Muskox
Management Report
of survey-inventory activities
1 July 2006–30 June 2008

Patricia Harper, Editor
Alaska Department of Fish and Game
Division of Wildlife Conservation

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Funded through
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2009 Set

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Cover Photo: A muskox seen from the road system near Nome. © 2009 ADF&G, by Kim Titus.

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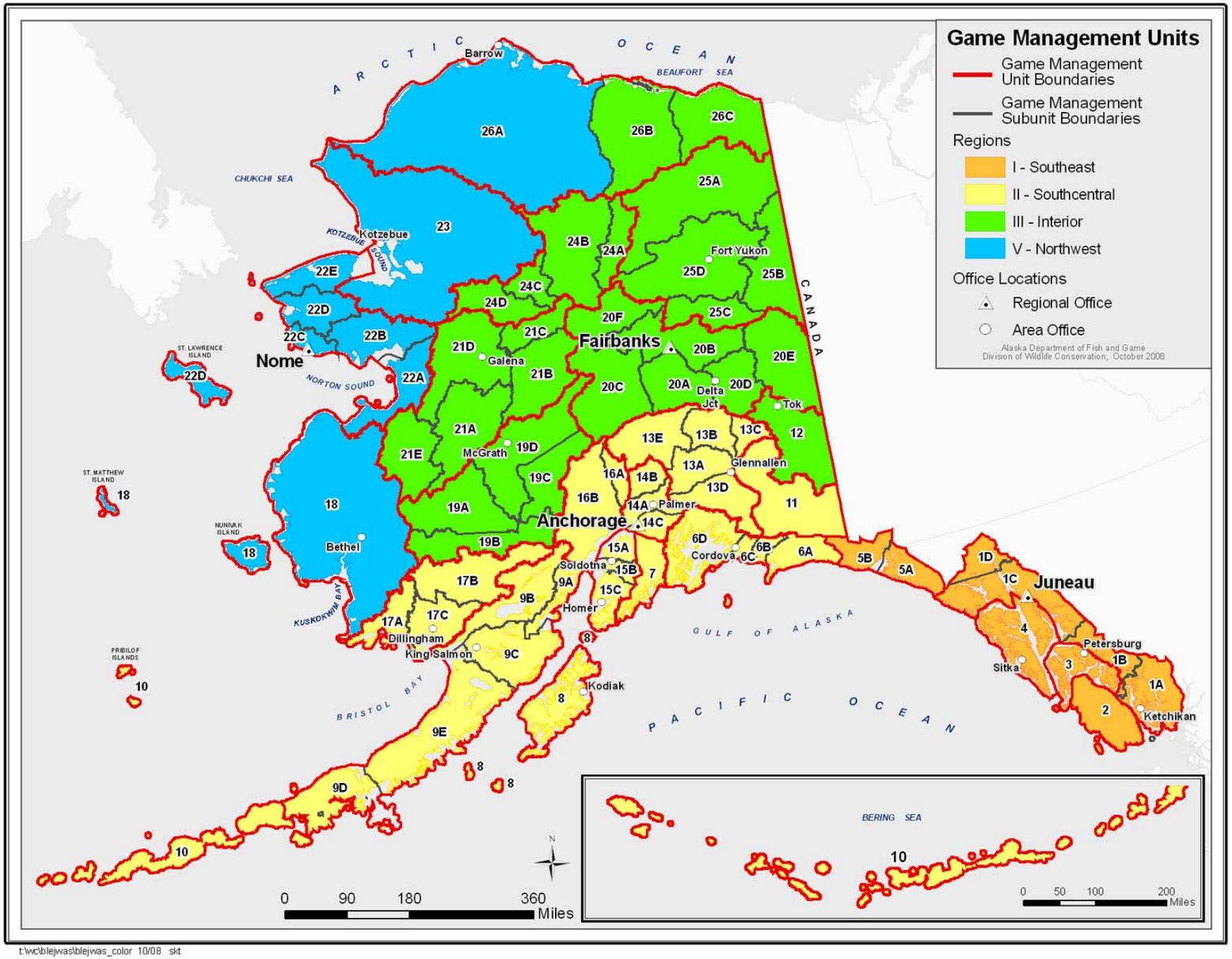
MUSKOX MANAGEMENT REPORT

