC DIRECTIONS

- Consider arrangements and conditions that may contribute to a lower harvest in Ivvavik National Park to allow for a seed population to feed adjacent areas, including Alaska.
- As the muskox population on the Yukon North Slope remains low, a managed harvest should be carefully considered and annually reviewed based on any reported harvest, population assessments and other factors in other parts of this sub-population's range in the Yukon, NWT and Alaska.



- In the event the North Slope muskox population remains small, harvest should reflect a conservative harvest rate in the range of 1%, bulls only, with consideration of a higher percentage (up to 3%) if the population could support that. Parameters determining the appropriate harvest percentage should be developed to ensure a sustainable harvest of this small population. A key parameter in determining this would be any female harvest.
- In determining and allocating a harvest quota, as established in the IFA, Inuvialuit subsistence harvest needs will be the first consideration, given Inuvialuit preferential and exclusive harvest rights established for muskox.
- A system for collecting muskox harvest information is important to manage the present and future harvest and the population. The basic information should include the number harvested, the age and sex of the animal, the date and location of the harvest and harvester identification. Harvester identification shall be kept confidential, and used only to confirm that the information recorded is accurate.
- Biological samples from harvested animals may be requested to further investigate parasite loads and genetic relationships.

Population size

Following several decades of muskox studies on the Alaska North Slope, a six year survey and collaring program on the Yukon North Slope and local observations from aboriginal hunters, park rangers, and government researchers, some key population characteristics have emerged which contribute to understanding the population status of North Slope muskoxen.

The range of muskoxen has expanded dramatically since the reintroduction almost 40 years ago and is now widely distributed in Alaska, Yukon and northwestern NWT. There are established breeding populations throughout the North Slope. Despite this large distribution, it remains a small population and it is unlikely that muskox numbers will greatly increase on the North Slope under current conditions.

Muskox populations are highly variable. The history of the Arctic Refuge sub-group has shown that numbers can climb quickly and crash quickly. The Canadian portion of the population ranged from 121 in 1993 to 287 in 2016 and appears to have stabilized at that level.

STRATEGIC DIRECTIONS

- The size of the North Slope muskoxen population should be determined when required for management purposes (ideally every 5 years) through late winter aerial surveys. Local observations should continue to be recorded to assist in understanding distribution and population trend. Surveys should be coordinated with Alaskan agencies using compatible methods so that survey results can be combined for an estimate of the total population. The survey interval should be reviewed as necessary based on available information.



- During the winter before a planned survey, local hunters and travelers should be asked to note where they see muskox groups so that those numbers can be considered if they occur in areas not surveyed during the aerial survey.
- Incidental observations of muskoxen should continue to be monitored during other field work conducted in the area by researchers or local residents and visitors.
- The use of satellite or radio collars should remain a management instrument as they have proven useful during the population surveys, and to track muskox movements. This tool should also be considered when habitat use, behavioral or movement questions need to be further informed.

Distribution

Locations of satellite collared muskoxen showed they are relatively sedentary through most of the year however they sometimes make large movements across their range in summer. The majority of wanderers probably return to the core range but local observations show that the muskoxen in the Richardson Mountains are now a resident breeding group. Muskoxen sighted east of the Richardson Mountains are thought to be associated with both the eastern movement of animals from Alaska and the Yukon North Slope and the westward movement of NWT mainland muskoxen. Ongoing work initiated in 2015 and 2016 in Yukon and NWT will help assess current movements of North Slope muskoxen. There is a possibility that the North Slope and NWT mainland muskoxen populations will come into contact, giving rise to two areas of management interest.

