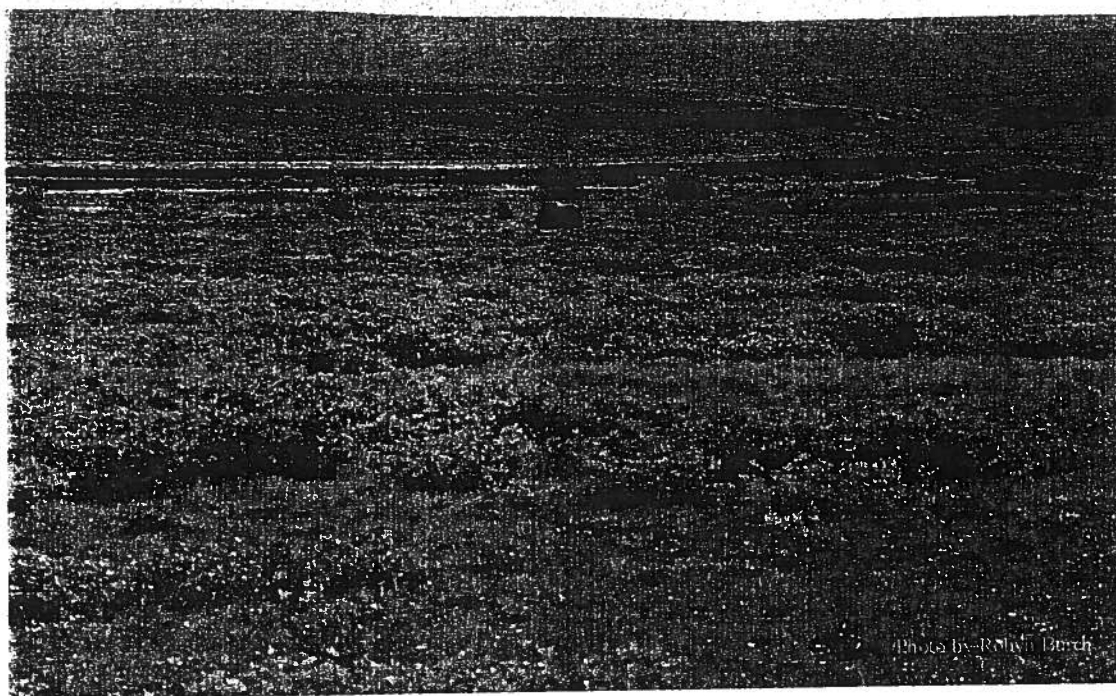


**Progress Report – 2000:**

**Incidental Observations, Aerial Surveys, and Preliminary Habitat  
Investigations for Muskoxen in Gates of the Arctic National Park and  
Preserve, Alaska**



**GAAR-00-003  
December 4, 2000**

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99707.**

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# INCIDENTAL OBSERVATIONS AND AERIAL SURVEYS FOR MUSKOXEN IN GATES OF THE ARCTIC NATIONAL PARK AND PRESERVE, ALASKA

## PROJECT REPORT September, 2000

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### SUMMARY:

Survey dates: 2000: April 25, 26 and 28 (winter survey)  
1999: April 26 - April 28 (winter survey)  
June 21 - June 23 (summer / calf survey)

Total distance: 2000 winter survey 1,519 km  
1999 winter survey 1,293 km  
1999 summer survey 2,297 km

Total muskoxen observed: 2000 winter survey: 3  
1999 winter survey: 0  
1999 summer survey: 0

Total incidental muskox observations within GAAR: 2000 (year to date); 4  
1999; 11

### INTRODUCTION:

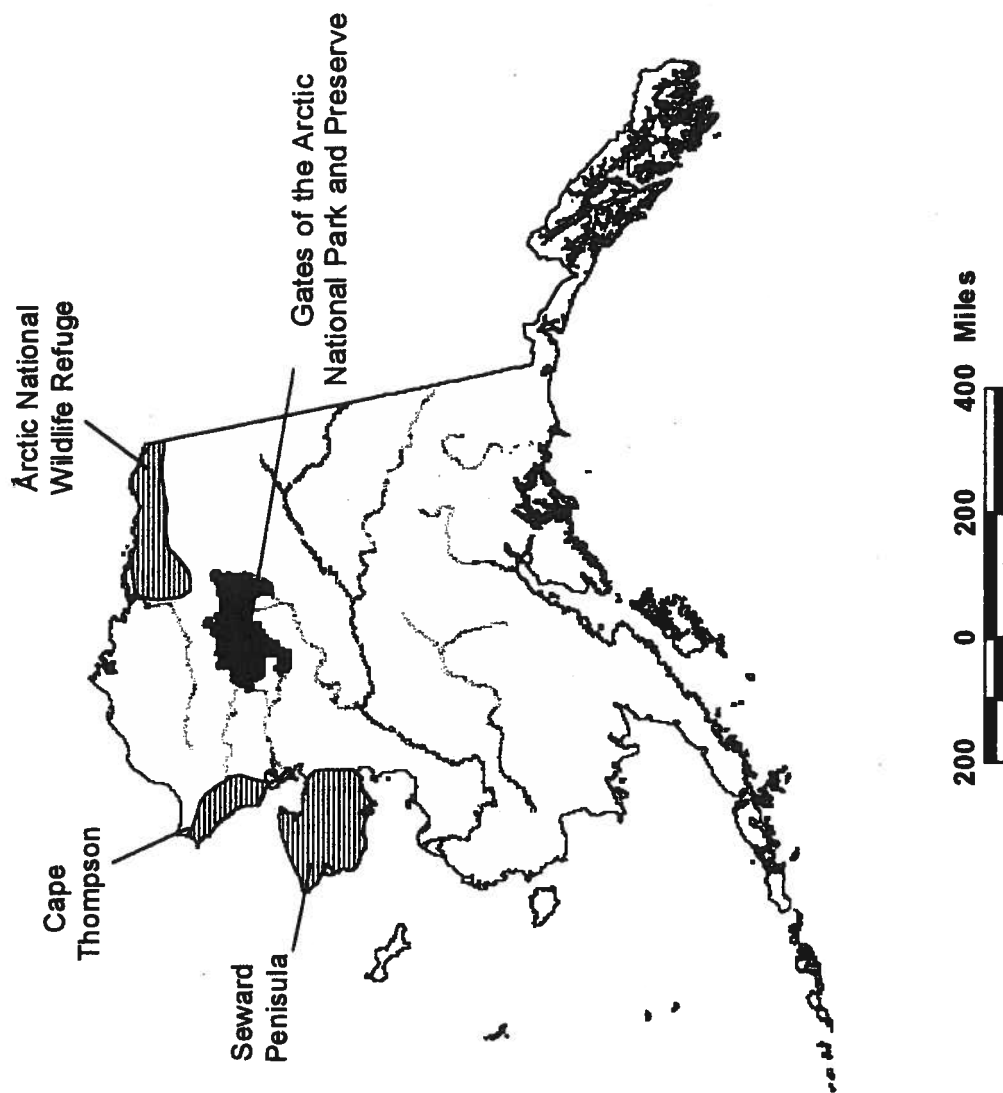
Muskoxen (*Ovibos moschatus*) were extirpated from northern Alaska in the middle of the 19<sup>th</sup> century (review in Lent 1999). Historical information indicates muskoxen were found in small numbers in the mountains and foothills of the Brooks Range (Rausch 1951, Ingstad 1954) and that these populations were the last to disappear from the state (Reed 1946). Muskoxen were reintroduced into northeastern Alaska in 1969 and 1970. Following their release, these muskoxen populations increased and expanded rapidly (Reynolds 1998, J. Dau, Alaska Dept. of Fish and Game, personal

communication)(Fig. 1). Although evidence suggests population growth of muskoxen in northeast Alaska has slowed, muskoxen continue to disperse into new areas outside of their current distribution (Lenart 1999). Muskoxen were also released in northwestern Alaska in the Cape Thompson region in 1970, 1977, and 1981 (Smith 1989) but growth and range expansion of this herd has occurred at a slower rate than those observed in northeast Alaska (J. Dau, Alaska Dept. of Fish and Game, personal communication). Reestablishment of populations of muskox into Gates of the Arctic National Park and Preserve (GAAR) would be a desirable outcome of the natural dispersal and range expansion currently taking place in muskox populations in Alaska.

Current muskox distribution within the state is generally limited to arctic regions characterized by low snow levels. In alpine areas, with greater amounts of snowfall, available habitat may be patchy in distribution since muskoxen are poorly adapted to crater through deep snow (Nellemann 1998). Therefore, data collected on muskoxen distribution patterns and habitat use in other locations in Alaska may not be applicable to GAAR due to the mountainous characteristics of this Park. However, the ability of muskoxen to use this habitat in Alaska is supported by historical records. The last two reported mixed sex groups of indigenous muskoxen in Alaska were killed in mountainous terrain in the eastern Brooks Range in 1892 / 1893, and 1897 / 1898 (Reed 1946).

