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Vegetation biomass and habitat selection by a newly introduced population of muskoxen in northern Québec

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Abstract: Ground coverage by woody and herbaceous plant species and standing biomass of vegetation susceptible to being grazed upon were estimated in a 156 km^2 area where 190 muskoxen were censused during the preceding autumn. Habitat use was estimated with droppings census. Six terrestrial habitat types were delineated on 1:32 000 aerial photographs and randomly sampled: low shrub on xeric sites (LSX; 64 km^2), low shrub on mesic sites (LSM; 45 km^2), bare ground (BG; 27 km^2), forest-tundra (FT; 12 km^2), wet meadow (WM; 2 km^2) and riparian willows (RW; 1 km^2). Dominant plant species varied greatly between habitat types, and only a few such as *Betula glandulosa, Salix arctophila,* and *Polygonum viviparum* were common. Tall shrubs were present only in RW where they covered most of the ground, and in FT. Low shrubs were uniformly distributed and covered 18-32 % of the ground, with the exception of RW (5 %). Ground cover by herbs had a similar range (i.e. 20-37 %), except in RW where the mean exceeded 50 %. Mosses and lichens occupied about half of the ground everywhere. Phytomass exhibited great variation within and between habitat types; extreme values averaged 892 kg•ha^{-1} in LSX, and 1965 kg•ha^{-1} in LSM. However the difference was not significant due to limited sample size and within habitat variance. Nevertheless the mass of herbaceous dicots was greater in RW than in any other habitat type. Total phytomass was 2-20 times greater in northern Québec than in Greenland. Based on droppings density, muskoxen preferred RW over BG and FT, and LSX over BG. Although the density of muskoxen in the study area was high relative to other muskox ranges, habitat quality and quantity should allow continued population growth.

Key words: forage, introduction, muskox, Ovibos, Canada

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Introduction

After the last glaciation, the muskox (*Ovibos* spp.) apparently did not colonize the Québec-Labrador peninsula as no remains have been found at archaeological sites (Banfield 1975), or in other deposits. Fifteen muskoxen (*O. moschatus*) were brought from Ellesmere Island to northern Québec near Kuujjuaq (Fig. 1) in 1967 for the Inuit to establish a muskox farm (Wilkinson and Teal 1984). The interest in farming