The two populations carry slightly different parasites and preventing the intermixing of these two populations so not to spread either parasite is of management interest. Muskoxen east of the Mackenzie River in the NWT carry a lungworm (*Umingmakstrongylus pallikuukensis*) which has not been found in the North Slope muskoxen population, while North Slope muskoxen carry another species of lungworm (*Protostrongylus stilesi*) that is not found in NWT mainland muskox. There has been a concern that if North Slope muskoxen picked up *U. pallikuukensis* from the NWT muskox, the parasite may spread from muskoxen to Dall's sheep. However research has demonstrated that there is no risk of transferring lungworms from muskoxen to Dall's sheep, but the other way around is possible (Kutz et al 2004). *P. stilesi* is commonly found in Dall's sheep populations throughout North America and is known to adversely affect sheep populations however it is thought that the worm has been transferred from the sheep to the North Slope muskoxen (Kutz et al 2001).

Researchers have found that the bacterium *Erysipelothrix rhusiopathiae* may have had a role in the rapid decline of multiple populations of muskox in western Canada and Alaska in recent years. It is believed that increased levels were detected in a declining population of muskox on the North Seward Peninsula of Alaska (Adams, 2016) although it has likely been present in Alaska since at least 1976 (Mavrot et al., 2016). The bacterium has also been linked to recent declines on Victoria and Banks Island (Kutz et al., 2015). The bacterium is considered an opportunistic generalist pathogen meaning it is found in a wide variety of species, but its prevalence may be linked to other health related issues or poor condition as evidenced by broken teeth or poor body condition (Forde et al., 2016).

The other area of management interest lies with the two populations mixing genetics. The North Slope muskoxen come from Greenlandic animals and are therefore a different subspecies than the native mainland muskoxen. Initially genetic analyses have shown that muskoxen are not a very genetically diverse species, and animals were very similar to each other even across many populations. More recent genetic analyses using updated techniques for North Slope, NWT mainland and Banks Island muskoxen tell a different story. While individual animals within populations were very similar to each other as expected, the 3 populations were very different from each other (Paetkau 2010).

STRATEGIC DIRECTIONS

- Samples for parasite and genetic analysis should be requested from muskoxen harvested from the potential overlap area of North Slope and NWT mainland populations.
- If muskoxen are reported in the overlap areas, researchers should discuss and make recommendations regarding whether the genetic distinctiveness of the populations should be maintained or if the populations would benefit from the introduction of new genetic material to increase the genetic diversity of those populations.
- Dead or diseased muskoxen should be reported when they are observed.



Muskox and caribou interactions

A number of communities throughout the range of the North Slope muskoxen population are concerned about potential negative effects of muskoxen on the Porcupine Caribou Herd. The main concern is 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.

Numerous studies regarding resource competition, habitat use and diet of muskoxen and caribou have been conducted on North Slope muskoxen and other populations. Most studies indicate little cause for concern regarding habitat or diet. The question regarding competition for food and space cannot be ruled out (Biddlecomb 1992, Ihl 1999, Jingfors 1980, Larter and Nagy 1997, Shank et al. 1978, Smits 1989, Thomas and Edmonds 1984, Wilkinson et al. 1976, Wilson 1992, Wilson and Klein 1991). For a full discussion of these differences see the fact sheets at <http://www.wmacns.ca/resources/factsheets/>

STRATEGIC DIRECTIONS

- Management authorities and researchers should consider community concerns to better understand possible effects and jointly develop an approach to further explore whether muskox have a negative influence on caribou.

Education and information exchange

The numerous meetings and workshops that were held while developing this framework have generated considerable new information and thinking about North Slope muskoxen. Research, communications and discussions have helped to clarify many issues, questions and concerns about North Slope muskoxen however it would be wise to continue reviewing existing information and sharing new information as it becomes available.

STRATEGIC DIRECTIONS

- Maintain and promote the website to post research and educational materials pertaining to North Slope muskoxen (http://www.wmacns.ca/north_slope/wildlife/muskox/)
- Ensure new information on muskox is provided to hunters, stakeholders and management partners in technical and plain language formats through a number of means, including reports, presentations, a web site and peer reviewed publications.
- Researchers should continue to communicate and cooperate with Alaskan and Northwest Territories researchers on muskox management and research.

