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STATUS AND DISPERSAL OF AN INTRODUCED MUSKOX POPULATION ON THE SEWARD PENINSULA

By

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(limited data through January 1985 included)

SUMMARY

Muskoxen (*Ovibos moschatus wardi* Zimmerman) were transplanted to the Seward Peninsula in 1970 and 1981. Precalving surveys in April 1984 accounted for 225 animals. Thirty-one muskoxen were radio-collared between 1981 and 1984; 17 of those transmitters were still functioning in January 1985. Radiotelemetry has improved census accuracy and provided information on movements, habitat selection, home ranges, and social organization.

Muskoxen were immobilized with M99 (etorphine hydrochloride, Lemmon Company, Sellersville, Pa.) and Rompun (xylazine hydrochloride, Haver-Lockhart, Shawnee, Kans.) in a hyaluronidase (Wydase, Wyeth Laboratories, Philadelphia, Pa.) matrix. M50-50 (diprenorphine hydrochloride, Lemmon Company, Sellersville, Pa.) was used as an antagonist. The most satisfactory method for darting was to hold the herd in a defensive formation with the aid of a dog.

Incidental sightings by Department staff and the public provided the best information on movements and distribution of muskoxen on the Seward Peninsula prior to the use of radiotelemetry. Among 124 sightings in locations outside the most heavily-used muskox range on the Seward Peninsula, mean number of animals per sighting was 1.6. Single animals accounted for 74% of these sightings.

Standard hematologic and serologic analysis was performed on whole blood samples taken from 9 animals. Serum from 17 animals showed no evidence of antibodies for contagious ecthyma, Q fever, epizootic hemorrhagic disease, bluetongue, brucellosis, or leptospirosis.

Estimated mean annual rate of increase from 1973 to 1984 was 15-18%. Of 125 muskoxen surveyed on 10 June 1984, 30 (24%) were calves. Natural mortality appeared to be low; most documented mortality occurred within the 1st year of life, or was due to advanced age, accidents, or human causes.

Numerous questions concerning age-specific productivity, population identity, and movements, remain unanswered.

Key Words: capture, home range, mortality, movements, muskox, *Ovibos moschatus*, population identity, radiotelemetry, Seward Peninsula, transplants.

CONTENTS

BACKGROUND

Indigenous populations of muskoxen (Ovibos moschatus) probably became extinct in Alaska before 1858 and almost certainly before 1865 (Stone 1901, Stefansson 1912). Muskoxen in Alaska today are descendants of animals brought from Greenland to reestablish the species as a free-ranging animal (Hoover 1929, Executive Order 5095; Palmer and Rouse 1936). Several authors have described the history of the original transplant to Nunivak Island (Bell 1931, Angell 1941, Young 1941, Spencer and Lensink 1970). Smith (1984a) reviewed the history and status of subsequent transplants of muskoxen from Nunivak Island to mainland Alaska. Grauvogel (1984) summarized transplant success, population status, and dispersal of muskoxen on the Seward Peninsula.

Historical and fossil records of indigenous muskoxen on the Seward Peninsula are poor. All muskoxen in the western hemisphere (Ovibos and extinct genera of the tribe Ovibovinae) must have passed through the Seward Peninsula during the Pleistocene, via the Bering land bridge, from their locus of origin in central Asia (Harington 1961). In 1948, an Ovibos moschatus skull was picked up by a gold dredge near Nome in deposits laid down during the Illinoian (penultimate) glaciation (Harington 1970). Abundant muskox skeletal materials and parts have been recovered on the Kiwalik and Buckland Rivers on the northeast coast of the Seward Peninsula. Beechey (1831) discovered muskox bones and even carcasses with flesh adhering in the frozen deposits at Elephant Point on Escholtz Bay in 1828. Beechey found the inhabitants of the Buckland River to be familiar with the species, and concluded that muskoxen had recently lived in the area.

The literature contains no records of Caucasian explorers observing muskoxen on the Seward Peninsula. However, Stefansson (1924) and other authors believed that muskox distribution and densities were reduced by the advance of human hunter-gatherer populations, and that hunting pressure, rather than climatic change, was the primary factor responsible for the receding range of the species following the Pleistocene. Establishment of viable populations in areas not recently occupied by muskoxen supports this hypothesis. There is growing evidence that given protection from humans, muskoxen can be successfully established in areas outside the range of relic populations existing at the time of European exploration.

In March 1970, 36 muskoxen (19 males and 17 females) captured on Nunivak Island were released on the Feather River 48 km northwest of Nome (Table 1). Following the 1970 release, most muskoxen moved to the western 1/3 of the Seward Peninsula, and a herd of 22 was observed in the area near Black Mountain and the Nuluk River in 1971 and 1972 (Fig. 1). Herd growth was slow at first because of the small size of the initial transplant, and because few cows were old enough to produce calves before 1973. Mortality (possibly dispersal-related) may have also delayed population growth (Grauvogel 1984). A survey in 1980 enumerated at least 104 muskoxen in the Black Mountain/ Nuluk River area. Successful establishment of muskoxen on the Seward Peninsula prompted release of an additional 36 muskoxen at Port Clarence near Black Mountain in 1981 (Fig. 1). Yearling female muskoxen released in 1981 attained sexual maturity in fall 1982, thereby significantly increasing the reproductive potential of the population.