Management of muskox populations has been a controversial issue for many years in northern Alaska. Many residents of the North Slope Borough (NSB), which includes Gates of the Arctic National Park and Preserve, have concerns about muskoxen. Some feel muskoxen have a detrimental effect on caribou populations and caribou hunting (North Slope Muskox Harvest Plan 1998).

Fig. 1. General location of muskox populations that may be sources of muskoxen observed in Gates of the Arctic National Park and Preserve.



\* Locations of muskox populations were derived from Smith (1987), Reynolds (1998), and Dau (Alaska Department of Fish and Game, personal communication).

Muskoxen have been designated by the Federal Subsistence Board as a species of customary and traditional use by residents of the communities of Anaktuvuk Pass, Atkasuk, Barrow, Nuiqsut, Point Hope, Point Lay, and Wainwright (Federal Subsistence Management Regulations 1999). Game regulations within game management units (GMUs) 26 and 23 have the potential to influence muskox dispersal into Gates of the Arctic National Park and Preserve. Under 1999 federal subsistence regulations, no muskox were to be harvested on federal lands in the areas immediately adjacent to the Park. In March 1998, the Alaska Board of Game determined 20 muskoxen were a reasonable harvest opportunity level for subsistence users in GMU 26B west of the Dalton Highway and north of the park (Tier II Hunt TX108). In GMU 26B east of the Dalton Highway it was determined that 5 muskoxen were required to meet subsistence use (Tier I hunt RX110). In addition, in GMU 26A to the northwest of the park and around the community of Anaktuvuk Pass located within the park boundaries, muskox could be harvested under emergency order of the Alaska Department of Fish and Game. Interest in increasing these harvest levels is strong. Proposals for harvest were submitted by the North Slope Regional Advisory Council in 1997 (Proposal # 97-108), 1998 (Proposal # 98-99) and 1999 (Proposal #99-63) to allow the subsistence harvest of up to 2 muskoxen per person. Implementation of such a proposed harvest level has the potential to undermine the reestablishment of the species in the Park. At this time, the National Park Service lacks basic information on historical and present extent of muskoxen habitat within Gates of the Arctic National Park and Preserve. This information is needed for informed decisions regarding this species within the park.



Information collected on muskoxen in Gates of the Arctic National Park and Preserve has been opportunistic and basic. Sightings have been collected from a variety of sources including word of mouth from park visitor, park employee trip reports, and reports from the residents of Anaktuvuk Pass. Muskoxen were observed along the Anaktuvuk River as early as 1986 (P. Reynolds, US Fish and Wildlife Service, personal communication). The first reported observation of a muskox in Gates of the Arctic National Park and Preserve was in 1989. A number of years followed without any recorded observations. In 1997, muskox observations were frequent enough that the National Park Service began maintaining a database of observations and locations of muskoxen within GAAR.

#### **METHODS:**

Beginning in 1999, incidental observations of muskoxen within Gates of the Arctic National Park and Preserve were tabulated in a database. Where possible, information regarding sex and age of animals and location of observation were obtained. Incidental observations came from park visitors, park employees and residents of the community of Anaktuvuk Pass.

Winter and summer aerial surveys were initiated in 1999. Surveys were conducted in 1999 from 26 -28 April, and from 21 - 23 June. During 2000, flights were conducted between April 25-28. Due to low densities of muskoxen and better survey conditions during the winter months, only the winter survey was conducted during 2000. Survey efforts were concentrated in major river drainages on the north and west side of the Park. All surveys were done with a Cessna 185. Sandy Hamilton (Arctic Air Alaska) piloted the plane for both winter surveys and Don Glaser (Arctic Wings) piloted the plane

for the summer survey. Park biologist John Burch was the observer during the 1999 winter survey and park biologist Jim Lawler was the observer during the summer 1999 and the winter 2000 surveys. Survey dates were chosen to approximately coincide with muskox survey dates conducted by other natural resource agencies (P. Reynolds, US Fish and Wildlife Service, personal communication; B. Lenart, Alaska Department of Fish and Game, personal communication).

Surveys were conducted by flying up one side of river drainages and down the other at low altitudes. In some instances, the size of the drainage required a zig-zag flight pattern to adequately cover the terrain. All surveys were concentrated in valley bottoms since these areas were expected to be the most favorable for muskoxen.

## **RESULTS:**

The majority of muskox observations within GAAR occur in the summer months when the greatest number of visitors and staff are in the park. Currently thirty four observations of muskoxen have been recorded in GAAR (Fig. 2). Observations along the Noatak River account for 68 % of the total and observations near Anaktuvuk Pass account for 15 % (Table 1). These figures are misleading however in that most observations on the Noatak are from small parties of recreationists likely resulting in multiple records from a single animal. In contrast, information from Anaktuvuk Pass has tended to be more community-based in nature and although multiple people may have observed muskoxen in specific areas, only a few records have resulted. However, both sets of sightings are likely multiple observations of 1 or 2 animals in each location. In

very few of the reported observations of muskoxen was the sex of the animal noted. Out of 34 records, 7 report seeing bull muskoxen.

Aerial surveys conducted to systematically locate muskoxen during winter covered 1,293 km in 1999 (Fig. 3) and 1,519 km in 2000 (Fig. 4). Weather conditions during the 1999 winter aerial survey were generally good. During the winter 2000 survey, an additional day was required to cover the survey area due to low clouds and fog. During both surveys, sufficient snow cover was present to provide excellent sightability.

The 1999 summer survey covered 2,297 km (Fig. 5). Flying conditions for this survey were excellent with high broken clouds and calm wind conditions. However, sightability on this survey was much lower than during the winter surveys due to the lack of snow.

Unfortunately, flight time was not recorded during the 1999 surveys. In 2000, total flight time was 12 hours and 3 minutes resulting in a survey rate of 2.1 km / minute.

No muskoxen were observed during either survey conducted in 1999. In 2000, 3 bull muskoxen were observed in 3 separate locations (Fig. 4). Two animals were in the Park and one animal was just west of the Park boundary. All animals observed were along the Noatak River and all were bedded down in small stands of short willow.

**Table 1.** Summary of incidental muskox observations in Gates of the Arctic National Park and Preserve, Brooks Range, AK.

| <u>Year</u>  | <u>General Location</u> | <u># of observations</u> | <u>Greatest # of muskoxen observed at one time</u> |
|--------------|-------------------------|--------------------------|----------------------------------------------------|
| <u>1989</u>  | Tinayguk                | 1                        | 1                                                  |
| <u>1994</u>  | Noatak                  | 1                        | 1                                                  |
| <u>1997</u>  | Noatak                  | 4 <sup>a</sup>           | 2                                                  |
|              | Anaktuvuk               | 1                        | 2                                                  |
| <u>1998</u>  | Noatak                  | 7                        | 2                                                  |
|              | Anaktuvuk               | 1                        | 1                                                  |
|              | Nigu                    | 1                        | 1                                                  |
|              | Itkillik                | 2                        | 1                                                  |
|              | N.Fork Koyukuk          | 1                        | 1                                                  |
| <u>1999</u>  | Noatak                  | 7                        | 1                                                  |
|              | Anaktuvuk               | 3                        | 1                                                  |
|              | Killik                  | 1                        | 1                                                  |
| <u>2000*</u> | Noatak                  | 4                        | 2                                                  |

\*Year to date (8/3/00)

<sup>a</sup> One of the four observations was of a muskox carcass.

Fig. 2. Muskox observations in Gates of the Arctic National Park and Preserve through August 2000.