TABLE OF CONTENTS

From: 1 July 2006
To: 30 June 2008



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WILDLIFE MANAGEMENT REPORT

Alaska Department of Fish and Game
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MUSKOX MANAGEMENT REPORT

From: 1 July 2006
To: 30 June 2008

LOCATION

GAME MANAGEMENT UNIT: 18 (41,159 mi^2)

GEOGRAPHICAL DESCRIPTION: Yukon-Kuskokwim Delta

BACKGROUND

NUNIVAK ISLAND

Muskoxen were once widely distributed in northern and western Alaska but were extirpated by the middle or late 1800s. In 1929, with the support of the Alaska Territorial Legislature, the U.S. Congress initiated a program to reintroduce muskoxen in Alaska. Thirty-one muskoxen were introduced from Greenland to Nunivak Island in Unit 18 during 1935–1936, as a first step toward reintroducing this species to Alaska. The Nunivak Island population grew slowly until approximately 1958 and then began a period of rapid growth. The first hunting season was opened in 1975, and the population has since fluctuated between 400 and 750 animals, exhibiting considerable reproductive potential, even under heavy harvest regimes. Low natural mortality and absence of predators benefit the Nunivak muskox population.

NELSON ISLAND

During March of 1967 and March 1968 groups of 8 and 23 subadult muskoxen, respectively, were translocated from Nunivak Island to Nelson Island, 20 miles across Etolin Strait. The Nelson Island muskox population exhibited an average annual growth rate of 22% between 1968 and 1981. When the population approached the management goal of 200–250 animals in 1981, the first hunting season was opened. Partially in response to a population decline in 1994 and 1995, the Nelson Island Muskox Herd Cooperative Management Plan was initially drafted and it was followed beginning in 1995. In this plan our goal is at least 250 animals. For approximately 20 years, the Nelson Island muskox population has fluctuated between a high of 327 animals prehunt in 2003 and a low of 123 precalving in 1994.

YUKON–KUSKOKWIM DELTA

Having originally emigrated from Nelson Island, fewer than 100 muskoxen inhabit the mainland of the Yukon–Kuskokwim Delta. Mainland muskoxen are scattered in small groups from the Kilbuck Mountains south of the Kuskokwim River to the Andreafsky Mountains

north of the Yukon River. Muskox are most consistently observed in the area around the mud volcanoes, Askinak and Kusivak mountains. Poaching is the major factor preventing the mainland population from becoming firmly established. Marked muskoxen have been documented returning to Nelson Island. This behavior complicates muskox management for Nelson Island and makes it difficult to determine the size of the mainland population.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

- Survey populations on Nunivak and Nelson Islands, using fixed-wing and rotary-wing aircraft in alternate years, to estimate population size and composition.

- Maintain a posthunt population of at least 250 muskoxen on Nelson Island and 500–550 on Nunivak Island.

- Issue drawing and registration permits for harvesting muskoxen to maintain optimal size, composition, and productivity of the muskox populations on Nunivak and Nelson Islands.

- Provide hunter orientation and posthunt checkout to ensure hunters understand permit requirements, properly identify legal muskoxen, and report their harvests timely and correctly.

- Determine the distribution and dispersal of muskoxen on the mainland.

- Use the cooperative management plans for Nunivak and Nelson Islands.

METHODS

Censuses were flown using a PA-12 Super Cub on Nelson Island to conduct a population census in July 2007. Population census flights were not conducted on Nunivak Island in 2007 or 2008, or on Nelson Island in 2008 due to inadequate survey weather conditions. For this reason we are reporting the 2005 numbers for Nunivak Island, the last year a survey was completed. During this census we classified muskoxen as calves, yearlings, 2-year-olds, 3-year-old and older males, 3-year-old and older females, or as unclassified.

Due to the nature of using a fixed wing to conduct surveys, and to reduce the number of passes required on each group, animals were clumped into broader age classes. Due to the amount of time available to study each animal, groups size, and terrain it becomes impractical to detriment age brackets beyond that.

