THE DISTRIBUTION OF FORAGE TYPES AMONG FOUR TERRESTRIAL HABITATS ON SOUTHERN BANKS ISLAND

NICHOLAS C. LARTER

AND

JOHN A. NAGY

DEPARTMENT OF RESOURCES, WILDLIFE & ECONOMIC DEVELOPMENT

GOVERNMENT OF THE NORTHWEST TERRITORIES

INUVIK, NT

2001

Manuscript Report No. 142

The contents of this report are the sole responsibility of the authors

ABSTRACT

Between June 1993 and August 1997, we recorded the presence of various classes of forage in wet sedge meadow, upland barren, hummock tundra, and stony barren habitats in two areas on southern Banks Island in order to assess the frequency occurrence and distribution of forages among these habitats. We visited >1400 plots during the study. We selected 10 classes of forage which were believed to represent important components of the diets of muskoxen and Peary caribou on Banks Island: sedge (mainly *Carex* spp.), willow (*Salix arctica*), grass (Poaceae), ericaceous shrub (mainly *Cassiope tetragona*), lichen, legume (*Astragalus* spp. and *Oxytropis* spp.), avens (*Dryas integrifolia*), saxifrage (*Saxifraga* spp.), horsetail (*Equisetum* spp.), and other forbs. Avens, lichen, and sedge were the most commonly found forages over all habitats. Sedge predominated in wet sedge meadows but horsetail, willow, and avens were commonly found. Upland barren (UB) and hummock tundra (HT) had a diversity of forages with avens, lichen, and sedge being the most common. All other forages occurred in >20% of the plots in these habitats except horsetail, which was absent. Lichen was more commonly found in UB than HT, whereas avens and willow were more commonly found in HT than UB. Stony barren is the most sparsely vegetated habitat with lichen, avens, saxifrage, and sedge being the most common forages. There were some site differences ($P<0.05$) in percent frequency occurrence of specific forages in habitats. Variation in the topography and physical environment are likely the cause of the specific differences, and represent natural variation found within habitat types.

TABLE OF CONTENTS

LIST OF FIGURES

INTRODUCTION

In 1994, the muskox population on Banks Island was at a historic high, estimated at *ca.* 65,000 (≥1 year-olds). Conversely, the Peary caribou population was at historic low numbers, estimated at *ca.* 700 (≥1 year-olds; Nagy *et al.* 1996). There has been continued debate as to whether or not competition for food between muskoxen and Peary caribou has been a factor in the decline of Peary caribou numbers on Banks Island (see Nagy *et al.* 1996). Studies conducted in the early 1970's, when the populations were estimated to be *ca.* 12,000 Peary caribou and *ca.* 4,000 muskoxen (Urquhart 1973), concluded that there was no competition for food (Wilkinson and Shank 1973; Wilkinson *et al.* 1976; Vincent and Gunn 1981). However, with the population estimates of the late 1980's and early 1990's, there was renewed local concern that competition for food with muskoxen was a factor in declining caribou numbers. A reanalysis of the historic data of Wilkinson *et al.* (1976) and Shank *et al.* (1978) by Larter and Nagy (1997) found seasonal similarities in the diet of muskoxen and Peary caribou during the early 1970's and their preliminary work (1993-1995) on monthly diets of muskoxen and Peary caribou on Banks Island found considerable similarity in diet between the two herbivores during certain times of the year.

Similarity in diet alone does not mean that competition for food is occurring. Knowledge of forage availability is an integral requirement for documenting competition for food (Klein and Staaland 1984; Gunn 1990), and in previous studies has been limited (Larter and Nagy 1997). In response to concerns voiced by local residents in Sachs Harbour, a comprehensive range study on Banks Island was initiated in 1993. One of the goals of the study was to collect data to better assess the issue of competition for food between Banks Island herbivores. Therefore, an important component of this study was to address forage availability including the distribution, quality, and seasonality of forages available for herbivores on Banks Island.