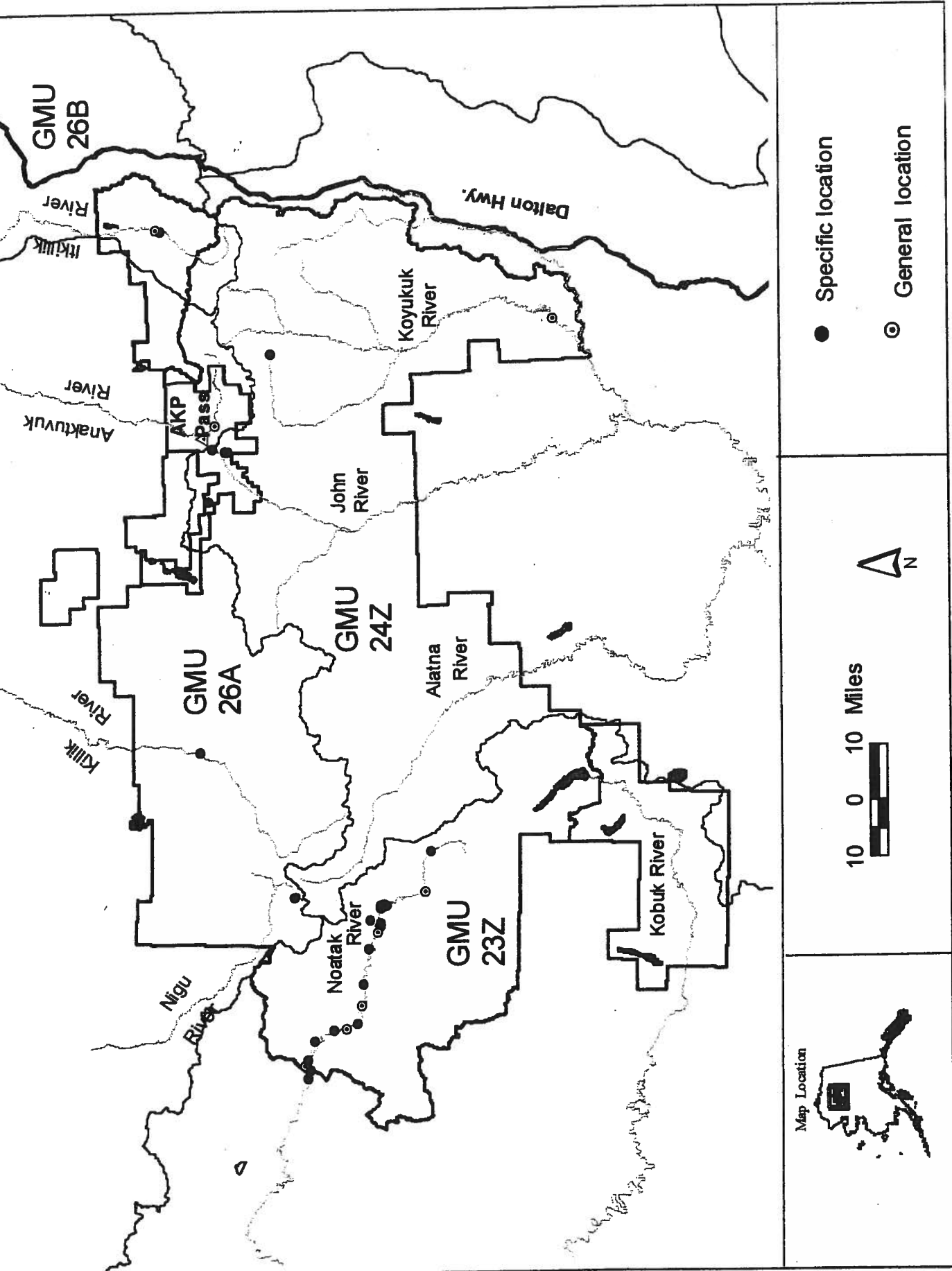
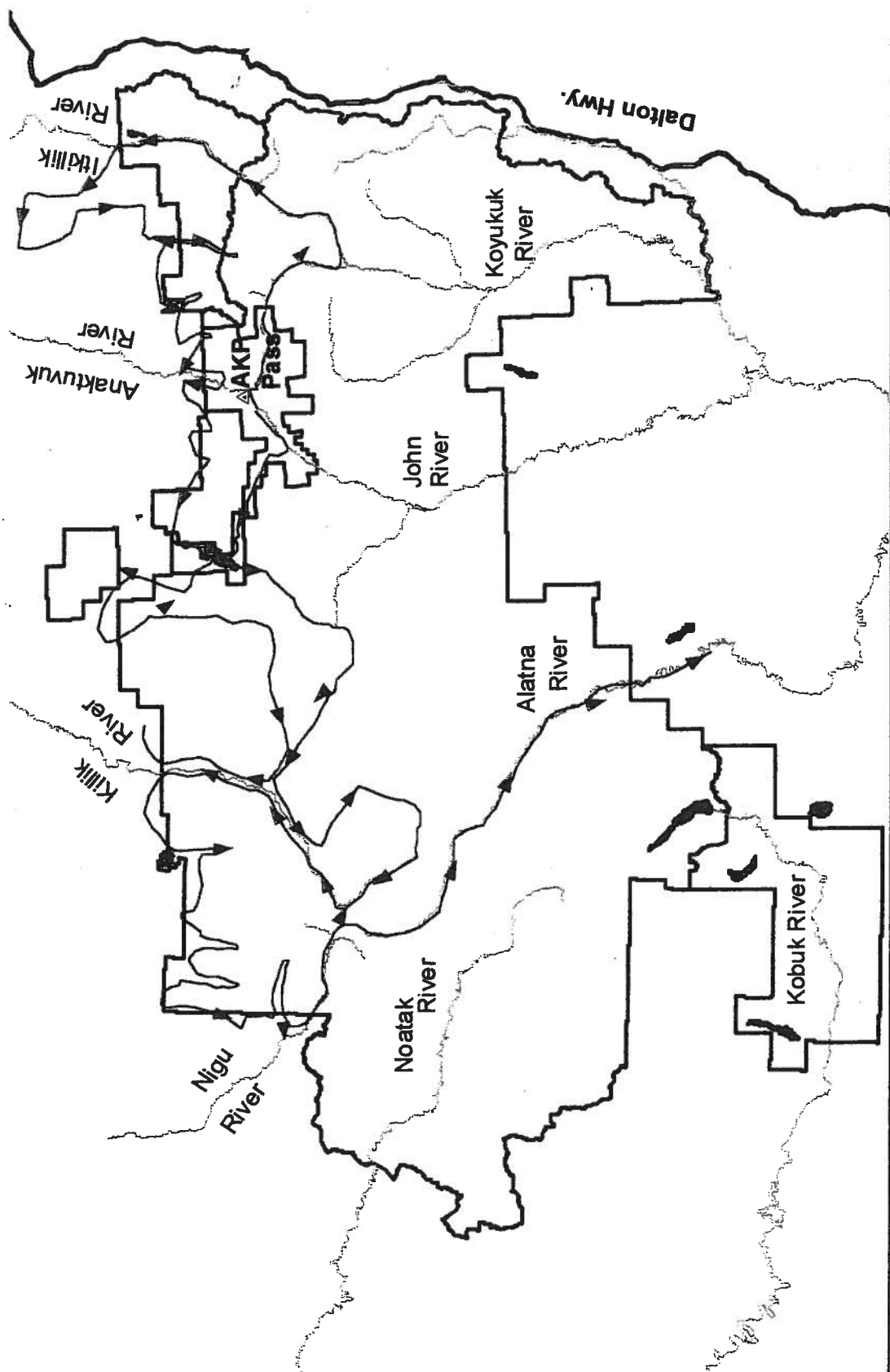


Fig. 3. Flight path of muskox survey conducted 26-28 April, 1999 in Gates of the Arctic National Park and Preserve.



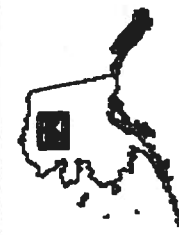
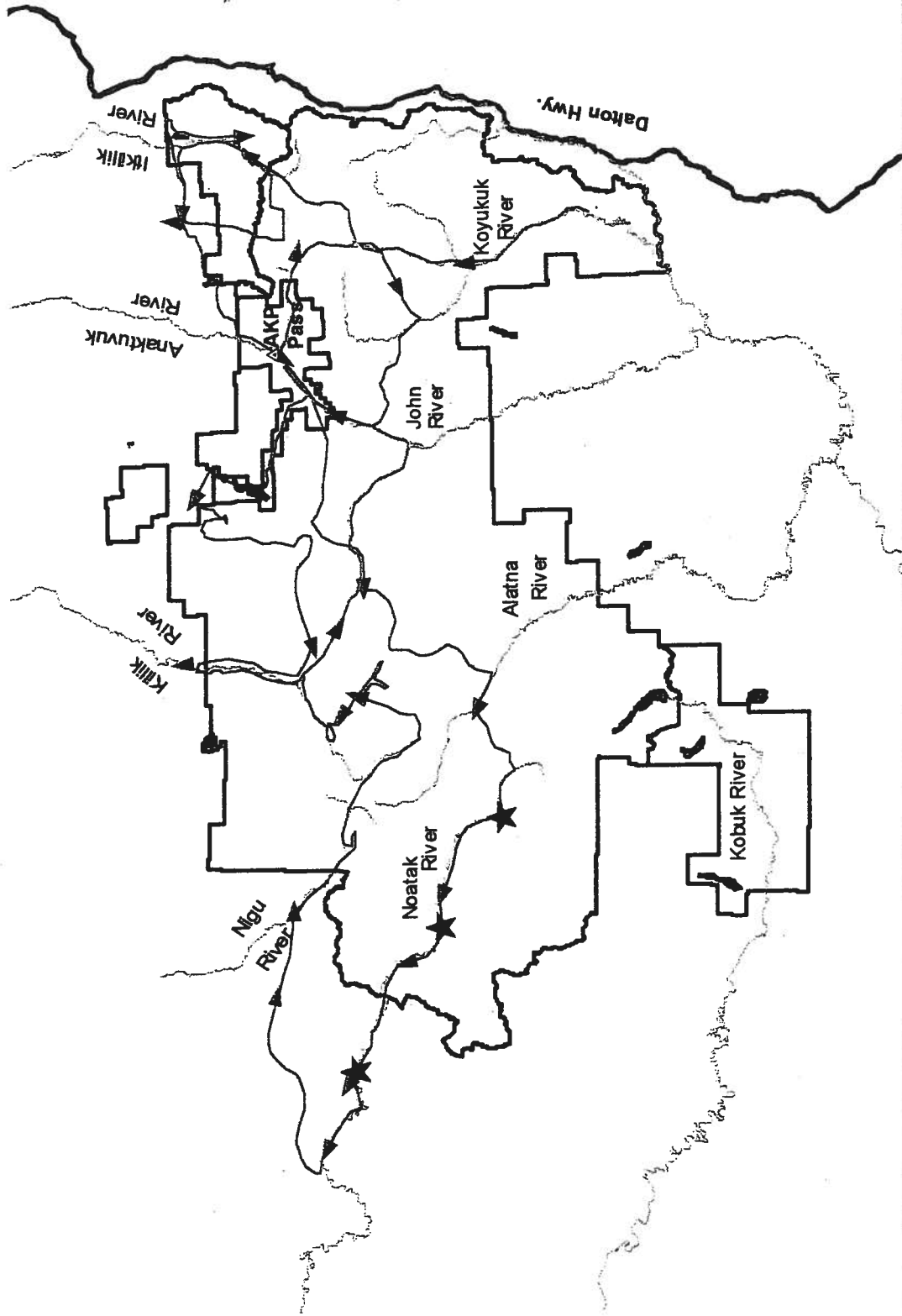
10 0 10 Miles



Flight path



Fig. 4. Flight path for muskox survey conducted 25-28 April, 2000 in Gates of the Arctic National Park and Preserve.

