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Rapid population increase in an introduced muskox population, West Greenland

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Abstract: In 1962 and 1965, 27 (13 and 14) muskox yearlings were translocated from East Greenland (71°N) to the Angujaartorfiup Nunaa range in West Greenland (67°N). Angujaartorfiup Nunaa is a 6.600 km^2 icefree, continental area where caribou are indigenous. The climate is strictly continental with a minimum of precipitation but with abundant vegetation. Aerial surveys in 1990 documented that the muskox population has increased to 2600 heads despite quota-based harvesting since 1988. The annual quota was 200, 300 and 400 for 1988, 1989 and 1990, respectively. Distribution of muskoxen shows a significant preference for low altitude habitats southeast of Kangerlussuaq Airport and around Arnangarnup Qoorua (Paradise valley). Annual population increment averages 30 % and the calf crop is around 24 % of the population. Yearling recruitment in the population reveals that calf mortality during winter is very limited. About half of the 1-year-old females are served and they eventually give birth to their first calf when they turn 2 years old. With half of the 2-year-old females reproducing, the calf/cow ration ranges between 0.9 and 1.0.

Key words: Introduction, populations, population dynamics

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Introduction

In 1962 and 1965 a total of 27 (13 and 14) muskoxen were introduced into Angujaartorfiup Nunaa (AN), West Greenland. The animals had been caught as 3-month-old calves in East Greenland, spent the winter in Copenhagen Zoo, and were released as yearlings in AN. The objective of this translocation was twofold; firstly, founding a new stable meat resource for the West Greenland Inuit hunters, and secondly, safeguarding the muskox against extinction in Greenland by securing a «reserve» population in West Greenland should the indigenous muskoxen of Northeast and North Greenland perish.

Caribou are indigenous to West Greenland and at the time of the muskox release the population was increasing rapidly, shortly thereafter to reach a peak of c. 30.000 (Thing, 1984; Meldgaard, 1986).

Study area

Angujaartorfiup Nunaa (AN) is a 6.600 km^2 large inland area situated south of Kangerlussuaq (66°15′ N–67°N) in the low Arctic part of West Greenland (Fig. 1). The Inland Ice and the glacier Maniitsup Sermia surround AN to the east, south, and west; Kangerlussuaq fiord to the north leaves only a narrow channel to the northeast of the airport through which corridor immigration and emigration can occur. The northeastern part of AN consists of low vegetated mountains and lowlands with a very high

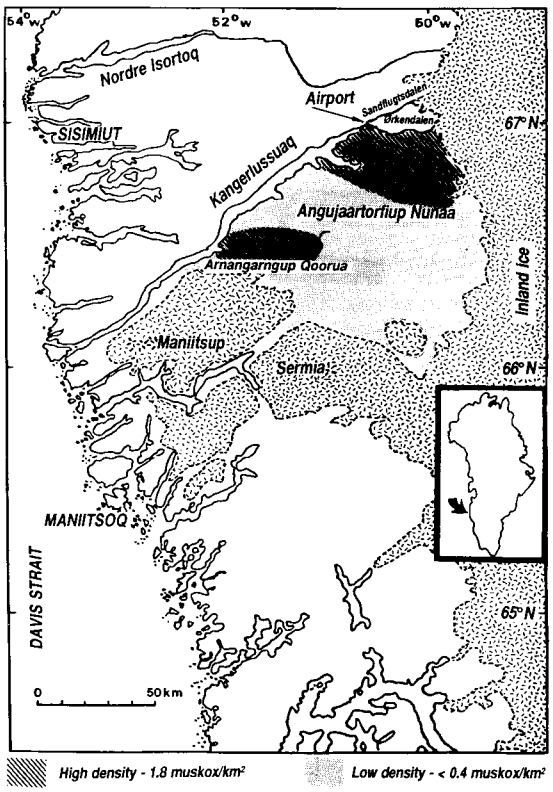

Fig. 1. Location of the study area and distribution of muskoxen in Angujaartorfiup Nunaa.

plant production; several broad east-west orientated valleys hold large brailed rivers feeding melt water from the Inland Ice to Kangerlussuaq fiord. Towards the southwest the terrain reaches elevations up to 1200 m above sea level. The climate is continental with high seasonal temperature amplitudes and a very low annual precipitation in the range of 1500 mm. Snow cover is limited and daily mean temperatures range above 0°C for about 4 months of the year (Thing, 1984; Langager, 1990).

Vegetation is abundant with meadow, moist dwarf shrub heath, grassland, and steppe as the important features. Availability of food in winter is very good because the limited snowcover allows for an unhindered access to the most productive vegetation types in the lowlands (Olesen, 1990;1993).

