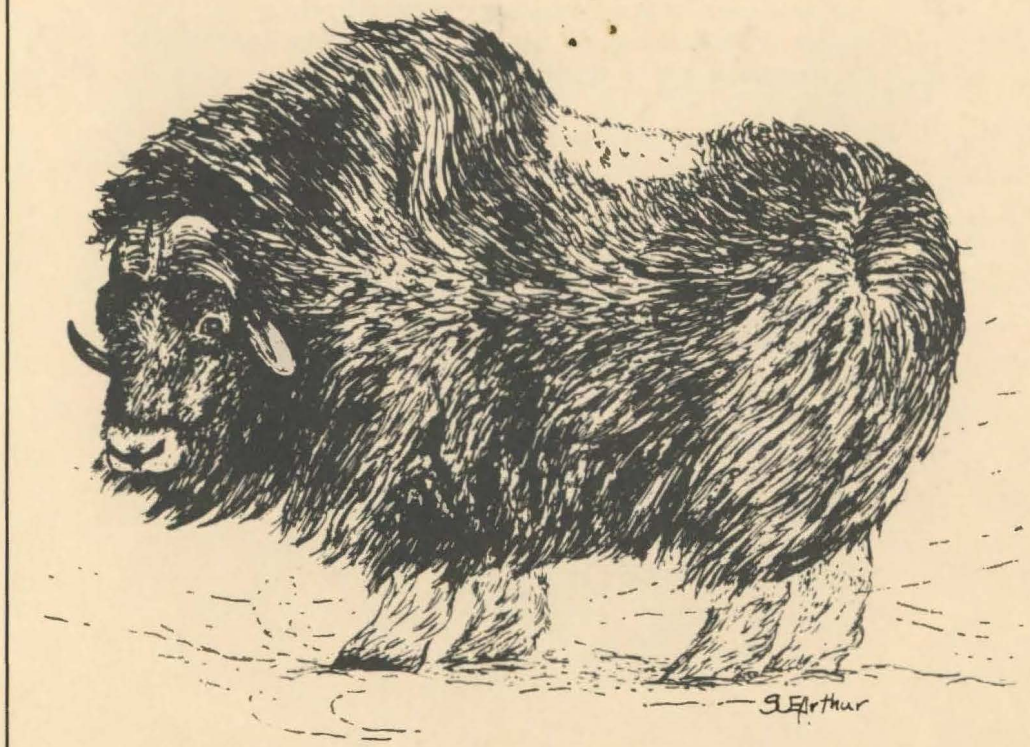
Alaska Department of Fish and Game
Division of Wildlife Conservation
Federal Aid in Wildlife Restoration
Annual Report of Survey—Inventory Activities
1 July 1987—30 June 1988

MUSKOX



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STATEWIDE HARVEST AND POPULATION STATUS

Muskox populations are found in Alaska on (1) Nunivak and Nelson Islands and on the adjacent mainland (Unit 18), (2) the Seward Peninsula (GMU 22), (3) the northwest coast near Point Hope (GMU 23), and (4) the eastern Arctic Slope (Subunits 26B and 26C). All herds (except the one on Nunivak Island) are the result of transplants between 1967 and 1970 from Nunivak Island. The animals found on the Yukon-Kuskokwim mainland are the result of emigration from Nelson Island.

The lichen range on Nunivak Island is critically overgrazed, because of the presence of 6,000 reindeer and 600 muskoxen on the island. Consequently, the muskox population objective for Nunivak is to reduce the herd to about 550 animals. Because this herd is characterized by high production and low natural mortality, we need to reduce it by increasing the harvest. Statistics on population size and harvest are given below.

The Nelson Island herd is dynamic; a considerable proportion of the population has emigrated to the mainland areas of Unit 18. Presently the objective is to maintain the herd at 250 animals. Recently there were only 120 muskoxen present on this island, down considerably from the 300 muskoxen reported for 1986-87. Thirty-six were harvested during the reporting period, equalling the harvest for the previous year.

The Seward Peninsula population has grown at an average annual rate of 19% since 1970, and it continues to expand into unoccupied habitat. Management objectives are still being developed for this herd. Recent population surveys showed that a direct count of 461 animals agreed very closely to a population estimate of 480 (± 132 at 95%) based on a mark-recapture census of collared animals. Muskoxen densities in this area averaged 1/32 mi^2.

The primary objective for muskoxen in GMU 23 is to maintain a healthy and viable population. The herd has increased slowly (1.5%/year), but calf production appears good (14%); the estimated population is at 123 animals. The Seward Peninsula (GMU 22) now supports over 4 times as many muskoxen as northern GMU 23; several factors are suspected for this disparity, including (1) differences in predation rates, (2) range nutritive quantity and quality, (3) climate, (4) human-induced mortality, and (5) dispersal.

The muskox population in GMU 26 has expanded and dispersed. Our overall objective for the unit is to determine the limits of muskox distribution by 1990 and estimate total herd size by 1992. Specific management objectives for Subunit 26B are to sustain a rate of increase of 10-20% per year until the herd reaches 200-300 animals and allow continued dispersal into suitable habitat. The management objective for Subunit 26C is

to also allow a sustained rate of increase of 10-20% per year; i.e., from 350-360 animals in 1987-88 to 600-800 by 1992. In addition, we want to maintain a ratio of 25-30 bulls:100 cows, allow continued dispersal of muskox into suitable vacant habitat, and permit the harvest of up to 15 bulls per year. In the spring of 1988, 410 muskox were counted (vs. 385 in 1987), representing an increase of 6.5%. Apparently, the herd is continuing to grow slowly, primarily because of low calf production. Bull:cow ratios have declined from 69:100 to 28:100 cows. Natural mortality is low, and the eastern Arctic range is still highly productive.

GMU/area	Estimated population	Hunting harvest		
		Male	Female	Total
18/Nunivak Island	609	34	31	65
18 Nelson Island	120+	15	15	30
18/Mainland	75-100	--	--	--
22/Seward Peninsula	527	--	--	--
23/Kotzebue Sound	123	--	--	--
26B, 26C/Eastern Arctic	410	5	--	5

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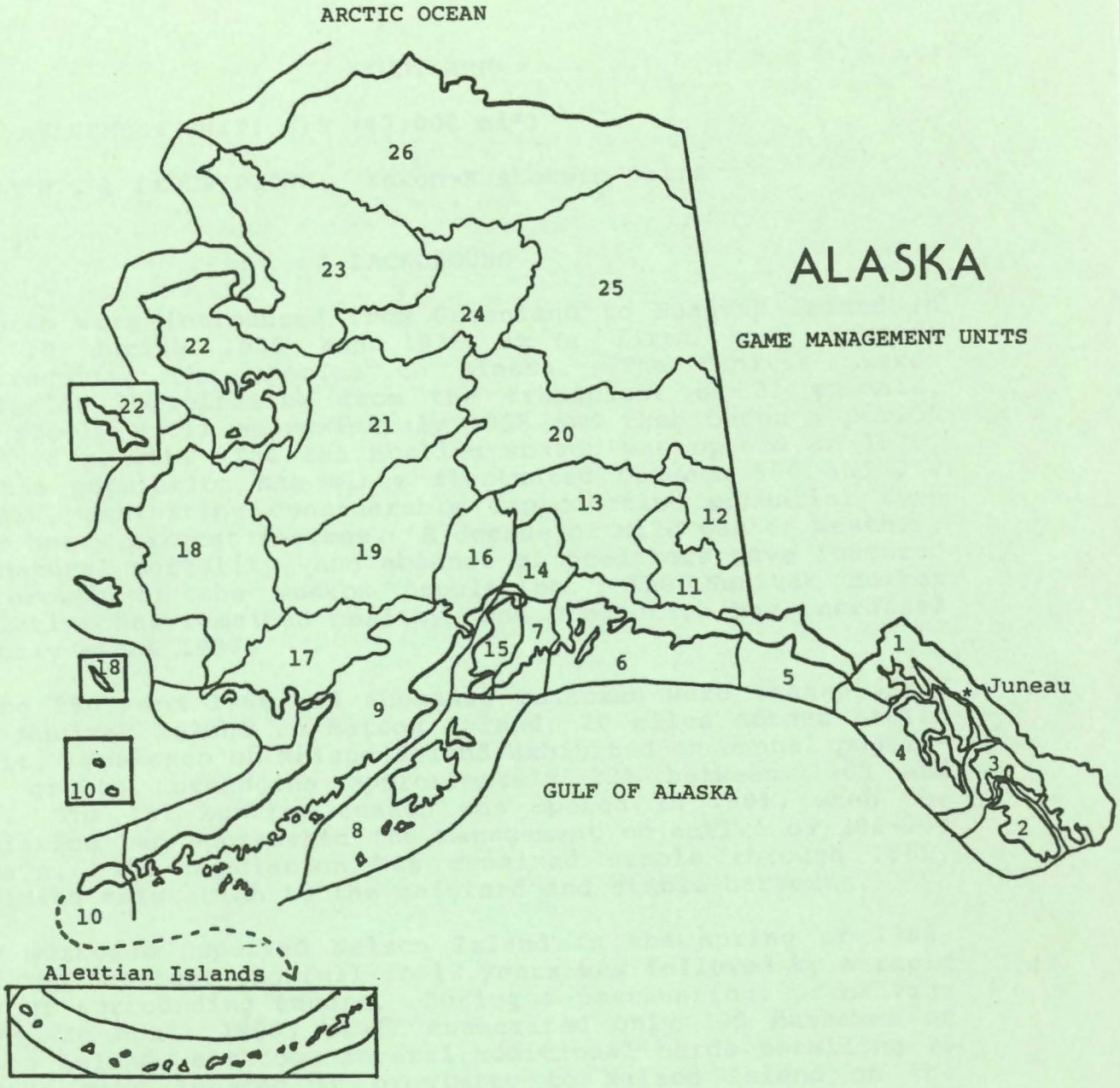
ARCTIC OCEAN
ALASKA
GAME MANAGEMENT UNITS
26
23
25
24
22
22
21
20
13
12
18
19
16
14
11
17
15
7
1
18
6
5
Juneau
9
4
3
10
GULF OF ALASKA
8
2
10
Aleutian Islands