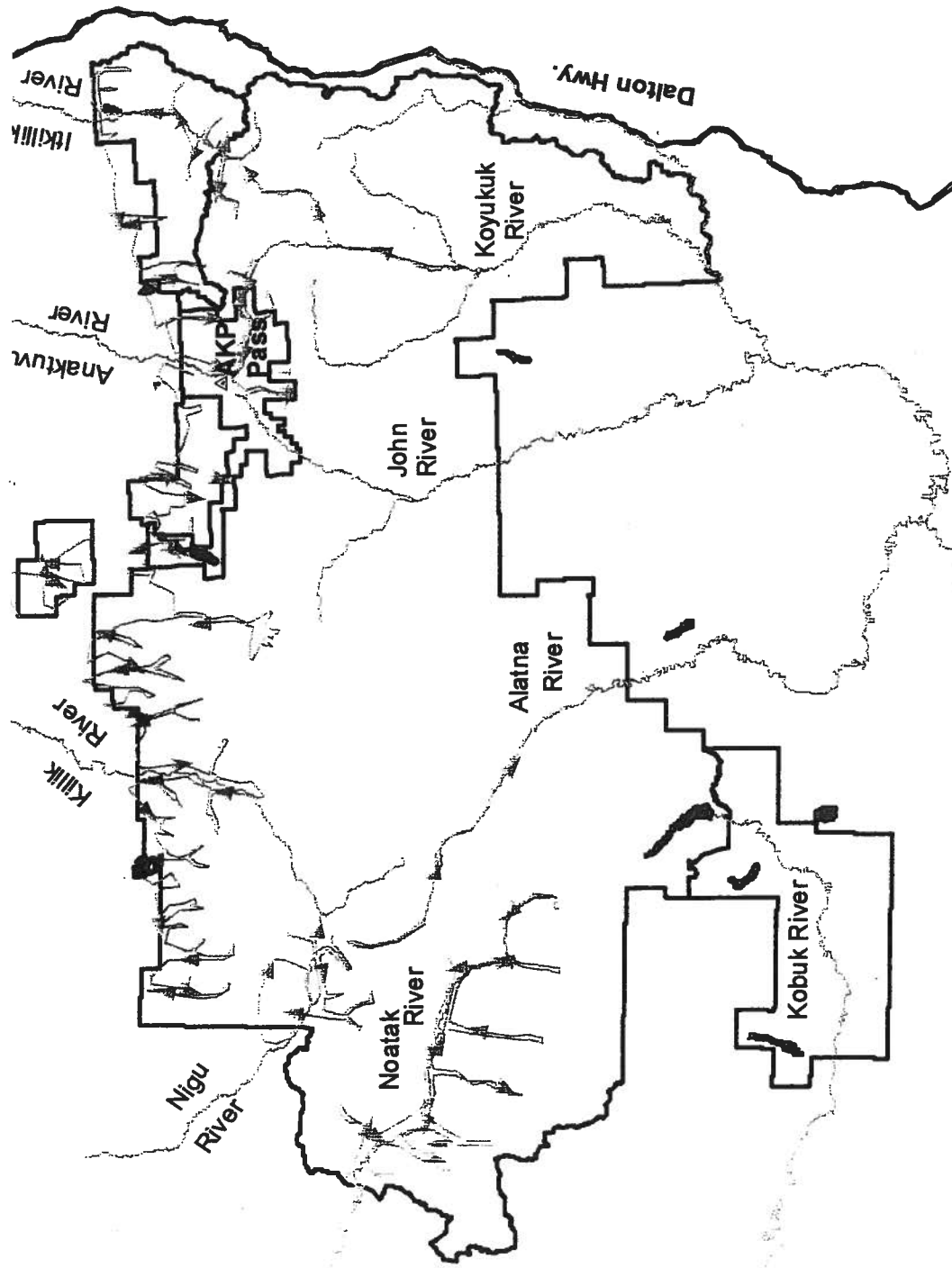


10 0 10 Miles



★ Observed muskoxen  
→ Flight path

Fig. 5. Flight path of muskox survey conducted 21-23 June, 1999 in Gates of the Arctic National Park and Preserve.



10 0 10 Miles



Flight path

## **DISCUSSION:**

Based on incidental observations, the maximum number of muskoxen occurring in Gates of the Arctic National Park and Preserve at any one time was likely in 1998 when a minimum of 6 muskox occurred. It appears 2 animals were along the Noatak River, 2 animals were near Anaktuvuk Pass, 1 was on the Itkillik River, and 1 was on the Nigu River. In addition, there was an unconfirmed sighting of a muskox on the North Fork of the Koyukuk River. The current minimum estimate for muskoxen in the Park and Preserve is 2 animals based on incidental observations in the Noatak River drainage.

These estimates are conservative in that observations are occurring in areas of the park with the most intensive human activity. Animals occupying less frequented portions of the park would be much less likely observed and therefore would not be reported in this form of data collection. It is most probable that animals being observed in Gates of the Arctic National Park and Preserve are mature adult males since this class of animal is more likely to disperse into non-traditional areas and pioneer new habitats. During 1998 in Alaska, bull muskox were observed in areas far from established herds such as along the Yukon River near Ruby, Galena (T. Seaton, Alaska Department of Fish and Game, personal communication), Rampart (S. Hamilton, Arctic Air Alaska, personal communication) and fifty miles downstream from Eagle (S. Swanson, National Park Service, personal communication). This has been suggested as a primary mechanism by which muskoxen colonize discontinuous habitat (Smith 1989). Although females are rarely seen alone or far from other muskoxen (P. Reynolds, US Fish and Wildlife Service, personal communication), caution should be used in assuming all animals observed in the park are dispersing males as most people observing muskoxen in the park

are not capable of differentiating between the sexes. In addition, small mixed sex groups of muskoxen have been known to colonize habitats prior to observations of bulls in these areas (J. Dau, Alaska Dept. of Fish and Game, personal communication).

From the results of the aerial survey work, it is unlikely, that any large groups of muskoxen currently occupy Gates of the Arctic National Park and Preserve. Singles and small groups however, could easily have been missed, particularly during the June 1999 survey when no snow cover existed. Although it is unlikely that breeding groups of muskoxen presently occupy the Gates of the Arctic National Park and Preserve, the potential for them to do so exists in some of the larger and wider drainages on the north and west side of the park. At present, mixed sex groups of muskox occur 30 miles to the northeast of the park along the Ribdon drainage (B. Lenart, Alaska Department of Fish and Game, personal communication). Dispersal of animals from this group may eventually lead to the presence of breeding populations within the park.

## **RECOMMENDATIONS:**

The largest political barrier to muskox re-establishment in Gates of the Arctic National Park and Preserve is the perception from members of local communities that muskoxen and caribou are incompatible. Attention needs to focus on the basis of this perception, and local historical knowledge of this species needs to be documented and examined. In addition, information from studies looking at muskoxen / caribou interactions needs to be made available to local residents in a visual format such as a poster, series of posters or a simple brochure.

Intensive aerial surveys throughout the northern and western portion of the park are difficult to justify at this time given the low density of muskoxen. A more appropriate survey would focus on specific areas of the park such as the Noatak and Anaktuvuk River drainages. These surveys should be done in the winter while snow covers the ground to provide the best sightability.

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# PRELIMINARY INVESTIGATION OF MUSKOX HABITAT IN GATES OF THE ARCTIC NATIONAL PARK AND PRESERVE, ALASKA

## PROJECT REPORT September, 2000

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### INTRODUCTION:

Geographical information systems (GIS) have been utilized to map muskoxen habitat in Greenland (Bay 1994) and in Alaska (Danks 2000). This tool has the potential to provide valuable insights into the potential extent of muskoxen re-colonization within Gates of the Arctic National Park and Preserve. Data layers (grids) currently available for the Park include landcover (Helt et al. 1999) and 1:63,360 USGS Digital Elevation Models (DEM) that provide terrain information on elevation, slope and aspect.