Material and methods

Aerial counts of the muskox population in AN have been conducted at irregular intervals during the last 14 years. The early surveys covered only part of the range but from 1985 the aerial surveys attempted to cover most areas up to 1000 m a.s.l. In 1987 a Bell 206 Jet Ranger helicopter was used for the census; in other years airplanes (Piber Cherokee and Partenavia Observer) were used. Due to the numerous valleys in AN selected topographical routes, instead of linear transects, were flown. An altitude of 200–300 m above ground was maintained and the routes were plotted on a 1:250000 map while counts and groups data were recorded on tape.

Data on sex and age distribution were gathered during ground surveys in March – November. Sex and age compostion of muskoxen were performed according to Olesen *et al.*, 1993) using binoculars and spotting scope. Animals were observed on distances usually not exceeding 200 m, ensuring that the exact sex and age of the animal could be decided.

Results

Since the introduction of muskoxen aerial counts of the population in AN have demonstrated that the population has increased to an estimated population size (precalving 1991) of 2544 (Table 1). Most of the animals remain in areas

Table 1. Aerial counts of muskoxen in Angujaartorfiup Nunaa.

Year	April 1977	March 1979	September 1985	September 1987	August 1988	August 1990
Count	150	230	967	1261	1286	2120
Estimated population size	-	-	-	1500	1543	2544
Source	Unpublished Holte, V.; Roby, D.; Thing, H.	Unpublished Holte, V.; Roby, D.; Thing, H.	Unpublished Vibe, C.	Aastrup, P. (1988)	This study	This study

below 400 m a.s.l. with concentrations of animals unchanged year round. Overall densities reach 0.4 muskoxen/km^2, but with 2/3 of the population concentrated in the 950 km^2 low altitude areas southeast of the Kangerlussuaq airport density of this area reaches 1.8 muskox/km^2 with local peak densities on heavily used habitats in Ørkendalen and Arnangarnup Qoorua well over 2.0 muskox/km^2.

Demographic data from 1977–1991 show a mean annual calf crop of 23.9 % of the population (range: 21–27 %) and a mean annual population increment of 32.0 % (range: 27–37 %) (Table 2). The calf/cow ratio was calculated in two ways due to the finding that yearling females may reach maturity and give birth to their first calf when they turn 2 years old (Olesen *et al.* 1993). When the ratio is based on females 3 years or older, values range from 1.00 to 1.30. However, the ratio values makes more sense when 50 % of the 2-year-old female cohort is included as reproductive females, resulting in a calf/cow ratio of 0.86 – 1.13 with a weighed mean of 0.99.

The sex and age composition of the muskox population in AN displays rather stable values in the different sex and age cohorts. Demographic data show that only a neglectible winter mortality in the calf and yearling cohorts exists, coinciding with the fact that calf or yearling carcasses have never been found although extensive areas have been patrolled with snowmobiles in late winter seasons.

Models of population growth predict a theoretical population size in 1990 close to 6.500 animals, based on a constant annual increment of 26 % and excluding the mortality factor; – and a population size of 2200, based on actual aerial counts (Fig. 2 curves A and B). The «C» curve illustrates, however, the most likely development and present status of the population; it is based on an estimated population size, taking into account an annual harvest of 200, 300 and 400 for the years 1988–1990, respectively, and an estimated carrying capacity of 5000 muskoxen.

Discussion

At the initiation of the study the high calf/cow ratios and the rapid ontogenetic development in age and sex features (Olesen *et al.*, 1993) caused some speculation, but reports on early sexual maturity and reproductive success in other introduced muskox populations (Alendal, 1971; Jingfors & Klein, 1982) rendered the comparative background; the West Greenland data were recalculated estimating a significant number of 2-year-old females to give birth which further indicates that for about 50 % of the yearling females the abundant high quality forage in AN

Table 2. Demographic data for the muskox population in Angujaartorfiup Nunaa, West Greenland. Data from before 1987: (Roby D., Holte, V., Thing, H.; unpublished).

Season/year	N	Calf/cow (3yr+)	Calf/*cow (0.5•2yr+3yr+)	Calves % of population	Annual population increase
May – Nov 77	258	–	–	24.8	33.0
Mar 80	277	–	–	26.0	35.1
Jun – Aug 87	292	–	–	27.1	37.1
Mar – Apr 88	408	1.30	1.13	22.0	28.0
Jul – Aug 88	498	1.02	0.88	23.6	31.0
Oct – Nov 88	562	1.00	0.89	23.7	31.1
Mar – Apr 89	728	1.17	1.02	25.1	33.6
Jul 89	252	1.20	1.06	25.4	34.0
Apr 90	943	1.25	1.07	23.8	31.2
Aug – Sep 90	373	1.02	0.86	21.2	26.9
Apr – May 91	278	–	–	21.0**	31.0***

*** annual increase for 1990 (all 1991 calves were not born at the end of the field period).
** calculated for 1990 calves, actually yearlings from April 20 1991.
* 50 % of the 2-year-old females are assumed to have a calf.