Descriptions of the flora of Banks Island have been made previously and four major habitat types have been described (Kevan 1974; Wilkinson *et al.* 1976; Zoltai *et al.* 1980; Ferguson 1991): wet sedge meadow, upland barren, hummock tundra, and stony barren. However, quantitative data were limited. One goal of the five-year range study was to quantify the frequency of occurrence of various forages within the four habitat types to address forage distribution and relate this back to the monthly diets of muskox and Peary caribou. Because rolling upland habitats were believed to be important foraging habitats for caribou (Parker 1978; Vincent and Gunn 1981; Larter and Nagy 1997) we wanted to compare forage distribution between upland barren and hummock tundra habitats. Also different snow conditions in these habitats affects forage availability during winter (Larter and Nagy 2000; 2001b). In this report we deal with one aspect of forage availability, the frequency of occurrence and distribution of forages among habitats. Other aspects of forage availability for herbivores on Banks Island have and will be reported elsewhere (Larter and Nagy 2001a; Larter *et al.* accepted).

METHODS

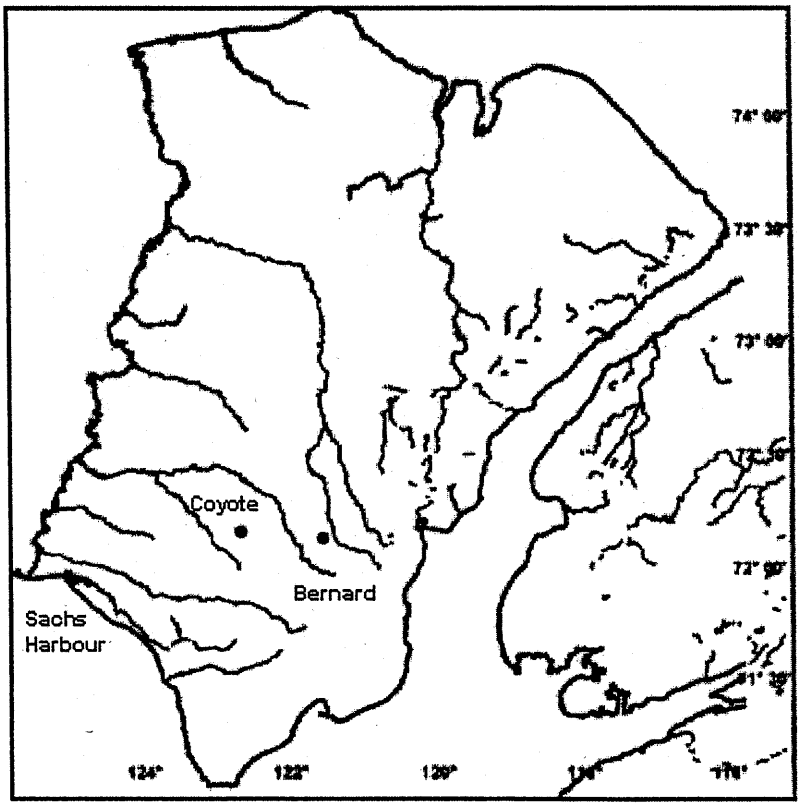
General Habitat Descriptions

Wet sedge meadows (WSM) are generally level hydric and hygric lowlands. Sedges (*Carex aquatilis* and *Eriophorum scheuchzeri*) predominate with vegetative cover of up to 100% except for standing water. Upland barrens (UB) are well drained sites found on the upper and middle parts of slopes. Vegetative cover is 20-50% and is dominated by dwarf shrubs and low growing flowers. Hummock tundra (HT) is found on moderately steep slopes and is characterized by individual hummocks which are vegetated primarily by dwarf shrubs and low growing flowers; vegetative cover is 35-50%. Stony barrens (SB) have a coarse gravely substrate and are found predominantly on wind blown areas, ridges, and gravel and sand bars; vegetation is sparse (<10% vegetative cover).