STUDY AREA

GAME MANAGEMENT UNIT: 18 (42,000 mi²)

GEOGRAPHICAL DESCRIPTION: Yukon-Kuskokwim Delta

BACKGROUND

Muskoxen were introduced from Greenland to Nunivak Island in Unit 18 during 1935 and 1936 as a first step towards reintroducing the species to Alaska. The Nunivak muskox population, originating from the transplant of 31 animals, grew slowly until approximately 1958 and then began a period of rapid growth. The 1st hunting season was opened in 1975, and the population has since fluctuated between 500 and 750 animals, exhibiting considerable reproductive potential even under heavy harvest regimes. A decade of mild winter weather, low natural mortality, and absence of predators have fostered the growth of the muskox population. The Nunivak muskox population has remained healthy, and production has increased slightly since 1987.

During 1967 and 1968, 23 subadult muskoxen were transplanted from Nunivak Island to Nelson Island, 20 miles across Etolin Strait. Muskoxen on Nelson Island exhibited an annual population growth, averaging approximately 22% between 1968 and 1981. The 1st hunting season was opened in 1981, when the population had approached the management objective of 200-250 animals. The population has remained stable through 1986, providing emigration to the mainland and stable harvests.

Many muskoxen departed Nelson Island in the spring of 1988, when the heaviest snowfall in 12 years was followed by a rapid thaw of surrounding tundra. During a posthunting, precalving survey in April 1988, staff enumerated only 120 muskoxen on Nelson Island, although several additional herds totalling 25 animals were located in proximity to Nelson Island on the mainland. The current harvest of 30 animals per year may need to be reduced, if the size of the herd remains small.

As many as 75-100 muskoxen now reside on the mainland of the Yukon-Kuskokwim Delta. Muskoxen are widely distributed at very low densities in small herds from the mouth of the Kuskokwim River to the mouth of the Yukon River. Muskox calves were observed in several mainland herds in 1988, and the mainland population is expected to grow.

POPULATION OBJECTIVES

To reduce the Nunivak Island herd from the 1988 precalving population (i.e., 609) to 550 muskoxen.

To maintain the Nelson Island herd size at a minimum of 250 animals.

To increase the dispersed, very low density mainland population (i.e., 75-100 animals) to several thousand muskoxen so that colonization of suitable upland tundra regions of Unit 18, including the Andreafsky and Kilbuck Mountains, will occur.

METHODS

A combined aerial and ground census of the Nunivak muskox population was completed on 24-27 March 1988. The aerial census provided information on numbers and distribution of muskoxen, and the ground census provided data on sex and age composition. Snowmachines were used to traverse the perimeter of the island and some interior mountains, and 2 U. S. Fish and Wildlife Service (USFWS) aircraft were used to survey the entire island.

An aerial survey of the Nelson Island muskox population was conducted on 25 April 1988. The island was completely surveyed during a 3-hour flight.

RESULTS AND DISCUSSION

Population Status and Trend

The 1988 posthunting, precalving population estimate for Nunivak Island of 609 animals represented a slight increase from the 1987 estimate of 587 animals. Since 1975, when harvests were initiated, the size of the population has ranged from 500 to 750 muskoxen.

Future population projections for Nunivak muskoxen were generated, using a model developed by T. Smith (ADF&G biologist, Nome). Recruitment rates were calculated, using the ratio of the number of yearlings in a given year to the number of 3-year-old and older females counted the previous year. The average recruitment rate (0.54) for 1977-88 was used in the projection. Survival rates were approximated, using known values for recruitment, harvest, and transplant removal. The muskox population on Nunivak Island is expected to continue to grow, if harvest levels are maintained at current levels. A transplant in 1989 would depress the growth rate initially, but the population would rapidly recover and continue to grow, albeit at a slower rate if harvest rates remain unchanged (Hinkes 1988). If this population is to be reduced, harvest rates need to be increased. As the population is reduced to the management objective of 500-550 muskoxen, it appears capable of supporting several proposed

transplants as well as substantial harvests during the next few years.

During the years of light-to-moderate snow accumulation (i.e., 1981-87), the Nelson Island population remained stable to slightly increasing at approximately 250 muskoxen. While sustaining annual harvests during this period, the herd provided a nucleus for emigration to the mainland. Because of unusually heavy snowfall, many muskoxen emigrated off Nelson Island in 1988, reducing the herd size to approximately 120 animals.

Mainland muskoxen are descendants of the 23 muskoxen introduced to Nelson Island in 1967-68. Tidal inlets around Nelson Island freeze in November and remain frozen until late May, allowing unrestricted movement of muskoxen between Nelson Island and the mainland. In the spring of 1988, the heaviest snowfall since 1976 led to substantial emigration of muskox from Nelson Island; however, muskoxen have been sighted on the mainland of the Yukon-Kuskokwim Delta for the past 14 years.

Population Size:

Results of a census conducted in the spring of 1988 indicate that the size of the precalving, posthunting Nunivak population was at least 609 muskoxen. I estimate that the postcalving population numbered at least 700 muskoxen in the summer of 1988. A total of 60 groups, including 609 muskoxen, were observed during the aerial census, and 50 groups, including 536 muskoxen, were located during the ground census. Complete documentation of the census is available (Hinkes 1988).

Results of a survey conducted in April 1988 indicate that the precalving, posthunting population on Nelson Island numbered at least 120 muskoxen. The postcalving population is estimated at 150 muskoxen. At the time of the survey, an additional 25 animals were located in 4 herds nearby on the mainland. Several additional small herds were observed moving away from Nelson Island during March and April 1988. The heaviest snowfall since 1976 fell on Nelson Island in early 1988. Local residents reported snowfall in drifts up to 5 feet. Most of the traditional muskox foraging areas on northern and western Nelson Island were covered by several feet of snow. Several subadult muskoxen were reported wandering about Nelson Island without adults in March. Some adult females harvested during the regular hunting season in February and March had less back and mesenteric fat than usual and fetuses that appeared smaller than normal. We believe reported incidents reflected food stress and resulting herd

fragmentation. No natural mortality was reported, although several animals were observed limping.

The heavy snowfall on Nelson Island was followed by a rapid thaw in late March 1988, resulting in surrounding tundra areas becoming partially free of snow. Most of Nelson Island remained covered with deep snow, and nearly all of the muskoxen on Nelson Island at the time of the April survey were located on the snow-free, southwest-facing slopes of Cape Vancouver. The persistent late-winter snow caused muskoxen to move away from Nelson Island during March, April, and early May. These animals apparently dispersed across frozen tidal inlets to the mainland.

During a posthunting, precalving aerial survey conducted in May 1987, 150 muskoxen were counted. Because patchy melting snow and fog hindered visibility, survey staff believed that the count reflected poor sightability, rather than a decline in the muskox population. Although surveys for determining the size of the mainland population have never been conducted, periodic sightings by staff and the public indicate that mainland muskoxen number 75-100 animals.