LIST OF REFERENCES

- Adams, L.G. 2016. Demography of a muskox decline in northwest Alaska, 2009–2013. Paper presented at the 1st International Muskox Health Ecology Symposium, 7–10 November 2016, Calgary, Alberta.
- Allen J.A. 1912. Probable recent extinction of the muskox in northern Alaska. *Science* 36:720-722. Washington, D.C.
- Barr, W. 1991. Back from the Brink: The Road to Muskox Conservation in the Northwest Territories. The Arctic Institute of North America, Univ. of Calgary, Calgary, Alberta.
- Biddlecomb, M.E. 1992. Comparative patterns of winter habitat use by muskoxen and caribou in northern Alaska. M.Sc. thesis, Univ. of Alaska, Fairbanks.
- Dehn, M. 1996. Distribution, abundance, and key habitat utilization of muskoxen on Yukon's arctic coast, and the potential impacts on these by hydro-carbon development. Yukon Fish and Wildlife Branch, Department of Renewable Resources, Whitehorse, YT. Report TR-96-03.
- Garner, G.W. and P.E. Reynolds. 1986. Muskox. Progress report by the U.S. Fish and Wildlife Service. Anchorage, Alaska.
- Harper, P., editor. 2013. Muskox management report of survey-inventory activities 1 July 2010-30 June 2012. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2013-2, Juneau
- Hoberg, E.P., L. Polley, A. Gunn, and J.S. Nishi. 1995. *Umingmakstrongylus pallikuukensis* gen.nov. et sp.nov. (Nematoda: Protostrongylidae) from muskoxen, *Ovibos moschatus*, in the central Canadian Arctic, with comments on biology and biogeography. *Can. J. Zool.* 73: 2266-2282.
- Hoberg, E.P., K.J. Monsen, S. Kutz and M.S. Blouin. 1999. Structure, biodiversity, and historical biogeography of nematode faunas in holarctic ruminants: morphological and molecular diagnoses for *Teladorsagia boreoarcticus* N. sp. (Nematoda: Ostertagiinae), a dimorphic cryptic species in muskoxen (*Ovibos moschatus*). *J. Parasitol.* 85: 910-934.
- Hoberg, E.P., S. J. Kutz, J. Nagy, E. J. Jenkins, B. T. Elkin, M. Branigan, and D. Cooley. 2002. *Protostrongylus stilesi* (Protostrongylidae), ecological isolation and putative host switching between Dall's sheep and muskoxen in a contact zone. *Comparative Parasitology*, 69: 1-9.
- Hone, E. 1934. The present status of muskox in arctic North America and Greenland. *Amer. Comm. For Int. Wildl. Protection.* No. 5, 87 pp.
- Ihl, C. 1999. Comparative habitat and diet selection of muskoxen and reindeer on the Seward Peninsula, western Alaska. M.Sc. thesis, Univ. of Alaska, Fairbanks.
- Jingfors, K.T. 1980. Habitat relationships and activity patterns of a reintroduced muskox population. MSc thesis. University of Alaska Fairbanks. Fairbanks, Alaska.