Data Collection

Patches of the 4 habitats described above were located at two study sites on south-central Banks Island (Fig. 1). Camp Coyote is located *ca*. 90km ENE of Sachs Harbour in an area of high muskox density (1.6-1.9 muskox/km^2) and Camp Bernard is located *ca*. 130km ENE of Sachs Harbour in an area of low muskox density (0.3-0.4 muskox/km^2). In each habitat patch, we established two or three fixed line transects. Individual transect lengths were dependent upon the dimensions of the habitat patches, and they ranged from 100-500m. Each habitat patch at each site was visited 3 times every summer for 5 summers (1993-1997) at the: 1) start of the growing season (12-20 June), 2) peak of the growing season (16-22 July) and, 3) senescence before snow cover (18-28 August).

Figure 1. Banks Island and the two study sites, Camp Coyote and Bernard.



During each visit, 10 plots of $0.125m^2$ (following Wein and Rencz 1976) were assigned to the transects. Plots were assigned systematically along each transect after the initial plot was chosen at random. Because this study was running in conjunction with a study that required destructive clipping of plots, no duplication of plot assignments over the course of the study was allowed. During summer 1993, an additional field trip in early August allowed us to collect data from each habitat. This proved to be fortuitous because inclement weather in late-August, 1993 prevented us from collecting data in HT and SB. Similarly, inclement weather in August 1997 prevented us from recording data in HT and SB from the Bernard study site.

At each plot we recorded the presence of 10 classes of forage: sedge (mainly *Carex* spp.), willow (*Salix arctica*), grass (Poaceae), ericaceous shrub (mainly *Cassiope tetragona*), lichen, legume (*Astragalus* spp., and *Oxytropis* spp.), avens (*Dryas integrifolia*), saxifrage (*Saxifraga* spp.), horsetail (*Equisetum* spp.), and other forbs. A separate study measured the aboveground standing crop of forage and those results will be reported elsewhere.

Statistical Analyses

We used a presence/absence method to assess forage distribution among habitats. We tallied the number of times a plant from a particular forage class occurred in a plot for each habitat and site combination (range 170-192 plots/habitat). Data were pooled over years and reported as proportions. Because ericads were recorded in only 5 of 1474 plots, they were pooled with the "other forbs" category for the analyses. We used a 2-tailed proportion test, with α=0.05 (Zar 1999) to compare the proportion of plots containing the various forages between areas. Although there were significant site differences in the proportion of plots containing some forage types, the overall distribution of forage types within habitats was similar. Therefore, we treated each site as a different sample from within a habitat and pooled the data before comparing proportions of plots containing various forages between upland barren and hummock tundra habitats.

RESULTS

Over the 5-year study we visited all of the possible 192 plots/habitat patch for WSM and UB. We visited 180 plots each in HT and SB at the Coyote site and 170 and 176 plots each in HT and SB, respectively, at the Bernard site.

WSM was dominated by sedges, however horsetail, willow, avens, and other forbs were also relatively common. Forage types found in WSM were similar between sites, but horsetail and other forbs were more commonly ($P<0.05$) found in WSM at Coyote (Fig. 2).

UB had a diversity of forage types with sedge, lichen, and avens being the most common. Willow, grass, legume, saxifrages and other forbs were also present. Legume, grass, willow, and sedge were more commonly ($P<0.05$) found in UB at Coyote, while saxifrage was more common ($P<0.05$) in UB at Bernard (Fig. 2).

HT had a diversity of forage types similar to UB with sedge, lichen and avens being the most common forages. Willow, grass, legume, saxifrage, and other forbs were also. Sedge, grass, legume, and saxifrage were more commonly ($P<0.05$) found in HT at Coyote, while willow and lichen were more common ($P<0.05$) at Bernard (Fig. 2). Willow and avens were more commonly ($P<0.05$) found in HT than UB while the converse was true for lichen (Fig. 3).