Population Composition:

Composition data are available from the 1988 Nunivak Island ground census conducted during 24-27 March 1988. This census was hampered by equipment breakdowns and occasional blowing snow and white-out conditions. As a result, the island was not covered as extensively as desired and some muskoxen were not observed or classified by the ground survey crew.

We classified 79% (480 muskoxen) of the 536 muskoxen observed in 50 groups, ranging in size from 1 to 34 animals. Sixty groups were observed during the aerial census. The 1988 ground census enumerated 145 3-year-old and older cows; if this number accurately reflects the actual percentage in the total population, then I estimate that 184 3-year-old and older cows were present in the population in spring 1988, exceeding those believed present (i.e., 164) during the 1987 census. Because this group is more productive than younger-aged cows, an increase in their number may partially explain the continued growth of the herd, despite heavy harvests.

Distribution and Movements:

At the time of the 1988 census, the greatest concentration of Nunivak Island muskoxen ($\underline{n}$ = 339) occurred along the western coast from Nash Harbor to the mouth of the Chakawakamuit River

and along the southeast coast from the Bangookbit Dunes to Twin Mountain.

At the time of the April 1988 aerial census, Nelson Island muskoxen were concentrated (i.e., 96 animals) primarily on the southwestern slopes of Cape Vancouver, which was essentially the only snow-free area on the island. The remaining muskoxen (i.e., 24 animals) were scattered on the steep slopes northeast of Tununak. No muskoxen were observed on the remainder of the island.

Although local residents, pilots, and biologists have reported numerous sightings of mainland muskoxen over the last 14 years, the frequency of reports increased rapidly during the spring of 1988 (March to May). Muskoxen have been attempting to colonize both exposed upland and open-tundra areas on the mainland that are topographically and floristically similar to Nelson and Nunivak Islands. Observations of muskoxen have been concentrated in 3 general areas on the mainland: (1) low ridges in open steppe-like tundra southwest of Bethel, (2) the "mud volcanoes" east of Chevak, and (3) Askinuk Mountains near Scammon Bay. In these locations, winds blow the upland tundra partially free of snow during the winter periods. Additional dispersing muskoxen have been observed on the mainland east of the Kolavinarak River in 1988. Some of these herds remained near Nelson Island, and other muskoxen are believed to have moved across Baird Inlet. We suspect there are other unreported herds of muskoxen on the mainland north and east of Nelson Island.

Mortality

Season and Bag Limit:

The spring and fall hunting seasons for bulls on Nunivak Island are from 1 to 30 September and 15 February to 15 March, respectively, for both resident and nonresident hunters. The spring and fall hunting seasons for cows on Nunivak Island are from 1 to 30 September and 1 February to 15 March, respectively, for both resident and nonresident hunters. There is no subsistence hunting season for muskoxen in Unit 18. The bag limit is 1 bull by drawing permit only or 1 cow by registration permit only. Five and 30 permits are issued for the fall and spring bull seasons, respectively. Thirty-five registration permits for cows are issued on a first-come, first-served basis.

The hunting season for bulls and cows on Nelson Island are from 1 February to 15 March. The bag limit is 1 muskox by registration permit only. Fifteen bull and 15 cow permits are

issued on a first-come, first-served basis. There is no open season on muskoxen for the remainder of Unit 18.

Human-induced Mortality:

Five drawing permits for bulls and 5 registration permits for cows were available to hunters during fall 1987. The 5 drawing permittees were notified in mid-July of their eligibility to hunt bull muskox in fall 1987. All 5 permittees elected to hunt, and each one harvested a muskox during the September season.

Five cow registration permits were available on a first-come, first-serve basis in Mekoryuk on 30 August 1987. All permits were applied for, and all 5 hunters harvested cow muskoxen during the fall season.

The names of 30 permittees were drawn for the bull muskox spring hunt on Nunivak Island. The waiting list of 109 alternate permittees was indicative of the continuing popularity of this hunt. In an effort to fill all unused permits, an additional 17 permittees from the alternate list were contacted. All 29 persons who eventually hunted were successful.

Seventeen registration permits for the spring cow hunt were available on 29 January on a first-come, first-serve basis in Mekoryuk. An additional 8, 3, and 2 permits were available in Bethel, Anchorage, and Fairbanks, respectively, on the same day. All 17 cow permits available at Mekoryuk were issued to local residents; 4 people remained on a waiting list. One person on the waiting list later received a permit.

The demand for the 8 permits issued at Bethel was remarkably high. The 1st person in line signed up at 0900 hours the morning before and remained 23 hours in line. The sign-up list contained 8 names by 2000 hours. Potential applicants could not leave the immediate area, and thus 8 people spent the night waiting inside the office building.

The demand for the 2 permits issued at Fairbanks was likewise high. The 1st applicant arrived at 2130 hours the evening before and slept on the front steps of the ADFG office wrapped in an electric blanket plugged into a car heater in extremely cold weather (i.e., -36 F). Four additional people were in line at 0730 hours, and 2 others appeared at 0815 hours. Only 3 of the 4 permits available in Anchorage were issued, and the remaining unutilized permit was transferred to Mekoryuk.

Hunters harvested 65 muskoxen during the fall of 1987 and spring of 1988 from Nunivak Island; i.e., 34 bulls and 31 cows. Thirty registration permits for Nelson Island muskoxen

(i.e., 15 bulls and 15 cows) were issued at the Nightmute Community Center on 21 January 1988. Because of poor weather, we could not travel to Nightmute on 20 January to hold an informational meeting in advance of permit issuance. All permits were issued the next day; no one was on a waiting list. These hunters attended a bilingual orientation on the identification of the age and sex classes of muskoxen, and all were successful during the course of the hunting season (i.e., 1 February to 25 March).

An additional 4 muskoxen from a herd of six were illegally harvested west of the village of Kwigillingok near the mouth of the Kuskokwim River in early May 1988. This case is currently under investigation.

Harvest Chronology:

Most of the spring harvest of muskoxen on Nunivak Island occurred immediately after the season opened and immediately before the the season closed. The severe weather during late February and early March 1988 in Unit 18 consisted of wind-chill factors to -75 F, heavy drifting snow, and white-out conditions. Hunter activity was minimal under these circumstances. Aircraft could not depart to Nunivak Island, and arriving hunters were stranded in Bethel for up to 4 days. On Nunivak Island the activities of several bull hunters were also curtailed.

Harvest chronology on Nelson Island in 1988 was influenced by similar weather conditions. Most muskoxen were harvested during the milder weather that occurred in mid- to late March.

Hunter Residency and Success:

Most (77%) drawing permittees were residents of Southcentral Alaska (i.e., primarily Anchorage). The remainder were residents of Interior and Southeast Alaska, and 1 hunter was a resident of Dillingham. No nonresidents harvested muskoxen in Unit 18 during the reporting period.

Four of the 5 cow registration permits available in fall 1987 were issued to Mekoryuk residents. The other permit was issued to a Southcentral Alaska resident.

All 17 cow muskox permits available at Mekoryuk for the spring 1988 hunt were issued to local residents. Of the 8 cow registration permits available at Bethel, seven were issued to Bethel residents and one was issued to a Lower Kalskag resident. Both permit holders who picked up a registration permit in Fairbanks were from the Fairbanks area. The 3 permits issued in Anchorage were taken by individuals from Valdez, Chugiak, and Anchorage.

Of the 30 muskox registration permits available at Nightmute, 29 were issued to Nelson Island residents and 1 permit was issued to a Bethel resident. Nightmute residents received 14 permits, Toksook Bay 9, Newtok 3, and Tununak 3.

Success rate for all hunters entering the field was 100%. Most muskox cow hunters on Nunivak Island were able to complete their hunts in 1 day. Hunters on Nelson Island were also able to complete their hunts in 1 day. Muskox bull hunters on Nunivak Island were more selective, taking 2 to 3 days to complete their hunts in good weather.

Transport Methods:

Boats were used as transportation for fall muskox hunting on Nunivak Island, and most hunting was concentrated along the shoreline. Snowmachines were used as transportation for the late-winter muskox hunts on both Nelson and Nunivak Islands, providing access to nearly every point on the islands.

Natural Mortality:

Information on natural mortality of muskoxen in Unit 18 is limited. A few muskoxen on Nunivak and Nelson Islands have fallen off cliffs each year. Small groups have been occasionally stranded on drifting sea ice around Nunivak Island and have perished. Several muskoxen have reportedly fallen through ice over thawing streams on Nelson Island in recent years. A single frightened muskox calf plunged into an open lead in the ice pack off southwest Nunivak Island at the time of the annual muskox survey in March 1988; the animal did not reappear.