Five adult cows in the 1981 transplant were equipped with radio collars. One cow fell into a crack in sea ice and drowned shortly after release. Two other radio-collared cows moved east 350 km and were found dead on the Tagagawik River. One of the remaining radio-collared cows and 4 yearlings moved to an area 21 km northeast of Nome and have remained there to the present. Both immigration and reproduction are contributing to growth of this band. Prior to this study, 6 additional muskoxen were radio-collared in the Black Mountain/Nuluk River area to aid in survey and inventory studies.

OBJECTIVES

To increase accuracy of muskox censuses on the Seward Peninsula through use of radiotelemetry.

To determine individual home ranges, habitat selection, seasonal movements, and productivity of the herd.

To determine if discrete subpopulations or persistent associations of individuals occur.

STUDY AREA

The Seward Peninsula is an area of 53,000 km^2 (20,463 mi^2) extending into the Bering Sea from the coast of northwestern Alaska (Fig. 1). Topography varies from coastal lowlands to rugged mountain ranges with a maximum elevation of 1,540 m (5,052 ft).

The climate is strongly influenced by surrounding water, and temperature, rainfall, snow, and icing conditions are typical of maritime areas in northwestern Alaska. The climate of the Peninsula's interior is more continental, with greater temperature extremes and lower precipitation. Mean annual precipitation is approximately 36 cm measured at Nome. Snow-cover usually persists from November through May and may be hard-packed and include ice layers, particularly near the coast.

The land surface is almost completely vegetated. Boreal forest is limited to the eastern 1/3 of the Peninsula; coastal regions are generally vegetated by tundra species, grasses, and low-growing willows.

MATERIALS AND METHODS

During the reporting period, 18 muskoxen were radio-collared: 7 in October 1983 and 11 in April 1984. Four animals radio-collared in 1984 died within 3 weeks of handling. Successfully instrumented animals were relocated at approximately 1-month intervals. Data were recorded on U. S. Geological Survey maps having a scale of 1 inch to the mile (1:63,360). Visual sightings were made in nearly every case. Herd size, composition, and habitat type were recorded in the field.

Muskoxen were immobilized with a mixture of M99 (etorphine hydrochloride, Lemmon Company, Sellersville, Pa. [1 mg/ml injectable]) and Rompun (xylazine hydrochloride, Hauer-Lockhart, Shawnee, Kans.). Hyaluronidase (Wydase, Wyeth Laboratories, Philadelphia, Pa.) was used to speed absorption. Drugs were administered with Cap-Chur darts (Palmer Chemical and Equipment Co., Douglasville, GA) fired from a Palmer Cap-Chur gun. Darts of 10 cc capacity were used with barbed needles 3.8 or 4.4 cm (1.5 or 1.75 inches) long. Reversal of sedation was obtained by injection of M50-50 (diprenorphine hydrochloride, Lemmon Company, Sellersville, Pa. [2 mg/ml]). Collected blood was transferred from a 50 cc syringe to evacuated containers (Vacutainers, Becton-Dickinson, Rutherford, N. J.). Plain collection tubes were used for blood screened for antibodies. Tubes containing heparin or EDTA were used for samples subjected to whole blood analysis. Whole blood collected from 9 immobilized animals was analyzed for magnesium, calcium, hemoglobin, packed cell volume, and red and white cell count. Serum from 17 muskoxen was tested for the presence of antibodies for contagious ecthyma, Q-fever, epizootic hemorrhagic disease, bluetongue, brucellosis, and leptospirosis.

Immobilized animals were instrumented with VHF radio transmitters (Telonics Inc., Mesa, AZ) and ear-tagged with numbered red plastic cattle tags (T-lock tags, Hasco Inc., Newport, N.Y.). Most animals were also marked with color-coded streamers (Safety Flag Co., Pawtucket, R.I.) held on the lower curve of the horn shaft with heat-shrink tubing and adhesive. Collared muskoxen were also tagged with numbered metal ear tags. Movement and distribution patterns were determined by radiotelemetry and from records of public sightings.

RESULTS AND DISCUSSION

Capture

Attempts at chemical immobilization were often unsatisfactory from the standpoint of efficacy and safety to the animal. A typical drug mixture used for an adult cow was 7.5 mg M99, 35 mg Rompun and 300 I.U. hyaluronidase. For an adult bull a typical dose was 8.5 mg M99, 35 mg Rompun, and 350 I.U. hyaluronidase. Muskoxen often required additional doses to achieve narcosis. The minimum dose allowing capture was 7.5 mg M99 with 35 mg Rompun. These animals were often active and required physical restraint as well. One adult bull was double-darted with a total of 19 mg M99. Both darts fully ejected their contents; however, onset of sedation required 30 min, and the animal maintained sternal recumbancy, head movements, and eye-blink response characteristic of a light drug dose.