Vegetation in SB was dominated by lichen, avens, saxifrage, and sedge; other forbs and grass were less common. Sedge, avens, and willow were more commonly ($P<0.05$) found in SB at Coyote; grass and other forbs were more common ($P<0.05$) at Bernard (Fig. 2).

Figure 2. Percent frequency occurrence of the different forage classes in the four major terrestrial habitats of Banks Island: wet sedge meadow (WSM), upland barren (UB), hummock tundra (HT), and stony barren (SB). * indicates significant differences in proportions between the two study sites.

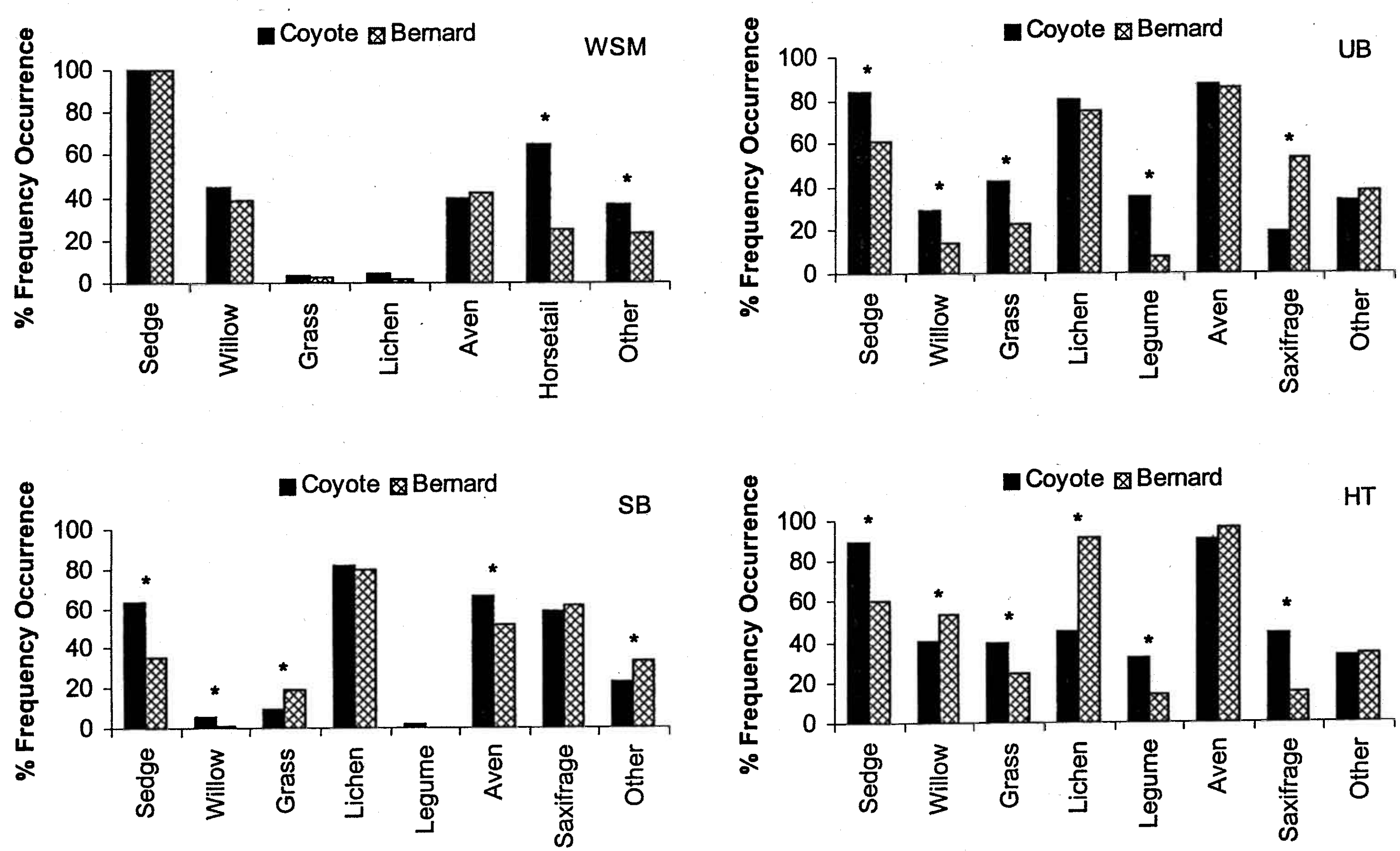
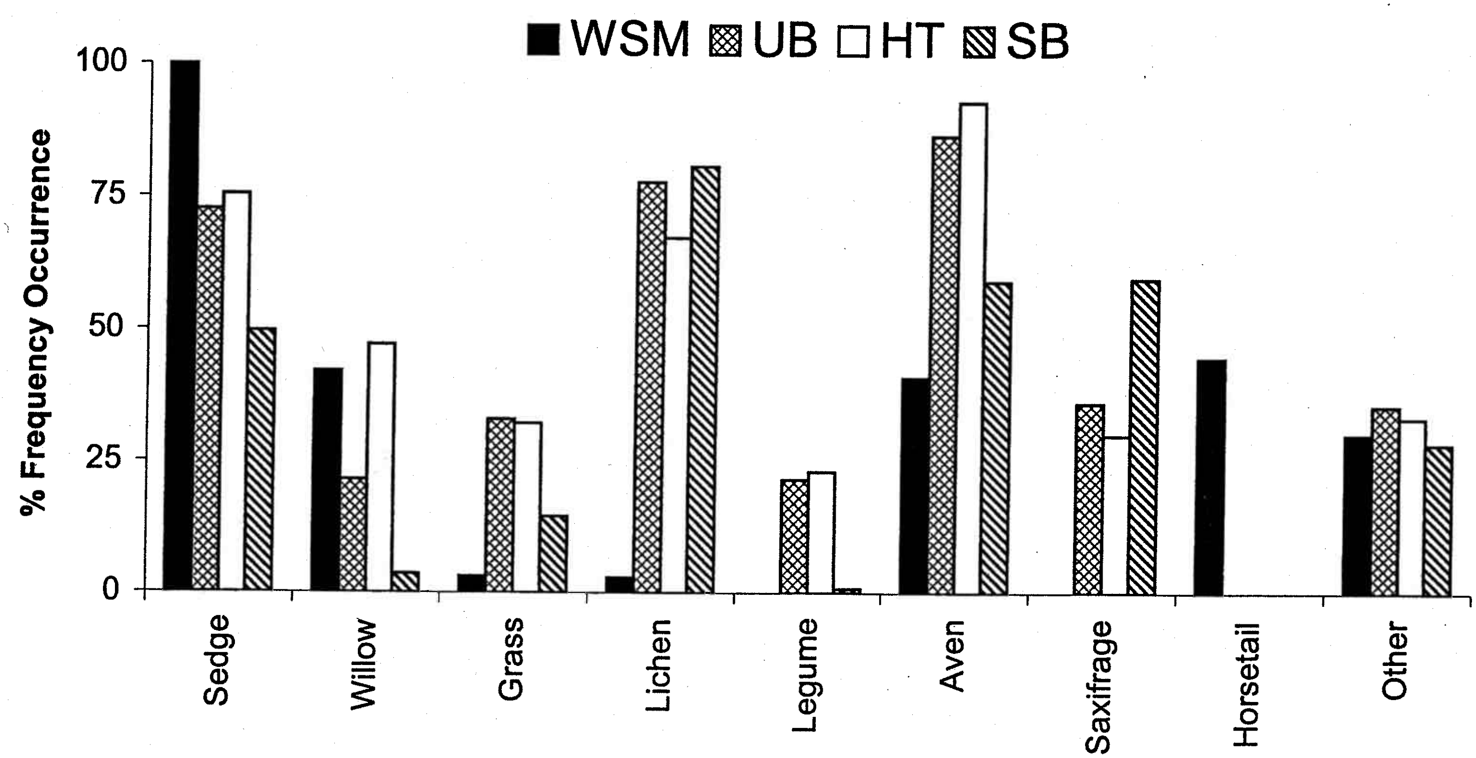


Figure 3. Percent frequency occurrence of the different forage classes in the four major terrestrial habitats of Banks Island: wet sedge meadow (WSM), upland barren (UB), hummock tundra (HT), and stony barren (SB). Data are pooled across sites.