The most significant source of natural mortality on Nunivak Island has been heavy snowfall followed by repeated cycles of freezing and thawing. Such environmental conditions make foraging difficult and may have caused more than 100 muskoxen to perish on Nunivak in 1969 and 1970. Extensive natural mortality has not been since reported.

There are no natural predators on Nunivak Island. Sightings of brown bears are occasionally reported on the east side of Nelson Island, but no predation on muskoxen has been observed. Brown bears are common only in the mountainous areas in northern and eastern portions of Unit 18. Mainland muskoxen have not yet reached these areas in any numbers. Wolf numbers in Unit 18 have increased slightly, although predation on mainland muskoxen has not yet been reported.

Habitat

The lichen range on Nunivak Island is considered critically overgrazed by U.S. Soil Conservation Service (SCS) staff.

There are now over 6,000 reindeer and an expected postcalving population of 700 muskoxen on Nunivak Island. The privately owned reindeer herd needs to be drastically reduced in size; ADFG and USFWS biologists have agreed to reduce the muskox population to a management guideline of 550 muskoxen by increasing harvest.

Large areas of upland tundra in Unit 18 appear capable of supporting at least several thousand muskoxen. If muskox transplants were proposed, the Lower Yukon Coastal Mayor's Association has suggested that an evaluation and inventory of the habitat be conducted.

Game Board Actions and Emergency Orders

In 1984, at the recommendation of Department staff, the Board of Game increased the Nunivak muskox harvest quota from 45 cows and 30 bulls to 50 cows and 35 bulls. The harvest was increased to reduce the herd and avoid winter mortality. This quota was maintained through 1986, when the Board of Game lowered the harvest to 35 bulls and 35 cows, again at the request of Department staff. At that time, we believed the Nunivak herd had been reduced to management guideline objectives and the growth rate stabilized.

CONCLUSIONS AND RECOMMENDATIONS

The Nunivak Island range survey conducted by the U.S. Soil Conservation Service was published in 1986 (Swanson et al. 1986). This report indicated the lichen range on Nunivak was overgrazed and suggested the size of both reindeer and muskox populations be reduced. We maintained this was largely a reindeer-induced problem; however, we remained open to further discussion. The results of the 1988 Nunivak Island census indicated approximately 50 more muskoxen than expected. The Nunivak Island muskox herd is characterized by high productivity and low natural mortality. ADFG staff will recommend that the muskox harvest be increased to 45 bulls and 45 cows; however, this bag limit should be reduced when the posthunting, precalving population reaches our management objective of 550 animals. Muskox transplants could also be conducted to remove surplus animals. The Nunivak Island muskox population is an important natural resource, and it can provide considerable beneficial uses on a sustained-yield basis.

The Nelson Island muskox population is dynamic; recently, a considerable proportion of the herd emigrated to the mainland areas of Unit 18. The heaviest snowfall since 1976 on Nelson Island led to substantial emigration in spring 1988, when the surrounding tundra became free of snow during a rapid thaw. While providing regular harvest and some emigration to the mainland, the Nelson Island population, which numbered

approximately 150 animals in spring 1988, remained stable at over 200 animals from 1981 to 1986. The current harvest level of 30 animals per year may need to be reduced if the population fails to increase in size; moreover, our management objectives should be reviewed annually to ascertain if they are realistic.

As many as 75-100 muskoxen now reside on the mainland portion of Unit 18. Muskoxen are distributed in small herds at very low densities in upland habitat between the Yukon and Kuskokwim Rivers. Calves were observed in several mainland herds in 1988. We anticipate that the mainland population will continue to grow and expand its range. Expanded survey and inventory efforts are recommended on mainland muskoxen. Hunting should remain closed on the mainland for the foreseeable future to allow the population to expand and colonize suitable habitat, including the Andreafsky and Kilbuck Mountains.

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STUDY AREA

GAME MANAGEMENT UNIT: 22 (B, C, D, and E) and 23 (17,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Seward Peninsula

BACKGROUND

Thirty-six and 35 muskoxen were reintroduced to the Seward Peninsula in 1970 and 1981, respectively. The transplanted animals were obtained from the Nunivak Island population, which was originally derived from eastern Greenland stock. Muskoxen soon occupied most of the Seward Peninsula, and annual population growth has exceeded 20% in some years. The Seward Peninsula population serves as an important center for expansion into surrounding areas unoccupied by muskoxen.

POPULATION OBJECTIVES

Work is underway to establish population objectives for muskoxen on the Seward Peninsula.

METHODS

Methods used to census the Seward Peninsula muskox population were described previously by Smith (1987). Approximately 11,780 mi^2 of muskox habitat was divided into 9 census areas, ranging in size from 805 mi^2 to 1,975 mi^2; each area was surveyed using aircraft. Various combinations of aircraft and crews were used during the survey: (1) Supercub with pilot and observer, (2) Cessna 180 with pilot and 2 observers, (3) Cessna 180 with pilot and 1 observer, and (4) Cessna 185 with pilot and 2 observers. Irregular transects were flown over each crew's assigned census areas in order to locate all muskoxen within the area in 1 day (5.0-7.5 hours of flight time). Small groups of muskoxen (1-15) were counted visually. Larger groups were photographed using 35-mm SLR cameras and color transparency film; lenses with focal lengths of 90-136 mm were optimum.

RESULTS AND DISCUSSION

Population Status and Trend

The Seward Peninsula muskox population has grown at an average annual rate of 19% since 1970, and the vast area of apparently suitable, unoccupied habitat suggests that continued growth can be anticipated.

Population Size:

The Seward Peninsula muskox population was censused in 1983, 1984, 1985, and 1988 (Table 1). The aerial photocensus conducted on 10-15 April 1988 resulted in a minimum count of 527 muskoxen. The 1984, 1985, and 1988 counts probably represented the actual size of the population. The 1983 count may have underestimated the actual size of the population by 10-15 animals (Smith 1986). These data indicate a 25% annual rate of increase from 1985 to 1988, remarkable for a species characterized as having a low reproductive potential. The following factors contributed to the success of the April 1988 census:

1. A stratified, random-sample aerial census of the moose population in Subunit 22D was conducted on 8-15 March 1988, prior to the muskox census. Moose census personnel also recorded the number of muskoxen observed, providing intensive coverage of an area increasingly utilized by muskoxen.

2. Unusually complete and heavy snow cover enhanced sightability and reduced mobility of muskoxen.

3. Considerable effort was made prior to the muskox census to locate and radio-collar additional animals, a critical element in this type of census (Smith 1987).

4. Since the original transplant in 1970, reports of muskox sightings by the public have served as an invaluable source of information. These reports were also another means of locating groups of muskoxen for radio-collaring and defining the population's range.

Based on these sources of information and the results of regular radio-tracking flights, a line was drawn from Candle on Kotzebue Sound to Moses Point on Norton Sound. The area west of this line (i.e., designated as the study area) was intended to include the range of nearly all muskoxen on the Seward Peninsula. Although some muskoxen undoubtedly occur east of this line, densities in this area were too low for existing survey methods to be effective, and I believe that few animals were missed. Additionally, a 5,326-mi^2 area in the central Seward Peninsula, including the Fish River flats and western half of the Kigluaik Mountains, was eliminated from the census area because I anticipated that very few muskoxen would be found there that had not been previously located during the moose census. This decision was based on the recent intensive coverage obtained during the moose census in Unit 22D, the paucity of sightings by the public within the area, the known home ranges of radio-collared animals, and the judgment that much of the habitat was not favorable for muskox

Table 1. Active radio collars, estimated population size, and percentage of radio-collared muskoxen at time of April census, 1983-88.

Year	Active radios	Population census	% Radio-collared animals
1983	7	175[a]	4
1984	14	225	6
1985	16	271	6
1988	31	527	6

[a] Corrected for animals missed. See text.

occupancy in late winter (i. e., mountainous or heavily forested). The remaining 11,780 mi^2 was subdivided into 9 census areas, ranging in size from 805 mi^2 to 1,975 mi^2.

A direct count estimate was obtained by summing the number of animals (1) observed by census crews, (2) located by radiotelemetry within the survey area but missed during the census, and (3) located outside the survey area by radiotelemetry or by moose census personnel. In order to measure sightability and completeness of coverage, census crews were not told the location of radio-collared animals (n = 31). After an area was visually searched, an aircraft equipped with telemetry equipment located groups that included radio-collared animals; any groups missed in the initial survey were noted. In addition, radio-collared animals were used to test the usefulness of a mark-recapture technique (Lincoln index) for estimating population size. Groups that included one or more radio-collared animals were considered marked, and those groups that did not were considered unmarked. A group was recaptured when it was located during the survey without the use of telemetry. Applying the survey results to standard mark-recapture formulas provided an estimate of the number of groups within the study area and a confidence interval (CI) around the estimate. Multiplying the extrapolated number of groups by the mean group size (marked and unmarked) produced an estimate of population size. The mark-recapture method was only applied to the 11,780 mi^2 systematically surveyed, whereas the direct count of 527 muskoxen provided above includes all animals seen within the 17,106-mi^2 study area. The mark-recapture extrapolation produced an estimate of 480 $\pm$ 132 (95% CI). The direct count method located 461 muskoxen in the same area.