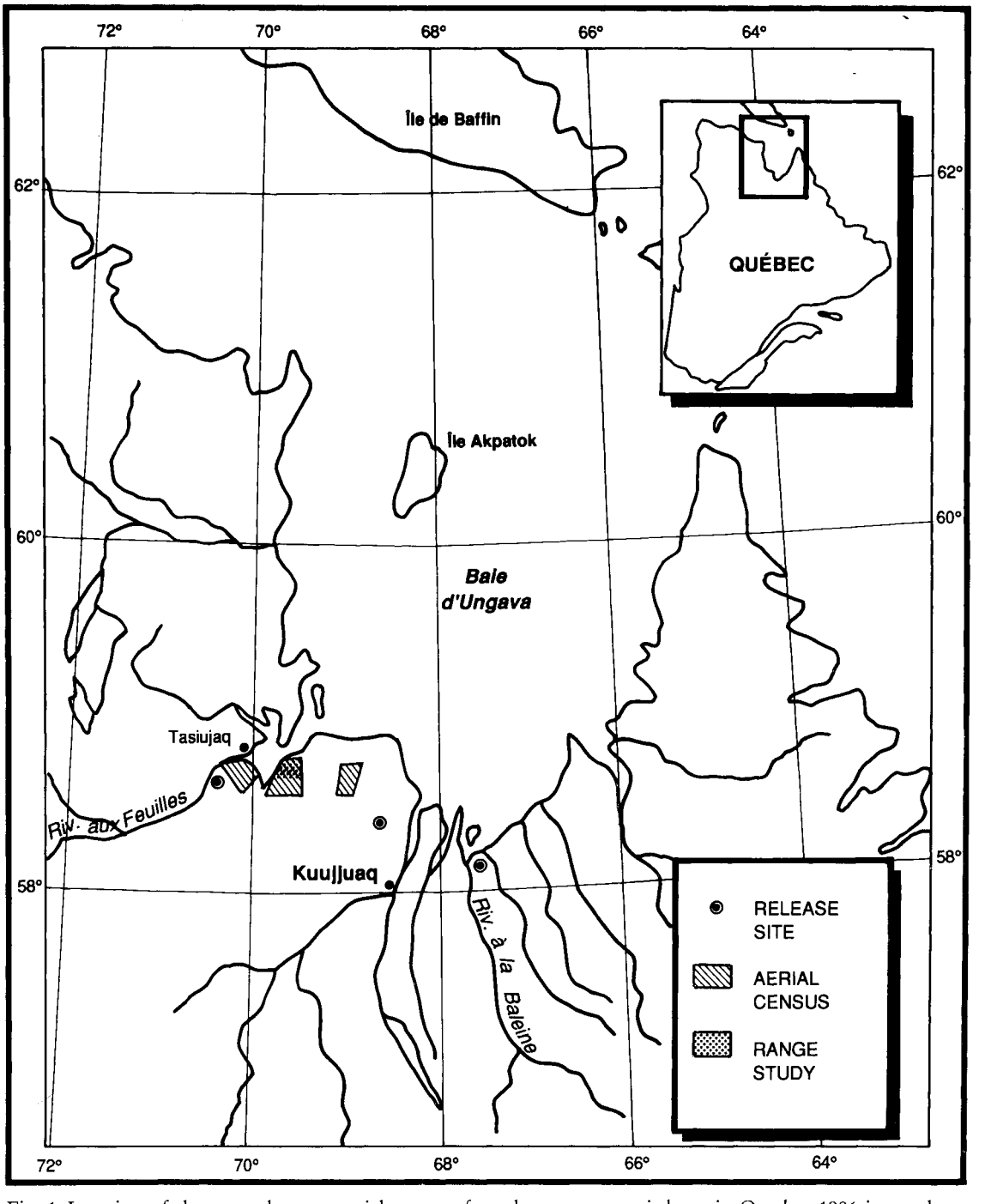

Fig. 1. Location of the area where an aerial census of muskoxen was carried out in October 1986 in northern Québec, and area where range studies were concentrated.

progressively faded, and the farm was closed in 1983. Meanwhile, 54 animals were released at three locations in northern Québec (Fig. 1), most being immatures (Le Hénaff 1985; Le Hénaff and Crête 1989). The introduction was successful and the population expanded rapidly: the finite rate of increase reached 1.25 between 1983 and 1986 (Le Hénaff and Crête 1989).

The muskoxen became firmly established in three adjacent areas located northwest of Kuuj-

juaq (Fig. 1). In the summer of 1987, we conducted a preliminary habitat survey in an 156 km^2 area where utilization was seemingly high: muskoxen were observed there during all eight aerial censuses carried out between 1983 and 1986 (Nault and Mathieu 1989).

Study area

The study area (156 km^2) is located southwest of Ungava Bay, at about 59° N (Fig. 1). Mean daily minimum and maximum air temperature are -29°C and -18°C respectively in January, and 4°C and 15°C respectively in July. The growing season lasts 40–60 days, with 600°•days above 5°C. Total annual precipitation averages 410 mm, 40–45 % of which fall as snow (Côté and Dufour 1983). The topography is broken by many ridges and valleys, with the maximum elevation reaching 150 m ASL. The bedrock is of volcanic and sedimentary origins in the west, and is granitic in the east (Sauvé 1959). The study area includes the northern limit of the forests which are present in few places in the south and cover only 12 km^2 (Payette 1983).

Muskoxen were not released in the study area, and the date of their arrival remains unknown. In 1983, 68 animals were censused in the area, as compared to 190 in the autumn of 1986.

Methods

The 156 km^2 area was stratified into six terrestrial habitat types using black and white aerial photographs (scale = 1:32 000), coupled with validation by aerial survey. The habitat types were: low shrubs on xeric sites (LSX; 64 km^2); low shrubs on mesic sites (LSM; 45 km^2); bare ground (BG; 27 km^2); forest-tundra (FT; 12 km^2); wet meadow (WM; 2 km^2); and riparian willows (RW; 1 km^2). Water bodies covered 5 km^2.