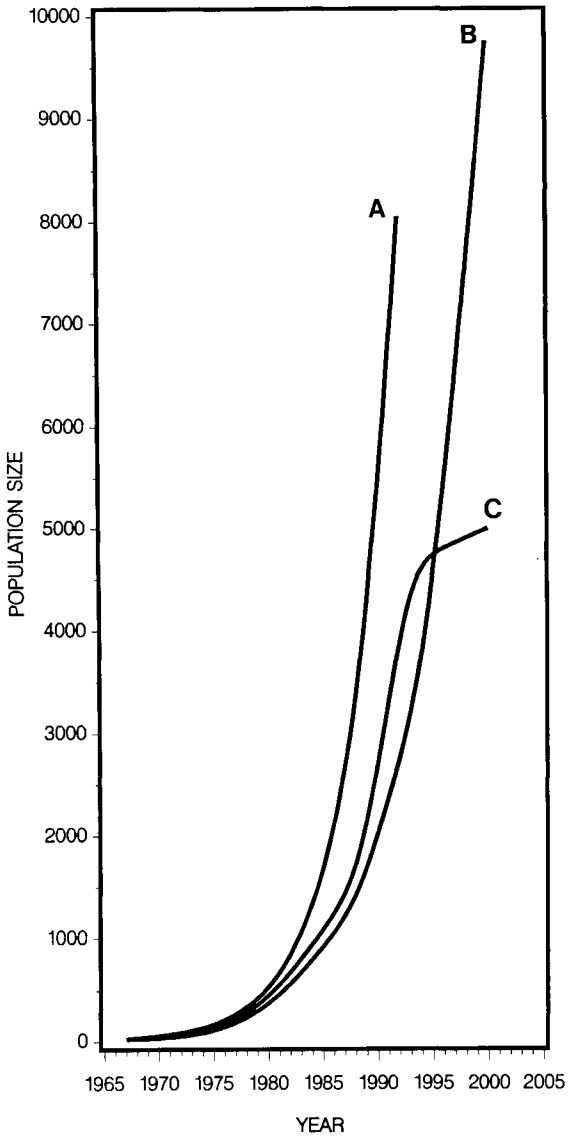

Fig. 2. Models of population development for the muskox population in Angujaartorfiup Nunaa.
A) Maximum curve. Based on an annual growth rate of 26 %.
B) Minimum curve. Based on actual aerial surveys.
C) Realistic curve. Aerial counts + 20 %, hunting quotas, and an estimated carrying capacity of 5000 muskoxen.

does bring their fall total body weight up to a treshold value where their first ovulation will occur. The total body weight of the 16-month-old females is believed to be in the range of 150–160 kg. Observations of calves following 2-year-old females were frequent and at least one 2-year-old female has been documented to be lactating (Olesen *et al.*, 1993).

In the study of Jingfors & Klein (1982) the calf to cow (2 years +) ratio for introduced muskox populations in Alaska ranged from 0.79 to 1.00 elucidating the tremendous reproductive potential in muskoxen. In AN cows older than 2 years give birth in successive years whereas the reproductive history of adult muskox females in northeast Greenland confirms breeding in alternate years (Thing *et al.*, 1987).

The rapid expansion of the muskox population in AN emulates the initial eruptive pattern described by Caughley (1970) for ungulates colonizing a new environment with abundant food resources. Until now no definite signs of a reduced calf crop or density dependent mortality have been observed. Population density on selected «hot spots» considerably exceeds that reported from other Arctic muskox ranges (Thomas *et al.*, 1981) indicating that the carrying capacity of the AN range may soon be reached. The annual population increment of 32 % is the highest ever recorded for this species and ranges well above the 17–24 % reported from Alaska (Jingfors & Klein, 1982) and the 21 % in Queen Maud Gulf, Canada (Gunn *et al.*, 1984).

Sex and age composition among the muskoxen of AN reveal that this population is vigorously expanding with a high proportion of young animals.

Analyses of premolar incremental lines show a mean life expectancy for muskox males of 12.7 ± 2.0 years (N=6), 4–5 years more than that reported for males in northeast Greenland (Thing *et al.*, 1987). This may be due to the fact that muskox males in AN are able to compensate during winter for the high energy expenditure during the fall rut, because of unhindered feeding on the almost snow-free lowland areas from October through April.

During the calving season (*i.e.* early May) a sex and age related segregation is evident interfering with the general demographic pattern in the population. Parturient cows leave preferred low altitude habitats and actively select unvegetated heights where most calves are born. The reason for this behaviour is assumed to be the high proportion of young bulls in the groups. These adolescents allocate considerable time and effort to social interactions within the groups thereby generating a significant level of excitation among group members; neonates, with no

Table 3. Sex and age composition of the Angujaartorfiup Nunaa muskox population 1988–1991. (% of observed animals).