Muskox densities in the 9 census units ranged from 1 muskox/6 mi^2 to 1 muskox/988 mi^2, excluding 1 unit where no animals were found. The overall density within the entire census area was 1 muskox/32 mi^2.

Population Composition:

Surveys of groups with radio-collared animals conducted on 19 May and 4 June 1988 determined a calf percentage of 18% (n = 112). This figure may have underestimated actual calf production because calving continued beyond the date of these surveys. Additionally, 15 of the 21 radio-collared animals were adult bulls that tended to separate from mixed-sex herds in spring and remain alone or form all-male groups. Thus groups that included no calves probably were disproportionately represented in the sample.

The winter conditions in 1987-88, which were the most severe since 1981 in terms of depth, hardness, and duration of snow cover, may have adversely affected the survival of neonate calves. Twenty-four muskoxen that wintered in an area with particularly severe snow conditions (i.e., near the head of the Koyuk River) were obligated to crater through 30-45 cm of compact snow, including icing layers. This area was still covered in snow during the 1st week of June; most areas used by muskoxen had melted out 3 weeks earlier. This herd produced no surviving calves in 1988. Three 3-year-old females that wintered in an equally harsh area near the headwaters of the Kuzitrin River were found to be in extremely poor condition when captured for radio-collaring on 25 May. Two of these cows gave birth to calves but subsequently lost them. The implications of winter range selection for muskoxen were discussed previously (Smith 1988).

It is obvious that estimates of productivity reported in previous progress reports have consistently underestimated actual population performance, in light of the minimum rates of increase observed. More accurate estimates could be obtained by a more systematic sampling scheme and more survey effort.

Mortality

Season and Bag Limit:

There are no open seasons in Unit 22.

Natural Mortality:

Two radio-collared bulls and 3 radio-collared cows (i.e., 16% of all radio-collared animals) died in the spring and summer of 1988, the highest rate of mortality among instrumented animals observed since radiotelemetry work was initiated in 1981. In addition, an unscavenged dead animal was observed during the April census. Unusually high morbidity and mortality were observed among moose and reindeer on the Seward Peninsula in 1988 as a result of severe winter conditions, and muskoxen that had been handled during radio-collaring in March were in extremely poor physical condition. Extrapolating the mortality rate of radio-collared muskoxen to the general population is probably not valid, because several of the radio-collared animals that died were old (14-19 years). Other data are not available for estimating actual adult mortality, but it was higher than normal. Neonate calf survival may have also been reduced, because of the poor condition of females at parturition.

CONCLUSIONS AND RECOMMENDATIONS

Although severe winter conditions in 1987-88 may have increased adult mortality and reduced calf survival, the Seward Peninsula muskox population continued to grow and expand its range. A census in 1988 produced a minimum count of 527 animals.

The muskox program on the Seward Peninsula is a high-profile success for management that enjoys considerable support from the public, as demonstrated by the numerous sighting reports turned in by individuals and the favorable comments relayed in general interactions with people in the Nome office and surrounding villages. Muskoxen were reintroduced to the Seward Peninsula as part of a larger program to reestablish their populations throughout suitable range in Alaska. The goals of this program were spelled out when it was initiated in 1929, but a detailed management plan has not been developed. If a management plan for Alaskan muskoxen was written today, it would need to retain considerable flexibility, because our understanding of muskox ecology is still rudimentary and experience in dealing with this species at densities approaching carrying capacity is not available. Muskox populations in parts of Canada and Greenland, which had been depleted nearly to the point of extinction around the turn of the century, have recently been restored to preimpact levels. Experience gained in managing these populations will benefit efforts to plan for future expansion of Alaskan muskox populations. I believe it is essential to maintain the statewide perspective concerning future planning and implementation that was present when restoration of muskoxen was proposed. The 5 muskox populations in Alaska should not be managed independently, but as components of an overall program. A general management framework could be developed with provision for refinement, as muskox numbers increase and knowledge of population dynamics at more natural population densities develops.

A final report summarizing results of research carried out on muskoxen on the Seward Peninsula from 1983 to 1987 was produced during this reporting period (Smith 1987). This report discussed growth of the population, census methodology, and methods for chemical immobilization of muskoxen. I concluded that the Seward Peninsula muskox population is homogenous and not composed of the isolated subpopulations that had been previously hypothesized.

Two papers were presented before the 2nd International Muskox Symposium in Saskatoon, Saskatchewan (1-4 October 1987): "The Status of Muskoxen in Alaska" and "The Role of Bulls in Pioneering New Habitats in an Expanding Muskox Population on the Seward Peninsula." The former presented current information on numbers and distribution of Alaskan muskox

populations. The latter provided evidence for a much different interpretation of the significance of distant movements of bulls than had been previously suggested, concluding that adult bulls are the leaders of permanent range expansion.

Acknowledgement

Nearly all of the operating funds for FY88 for muskox research and survey-inventory activities on the Seward Peninsula were provided by the National Park Service under Cooperative Agreement No. CA 9700-6-8021. In addition, Park Service personnel participated in routine radio-tracking flights, muskox capture operations, and the census.

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PREPARED BY:

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Submitted by:

Steven Machida
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STUDY AREA

GAME MANAGEMENT UNIT: Northern 23 (43,000 mi²)

GEOGRAPHICAL DESCRIPTION: Northern Kotzebue Sound and western Brooks Range

BACKGROUND

Following their extirpation in the 1800's, muskoxen were absent from Unit 23 until 1970, when 36 were transplanted from Nunivak Island to Cape Thompson. A second transplant from Nunivak Island (i.e., 34 muskoxen) took place at Cape Thompson in 1977.

In an effort to determine the herd's movements and distribution, radio collars were placed on 2 muskoxen in September 1983. In 1986 one of the 2 existing collars was replaced and 5 additional muskoxen were radio-collared in the Kukpuk River area and in the vicinity of Rabbit Creek.

In June 1981, 76 muskoxen were counted in northern Unit 23, and in 1985 100 animals in 4 separate groups were counted. In May 1988 a comprehensive census conducted for the first time in northern Unit 23 resulted in a minimum count of 123 muskoxen.

POPULATION OBJECTIVES

To establish and maintain a healthy and viable muskox population in Unit 23.

METHODS

Radiotelemetry has been used to obtain movement and distribution information for muskoxen in northwest Alaska. There are presently 7 radio collars on muskoxen in the northern portion of Unit 23.

On 17-19 May 1988 a comprehensive muskox census was conducted between the mouth of the Noatak River and Cape Lisburne. This area was broken down into 10 separate survey areas. Survey areas ranged in size from 220 mi² to 368 mi² (Table 1); however, the northern half of area No. 1 was not surveyed because of high winds and cloud cover. For the same reason, a portion of area No. 2 was not surveyed. Survey times varied from 1 to 5.5 hours. Five aircraft and 12 people were involved in the census (Table 2). A pilot and observer team surveyed from each of 2 Piper PA-18's and a PA-12. A pilot with 1 to 2 observers surveyed from each of 2 Cessna 185's.

Table 1. Survey area sizes and times for Unit 23 muskox census 17-19 May 1988.

Date	Survey area No.	Area size (mi^2)	Survey time (hrs)	Min/mi^2
5/18	1[a]	222	1.0	0.3
5/18	2[a]	220	3.5	0.9
5/17	3	310	2.9	0.6
5/17	4	350	3.9	0.7
5/17	5	368	5.5	0.9
5/18	6	331	2.7	0.5
5/19	7	295	3.7	0.8
5/17	8	341	4.4	0.8
5/19	9	316	---	---
5/18	10	279	2.8	0.6

[a] These areas were not completely surveyed because of high winds and cloud cover.

Table 2. Aircraft type, participants, and number of muskox counted during Unit 23 muskox census, 17-19 May 1988.