DISCUSSION

Sedge and avens were the most commonly found forages over all habitats, while lichen was present in *ca.* 75% of plots in all upland habitats (Fig. 3). Although lichen was frequently found in upland habitats substantial lichen mats were non-existent. More often small fragments of *Cladina* spp., *Cladonia* spp., *Cetraria* spp. or *Thamnolia subuliformis* were present. We expected sedge (*Carex aquatilis*) to be the predominant forage in wet sedge meadows, but we did not expect such a high occurrence of sedge (unidentified *Carex* spp.) in the upland habitats. Sedge was the most common monocot of upland habitats. Although willow (*Salix arctica*) is often associated with more mesic habitats, willow was fairly commonly found in wet sedge meadows (*ca.* 40% of plots).

The distribution, amount, and quality of forages are integral components in assessing food competition. In the High Arctic, where vegetation is usually sparse and widely distributed, attention must be paid to sampling protocols used to describe vegetation characteristics. We used rectangular shaped plots, following Wein and Rencz 1976, to get the best representation of plant communities, and pooled data collected across years in order to maximize sample size. It is unlikely that changes in natality or mortality of individual plants, or a directional shift in plant distribution over this 5-year period had any effect on our results from upland habitats.

Changes in grazing pressure exerted by erupting ungulate populations have been shown to modify forage availability through changes in species composition (Caughley 1970; McNaughton 1979; Henry *et al.* 1986) and it could be argued that because wet sedge meadow habitat is predominantly used by muskox, pooling data across years for wet sedge meadow habitat was inappropriate and affected our results. Although muskox numbers were at historic high levels during the study, the greatest increase in muskox numbers had occurred during the mid to late-1980's.

Smith (1996) found no change in plant species composition in wet sedge meadows of northern Banks Island resulting from grazing by high densities of muskox (1.8 muskox/km^2). In this study we were looking at types of forages, not individual plant species, therefore we do not believe that pooling the data affected our results for wet sedge meadow habitat.

As in other studies describing High Arctic wet sedge meadows (Muc 1977; Ferguson 1991; Henry and Svoboda 1994; Thomas *et al.*1999), we found sedge the dominant forage; it was present in all 384 plots visited. Henry and Svoboda (1994) reported that dwarf shrubs (*Salix arctica* and *Dryas integrifolia*) were more prominent in meadows where grazers had been historically absent than in grazed wet sedge medows. We found no differences in occurrence of these plants between the two sites which had been exposed to grazing by different densities of muskox.

Oakes *et al.* (1992) documented the presence of plant species in "dicot habitat" of northern Banks Island. This habitat lumped what we have called hummock tundra, upland and stony barren habitats together. They found monocots (grass) and *Salix* spp. in the majority of 180 plots sampled; other forbs and *Dryas integrifolia* were also common. Similarly, we found other forbs and *Dryas integrifolia* commonly occurred. Contrastingly, we found *Salix* spp. in <50% of the plots sampled, and sedge, not grass, was the dominant monocot in the habitats we sampled on southern Banks Island. In a separate study, Larter and Nagy (unpubl. data) found sedge as the dominant monocot in upland barren habitat through the southern two thirds of Banks Island, but grass was the dominant monocot in upland barren habitat in the north-western part of the island.