Terrain characteristics are useful in predicting snow distribution patterns within a landscape (Nellemann and Thomsen 1994, Nellemann and Reynolds 1997, Nellemann 1998). This is useful when examining muskox habitat since muskox are poorly adapted to dealing with deep snow (Fancy and White 1985, Klein 1986, Smith 1989), and snow accumulation and melt patterns influence plant distribution, biomass, and phenology (White and Trudell 1980, Murray and Miller 1982).

It should be noted that all incidental muskox locations included in this report occurred from May through September. As a result, this report only deals with potential summer muskox habitat. Results from this analysis are not applicable to those times of the year when snow may restrict animal movements or make some habitats unavailable.

For this report, we utilized GIS to develop a descriptive model of habitat characteristics associated with incidental muskox observations in Gates of the Arctic National Park and Preserve. Results from this initial effort will be used to evaluate the appropriateness of applying existing (i.e. Danks 2000) habitat models to the Park.

## **METHODS:**

A geographical information system (ArcView GIS 3.2, Environmental Systems Research Inc. [ESRI], 1999) was used to relate geographical location of incidental muskoxen observations ( $n = 34$ ) to landcover and terrain characteristics. All data were projected using Albers equal area conic projection. The ArcView extensions *Alaska Pak* (NPS, Alaska support office 1999), *Geoprocessing*, *Graticulates and Measured Grids*, *Spatial analyst*, and *Spatial tools* (ESRI 1999) facilitated analysis. All lands within Gates of the Arctic National Park and Preserve and within a 10 mile buffer around the perimeter of the Park unit were included in this analysis.

Buffer zones were created around each point location of incidental muskoxen observation (Fig. 2) within Gates of the Arctic National Park and Preserve for this analysis. Danks (2000) provided a graph of a logistical relationship between buffer size and group size based on daily range requirements for muskoxen. For a group size of 2 muskoxen (the largest group size observed within the park), this resulted in a 75 meter radius buffer. However, given the general nature of the observation data, and the error associated with handheld or aircraft mounted GPS units, this criterion was judged to be too rigorous and a second more conservative buffer of 500 meter radius was created. This 500 meter buffer was used for all analyses. Buffer coverages were converted to 5 meter by 5 meter grids to allow analysis since data from landcover and digital elevation

models were in grid format. A small grid size was chosen to minimize the effect of changing a round buffer area into a series of rectangular grids.

A landcover map was produced by Earth Satellite Corporation (Rockville, MD), the Natural Heritage Program (University of Alaska, Anchorage), and the National Park Service (AKSO-GIS, Anchorage, Alaska) using Landsat Thematic Mapper multispectral imagery as the primary data source. Vegetation was classified using a modified version of the Alaska Vegetation Classification system (Viereck et al. 1992). Landcover was mapped throughout the park and within a 10 mile buffer strip along the perimeter of the park and covers a total of 13.7 million acres. Land cover was separated into 30 classes (Table 2). An accuracy assessment of the landcover map resulted in an overall accuracy estimate of all classes of 83.1% based on a 5 acre minimum mapping unit data set. A thorough treatment of landcover and mapping accuracy in Gates of the Arctic National Park and Preserve is provided in *Landsat derived map and landcover descriptions for Gates of the Arctic National Park and Preserve, October 1999* (Helt et al. 1999). A filtered map using 2 acres as a minimum mapping unit (MMU) was used to examine landcover and muskox distribution relationships. Grid cell size for the landcover map was 30 meter. Spatial analyst was used to tabulate each landcover type within the 500 meter muskox buffer. Landcover types within the 10 mile buffered Park boundary and within the 500 meter buffer were sequentially ranked according to their relative presence for analysis.

Landcover type in observed muskoxen location buffers was investigated with a chi-square goodness of fit test. Observed proportions of use of landcover were compared to landcover proportions within Gates of the Arctic National Park and Preserve (expected

use if no selection occurred). Determination of which landcover types were being used more or less than available were made by using 95% Bonferroni simultaneous confidence intervals (Manly et al. 1995, Cherry 1996) constructed for proportions of landcover use within the muskoxen buffer. If the proportion available of a given landcover type fell outside the confidence intervals, then selection is assumed to be occurring, either for or against that landcover type. Confidence intervals were constructed for all landcover types with greater than 2% cover within Gates of the Arctic National Park and Preserve ( $n = 11$ ). All landcover types with less than 2% coverage were lumped as a single category.

Digital elevation models (DEMs) in grid format were used to examine topographical characteristics of observed muskox locations in Gates of the Arctic National Park and Preserve. These models were on a 1:250,000 scale and grid cell size was 90 meter. Six adjacent elevation grids were required to examine all incidental muskox observations within the park. These grids were transformed into 1 grid using the mosaic function. The surface function of *Spatial Analyst* (ESRI 1999) was used to generate slope and aspect grids from the elevation model. Slope grids were converted from floating point to integer grids to facilitate analysis. Elevation, slope and aspect grids were examined only within each 500 meter muskox buffer by "masking" these grids using the 500 meter buffer (i.e. the analysis extent was the 500 meter buffer).

## RESULTS:

### Landcover

Out of 30 potential landcover types in Gates of the Arctic National Park and Preserve, buffered muskoxen locations intersected 22 landcovers (Table 2). Eliminating landcover types with no forage for muskoxen (i.e. silty water, clear water and snow and ice) resulted in 19 landcover types within buffered muskoxen locations. Three of these landcovers accounted for 51% of the area found within the buffers (mesic herbaceous = 19.3%, prostrate shrub = 16.7% and shrub birch-ericaceous-willow = 14.9%). The other 16 landcover types are less well represented within the buffered areas (Fig. 6). Eleven of these vegetation classes each contained less than 2% of the area within the buffers (Table 2). Characteristics of the 3 dominate landcover types within the buffered area were given by Helt et al. (1999) as follows:

#### 1. Mesic Herbaceous

*Sites are moist and tussocks may dominate. Permanent standing water is not present. Herbaceous cover is greater than 25%, tree canopy is less than 10% or absent, and shrub cover is less than 25%. [This class] occurs primarily on rolling hills, valley bottoms, terraces, and flood plains.... Upland herbaceous meadows as well as tussock tundra are included in this class. The majority of mesic herbaceous sites contain some tussocks.*

*The dominant graminoid species include Carex membranacea (fragile sedge), Carex lugens, Carex bigelowii (Bigelow sedge), Calamagrostis canadensis (bluejoint grass), Eriophorum russeolum (russet cottongrass), and*

Eriophorum vaginatum (tussock cottongrass). Ledum palustre (Labrador tea), Vaccinium uliginosum (bog blueberry), and Dryas octopetala (white mountain avens) are common. Other species include Salix reticulata (netleaf willow), Pedicularis species, and Polygonum bistorta (pink plume). Mosses are also commonly found in tussock dominated sites and include Sphagnum (peat moss) species and Hyocomium splendens (feather moss).

## 2. Prostrate shrub

Shrub height is less than 0.3 feet with total prostrate shrub cover greater than 25%. Less than 33% of the total cover is bare-ground, less than 25% of the total cover is fruticose lichen, and less than 25% tussocks. Tree canopy is less than 10% or absent. ...Prostrate shrub is the predominant shrub type found within alpine areas of GAAR....[it] is found on unstable to stable surfaces such as mountain slopes, high mountain valley floors, rounded mountain ridges (exposed bedrock), the riverside edge of river terraces, and on sorted patterned ground.

The prostrate shrub class is comprised of vegetation that generally reaches a height of 4 inches or less. The dominant shrub is Dryas octopetala (white mountain avens). Other strong associates are Dryas integrifolia (entire-leaf mountain avens), Salix reticulata (netleaf willow), Salix arctica (arctic willow), Salix phlebophylla (skeletonleaf willow), Cassiope tetragona (four-angled cassiope), Vaccinium uliginosum (bog blueberry), Arctostaphylos rubra (red-fruit bearberry), and Arctostaphylos alpina (alpine bearberry). Herbaceous vegetation often has high cover values and includes Carex bigelowii (Bigelow

sedge), Silene acaulis (moss campion), Mimuartia species, Pedicularis species, Boykinia richardsonii, and Anemone narcissiflora (narcissus-flowered anemone). Multiple species of fruitocose lichen also occur.

### 3. Shrub birch-ericaceous-willow

Shrub height is 0.3 to 3.5 feet with greater than 25% of the vegetation cover as low shrub. Less than 25% of the site is covered by tussocks, less than 2/3 of the total shrub cover is willow, and less than 75% of the total shrub cover is shrub birch. Tree canopy is less than 10% or absent. It is found growing on valley bottoms, floodplains, toeslopes, and colluvial and glacial drift sideslopes surfaces. The sites are generally mesic sites, often with small amount of standing water present. On these wetter sites, the willow species grow on the dryer portions (mounds), and the more hydrophilic vegetation (such as Carex aquatilis) concentrates in the troughs.