Patenaude (1982) reported successful immobilization of captive adult bulls given 5.0-5.5 mg of M99. At the Catskill Game Farm, Heck and Rivenburg (<u>in</u> Patenaude 1982) reported that captive adult female muskoxen were immobilized with 1.6-3.0 mg M99. Clausen et al. (1984) achieved good results with a large number of adult wild muskoxen on Greenland using 2 mg M99 with 30 mg Rompun. We are unable to explain why muskoxen on the

Seward Peninsula required such large drug doses for immobilization. Possible factors include:

1. Ineffective drug delivery. Fully-loaded 10 cc darts have poor ballistic performance. When these darts were fired at paper targets they sometimes showed keyhole penetration patterns. If the darts were not fully stabilized in flight, needle penetration may have been poor. The long guard hairs of some muskoxen may have caused premature drug ejection. Several darts failed to fully inject their contents. Because of the large volume of drug, complete injection requires considerable internal pressure and effective lubrication of the plunger. Drug injection caused substantial back-pressure. On at least 2 occasions the barb failed to hold the needle in the animal, and the dart was blown back out, ejecting at least part of its contents into the air.

2. Incomplete absorption of the drug. The large drug volume was difficult to introduce into the animal's circulatory system. The drug was observed to leak back out of the needle hole on several occasions. Muskoxen were particularly difficult to tranquilize during fall, and we suspect that absorption was hampered by failure to penetrate the subcutaneous fat layer. We countered this possibility by using long needles (4.4 cm) and by avoiding dart placement in areas of heavy fat deposition. Problems with these measures were the tendency for long needles to strike bone and difficulty in penetrating thick layers of hair on the lower hind leg.

Muskoxen handled in the present study demonstrated substantial individual variation in response to immobilizing drugs; this is consistent with the observations of Clausen et al. (1984). It is not known if this variation reflects physiological differences in resistance to drugs or mechanical factors discussed previously.

A 3-year-old bull immobilized on 12 April 1984 died without regaining consciousness after administration of M50-50. This animal was inadvertently overdosed with 9.5 mg M99 intended for an adult bull. The muskox was deeply narcotized but respiration and heart rate appeared adequate. Twenty mg of M50-50 were injected intramuscularly. The animal did not recover and stopped breathing after 12 minutes; artificial resuscitation was attempted without success.

Two adult females captured on 12 April 1984 recovered from the drug following administration of M50-50 but were found dead on

17 April 1984 within 1.6 km of their capture locations. One of these animals had been darted with 2 darts containing a total of 17 mg of M99; the 1st dart had no apparent effect. Two females captured on 13 April 1984 were alive on 17 April but were found dead on 27 April. One of the animals had been darted with 2 darts, each containing 7.5 mg of M99. These animals were retrieved and necropsied. Both females had given birth. One calf was born alive and had eaten vegetation before it died. Cause of death could not be determined conclusively, but both females showed evidence of uterine hemorrhage. No other capture-related mortalities have occurred in muskoxen on the Seward Peninsula.

To minimize physiological stress, several methods of immobilizing muskoxen were tried: 1) shooting darts from a helicopter; 2) shooting darts from the ground after approaching the animal on foot; and 3) holding the herd in a group defense formation with ground personnel and a dog, and then darting selected animals.

Darting muskoxen from a helicopter was the least efficient method. Because muskoxen often turned to face the helicopter at close range, placement of the dart in the hindquarters was difficult. In addition, darts fired downward through the trailing skirt of guard hairs may have been deflected or may have ejected their contents before the needle had penetrated. The long pelage of muskoxen made it difficult to determine if a hit had been made. Finally, pursuing muskoxen with a helicopter resulted in unnecessary stress to the animals.

Ground darting after a stalk was a more effective method, because it improved accuracy of dart placement, increased selectivity, and was less traumatic to the animals. However, darting from the ground was not without problems. Sometimes the herd would stampede when only 1 shot was fired. Large darts loaded with 10 cc of fluid have poor ballistic performance and are not accurate beyond 15-25 m. It was often difficult and time-consuming to approach muskoxen this closely in open terrain.

Darting muskoxen from the ground with the aid of a dog was the most efficient method. Dogs have been used since prehistoric times by hunters to aid them in killing muskoxen (Pike 1892; MacMillan 1918; Stefansson 1921, 1924; Hone 1934). Muskoxen adopt a tightly-grouped defensive formation (Gray 1974) in response to wolf attack or threats from other sources. This formation is a fairly effective strategy against wolves, but when early men learned to elicit this behavior using domestic dogs, they were able to easily kill entire herds with primitive weapons. Arctic explorers, whalers, and traders adopted this hunting method, and with the improved capabilities of modern firearms, proceeded to wreak havoc on the remaining muskox populations in Canada and Greenland. More recently, Danish researchers working in Greenland (Clausen et al. 1984) revived the technique of using dogs, for use with modern live-capture equipment with performance limitations similar to those of primitive hunting weapons. Critical to this technique is a dog or dogs of the proper temperament. The dogs must be aggressive enough to maintain a sustained but controlled attack and be quick and wary enough to escape potentially lethal charges. With an active, aggressive dog, it is possible to hold an entire herd indefinitely and dart as many animals as required at a range of less than 20 m. Although muskoxen were visibly agitated by this treatment, the method appears to be much less stressful than helicopter darting.