The site differences in plant composition we report are likely more related to differences in topography like slope, aspect and moisture regime rather than herbivory (Smith 1996). The Bernard site is situated to the east of Big River where the topographic features run in a more north-south direction. The topographic features to the east of Big River run in a more NW-SE direction. Therefore, these data include natural variation in species composition found within these habitats.

It must be stressed that these data represent the presence and frequency of occurrence of various forage classes in four different habitats, not the biomass of aboveground forage or percent cover as reported elsewhere. Forages may commonly occur but may represent minimal biomass. Lichen occurred in all habitats and was frequently found in plots in upland habitats, but its estimated biomass was $<3 g/m^2$ (Larter and Nagy 1997). Conversely, legumes occurred in $<25\%$ of plots in upland habitats but have over twice the estimated biomass.

Quantitative measures of plant distribution, although important in helping address forage availability, require additional information on the amounts of different plants (aboveground standing crop), and the quality of these plants before thorough assessments of forage availability in these habitats can be made. Data on forage quality have already been reported for Banks Island (Larter and Nagy 2001a; Larter *et al.* accepted), and data on aboveground standing crop have been collected (N. Larter and J. Nagy unpubl. data). As well, diet composition of muskox and caribou has been reported for Banks Island (Larter and Nagy 1997; unpubl. data). By incorporating the monthly diet data with the distribution and availability of various forage classes on Banks Island, issues like food competition and carrying capacity can be addressed.

RECOMMENDATIONS

1) Integrate these data with the data on aboveground standing crop and forage quality to estimate seasonal availability of crude protein for these habitat types.

2) When additional information on habitat classification and availability become available, update estimates of the seasonal availability of crude protein, map seasonal changes, and derive estimates of food availability for herbivores.

3) Once estimates of forage availability have been derived, combine with monthly diet data to assess carrying capacity and competition for forage between muskox and caribou.

ACKNOWLEDGMENTS

We thank Andrew Esau, Darren Nasogaluak, Les Raddi, Tony Raddi, and Dwayne Semple for assistance in collecting field data. Donna Goose and Chris Kuhnert assisted with data entry. We thank the community of Sachs Harbour for its support of Banks Island Range Study. Mark O'Donoghue provided comments on earlier drafts of this report. Funding for this project was made possible through the Inuvialuit Final Agreement.

LITERATURE CITED

Caughley, G. 1970. Eruption of ungulate populations, with emphasis on Himalayan thar in New Zealand. Ecology 51: 53-72.

Ferguson, R.S. 1991. Detection and classification of muskox habitat on Banks Island, Northwest Territories, canada, using landsat thematic mapper data. Arctic 44: 66-74.

Gunn, A. 1990. Status of muskox populations in Canada. *In*: Holst. B. (Ed.). *International studbook for muskox* (*Ovibos moschatus*). Copenhagen Zoo, Copenhagen, pp 49-72.

Henry, G.H.R., Freedman, B. and Svoboda, J. 1986. Survey of vegetated areas and muskox populations in east-central Ellesmere Island. Arctic 39:78-81.

Henry, G.H.R. and Svoboda, J. 1994. Comparisons of grazed and non-grazed high-arctic sedge meadows. *In*: Svoboda, J. and Freedman, B. (Eds.). *Ecology of a Polar Oasis*. Captus Univ. Publ., Toronto, pp. 193-194.

Kevan, P.G. 1974. Peary caribou and muskoxen on Banks Island. Arctic 27: 256-264.

Klein, D.R. and Staaland, H. 1984. Extinction of Svalbard muskoxen through competitive exclusion: An hypothesis. Biol. Pap. Univ. Alaska Spec. Rep. 4: 26-31.

Larter, N.C. and Nagy, J.A. 1997. Peary caribou, muskoxen and Banks island forage: assessing seasonal diet similarities. Rangifer 17: 9-16.

Larter, N.C. and Nagy, J.A. 2000. Annual and seasonal differences in snow depth, density, and resistance in four habitats on southern Banks Island, 1993-1998. Gov. N.W.T., Dept. Res. Wildl. Econ. Dev. Ms. Rep. No. 136, Yellowknife.