In early August 1987, 20 vegetation sampling plots were randomly distributed over the study area: LSX = 7; LSM = 5; BG = 1; FT = 2; WM = 3; RW = 2. Vegetation census was performed according to Braun-Blanquet's abundance-dominance scale (Mueller-Dombois and Ellenberg 1974). Circular plot sizes varied with vegetation height when estimating ground cover: 25 m^2 for trees, 7 or 3 m^2 for tall shrubs and 1 m^2 for low shrubs, herbs, mosses and lichens. Plant taxonomy followed Porsild and Cody (1980) for vascular plants, Thompson (1984) for lichens and Crum (1983) and Nyholm (1954–1963) for mosses. Phytomass of herbaceous dicot, herbaceous monocot, leaves and current year twigs of shrubs was estimated in 1 m^2 plots. Plants were clipped, oven-dried and weighed.

Density of all muskox droppings (dormant and growing seasons combined) was estimated using 38 circular plots (radius = 5 m) distributed at random and including 80 % of the vegetation sampling plots.

Variation in vegetation characteristics or droppings density between habitat types was tested with one-way ANOVA. Paired comparisons of habitat types and standard errors of means were estimated with LSMEANS statement (SAS Institute Inc. 1985).

Results

We identified 122 taxa in our 20 sampling plots: tree = 2, shrub = 18, herbaceous species = 77, lichens = 7 and bryophytes = 18 (Nault and Mathieu 1989). Although the small sample size does not allow us to describe the differences between habitat types for all plant species, the most common species, especially herbs, mosses and lichens, did differ markedly between habitat types. Only 3 species were common in 3 habitat types: *Betula glandulosa, Salix arctophila* and *Polygonum viviparum* (Table 1). Three other shrub species, three herbs and three mosses and lichens were common in two habitats types each (Table 1); all others were common in only one habitat.

Percent ground cover was relatively homogenous between all habitat types for both low shrubs, and mosses and lichens (Table 2). Tall shrubs were present in RW and FT only, and were significantly ($P < 0.0001$) more abundant in RW than in FT. Herbs were significantly ($P < 0.047$) more abundant in RW than in FT, LSM, and LSX.

Phytomass exhibited much variation between and within habitat types (Table 3). As a result, differences between types were not significant for total biomass ($P = 0.38$), leaves and twigs biomass ($P = 0.40$), and monocot biomass ($P = 0.69$). However, the mass of herbaceous dicots in RW significantly ($P < 0.022$), exceeded that of all other habitat types. Leaves and twigs of

Table 1. Relative importance of the commonest plant species (1=the most abundant) per height stratum according to habitat type in a 156-km^2 area of northern Québec where muskoxen were successfully introduced, August 1987.

	Low shrub xeric	Low shrub mesic	Forest tundra	Wet meadow	Riparian willow
Trees					
Larix laricina			1		
Picea mariana			2		
Shrubs					
Salix uva-ursi	1				
Salix herbacaea	2				3
Vaccinium uliginosum	3			2	
Betula glandulosa		1	1		2
Salix arctophila		2	2	1	
Rhododendron lapponicum		3			
Salix planifolia			3		1
Vaccinium vitis-idaea				3	
Herbs					
Carex rupestris	1				
Luzula confusa	2				
Polygonum viviparum	3	2		1	
Carex bigelowi		1			3
Carex rariflora		3		2	
Carex aquatilis			2		
Solidago macrophylla			1		2
Rubus acaulis			3		1
Eriophorum spissum				3	
Mosses and lichens					
Cladina rangiferina	1	2			
Hylocomium spendens	2				
Bryum longisetum	3				
Ochrolecia frigida	3	1			
Sphagnum rubellum	2	3			
Pleurozium schreberi			1		
Meesia triqueta			3		
Dicranum groenlandicum				1	
Catoscopium migritum				2	
Rhacomitrium lanuginosum				3	
Aulacomnium palustre					1
Polytrichum strictum					2
Brachythecium sp.					3

shrubs made up more than half of the available phytomass in all types except in WM where monocots dominated. Total dry phytomass, excluding bryophytes and lichens, averaged between 892 and 1965 kg·ha^{-1} according to habitat types, but estimates were imprecise due to high variability and small sample size.