Marking

Muskoxen radio-collared in 1981 were fitted with numbered yellow collars, but these collars were not useful as a visual aid. Collars could rarely be seen from the air because of the animals' long hair, and because muskoxen often grouped in a tight formation. Neck hair tended to bunch up under the visual collar and the collar appeared to be uncomfortable for the animal. Muskoxen collared in 1982, 1983, and 1984 were ear-tagged in both ears with large numbered red-plastic cattle tags. Most animals were also marked with color-coded streamers attached to the lower curve of the horn. The streamer was threaded through a 2.6 cm section of heat-shrink tubing, adhesive was applied to the horn, and the tubing with streamer attached was pushed onto the horn. Tubing was then shrunk with a propane torch. Collared muskoxen were also tagged with numbered metal ear tags. Both plastic ear tags and streamers could usually be seen from the air. Ear-tag numbers could be read by observers on the ground using a spotting scope. Horn streamers were highly visible when first applied and allowed individual identification, but were not durable. Bulls often shed their streamers within the 1st 2 months, either by horning the ground as described by Smith (1976) or by horning vegetation. In all cases where streamers were lost, the heat-shrink tubing remained on the horn and could sometimes be seen from the air. Unfortunately, this provided no clues for individual recognition. Horn streamers were used by Jonkel et al. (1975) and Reynolds et al. (1982). Neither author reported the extensive losses we experienced. Horn streamers appear to be a useful marking technique; however, the problem of durability remains to be solved, either with better materials or a different method of attachment.

Population Growth

Data on early growth of the Seward Peninsula muskox population are incomplete. Grauvogel (1984) summarized available population data and its limitations. The 1st attempt to obtain a complete census was made in 1983 when 162 muskoxen were observed (Table 2). Observers conducting counts prior to 1984 assumed that muskoxen in the Black Mountain, Nuluk River, and Nome areas were different subpopulations occupying separate ranges and that interchange between subpopulations was minimal. Thus, counts made at different times in different areas could be combined by simple addition to arrive at a population estimate. Recent movement data from radio-collared animals indicate that this assumption is not valid. The 1984 precalving counts were conducted in 1 time period with the aid of radio-collared animals. The minimum estimate of the Seward Peninsula population was 225 muskoxen (Table 2).

Grauvogel (1984) estimated that the mean annual rate of increase of the Seward Peninsula muskox population was 16-21%. With the improved precision of recent population data, it may be useful to reexamine these estimates. Calf production was limited in the early years following the 1970 transplant, by the immaturity of most females (only 3 cows were 3 years old or older prior to 1972). Although muskox cows commonly produce calves in their 3rd year (Smith 1976), very little reproduction was noted prior to 1973 (Pegau 1974b); 2 newborn calves were observed in 1970 and 1 in 1972 (Pegau 1973, 1974a). If we assume an initial population of 36 animals and a 1984 precalving population of 225, mean annual rate of increase from 1973 to 1984 was 18%. If muskoxen that were introduced in 1981, and their offspring, are subtracted from the 1984 count, the rate was 15%. A 15-18% rate of increase is similar to the value reported for Nunivak Island (16.4%) by Spencer and Lensink (1970). Because of mortality and dispersal, the existing population probably arose from fewer than 36 animals, and herd growth may have been higher. Scenarios resulting in higher estimates of herd growth are discussed by Grauvogel (1984).

An aerial survey on 10 June 1984 recorded 30 calves among a sample of 125 muskoxen (24%). Although this was not a complete census, it is believed to be a representative sample of the population.

Movements and Distribution

Twenty-eight muskoxen were radio-tagged between 1981 and 1984 (Table 3). These animals were relocated 245 times during that period. Quantitative analysis of the radio-collared muskox movement data will be presented in the final report. However, a number of preliminary observations are noteworthy:

The longest movements recorded for muskoxen on the Seward Peninsula were made by 2 females released at Port Clarence as 2+ and 3+ year-olds in 1981, and found dead on the Tagagawik River in fall 1982 (350 km from the release site). A 5-year-old male transplanted as a yearling in 1970 was shot near the village of Selawik in August 1974 at a distance of 345 km from the release site. All 4 radio-collared adult females transplanted in 1981 moved great distances in the year following release. Adult muskoxen probably established home ranges on Nunivak Island using geographic features or other means of orientation. An abrupt transfer to an unfamiliar environment may be more traumatic for adults than for juveniles. However, within a year following release, both surviving radio-collared muskoxen established typical movement patterns.