Larter, N.C. and Nagy, J.A. 2001a. Seasonal and annual variability in the quality of important forage plants found on Banks Island, Canadian High Arctic. Appl. Veg. Sci. 4: 115-128.

Larter, N.C. and Nagy, J.A. 2001b. Variation between snow conditions at Peary caribou and muskox feeding sites and elsewhere in foraging habitats on Banks island in the Canadian High Arctic. Arct. Antarct. Alp. Res. 33: 123-130.

Larter, N.C., Nagy, J.A. and Hik, D.S. accepted. Does seasonal variation in forage quality influence the potential for resource competition between muskoxen and Peary caribou on Banks Island? Rangifer.

McNaughton, S.J. 1979. Grassland-herbivore dynamics. *In*: Sinclair, A.R.E. and Norton-Griffiths, M. (Eds.) *Serengeti: dynamics of an ecosystem*. Univ. Chicago Press, Chicago, pp. 46-82.

Muc, M. 1977. Ecology and primary production of sedge-moss meadow communities, Truelove Lowland. *In*: Bliss, L.C. (Ed.). *Truelove lowland Devon Island, Canada: A high-arctic ecosystem*. Univ. of Alberta Press, Edmonton, pp. 157-184.

Nagy, J.A., Larter, N.C. and Fraser, V.P. 1996. Population demography of Peary caribou and muskox on Banks Island, N.W.T., 1982-1992. Rangifer 9: 213-222.

Oakes, E.J., Harmsen, R. and Eberl, C. 1992. Sex, age and seasonal differences in the diets and activity budgets of muskoxen (*Ovibos moschatus*). Can. J. Zool. 70: 605-616.

Parker, G.R. 1978. The diets of muskoxen and Peary caribou on some islands in the Canadian High Arctic. Canadian Wildlife Service Occ. Pap. No. 35.

Porsild, A.E. and Cody, W.J. 1980. *The vascular plants of continental Northwest Territories, Canada*. National Museum of Canada, Ottawa. 667pp.

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

Smith, D.L. 1996. *Muskoxen/sedge meadow interactions, North-Central Banks Island, Northwest Territories, Canada*. PhD. thesis, Univ. of Saskatchewan, Saskatoon.

Thomas, D.C., Edmonds, E.J. and Armbruster, H.J. 1999. Range types and their relative use by Peary caribou and muskoxen on Melville Island, N.W.T. Tech. Rep. Ser. No. 343, Canadian Wildlife Service, Edmonton. 146pp.

Urquhart, D.H. 1973. *Oil exploration and Banks Island wildlife*. Unpubl. N.W.T. Wildlife Service Report, Yellowknife. 105pp.

Vincent, D. and Gunn, A. 1981. Population increase of muskoxen on Banks Island and implications for competition with Peary caribou. Arctic 34: 175-179.

Wein, R.W. and Rencz, A.N. 1976. Plant cover and standing crop sampling procedures for the Canadian high arctic. Arct. Apl. Res. 8: 139-150.

Wilkinson, P.F. and Shank, C.C. 1973. The range-relationships of muskoxen and caribou in Northern Banks Island in Summer 1973: A study of interspecies competition. Unpubl. Rep. G.N.W.T. Dept. of Economic Development, Game Management Division, Yellowknife. 749pp.

Wilkinson, P.F., Shank, C.C. and Penner, D.F. 1976. Muskox-caribou summer range relations on Banks Island, N.W.T. J. Wildl. Manage. 40: 151-162.

Zar, J.H. 1999. *Biostatistical analysis 4th edition*. Prentice-Hall, Inc., Englewood Hills, New Jersey. 718pp.

Zoltai, S.C., Karasiuk, D.J. and Scotter, G.W. 1980. *A natural resource survey of the Thomsen River area, Banks Island, Northwest Territories*. Canadian Parks Service, Ottawa. 153pp.