Survey area No.	Aircraft type	Pilot/Observer(s)	Muskox	
			Adults	Calves
1	C-185	Smith/Koonuk, Kowunna	23	0
2	PA-12	Larsen/Tuzroyluk	0	0
3	C-185	Smith/Kowunna	10	2
4	PA-12	Larsen/Tuzroyluk	35	11
5	PA-18	Rood/Bunn	10	0
6	PA-18	Rood/Bunn	2[a]	0
7	PA-12	Larsen/Larsen	26	4
8	PA-18	Yoder/Nelson	0	0
9	C-185	Smith/Doyle, Karmun	0	0
10	C-185	Yoder/Nelson	0	0
TOTAL			106	17

[a] These muskoxen were missed during the actual survey but were spotted later by a survey pilot returning to Kotzebue from Point Hope.

Areas were intensively searched, and observations of muskoxen were recorded on 1:250,000-scale maps. Muskoxen were classified as either adults (1 year old and older) or calves-of-the-year.

RESULTS AND DISCUSSION

Population Status and Trend

Muskox numbers in northern Unit 23 have increased very slowly following their reintroduction. Assuming that the minimum number of muskoxen present following the 2nd transplant in 1977 was 71, the minimum population size in 1988 was 123, an increase of only 52 muskoxen. This represents an average annual rate of increase of only 1.5%. Despite this slow increase, there is no reason to believe that the age structure of the population has not remained stable. Annual calf production appears to be good.

Population Size:

One hundred twenty-three muskoxen (106 adults and 17 calves) were counted during the 3-day census in northern Unit 23 (Table 2). Sightability of muskoxen during the census was relatively good; however, on 3 separate instances, muskoxen were missed or would have been missed had not past knowledge of distribution and some luck been a factor. A week before the survey, a group of 13 adults and 5 calves were located near Cape Thompson (i.e., survey area No. 4) using radiotelemetry. During the survey, however, they were not spotted until extra searching was done. In another instance, a pilot-observer team surveying area No. 6 missed 2 muskox bulls adjacent to the Wulik River. By chance, another pilot-observer team returning from Point Hope via the Wulik River spotted the 2 bulls. In a 3rd instance, a pilot-observer team surveying area No. 7 missed a group of 10 adults and 3 calves near Rabbit Creek that were found later using radiotelemetry. Without luck, use of radiotelemetry, and previous knowledge, 25 adults and 8 calves would have been missed. This constitutes 23% and 47% of all observed adults and calves, respectively.

Population Composition:

Of the 123 muskoxen observed during the census, 17 were calves (14%). Yearling recruitment could not be determined because of the difficulty distinguishing yearlings from 2-year-olds. Adult bulls and cows were likewise not differentiated during the census, because all observations were made from aircraft. Future attempts should be made to conduct ground-based surveys to obtain accurate sex and age composition data.

Distribution and Movements:

Muskoxen in Unit 23 have dispersed north, south, and east from their original transplant-release site at Cape Thompson. Most of the muskoxen were distributed along the northwest coast of the unit between Cape Krusenstern and Cape Lisburne. Major concentrations were located at Cape Thompson, the lower Kukpuk River, and Rabbit Creek in the Mulgrave Hills. Isolated reports of 1 to 2 adult bull muskoxen in the Nimiuktuk and upper Kobuk River drainages have been received during the past 5 years (i.e., 1984-88). Additionally, people have reported seeing muskoxen in the vicinity of Selawik, Deering, and Buckland. These muskoxen are believed to have moved north from transplant sites on the Seward Peninsula.

Mortality

Season and Bag Limit:

There is no open season in Unit 23.

Human-induced Mortality:

Although muskox hunting is prohibited in Unit 23, we know of several that were killed by hunters during the past several years. Although no reports of dead muskoxen were received during the reporting period, human-induced mortality is nonetheless suspected of significantly impacting the growth of the herd.

CONCLUSIONS AND RECOMMENDATIONS

The census conducted in the Cape Thompson area coincided with a similar census conducted further south on the Seward Peninsula. Although the original transplants to the Seward Peninsula and Cape Thompson were nearly identical in number, the Seward Peninsula now supports over 4 times as many muskoxen as northern Unit 23.

Factors suspected of contributing to this disparity include (1) differences in predation rates, (2) range nutritive quantity and quality, (3) climate, (4) human-induced mortality, and (5) dispersal. The extent to which each of these factors contributed to the low growth rate is unknown. Substantial staff time and funding would be needed to adequately explore them. In my opinion, this would be a worthwhile graduate study project. However, in the absence of such a study, I recommend that 1 additional muskox be radio-collared in each of the known groups that do not presently have a collared animal. This would amount to approximately 11 additional collared animals.

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SUBMITTED BY:

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STUDY AREA

GAME MANAGEMENT UNIT: 26B and 26C (26,000 mi²)

GEOGRAPHICAL DESCRIPTION: Central and eastern Arctic Slope

BACKGROUND

Muskoxen have lived in association with tundra regions in Alaska since their arrival in North America via the Bering Land Bridge during the late Illinoian Ice Age (Gunn 1982). At their peak, muskoxen were scattered across the North Slope and apparently abundant in local areas. Archaeological evidence suggests that as Nunamiut Eskimos colonized northern Alaska they eliminated large groups of muskoxen (Garner and Reynolds 1986). Eskimos armed with rifles obtained from whalers finally extirpated muskoxen in Alaska between 1858 and 1865 (Garner and Reynolds 1986).

Muskoxen were reintroduced to Alaska when animals from Greenland were transplanted to Nunivak Island in the 1930's. The populations in Subunits 26B (Kavik River, Arctic National Wildlife Refuge [ANWR]) and 26C (Barter Island) were established by subsequent transplants totalling 64 muskoxen from Nunivak Island in 1969 and 1970, respectively. The purpose of this effort was to reestablish the species on its historic range and provide opportunities for high-quality recreational hunting (Boertje 1984).

The eastern Arctic muskox population has expanded and dispersed. Those subpopulations remaining in the vicinity of the original transplant (Subunit 26C) can now support limited hunting opportunities for bull muskoxen. Those that have colonized new areas to the east and west are still in need of full protection as they establish themselves as residents. Under the terms of state and federal subsistence laws, the Board of Game reviewed the history of muskoxen and found that there were no rural residents who had customarily and traditionally used muskoxen in Unit 26; accordingly, there is no subsistence hunting season. Under the revised draft management plans for muskoxen in the eastern Arctic (ADF&G 1976, Bos 1980), the management goal is to provide for diversified recreational uses of wildlife. The primary and secondary strategic objectives, respectively, are to provide the opportunities to hunt muskoxen under aesthetically pleasing conditions and view and photograph them.

MANAGEMENT OBJECTIVES

Unit 26

To assess progress toward long-term goals by determining the limits of muskox distribution by 1990.

To estimate total herd size by 1992.

Subunit 26B

To provide a sustained rate of increase of 10-20% per year in the precalving muskox population until the herd reaches 200-300 animals.

To allow continued dispersal of muskoxen to suitable vacant habitats.

Subunit 26C

To provide a sustained rate of increase of 10-20% per year in the precalving muskox population from the present 350-360 animals to 600-800 by 1992.

To provide a sustained ratio of at least 25-30 bulls:100 cows.

To allow continued dispersal of muskoxen to suitable vacant habitats.

To provide the opportunity to harvest up to 15 bull muskoxen under aesthetically pleasing hunting conditions.

METHODS

Herd Management

Precalving muskox surveys were conducted during the 1st week of April 1987 in Subunits 26B and 26C by U.S. Fish and Wildlife Service (USFWS) biologists. The 1987 postcalving count was not conducted because of bad weather.

Composition counts were also conducted by USFWS biologists in Subunit 26C. During the 1st week of July 1987, groups of muskoxen were located from the air by helicopter and then classified from the ground as young bulls, adult bulls, cows, calves, and yearlings.

Hunter Management

Mandatory hunt reports for the spring 1988 permit hunt were analyzed.

RESULTS AND DISCUSSION

Population Status and Trend

The muskox population across the eastern Arctic has been in an eruptive growth phase since shortly after the 1970 transplant (Garner and Reynolds 1986). From 1972 to 1986, the number of muskoxen counted in Subunit 26C increased at an average annual rate of 20% (Fig. 1). The lower number of muskoxen counted in Subunit 26C in 1986 and 1987 was probably due to emigration to Subunit 26B.

Muskoxen were first observed in Subunit 26B in 1983, and the population grew slowly until 1986-87, when it increased sharply by 500-600% (Fig. 1) because of immigrations from Subunit 26C. During this reporting period, there was a slight decline in the numbers of muskoxen observed in Subunit 26C. The contrasting patterns of herd growth in Subunits 26B and 26C during 1986-88 imply there may have been significant movement of animals between these subunits.