Shrub species commonly found within this mapping class include Betula nana (dwarf arctic birch) of Betula glandulosa (resin birch), Vaccinium uliginosum (bog blueberry), Ledum palustre (Labrador tea), Andromeda polifolia (bog rosemary), Vaccinium vitis-idaea, Empetrum nigrum (crowberry), Salix planifolia subspecies pulchra (diamondleaf willow), and Loiseleuria procumbens (alpine azalea). Some sites are dominated by willow, primarily Salix planifolia subspecies pulchra (diamondleaf willow), Salix lanata subspecies richardsonii (Richardson willow), Salix brachycarpa (barren-ground willow), and Salix myrtillifolia (low blueberry willow). Herbaceous species include Eriophorum

species, Calamagrostis canadensis (bluejoint grass), Carex bigelowii (Bigelow sedge), and Carex aquatilis (water sedge). Lichen and mosses also commonly occur.

The calculated chi-square statistic indicated observed muskoxen location buffers occurred in land cover types in different proportions than was available in the environment ( $X^2 = 3080.2$ ,  $df = 11$ ). Proportion of occurrence of observed muskoxen buffers was significantly greater in mesic herbaceous landcover type than was the proportion available. Open tall shrub and closed tall shrub landcover types were also significantly selected for, although less so than the mesic herbaceous type. Proportion of occurrence of observed muskoxen buffers were significantly less in black spruce-like forest, spruce woodland, prostrate shrub and bare ground landcover types than one would assume based on availability (Table 3, Fig. 7).

Table 2. Landcover types within Gates of the Arctic National Park and Preserve, Alaska and within a 10 mile outside buffer along the perimeter of the park area, and landcover types within a 500 meter buffer of observed muskox locations. Total area of each landcover type is given as well as the sequential rank with 1 being the most abundant landcover type and 30 being the least abundant type.

| Landcover Type                    | Within the Park<br>and 10 mile buffer <sup>a</sup> |       |      | Within 500 m<br>Muskox buffer |       |      |
|-----------------------------------|----------------------------------------------------|-------|------|-------------------------------|-------|------|
|                                   | Total Area                                         | %     | Rank | Total area                    | %     | Rank |
| Prostrate shrub                   | 2365852.6                                          | 17.2  | 1    | 1066.0                        | 16.7  | 2    |
| Shrub birch-ericaceous-willow     | 2088107.3                                          | 15.2  | 2    | 951.3                         | 14.9  | 3    |
| Bare-ground                       | 1221000.7                                          | 8.9   | 3    | 494.3                         | 7.7   | 4    |
| Open black spruce-like forest     | 1110745.5                                          | 8.1   | 4    | 93.0                          | 1.5   | 12   |
| Sparsely vegetated                | 1001931.2                                          | 7.3   | 5    | 440.6                         | 6.9   | 5    |
| Shrub birch-willow-tussock tundra | 925309.0                                           | 6.7   | 6    | 379.9                         | 6.0   | 8    |
| Mesic herbaceous                  | 853264.8                                           | 6.2   | 7    | 1233.6                        | 19.3  | 1    |
| Prostrate shrub-rock              | 832698.8                                           | 6.1   | 8    | 206.5                         | 3.2   | 10   |
| Spruce woodland                   | 815661.0                                           | 5.9   | 9    | 11.9                          | 0.2   | 17   |
| Shadow/indeterminate              | 621280.4                                           | 4.5   | 10   | 79.2                          | 1.2   | 13   |
| Open white spruce-like forest     | 412165.1                                           | 3.0   | 11   |                               |       |      |
| Open tall shrub                   | 410129.6                                           | 3.0   | 12   | 387.1                         | 6.1   | 7    |
| Closed tall shrub                 | 397866.4                                           | 2.9   | 13   | 417.1                         | 6.5   | 6    |
| Prostrate shrub-lichen            | 158345.7                                           | 1.2   | 14   | 63.6                          | 1.0   | 14   |
| Spruce-lichen woodland            | 87922.7                                            | 0.6   | 15   |                               |       |      |
| Clear water                       | 86552.4                                            | 0.6   | 16   | 140.3                         | 2.2   | 11   |
| Silty water                       | 71507.9                                            | 0.5   | 17   | 353.6                         | 5.5   | 9    |
| Snow/Ice                          | 49013.2                                            | 0.4   | 18   | 3.1                           | < 0.1 | 21   |
| Open spruce-broadleaf forest      | 41309.1                                            | 0.3   | 19   | 11.5                          | 0.2   | 18   |
| Wet herbaceous                    | 36218.7                                            | 0.3   | 20   | 23.2                          | 0.4   | 15   |
| Closed spruce-broadleaf forest    | 33047.7                                            | 0.2   | 21   | 8.3                           | 0.1   | 19   |
| Open paper birch-aspen forest     | 31259.3                                            | 0.2   | 22   |                               |       |      |
| Closed low willow                 | 24455.2                                            | 0.2   | 23   | 13.4                          | 0.2   | 16   |
| Mosaic/pattern vegetation         | 24431.3                                            | 0.2   | 24   |                               |       |      |
| Closed paper birch-aspen forest   | 19729.3                                            | 0.1   | 25   |                               |       |      |
| Open balsam poplar forest         | 12360.4                                            | 0.1   | 26   | 0.1                           | < 0.1 | 22   |
| Closed balsam poplar forest       | 10131.7                                            | 0.1   | 27   | 7.3                           | 0.1   | 20   |
| Dense-open white spruce forest    | 5889.9                                             | < 0.1 | 28   |                               |       |      |
| Aquatic herbaceous                | 332.0                                              | < 0.1 | 29   |                               |       |      |
| Sand dunes                        | 10.0                                               | < 0.1 | 30   |                               |       |      |
| <b>TOTAL</b>                      | <b>13,748,529</b>                                  |       |      | <b>6384.9</b>                 |       |      |

<sup>a</sup> Area of landcover types within Gates of the Arctic National Park and Preserve were taken from Landsat derived map and landcover descriptions for Gates of the Arctic National Park and Preserve, October 1999 (Helt et al. 1999).

# Used and available Landcover types in Gates of the Arctic National Park and Preserve

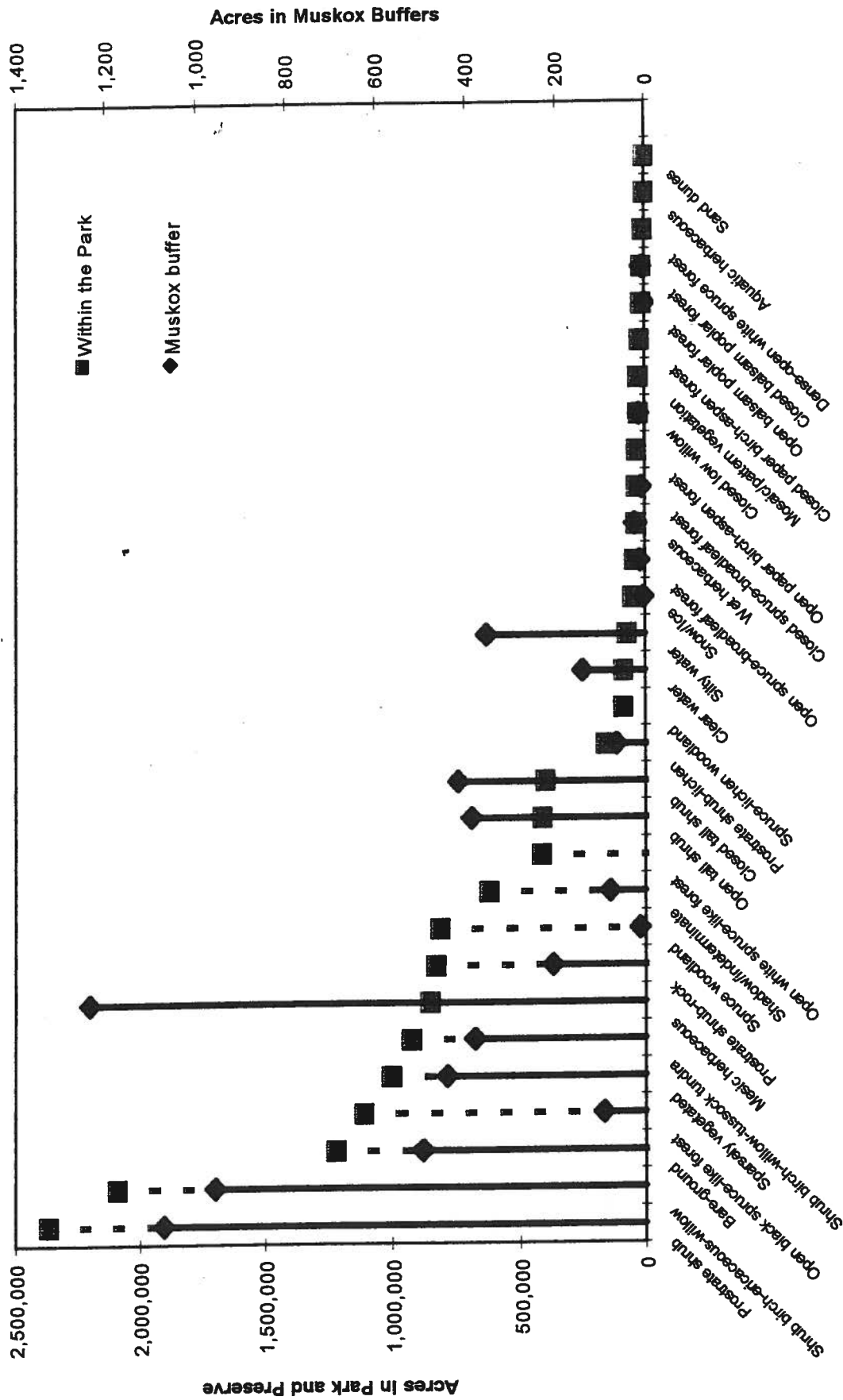


Fig. 6 Area of landcover types in Gates of the Arctic National Park and Preserve, Alaska and area of habitats within a 500 meter buffer of muskoxen locations in Gates of the Arctic National Park and Preserve, Alaska.