Two muskoxen (Appendix A, Nos. 44 and 48) were radio-collared more than 50 km from areas where wintering concentrations of muskoxen are commonly found. Both animals eventually returned to the Black Mountain/Nuluk River area and joined established herds. Efforts to locate and mark muskoxen outside core wintering areas will continue in order to document their movements and relationships to the rest of the population.

Sightings by the public have provided a valuable source of information on distribution of muskoxen on the Seward Peninsula. During 1970-84, 207 sightings were recorded, and data are available for all years except 1977 and 1978. Efforts by department biologists to solicit information from the public varied annually, and the number of sightings in a given year partly reflects efforts to involve the public. Requests for sighting reports were made through various media: local radio spots, articles in the local newspaper, and public notices.

At least 4 potential biases must be considered in evaluating distribution information obtained in this manner:

1. The distribution of observations is influenced by the distribution of the human population as well as the distribution of species for which information is sought.

2. The probability that a sighting will be reported decreases with distance from Nome (the community with the largest population). Even though a sighting may be more noteworthy at a greater distance, it is less likely that a person would have seen a request for information, and more effort is required to report it.

3. People vary considerably in experience and ability to interpret their observations. Sex and age determinations made by the public are not consistently accurate.

4. Confusion with other species is conceivable but improbable. Although muskoxen are often mistaken for bears when first sighted, observers are usually

interested enough to confirm identification by extended observation. Confusion with any other species inhabiting the Seward Peninsula is unlikely.

Sighting records indicate that muskoxen occupied the Black Mountain/Nuluk River area within a year following the 1970 transplant. Since 1970, sighting records have generally extended eastward, but substantial easterly movements of some animals occurred within 5 years of the introduction. Muskox sightings in 1975-79 and 1980-84 show a continuation of the trend observed in 1970-74.

The majority of distant sightings occurred in fall. Of 124 significant sightings (those which fall outside the typical range of the population) between 1970 and 1984, 104 (84%) were made between July and October. Eighty-one (65%) were made in August and September. Mean animals per significant sighting was 1.6 ($\underline{N}$ = 172), and single animals accounted for 92 (74%) of the significant sightings. Of 18 significant sightings for which sex and age were reported, 14 were adult bulls.

Blood Parameters

Original attempts to obtain blood from the jugular vein were abandoned because of difficulty locating the vein through heavy neck hair. The preferred site for blood collection was the tarsal or carpal vein which is readily observed after hair is clipped from a small area of skin. Whole blood collected from 9 muskoxen immobilized with M99 and Rompun was analyzed for magnesium, calcium, hemoglobin, packed celled volume, and red and white cell count (Table 4). Serum from 17 muskoxen was tested for the presence of antibodies for contagious ecthyma, Q fever, epizootic hemorrhagic disease, bluetongue, brucellosis, and leptospirosis. No sample gave a positive indication of exposure to the disease organisms for which it was tested.

Mortality

All muskoxen transplanted in 1970 were marked with numbered metal ear tags. Two of these animals were recaptured in 1982 and 1983 and radio-collared (Appendix A, Nos. 12 and 21). The year and location of death of 4 animals transplanted in 1970 has been documented (Table 5, Appendix A). One died in 1971 on the beach 50 km west of Nome. One bull was killed near the village of Selawik in 1974 by a hunter who mistook it for a bear. A bull found dead in February 1984 on the Seward Peninsula was 16 years old at death. A radio-collared cow died in April 1984 at 15 years of age. A radio-collared cow born in 1968 produced a calf in 1983 and was still alive at the time of writing. Buckley et al. (1954) reported that a cow released on Nunivak Island in 1936 lived to be 23 years old.

Few instances of mortality among Seward Peninsula muskoxen have been documented (Table 5). The population is still relatively young and is not exposed to significant levels of predation. Most observed mortality occurred within the 1st year of life, or was related to advanced age, accidents, or human causes. Undocumented mortality certainly occurs.

RECOMMENDATIONS

Muskoxen have expanded their range on the Seward Peninsula at a fairly conservative rate since the initial transplant in 1970. Although much of the Peninsula appears to offer suitable habitat, only a fraction of it is actually used by muskoxen. Muskoxen have highly specialized winter habitat requirements (Lent and Knutson 1971, Lent 1974, Smith 1984b). Furthermore, they tend to remain in a relatively limited area once established on winter range. This conservatism in range expansion may have been selected for because of higher mortality among animals choosing inappropriate winter ranges. However, suitable winter habitat appears to be fairly extensive on the Seward Peninsula, and as the population continues to grow, expansion into areas not currently used in winter is expected.

The majority of extensive movements both in public sighting records and as determined by radiotelemetry were made by single adult bulls during the rut. The role of long-range movements by bulls in pioneering new habitats, and mechanisms for range expansion of introduced muskox herds, deserve further study.