- Jingfors, K.T. and D.R. Klein. 1982. Productivity in recently established muskox populations in Alaska. *J. Wildl. Manage.* 46: 1092-1096.
- Kienzler, M. 2011. Fieldwork summary: Yukon North Slope muskox survey, April 2011. Government of Yukon. Unpublished report. 4 pp.
- Kutz, S.J., B. Elkin, A. Gunn and J.P. Dubey. 2000. Prevalence of *Toxoplasma gonii* antibodies in muskox (*Ovibos moschatus*) sera from northern Canada. *J. Parasitol.* 86: 879-882.
- Kutz, S, A. Veitch, E. Hoberg, B. Elkin, E. Jenkins and L. Polley. 2001. New host and geographic records for two protostrongylids in Dall's sheep. *Journal of Wildlife Diseases* 37:761-774.
- Kutz S., E. Garde, A. Veitch, J. Nagy, F. Ghandi and L. Polley. 2004. Muskox lungworm (*Umingmakstrongylus pallikuukensis*) does not establish in experimentally exposed thinhorn sheep (*Ovis dalli*). *Journal of Wildlife Diseases*, 40(2):197-204.
- Larter, N.C. and J.A. Nagy. 1997. Peary caribou, muskoxen and Banks Island forage: assessing seasonal diet similarities. *Rangifer* 17: 9-16.
- Lenart, E.A. 2013. Units 26B and 26C muskox. Pages 75-97. [In] P. Harper, editor. Muskox management report of survey-inventory activities, 1 July 1998 to 30 June 2000. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2013-2, Juneau.
- Lenart, E.A. 2015. Units 26B and 26C muskox. Chapter 4, pages 1-26 [In] Harper, P., and L. A. McCarthy, editors. 2015. Muskox management report of survey-inventory activities 1 July 2012-30 June 2014 [web page]. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2015-2, Juneau.
- Lent, P.C. 1999. Muskoxen and their hunters: a history. *Animal Natural History Series*, Vol. 5. University of Oklahoma Press, Norman.
- Mavrot, F., McIntyre, A., Orsel, K., Adams, L., Beckmen, K., Branigan, M., Checkley, S., et al. 2016. Serological survey for exposure to *Erysipelothrix rhusiopathiae* in muskoxen across the Arctic. Paper presented at the 1st International Muskox Health Ecology Symposium, 7-10 November 2016, Calgary, Alberta.
- Paetkau, D. 2010. President, Wildlife Genetics International, Nelson, BC. Analysis results memo to Government of Yukon and Government of the Northwest Territories, dated 10 March 2010).
- Reynolds, P. 1989. Status of a transplanted muskox population in northeastern Alaska. *Canadian Journal of Zoology* 67:A26-A30.
- Reynolds, P. 1998. Dynamics and range expansion of a reestablished muskox population. *Journal of Wildlife Management* 62(2): 734-744.

Reynolds, P. 2009. Current status of muskoxen in northeastern Alaska, Game Management Units 26 A, B+ C. November 2009. U.S. Fish and Wildlife Service, unpubl. report. 9 pp.

Reynolds, P. 2011. 2011 precalving muskoxen census in Arctic National Wildlife Refuge 26C and adjacent regions. May 2011. U.S. Fish and Wildlife Service, unpubl. report. 15 pp.

K. Russell, Caribou/Sheep/Goat Program Technician, Government of Yukon. Pers comm., 19 October 2011.

Shank, C.C., P.F. Wilkinson and D.F. Penner. 1978. Diet of Peary caribou, Banks Island, N.W.T. Arctic 31: 125-132.

Smits, C.M.M. 1989. A review of competition for limiting resources between muskox and the Porcupine Caribou Herd. Unpublished report. 10 pp.

Thomas, D.C. and J.E. Edmonds. 1984. Competition between caribou and muskoxen, Melville Island, N.W.T., Canada. Biol. Pap. Univ. Alaska Spec. Rep. 4: 93-100.

Youngman, P.M. 1975. Mammals of the Yukon Territory. Publications of Zoology. No. 10. National Museums of Canada. Ottawa.

Wilkinson, P.F., C.C. Shank and D.F. Penner. 1976. Muskox-caribou summer range relations on Banks Island, N.W.T. Journal of Wildlife Management. 40: 151-162.

Wilson, K.J. 1992. Spatial scales of muskox resource selection in late-winter. M.Sc. thesis, Univ. of Alaska, Fairbanks.

Wilson, K.J. and D.R. Klein. 1991. The characteristics of muskox late winter habitat in Arctic National Wildlife Refuge, Alaska. Rangifer 11: 79-80

APPENDIX 1

List of Additional Supporting Materials

The following is a list of reports from the numerous engagement meetings hosted by the WMAC (NS) during the preparation of this framework. These are available in a separate, companion volume: Yukon North Slope Muskox Framework: Supplemental Materials. This document is available through WMAC (NS) and its partners.