Season/year	N	calves	1yr ♂	1yr ♀	2yr ♂	2yr ♀	3yr ♂	3yr+ ♀	4yr+ ♂
Mar – Apr 88	408	21.8	10.8	6.7	11.3	5.1	10.8	16.7	16.7
Jul – Aug 88	498	23.7	10.2	9.0	8.0	8.0	2.2	23.1	15.7
Oct – Nov 88	562	23.8	9.4	8.9	8.7	6.0	4.6	23.8	14.6
Mar – Apr 89	728	25.1	8.8	7.6	6.7	6.4	9.6	21.4	12.9
Jul 89	252	25.4	9.1	9.6	9.1	5.2	5.6	21.0	15.1
Apr 90	943	23.8	9.0	8.1	11.3	7.8	8.0	18.9	17.9
Aug – Sep 90	373	21.2	9.4	10.2	9.2	6.4	8.5	20.6	11.5
Apr – May 91	278	11.9*	10.5	10.5	8.3	9.0	5.8	18.3	25.5

* Not all calves were born at the end of the field period May 8.

well-established maternal bond, may easily be injured if they are present in an excited and highly mobile group during the *post partum* period. Lent (1974) described muskox calves as particularly susceptible to disturbances also indicating that formation of a lasting cow-calf bond requires quite some time.

A resulting bias for the population demographics and dynamics is that cows in this season are under-represented in the lowlands. According to Table 2 the highest calf/cow ratios are seen in March – April (*i.e.* late winter and pre-calving seasons). Censuses also render the highest percentage of males (3 yr+) in the pre-calving period (Table 3).

Management perspectives

Muskoxen appear to be highly adaptable Arctic ungulates adjusting their reproductive potential in accordance with the nutritional regime of a given range (Olesen *et al.*, 1993). As a contrast to the fluctuating Greenland caribou populations muskoxen seem a much more stable wildlife resource thereby constituting a steady meat supply to the Inuit hunters of West Greenland to whom the muskox is rapidly becoming an attractive alternative to the traditional land game: the caribou.

As the population is approaching the carrying capacity of AN emigration will increase. The obvious route of emigration from the core range is by heading north across the 20 km long river valley (Sandflugtsdalen) due east of Kangerlussuaq airport. Already in the late 1970's the first solitary muskox bulls were seen in the caribou calving range north of this valley, but not until 1991 have groups with adult females and calves been spotted north of Kangerlussuaq. One of these groups was seen c.80 km west of the airport approaching the coastal ranges near the Davis Strait (J. Thrysøe, pers. com.).

With the first signs of overgrazing and destruction of willow thickets followed by a beginning wind erosion on certain habitats, quota-based harvesting must be set to match the size of the annual recruitment (600 animals in 1991). Yet, there are unused muskox habitats in AN but according to harvest models, large herbivor populations should be kept at 60–70 % of range carrying capacity to maximize yield (Caughley, 1976). Estimating carrying capacity of the AN at 5000 (based upon data on available habitat types and vegetation (Olesen 1993)), the population should be maintained on a level of 3000 muskoxen.

The presence of the indigenous caribou population makes it important to keep the number of muskoxen below the absolute carrying capacity of the area. The two herbivore species do, under the present forage conditions, overlap in their diets during winter (Olesen, 1991). However, the expanding muskox population has had no detrimental effect on the caribou up till now, but as muskoxen cope much better with the graminoid food available in AN (Staaland & Olesen, 1991) they could possibly be instrumental in exterminating caribou locally by reaching or overriding the carrying capacity for an extensive time span.

Apparently the 1990 hunt in AN did not succeed in fulfilling the quota of 400 animals be-

cause muskoxen concentrated in fairly inaccessible areas adjacent to the Ice Sheet far from the fiord. (Sisimiut Game Officer, pers. com.).

To aussure a satisfactory muskox harvest it will be essential to expand hunting areas into the core areas south of Ørkendalen (*i.e.* north part of AN). Low altitudes might make it possible to use a mobile and commercial field slaughter facility. At present, a large «surplus» of adolescent and adult males occupies prime as well as potential winter habitats. Trophy hunting by foreigners would help turning the sex ratio in favour of reproducing females thereby further increasing the calf crop. It is strongly recommended to maximize yearling recruitment in the population because of the superior meat quality and the optimal forage to meat conversion efficiency by this cohort.

The combined efforts of traditional meat harvest, trophy hunting, slaughtering, new translocations and tourism related trade in hides, horns and wool should all help maintain the muskox population on a desired level and furthermore generate an economic acitivity in many of the local communities in West Greenland.

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