The relatively high proportion of instrumented animals in the Seward Peninsula population facilitates accurate estimation of population parameters.

Future efforts to improve capture methods will focus on more efficient drug delivery. Some unsatisfactory results with chemical immobilization can be attributed to difficulty in injecting large volumes of fluid. A more concentrated narcotic may eliminate some mechanical difficulties encountered with M99, which is currently supplied in concentrations of 1 mg/ml. When more than 1 dart is required, care must be taken not to exceed acceptable dosages of Rompun if darts are pre-loaded with both M99 and Rompun. Muskoxen appear to be more sensitive to Rompun than many other species, and may be inadvertently overdosed with the synergist before effective narcosis is attained. Hyaluronidase appears to significantly reduce induction time and has no apparent adverse side-effects.

Although the exact causes of the 4 delayed mortalities in April 1984 are not known, advanced gestation was probably a contributing factor. Reynolds et al. (1982, 1984) reported good capture results in April using similar doses of M99 and Rompun on muskoxen in the Arctic National Wildlife Refuge. However, a 3-year-old female captured on 15 April 1982 was found dead on 14 May. A cow captured on 15 April gave birth to a stillborn calf on about 30 April 1982. Until more is known regarding effects of these drugs on the fetus and on late-term females, caution should be used in chemical immobilization of pregnant females in spring.

Substantial difficulties in immobilizing both males and females were also encountered during the rut. Retention of the drug in fat or increased drug resistance associated with physiological changes are possible explanations of this effect. Harem disruption is undesirable, and capture operations probably should not be scheduled during rut unless specifically required by study objectives.

The following questions will be examined during the remainder of this study:

1) What happens to muskoxen sighted at great distance from commonly-used winter ranges? Do they remain isolated, band together to form separate subpopulations, or eventually return to existing herds? Do individuals that make these long movements make subsequent long movements after they have joined an existing herd? What is the role of prior experience and leadership in range expansion?

2) Are there undiscovered, isolated herds separated from the main population? Although no large herds have been located or reported, it is conceivable that such groups exist.

3) Are there discrete subpopulations or herds in areas most heavily used by muskoxen as previously suggested (Grauvogel 1984) or 1 large population occupying several core areas?

4) What is the reproductive performance of the population; what is the reproductive lifespan of known-age animals?

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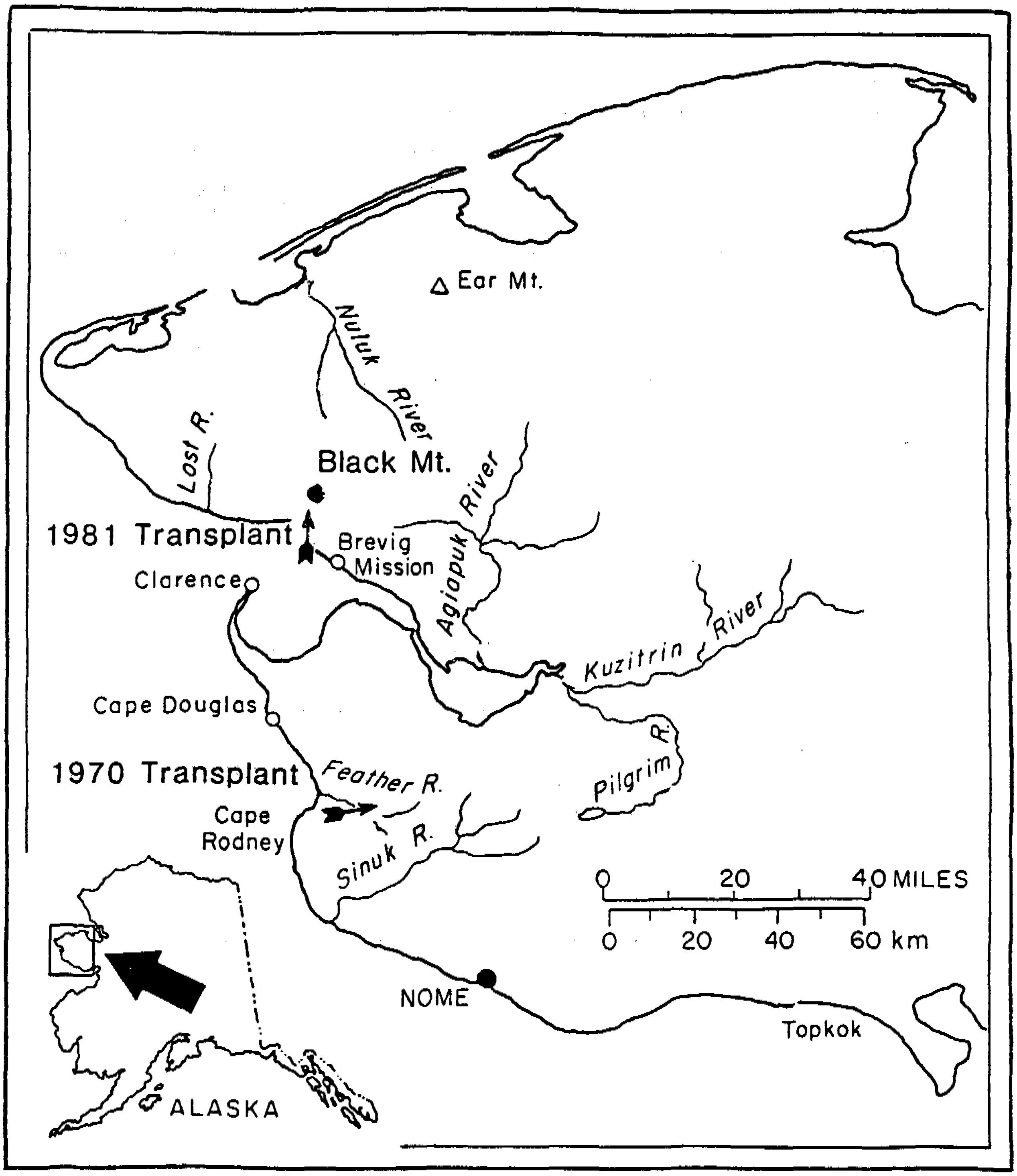