The total muskox population trend in Unit 26 continues upward; however, the rate of increase may be decreasing, as indicated by the total counts in 1987 and 1988. As muskoxen continue their dispersal, obtaining an accurate total count becomes more difficult. The apparently decreasing rate of increase could be due to several factors, including inconclusive surveys, decreased productivity, or increasing mortality.

Population Size:

During precalving aerial surveys of Subunits 26B and 26C, biologists from the USFWS counted 410 muskoxen in 1988, representing an increase of only 6.5% over the 385 counted in 1987. Postcalving counts of the total herd have not been conducted since 1986 (Table 1). Subunit 26C maintains the core of the population in the areas of the Tamayariak, Sadlerochit, and Okerokovik Rivers.

The muskox population in Unit 26 continues to grow (Table 1); however, the rate may be declining. Muskoxen in the eastern Arctic have become more difficult to census in the last few years because of their increased dispersal. Greater survey effort will be needed to monitor population growth in Subunits 26B and 26C.

Population Composition:

During composition counts (Table 2) in July 1987, staff located 339 muskoxen, representing approximately 80% of the population (P. Reynolds, pers. commun.). Between 1984 and 1987, male:female ratios (i.e., all ages) declined from 88:100 to 49:100 and bull:cow ratios declined from 69:100 to 28:100.

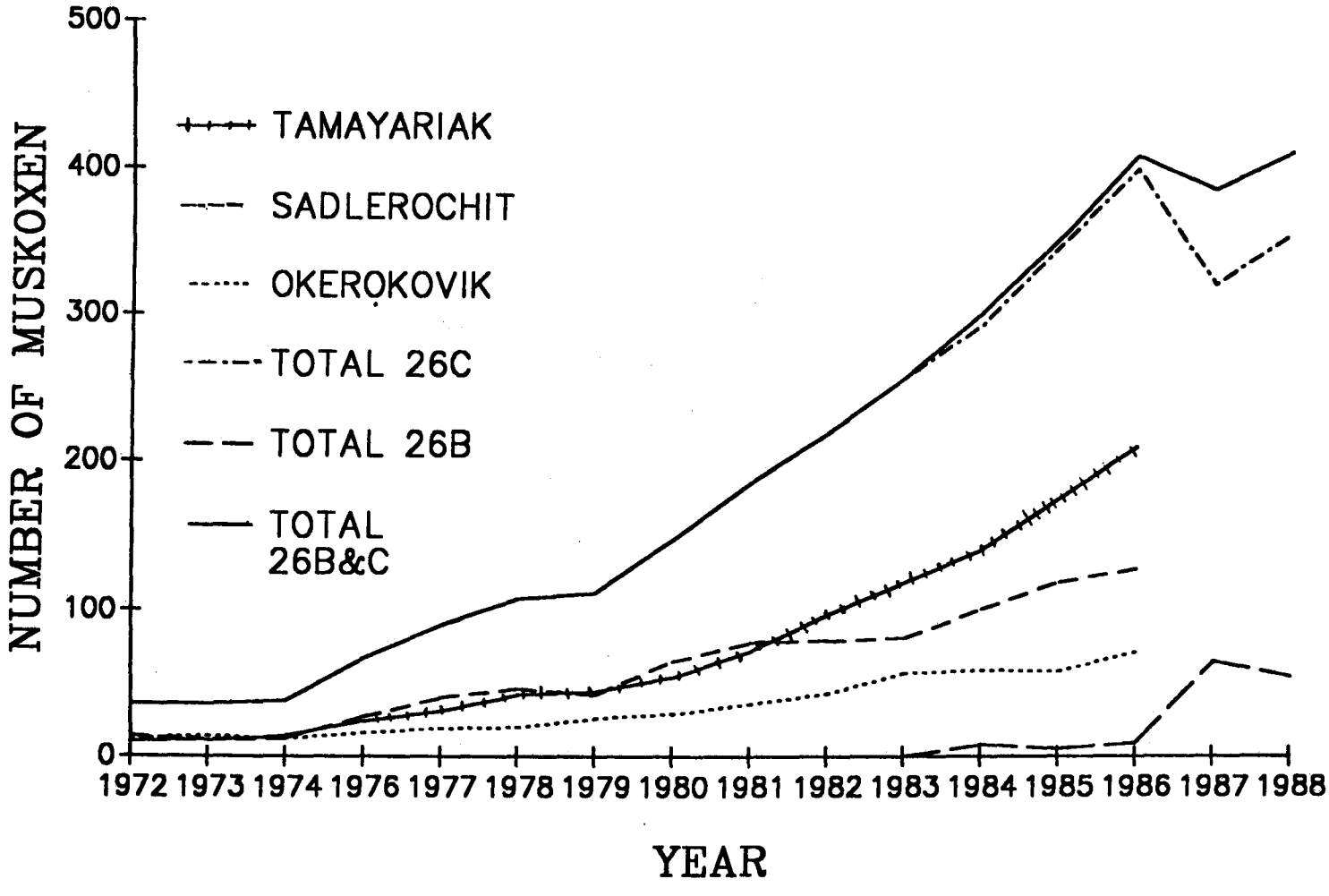

Figure 1. Muskoxen population sizes, Arctic Coastal Plain, Alaska. (Data source: P. Reynolds, USFWS.)

Table 1. Muskox population status, based on precalving (spring) and postcalving (summer-fall)[a] aerial surveys,[b] Subunits 26B and 26C, 1982-88.

Year	Subunit 26B		Subunit 26C		Total	
	Pre-calving	Post-calving	Pre-calving	Post-calving	Pre-calving	Post-calving
1982	0	0	219	240	219	240
1983	0	8	257	303	257	311
1984	8	6	293	377	301	383
1985	5	10	347	466	352	476
1986	9	68	399	360	408	428
1987	65		320		385	
1988	55		355		410	

[a] Postcalving surveys were not conducted in 1987 because of poor weather, and 1988 surveys will be reported next year.

[b] Data source: P. E. Reynolds, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks.

Table 2. Muskox population composition[a] classified during aerial surveys,[b] Subunit 26C, summers 1983-87.

Year	Bulls: 100 cows	Ad bulls: 100 cows	Yrlgs: 100 cows	Calves: 100 cows	Yrlg % in herd	Calf % in herd	Total
1983	69	39	40	66	13	22	211
1984	88	69	51	75	14	21	341
1985	66	54	48	75	15	23	419
1986	50	35	42	39	17	15	360
1987	49	28	32	48	12	19	339

[a] Bulls:100 cows are all 2+ years old, adult bulls are 4+ years old, and cows in ratios are 3+ years old.

[b] Data source: P. E. Reynolds, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks.

This may reflect the dispersal of bulls and the greater difficulty in locating muskoxen. Calf and yearling percentages in the Subunit 26C population declined in 1986 and 1987, respectively. The decrease in yearlings from 17% to 12% between 1986 and 1987 was probably due to low calf production in 1986. Although the increase in the calf:cow ratio to 48:100 (19%, i.e., calves in the herd) in 1987 should cause greater recruitment to the population, it is still lower than earlier ratios.

Distribution and Movements:

Muskoxen are concentrated in the eastern Arctic between the Canning and Katakturuk Rivers, along the Sadlerochit River, and between the Jago and Aichilik Rivers (Garner and Reynolds 1986). They have used these areas for calving since shortly after their releases in 1969 and 1970. Radiotelemetry data for marked bulls and cows indicate that the Tamayariak group, between the Canning and Katakturuk Rivers, and the Sadlerochit group are parts of the same reproductive subpopulation. Muskoxen of the Okerokovik area, between the Jago and Aichilik Rivers, form the other reproductive subpopulation found in the eastern Arctic. Within these core areas, dispersal from localized areas of concentration has increased since the early 1980's (Garner and Reynolds 1986).

Muskoxen have also dispersed from the Arctic Slope of ANWR eastward into northwestern Yukon Territory and the MacKenzie River delta in Canada (Garner and Reynolds 1986). In Alaska they have been observed to the south in the Romanzof Mountains, along the Middle and East Fork of the Chandalar River, and along the Sheenjek River. To the west, mixed herds of muskoxen have been observed frequently along the Sagavanirktok River and from Prudhoe Bay to Toolik Lake. The 2 radio-marked cows that dispersed to Subunit 26B in 1986 are still there.

Bull muskoxen are usually the first to explore new territory; they have been seen as far west as Nuiqsut, the Colville River, and the Killik River (Garner and Reynolds 1986). One muskox was sighted near Anaktuvuk Pass during the winter of 1985-86 (Whitten 1986). Despite some exploratory movements, no resident groups are known to occur west of the Canning River.