Paulatuk Hunters and Trappers Committee. 1996. Report on Aklavik Musk-ox Hunt Training, Nov 19 – 26, 1996. Report to the Wildlife Management Advisory Council (North Slope). 10 pages.

Raillard, M. 1996. Kaktovik Community Meeting on Muskox, March 22, 1996. 5 pages.

Wildlife Management Advisory Council (North Slope). 1995. Muskox Management on the Yukon North Slope. Summary of the WMAC(NS) Public Meeting, Aklavik, NT, December 11, 1995. 5 pages.

Wildlife Management Advisory Council (North Slope). 1996. Muskox Management on the Yukon North Slope. Summary of the WMAC(NS) Public Meeting, Aklavik, NT, March 14, 1996. 7 pages

Wildlife Management Advisory Council (North Slope). 1999. Memo to file: Joint Meeting on North Slope Muskox Management, Anchorage, Alaska, December 10, 1999. 4 pages.

Wildlife Management Advisory Council (North Slope). 2001. Report: Yukon North Slope Muskox Management Workshop, October 24 – 26, 2001. Wildlife Management Advisory Council (North Slope), Whitehorse, Yukon. 51 pages.

Wildlife Management Advisory Council (North Slope). 2003. Draft summary notes: Meeting concerning draft North Slope Muskox Management Plan, Inuvik, NWT, June 11, 2003. Wildlife Management Advisory Council (North Slope), Whitehorse, Yukon. 8 pages

Wildlife Management Advisory Council (North Slope). 2004. Summary: Canada-Alaska North Slope Muskox Working Group Meeting, Anchorage, Alaska, November 1, 2004. 4 pages.

Wildlife Management Advisory Council (North Slope). 2007. Muskox Management Workshop – November 21, 2006, Aklavik, Northwest Territories. Summary Notes.

APPENDIX 2

List of muskox management organizations

The following organizations may participate in or have an interest in the management of North Slope muskoxen:

- Aklavik Hunters and Trappers Committee
- Alaska Department of Fish and Game
- Ehdiitat Renewable Resource Council
- Government of the Northwest Territories, Department of Energy and Natural Resources
- Government of Yukon, Department of Environment
- Gwich'in Renewable Resource Board
- Inuvialuit Game Council
- Mayo District Renewable Resources Council
- Nihtat Gwich'in Renewable Resource Council
- North Slope Borough, Department of Wildlife Management
- North Yukon Renewable Resources Council
- Parks Canada, Western Arctic and Yukon Field Units
- Porcupine Caribou Management Board
- Tet'lit Gwich'in Renewable Resource Council
- Tsiigehtchic Renewable Resource Council
- U.S. Bureau of Land Management
- U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge
- U.S. National Park Service
- Village of Kaktovik, Alaska
- Vuntut Gwitchin First Nation
- Wildlife Management Advisory Council (North Slope)
- Wildlife Management Advisory Council (Northwest Territories)
- Yukon Fish and Wildlife Management Board

APPENDIX 3

List of plans with implications for muskoxen

In addition to the legislative considerations, a number of other wildlife and habitat management plans may have implications for the management of North Slope muskoxen. As of 2016, these include the following:

- [Alaska] Operational Plan for Unit 26B Muskox Recovery, 2012–2018
- The Aklavik Inuvialuit Community Conservation Plan (2016)
- The Herschel Island-Qikiqtaruk Territorial Park Management Plan (2018)
- The Ivvavik National Park of Canada Management Plan (2018)
- The Yukon North Slope Muskox Research and Monitoring Plan (under development)
- The Yukon North Slope Wildlife Conservation and Management Plan (2003)
- Vuntut National Park of Canada Management Plan (date)