Droppings densities varied significantly (P = 0.05) between habitat types. RW appeared to be a preferred habitat, LSX and LSM were mode-

Table 2. Average percent (SE) ground cover by vegetation per height stratum for five habitat types used by muskoxen in a 156 km^2 area of northern Québec where the species was successfully introduced, August 1987.

	Low shrub xeric	Low shrub mesic	Forest tundra	Wet meadow	Riparian willow
Trees	0	0	38 (38)	0	0
Tall shrubs	0	0	13 (6)	0	80 (6)
Low shrubs	24 (6)	32 (7)	25 (11)	18 (9)	5 (11)
Herbs	20 (6)	22 (7)	20 (11)	37 (9)	55 (11)
Mosses & lichens	56 (7)	46 (8)	55 (12)	45 (10)	40 (13)

Table 3. Average (SE) dry standing biomass ($kg \cdot ha^{-1}$) of vegetation per plant category for five habitat types used by muskoxen in a 156 km^2 area of northern Québec where the species was successfully introduced, August 1987.

	Low shrub xeric	Low shrub mesic	Forest tundra	Wet meadow	Riparian willow
Leaves and twigs[a] of shrubs	653 (281)	1218 (333)	873 (526)	253 (430)	260 (526)
Herbaceous dicot	92 (44)	34 (52)	68 (83)	15 (67)	370 (83)
Herbaceou monocot	147 (265)	713 (314)	373 (497)	661 (405)	363 (497)
Total biomass	892 (350)	1965 (414)	1314 (655)	929 (535)	993 (655)

[a] Current year growth only.

rately used, and BG and FT were used least by muskoxen (Table 4). Paired comparisons revealed that RW was preferred over BG ($P = 0.01$) and FT ($P = 0.02$), and LSX over BG ($P = 0.05$). Significant differences ($P > 0.05$) were not found between the most used habitat, RW and the moderately used ones, LSX and LSM.

Table 4. Average density ($number \cdot ha^{-1}$) of muskox droppings per habitat type in a 156-km^2 area of northern Québec where the species was successfully introduced, August 1987.

	Low shrub xeric (LSX)	Low shrub mesic (LSM)	Forest tundra (FT)	Riparian willow (RW)	Bare ground (BG)
Mean	573	531	96	987	0
SE; n	135;14	146;12	254;4	254;4	254;4
Different from ($P < 0.05$)	BG	-	RW	BG/FT	RW/LSX

Discussion

The study areas is located at the southern limit of muskox distribution (Klein 1986), and environmental conditions are relatively favorable for the vegetation on which this mammalian species feeds. Compared to northern Greenland (Klein and Bay 1990), the number of degree•days during the growing season is much higher in our study area, which is reflected in greater plant diversity and phytomass. Overall dry standing biomass (including only current year woody tissues) averaged 1087 kg•ha^{-1} (SE = 200; n = 20) in the study area, which exceeds the most productive habitat of northern Greenland i.e. 398 kg•ha^{-1} (Klein and Bay 1990). Comparison with other study areas is difficult due to the use of different methods (Bliss 1986; Thing *et al.* 1987).

We did not determine the feeding habits of the animals, but based on our limited droppings census, muskoxen apparently are selecting habitats similar to elsewhere at the southern end of the species range. The diet in similar areas is dominated by willows during summer, and willows remain an important component of winter forage; riparian vegetation appears to be the preferred habitat (Klein 1986). In winter our animals probably select wind-exposed LSX and LSM as they do in east-central Greenland (Thing *et al.* 1987.).

Muskox density can reach or slightly exceed 1 animal • km^2 of suitable habitats in Greenland (Lassen 1984; Thing *et al.* 1987) and in the Canadian Arctic Archipelago (Thomas *et al.* 1981, Bliss 1986). In our study area the density was 1.2 individuals • km^2 in October 1986. Despite the comparatively high density of muskoxen, we conclude that muskox habitat is of good quality and of sufficient quantity in northern Québec. Although the 1986 density may have been high enough for the animals to affect the vegetation, we think that sufficient areas of similar habitats are seemingly available to allow continued population growth for the foreseeable future.

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