Fig. 1. Seward Peninsula, Alaska, study area and muskox transplant sites, 1970, 1981.

Table 1. Sex and age of muskoxen transplanted to the Seward Peninsula from Nunivak Island, Alaska, 1970 and 1981.

Year	4+		3 yrs		2 yrs		Yearling		Totals
	M	F	M	F	M	F	M	F	
1970	0	0	0	2	3	1	16	14	36
1981	0	1	0	3	0	1	10	21	36

Table 2. Composition of the Seward Peninsula muskox population from precalving surveys, 1983 and 1984.

Year	4+ yrs		3 yrs		2 yrs		Yrlgs	Unknown	Totals
	M	F	M	F	M	F			
1983	25	31	9	14	11	12	24	36	162
1984	9	46	8	7	6	7	34	108	225

Table 3. History of muskox radio-collaring on the Seward Peninsula, Alaska, 1981-84.

	Year			
	1981	1982	1983	1984
Animals collared	4	6	7	7[a]
Active radios	4	10	15	22
Estimated % of population	4.0	6.9	9.3	9.8

[a] Four additional muskoxen were radio-collared but died within 3 weeks.

Table 4. Replicate measurements of selected blood parameters[a], Seward Peninsula, Alaska, radio-collared muskoxen, April 1984.

No./sex	Mg (mg/dl)	Ca (mg/dl)	HCT (%)	Hb (g/dl)	RBC (10^6/ul)	WBC (10^6/ul)	MCV (fl)
14/M	2.7	10.4	41.3	15.9	8.53	4.8	49
	2.9	10.7	42.3	15.8	8.50	4.8	50
19/M	2.9	9.4	36.6	12.9	6.83	3.2	54
	2.7	9.5	34.8	12.9	6.83	3.0	52
41/M	2.8	9.5	48.7	13.0	7.40	4.4	67
	2.7	9.6	35.5	13.3	7.04	3.0	51
45/M	2.7	10.6	47.3	14.0	7.97	3.5	60
	2.6	11.0	37.8	14.1	7.74	4.6	50
--/M	3.1	10.3	34.2	13.6	7.19	4.0	48
	3.0	10.5	36.5	14.3	7.65	3.4	48
17/F	3.0	9.9	45.5	17.5	9.44	4.8	49
	2.8	9.8	45.4	17.1	9.34	5.3	50
35/F	2.7	9.5	41.6	15.9	7.94	6.6	53
	2.6	9.6	43.1	15.4	8.22	6.3	53
39/F	2.6	8.7	26.0	9.9	5.20	3.3	51
	2.6	8.7	34.9	13.3	6.92	3.9	51
50/F	2.9	9.5	39.9	15.1	8.01	3.9	50
	2.9	9.5	40.8	15.0	8.11	4.2	51

[a] Key to abbreviations used in table:
Mg-Magnesium
CA-Calcium
HCT-Hematocril
Hb-Hemoglobin
RBC-Red blood cells
WBC-White blood cells
MCR-Mixed cell volume

Table 5. Observed mortality of muskoxen on the Seward Peninsula, Alaska, 1970-1984.

Year	Sex and age	Location	Probable cause of death
1970	No mortalities reported	--	--
1971	Yearling female	On beach 50 km east of Nome	Fell through ice
	2 to 3-year-old female	Foothills between Sinuk & Feather Rivers	Bear kill?
1972	Adult, sex unknown	16 km below Tin City on beach	Drowned
1973	No mortalities reported	--	--
1974	6-year-old male	Near Selawik	Mistaken for bear & shot
1975	No mortalities reported	--	--
1976	No mortalities reported	--	--
1977	No mortalities reported	--	--
1978	No mortalities reported	--	--
1979	No mortalities reported	--	--
1980	No mortalities reported	--	--
1981	Radio-collared adult	3 km from Port Clarence	Fell through ice
	Yearling, sex unknown	Nuluk River	Unknown
	Adult male	Golden Gate Creek	Unknown
1982	2 adult females radio-collared in 1981	Tagagawik River	Unknown
	1 adult male	Near Teller	Illegal kill
1983	No mortalities reported	--	--

Table 5. Continued.