Table 3. Proportion of landcover types within Gates of the Arctic National Park and Preserve, Alaska and within a 10 mile outside buffer along the perimeter of the park area, and landcover types within a 500 meter buffer of observed muskox locations. A 95% Bonferroni confidence interval was constructed around each of the proportions of each land cover type within the 500 meter muskoxen buffer.

| Land Cover Type                   | Proportion within<br>GAAR | Proportion Used by<br>Muskoxen | Bonferroni Confidence Limits |       |
|-----------------------------------|---------------------------|--------------------------------|------------------------------|-------|
|                                   |                           |                                | Lower                        | Upper |
| Prostrate Shrub                   | 0.172                     | 0.167                          | 0.154                        | 0.180 |
| Shrub birch-ericaceous-willow     | 0.152                     | 0.149                          | 0.136                        | 0.162 |
| Bare-ground                       | 0.089                     | 0.077*                         | 0.068                        | 0.087 |
| Open black spruce-like forest     | 0.081                     | 0.015*                         | 0.010                        | 0.019 |
| Sparsely vegetated                | 0.073                     | 0.069                          | 0.060                        | 0.078 |
| Shrub birch-willow-tussock tundra | 0.067                     | 0.059                          | 0.051                        | 0.068 |
| Mesic herbaceous                  | 0.062                     | 0.193*                         | 0.179                        | 0.207 |
| Prostrate shrub-rock              | 0.061                     | 0.032*                         | 0.026                        | 0.039 |
| Spruce woodland                   | 0.059                     | 0.002*                         | 0.000                        | 0.003 |
| Open tall shrub                   | 0.030                     | 0.061*                         | 0.052                        | 0.069 |
| Closed Tall shrub                 | 0.029                     | 0.065*                         | 0.057                        | 0.074 |
| Other                             | 0.126                     | 0.110*                         | 0.099                        | 0.121 |

\* Land cover types used by muskoxen with a significantly different proportion than available within Gates of the Arctic National Park and Preserve.

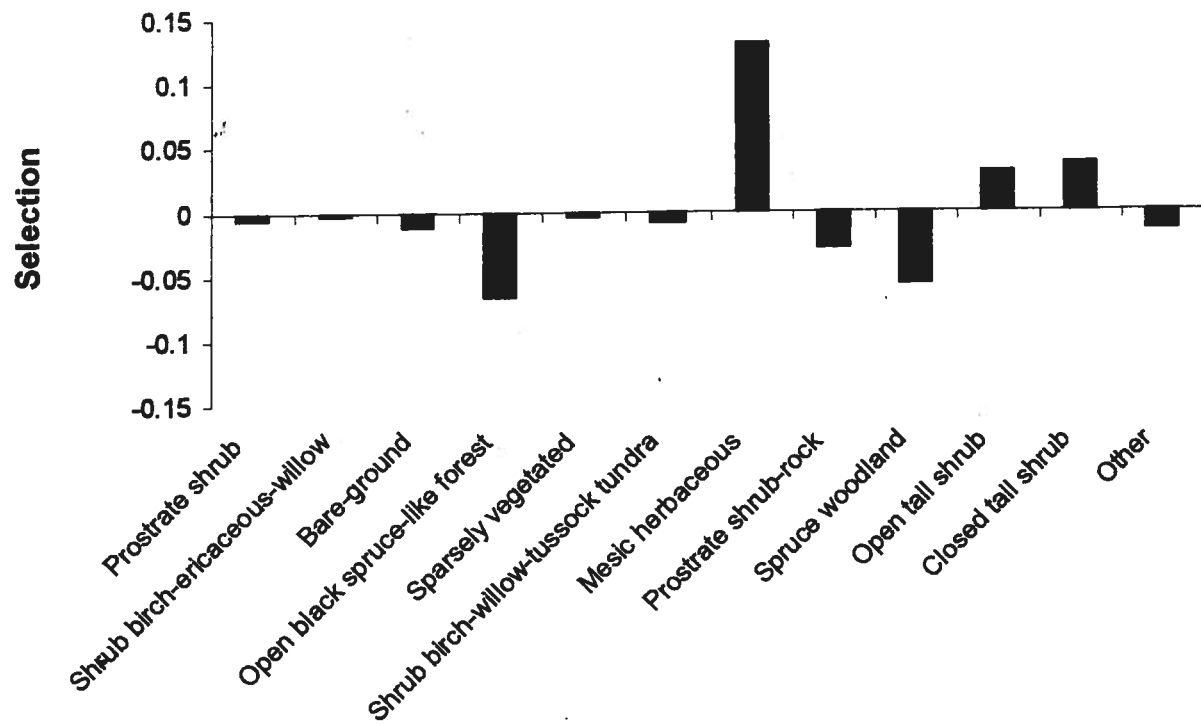


**Fig 7.** Selection for or against available land cover types within Gates of the Arctic National Park and Preserve based on incidental observations of muskoxen. Values were obtained by subtracting mean proportions of land cover types within the preserve (available) from mean proportions of land cover within a 500 meter buffer of reported muskoxen locations (used).

## **Elevation**

Elevation in Gates of the Arctic National Park and Preserve and in the 10 mile buffer around the perimeter of the Park and Preserve varies between a low of 51 meters (167 feet) along Kobuk River to a high of 2537 meters (8323 feet) on the top of Mount Igikpak. Mean ( $\pm$  STD) elevation of this area is 1187 ( $\pm$  658) meters [3894 ( $\pm$  2159) feet]. Muskoxen were most commonly found in lower elevations within the park. Mean elevation within the 500 meter buffered areas was 657 ( $\pm$  234) meters [2155 ( $\pm$  768) feet]. Elevation within the 500 meter buffered area varied from 247 meters (810 feet), on the North Fork of the Koyukuk in 1998 (Johnson, NPS Park Ranger) to 1587 meters (5206 feet) in the headwaters of the Tinyaguk (Forner and Collins, NPS Park rangers)(Fig 8).

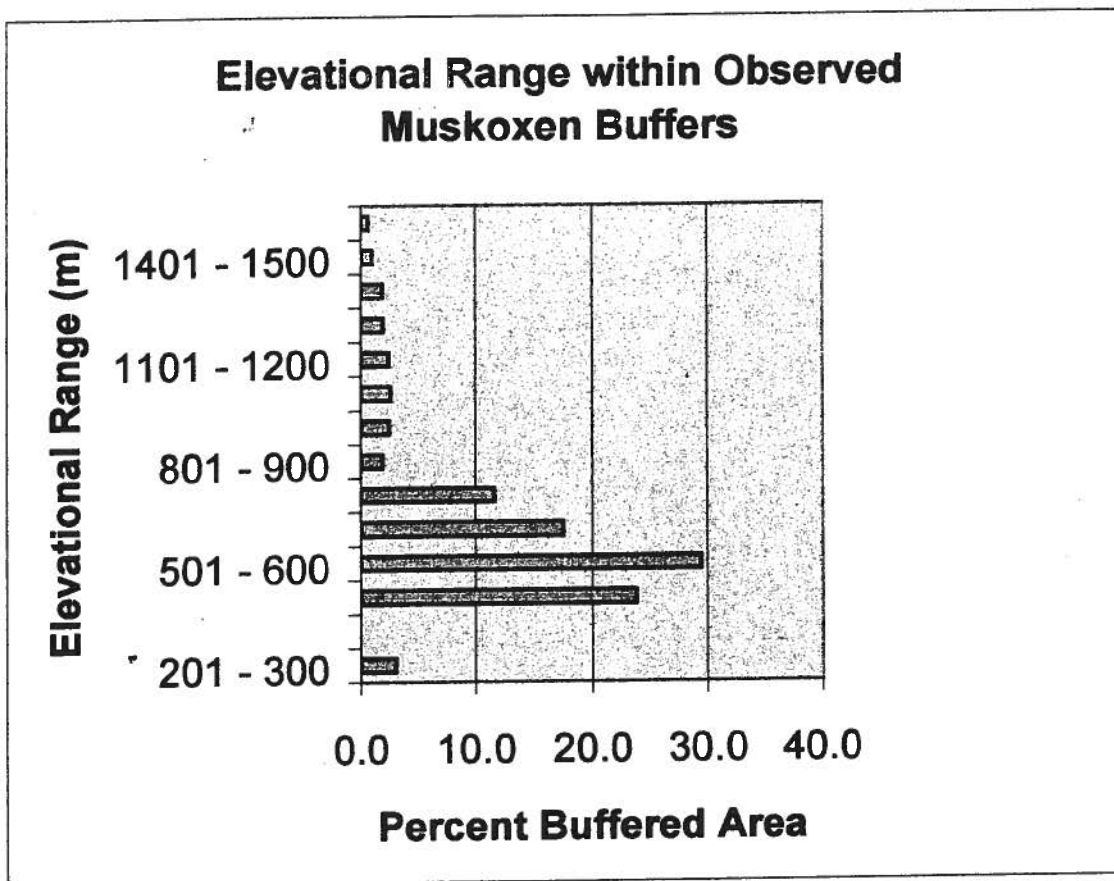


**Fig. 8.** A digital elevation model was used to determine elevations within a 500 meter radius of observed muskoxen locations. A count of the number of grids at each elevation was used to calculate percentages in each elevation category.