Mortality

Season and Bag Limit:

The open season for resident and nonresident hunters in that portion of Unit 26 within the Arctic National Wildlife Refuge is 1-31 March. The bag limit is 1 bull by registration permit only. Five permits will be issued at Kaktovik on a first-come, first-served basis.

Human-induced Mortality:

Harvests of only 5 bull muskoxen per year have been allowed since hunting began in 1983. From 1983 to 1988, 26 bulls have been taken (Table 3), and most of this harvest has occurred in the Sadlerochit River area. Few illegal harvests have been documented in the past 6 years. The small annual harvest of 5 bulls has not significantly affected the population. Greater hunting opportunity could be achieved without measurable effect on the population by raising the harvest to 10 bulls per year.

Hunter Residency and Success:

Since legal bull harvests began in 1983, Alaskan residents living outside Kaktovik have accounted for 18 muskoxen, Kaktovik residents for seven, and nonresidents for one (Table 4). Only 2 Kaktovik hunters and 2 Alaska residents have been unsuccessful. All hunters in 1988 were residents of Alaska, and all were successful.

Permit Hunts:

Five permits were issued in Kaktovik again this year; two were issued to Kaktovik residents and 3 to other Alaska residents (Table 4). Of the 30 permits issued since 1983, 30% were obtained by local residents, 67% by nonlocal residents, and 3% by nonresidents. Nonlocal hunters were still unhappy that permits were only issued in Kaktovik, although more nonlocals than locals have obtained permits over the years (Table 4). This situation has created tensions between Kaktovik residents and others, and it should be changed.

Harvest Chronology:

The muskox hunts have occurred in March since hunting began in 1983. This has sometimes resulted in congestion of hunters in the Sadlerochit River area, because of extremely inclement weather during most of that month (Whitten 1985). An additional hunting season in the autumn could alleviate this crowding situation.

Transport Methods:

Since 1983 hunters have accessed muskox hunting areas with airplanes or snow machines; however, snow machines are the more commonly used means of transportation (Table 5). Of 21 hunters for which the method of transportation is known, 33% and 67% used airplanes and snow machines, respectively.

Table 3. Annual muskoxen harvest and other known mortality, Subunits 26B and 26C, 1983-88.

Year	Hunter kill		Other known mortality			
	Reported harvest of bulls	Estimated illegal harvest	Bulls	Cows	Yrlg	Total
1983	4					
1984	5		2			2
1985	4			4		4
1986	3	1	1	4	1	6
1987	5					
1988	5					

Table 4. Muskoxen hunter residency[a] and success for permit hunt No. 1007, Subunit 26C, 1983-88.

Year	Permits issued	Successful				Unsuccessful			
		Resident				Resident			
		Local[b]	Non-local	Non-res.	Total	Local	Non-local	Non-res.	Total
1983	5	0	4		4	0	1		1
1984	5	0	5		5	0	0		0
1985	5	0	4		4	0	1		1
1986	5	2	1		3	2	0		2
1987	5	3	1	1	5	0	0	0	0
1988	5	2	3	0	5	0	0	0	0

[a] Only residents of Alaska were allowed to hunt muskoxen before 1987.

[b] Local is resident of Kaktovik, Alaska.

Table 5. Successful muskox hunter transport methods, Subunit 26C, 1983-88.

Year	Airplane	Snow machine
1983	3	1
1984	1	4
1985	1	3
1986	Data missing	
1987	0	3
1988	2	3

Natural Mortality:

Natural mortality of muskoxen in the eastern Arctic is low. Of 10 nonhunting mortalities observed between 1983 and 1985, five were due to predation, three to old age and malnutrition, and two to unknown causes (Garner and Reynolds 1986). In 1986 most mortalities observed in Unit 26 were associated with grizzly bear predation or scavenging (Whitten 1986).

Yearling and calf mortality rates for 1983 and 1985 were estimated to be 8% and 15%, respectively (Garner and Reynolds 1986). Extreme winter weather probably accounts for a large proportion of the yearling and calf mortality.

Habitat Assessment

Biologists from the USFWS recorded habitat use by muskoxen during radio-relocation flights. They observed that muskoxen used river and creek habitats frequently throughout summer. During winter and through calving, they typically used ridges, plateaus, and bluffs (Garner and Reynolds 1986). The probable advantage in using higher areas during winter relates to shallower or absent snow due to wind. Also, temperature inversions result in warmer temperatures at higher altitude, hastening snow melt. This allows muskoxen to find food more easily. Flat tundra was used most during precalving and least during the fall.

Phenological progression apparently dictates muskox habitat association (Garner and Reynolds 1986). Their use of higher terrain in spring correlates with earlier green-up of low shrub, forb, and tussock communities. Muskoxen then shift to river and creek drainages when willows emerge in summer. They prefer riparian willow areas throughout fall and into winter.

The high productivity of range in the eastern Arctic is probably the main reason muskoxen have flourished there. In addition, muskoxen are able to use a wide variety of foods, including standing dead vegetation. In 1985 the muskox population had apparently not reached carrying capacity because there was no qualitative evidence to suggest that their foraging had affected the vegetation (Garner and Reynolds 1986). However, if calf production continues below that recorded in the early 1980's, more intensive range studies may be required.

Game Board Actions and Emergency Orders

The hunting season (i.e., 1-31 March) was instituted by the Board of Game in 1983 as a recreational hunt regulated by drawing permit in Subunit 26C. From 1983 through 1985, only Alaska residents could apply for drawing permits.

In 1986, in response to the Madison vs. state of Alaska court decision, the drawing permit was changed to a registration permit and all permits were issued in Kaktovik on a first-come, first-served basis. Also in 1986 the tag fee was reduced from $500 to $25 for Alaska residents.

Beginning in 1987 nonresidents were also eligible for registration permits, but all permits were still issued in Kaktovik. This created difficulty for nonlocal hunters and dissatisfaction among many hunters.

To provide broader availability of permits and better distribution of hunting pressure, ADF&G proposed that the Board of Game (1) change the regulations by establishing a fall season (i.e., 15 August-15 September) in addition to the March season, (2) increase the harvest limit to 10 bulls, and (3) have 5 permits issued in Kaktovik and five in Fairbanks. The hunt would still be administered by registration permit on a first-come, first-served basis. Hunters who receive permits in Kaktovik would be able to hunt in all of Subunit 26C. Hunters receiving permits in Fairbanks would be able to hunt in one of 2 zones in Subunit 26C; i.e., 3 permits issued for the area between Marsh Creek and the Canning River and 2 permits issued for the area between the Jago River and the Alaska-Canada border. This proposal was adopted and will take effect on 1 July 1988.

CONCLUSIONS AND RECOMMENDATIONS

The ADF&G is in the process of developing a management plan for muskoxen in the eastern Arctic Slope area. This plan will consider the interests of the public and all state and federal agencies involved in managing muskoxen and their habitat. The objectives in this report reflect recent population growth trends, public interest in muskox hunting, and especially ADF&G's intention to encourage the continued expansion and dispersal of the Arctic Slope muskox herd.

The muskox population in Subunit 26C is growing but at a slower rate than in previous years because of lower calf production in 1986 and 1987 as well as dispersal of bulls and some mixed groups to the east and west. Because the population has apparently not reached carrying capacity, I expect the herd in Subunit 26C to continue to be a source for emigrants to adjacent areas. The establishment of a limited number of resident muskoxen in Subunit 26B has occurred only recently; however, the rate of increase for the last 2 years (1987, 1988) indicates that this new herd may grow as rapidly as those in Subunit 26C.

The harvest of 5 bull muskoxen per year in Subunit 26C does not seem to be affecting the growth or dispersal of the population. It is reasonable to expect that 10-15 bulls could be harvested with no effect on herd growth, and I recommend an increase in permit numbers to produce this harvest. These changes will still allow muskox numbers to increase, while providing more hunting opportunities.

The management objectives for growth and dispersal of the muskox herd in Subunit 26B and 26C are being met, and I recommend that these management strategies, including the recommended increase in permits for bulls, be continued. However, more data are needed to determine the distribution and total number of muskoxen across the eastern Arctic. This is especially important because of our interest in herd growth and the potential impacts of oil and gas development on the establishment of new muskoxen herds on the coastal plain. Biologists from the USFWS acquired most of the information used in this report, but they are limited to investigations in ANWR. I recommend that ADF&G allocate muskox survey and inventory funds for FY 90 to permit greater cooperative work with ANWR in Subunit 26C, to expand aerial surveys outside ANWR in Subunit 26B, and to capture, radio collar, and observe at least 10 bulls and 10 cows in or near Subunit 26B.

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