Year	Sex and age	Location	Probable cause of death
1984	16-year-old male from 1970 transplant	Near Brevig	Unknown
	15-year-old female from 1970 transplant, radio-collar No. 120	Don R.	Unknown
	Adult female	Nuluk R.	Capture mort.
	3-year-old male	Nuluk R.	Capture mort.
	2 adult females	Pinguk R.	Capture mort.
	Adult female	Black Mt.	Capture mort.
	Radio-collared adult male, No. 480	N. of Teller	Unknown

Appendix A. Identification and status of marked and radio-collared muskoxen on the Seward Peninsula, 1981-1985.[a]

Animal/ visual collar number	Sex	Date collared	Location	Approximate age at collaring	Plastic ear tag Nos. & color Left	Right	Metal ear tag nos. Left	Right	Horn streamer colors Left	Right	Radio status, January 1985	Remarks
1/45	F	3/24/81	Pt. Clarence	4+	--	--	334		--	--	Functional	Trans. from Nunivak, 1981
2/--	M	10/18/83	Pinguk R.	6 mos.	R20	R20	--	--	--	--	Not collared	Cow No. 37's calf
3/46	F	3/25/81	Pt. Clarence	2+	--	--	369		--	--	Animal dead, fall '82	Died on Tag R. w/No. 6
6/47	F	3/24/81	Pt. Clarence	3+	--	--	13		--	--	Animal dead, fall '82	Died on Tag R. w/No. 3
8/48	F	3/24/81	Pt. Clarence	3+	--	--	29		--	--	Functional	Trans. from Nunivak, 1981
11/--	M	10/18/83	Nuluk R.	6-7	R2	R2	--	--	Or	Or	Functional	
12/43	F	6/23/82	California R.	13	R66	R66	10035	10036	--	--	Animal dead, 4/09/84	Trans. from Nunivak, 1970
13/--	F	10/18/83	Upper Nuluk	5-6	R3	R3	--	--	Wh	Wh	Functional	
14/--	M	4/12/84	Pinguk R.	6+	R4	R4	17224	17225	Red	Wh	Functional	
15/--	M	10/18/83	Pinguk R.	6-7	R5	R5	--	--	Red	Red	Functional	
16/64	F	6/23/82	Pinguk R.	3	R64	R64	17207	17208	--	--	Not located, since 1/25/84	
18/61	F	6/23/82	Nuluk R.	3	R68	R68	17204	17203	--	--	Functional	1st transmission, 1/25/84

Appendix A. Continued.

Animal/ visual collar number	Sex	Date collared	Location	Approximate age at collaring	Plastic ear tag Nos. & color Left	Plastic ear tag Nos. & color Right	Metal ear tag nos. Left	Metal ear tag nos. Right	Horn streamer colors Left	Horn streamer colors Right	Radio status, January 1985	Remarks
19/--	M	4/12/84	Nuluk R.	8-10	R7	R7	17236	17236	Blk	Red	Functional	
20/63	F	6/23/82	Cooper Cr.	--	R63	R63	17205	17026	--	--	Functional	
21/--	F	10/18/83	Pinguk R.	15	R8	R8	10032	10031	--	--	Functional	L. horn broken at curve. Trans. from Nunivak, 1970
22/65	M	6/23/82	Pinguk R.	4	R65	R65	--	--	--	--	Functional	
23/--	M	4/13/84	Black Mt.	10+	R9	R9	--	17234	Red	Yel	Animal dead, 6/10/84	Scarred on left side
24/62	F	6/23/82	Nuluk R.	6	R62	R62	17201	17202	--	--	Functional	
34/--	M	10/27/83	Don R.	12+	R11	R11	17211	17212	Blk	Yel	Functional	
37/--	F	10/18/83	Pinguk R.	5-6	R14	R14	--	--	Yel	Blk	Functional	
39/--	F	4/12/84	Nuluk R.	10+	R15	R15	17238	17237	Red	--	Functional	Broken right horn
41/--	M	4/12/84	Nuluk R.	4	R16	R16	17234	17233	Blk	Red	Functional	
44/--	M	8/29/83	Solomon	2+	R1	R1	--	--	Red	Red	Functional	
45/--	M	4/13/84	Black Mt.	7+	R17	R17	--	17240	--	--	Not located since 5/03/84	
48/--	M	6/06/84	Kougarok R.	8-9	R19	R19	--	17241	Yel	Yel	Animal dead; 11/01/84	

[a] Does not include 4 muskoxen radio-collared in April 1984 that died within 3 weeks of handling.