### Slope and Aspect

Distribution of muskoxen observations are heavily skewed toward flat terrain (Fig. 9). Slopes within the 500 meter muskoxen buffer averaged  $4 \pm 6.8$  degrees. Slopes within the 500 meter buffer ranged from 0 to 40 degrees. Slopes within the Park and Preserve area ranged from 0 – 90 with a mean slope of  $13 \pm 10.5$  degrees. As a consequence of the low slope angles associated with the muskoxen observations, measurements of aspect likely have little meaning since muskoxen appear to be spending the majority of time in areas with little or no slope.

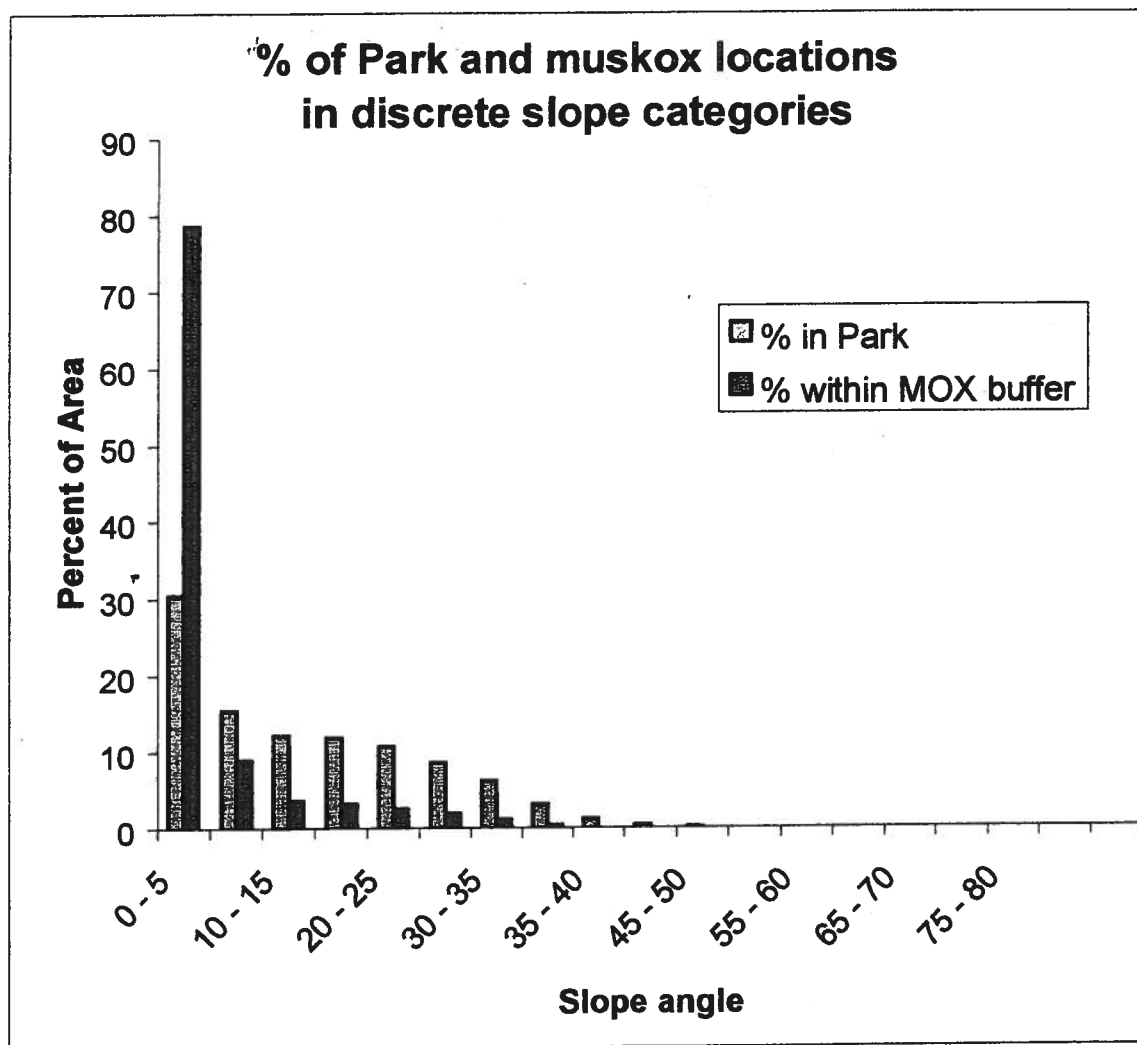


**Fig. 9.** A digital elevation model was used to determine slope angles within Gates of the Arctic National Park and Preserve and within a 500 meter radius of observed muskoxen locations. A count of the number of grids at each slope angle was used to calculate percentages of slope coverage in each slope angle category.

## DISCUSSION:

This preliminary effort to quantify aspects of habitat selection by muskox in Gates of the Arctic National Park and Preserve indicates muskox are most commonly observed in shrub and herbaceous landcover types. Although some of this may be a consequence of the abundance of this landcover type within the Park area (prostrate shrub, shrub birch-ericaceous-willow), other shrub types are being actively selected for (closed tall shrub, open tall shrub). Of particular interest is the willow component of the shrub landcover since willow has been shown to be an important component of the diet for muskoxen in the southern portions of their range, both in the summer and in the winter (Jingfors, 1980; Robus 1981; O'Brian, 1988; Wilson, 1992; Ihl, 1999). The selection of the herbaceous landcover type is also of interest. Muskoxen are well adapted as bulk feeders (White et al. 1984, Klein 1992, Adamczewski et al., 1994 *a, b*), therefore the high plant biomass and high graminoid characteristics of the mesic herbaceous landcover type (Helt et al. 1999) would be well suited to the feeding strategy of muskoxen. The selection of lower and flatter areas by muskoxen within the Park area is also consistent with higher plant biomass, and therefore better muskox habitat; logically, these areas would be drainages.

A large degree of caution needs to be exercised when interpreting the results of this habitat assessment exercise. The first consideration is the data quality. Accuracy of the muskoxen locations is poor with most locations being reported as general vicinities. As compensation, large (500 meter) muskoxen buffers were created for the analysis. Results therefore are only applicable to habitat component selection at a large scale. This presents a problem because all muskox observations were for at most a pair of animals. Single animals and pairs of animals can select forage patch sizes with smaller areas than

can groups of muskoxen. It is conceivable that single animals select patch sizes smaller than the 2 acre minimum mapping unit of the landcover map. A second consideration is sample size. This analysis was based on 34 muskoxen locations. This is a sparse data set from which to draw conclusions. Along the same lines, many of these observations were likely the same animal or same set of animals, this constitutes pseudoreplication (Aebischer et al. 1993) and would bias the results to habitat selection by a few individuals. In addition, muskox observations are not randomly distributed in areas where muskox are likely occurring but are heavily skewed toward areas utilized by people. This problem is most evident along the Noatak River. The final consideration is season in which the observations were made. The majority of these observations were made following green up and prior to plant senescence, when forage quality and forage quantity would be highest. Snow cover at this time of year is typically minimal or absent. Muskoxen therefore, would not likely be constrained in habitat selection in summer compared to other seasons.

For this preliminary analysis, I chose to investigate 3 habitat variables: landcover, elevation, and slope. Additional habitat components should be added to future analysis. Development of a terrain ruggedness index for the park area has great potential to improve our understanding of muskox habitat characteristics since this has been shown to have a strong influence on muskox habitat selection (Nellemann and Thomsen 1994, Nellemann and Reynolds 1997, Nellemann 1998, Danks 2000). In addition, a quantitative measure of distance to water might provide some insights since our results indicate flat, low areas are attractive to muskox. Finally, the interaction of these

variables needs to be considered since at this time, no attempt had been made to tease out the relative importance of individual habitat variables.

This initial habitat assessment exercise is useful in providing a start for developing a more sophisticated habitat model for muskoxen in Gates of the Arctic National Park and Preserve. Additional muskox observations in varied locations throughout the Park area will improve the model. The current late winter survey also has the potential to illuminate muskoxen habitat relationships since muskoxen are observed as a time of year when they are likely the most constrained in their habitat selection and relatively accurate locations can be plotted.

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