Note that the terminology describing these cohorts is somewhat unorthodox and is explained by the history and method of the musk ox surveys. Previously, we conducted composition counts using snow machines in late winter (precalving). The youngest cohort was called "short yearling" or "yearling," while the next older cohort was nearly 2 years old; members of the second cohort were called 2-year-olds, and so forth for older cohorts. As surveys were completed earlier and earlier in the year, the older terminology was retained with the addition

of calves. For comparison of survey from 1996 and all survey from previous to 1994 the actual age of animals in the age classes for the current, midsummer surveys (post calving) is about 6 to 9 months younger than the named classes. In years that muskoxen were counted with a helicopter of snow machine age cohorts are more precisely separated verses years when a fixed wing is used.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Throughout the reporting period, the population on Nunivak Island remained healthy and productive. The trend is a stable population kept at 500-550 animals post hunt pre-calving by using drawing and registration permits to take 60-90 animals a year.

The population on Nelson Island fluctuates much more than the Nunivak population. Several factors contribute to this. These include human induced mortality and movements on and off the island.

Population Size

During a fixed-wing census of Nunivak Island conducted in July 2005, we counted 588 muskoxen. Census on Nelson Island in 2007 and 2008 was not conducted due to poor survey weather.

In July 2007, a census of Nelson Island muskoxen using a fixed-wing aircraft was conducted, and counted 374 muskoxen. A census on Nelson Island in 2008 was not conducted due to poor survey weather. Table 1 shows the history of population size on Nelson Island during the period 1981–2008.

We do not have survey information to estimate the population of mainland muskoxen. Incidental observations indicate the population is small and widely dispersed. Some muskoxen probably return to Nelson Island from the mainland, confounding census data in both areas.

Population Composition

On Nunivak Island for 2005 we used a fixed wing aircraft to conduct a census of the population. In 2005 we classified the muskoxen as 161 four-year-old or older bulls, 143 three-year-old or older cows, 13 three-year-old-bulls, 91 two-year-olds, 110 yearlings and 70 unknown (Table 3).

On Nelson Island we used a Piper PA-12 for the census. In June 2007 we found 61 three-year-old or older bulls, 106 three-year-old or older cows, 99 calves and 102 unknown (Table 4).This survey was conducted by an untrained observer so attempts to pull out numbers of 2 year old bulls were not don. In addition it reams unclear if the 99 animals recorded as yearlings in her notes are calves, yearling or both combined (personal communications). Historical 99 calves would be the largest calf crop and highest calf ratio recorded in a survey,

making up 26.5 percent of the population. Historically 3 other postcalving surveys have documented calf ratios around 26 percent.

Distribution and Movements

Nunivak Island is a closed system, in the winter muskoxen were distributed throughout the island but are concentrated along the south and west sides of the island. In the summer Musk ox disperse more homogenously throughout the interior of the island.

Nelson Island muskoxen are distributed throughout the island but are concentrated on the cliffs of Cape Vancouver and on hills northeast of Tununak. Individuals and small herds are on the hills in the central portion of the island and along the escarpment above Nightmute.

We have had reports of muskoxen in the Kilbuck Mountains, northeast to the Portage Mountains near Lower Kalskag, northwest into the Andreafsky Mountains, and west to the Askinuk Mountains. Solitary males are usually the first muskoxen to be seen in new areas.

Department and U.S. Fish and Wildlife Service staff in cooperation with ADF&G staff radio collared 5 muskoxen (2 bulls and 3 cows) from herds of 9 and 12 animals south of the Yukon River between Bethel and Pilot Station in March 1989. A 4-year-old female that was probably born on Nelson Island was radiocollared on the mainland as a 3-year-old on 30 March 1989 south of the Yukon River near Pilot Station. By August 1989 this animal moved approximately 160 miles east to a location near the village of Lower Kalskag, north of the Kuskokwim River. A hunter subsequently legally shot this musk ox on 24 March 1990 near Toksook Bay on Nelson Island, approximately 200 miles west of its last known location.

MORTALITY

Harvest

Seasons and Bag Limits.

2006–2007 and 2007–2008 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 18, Nunivak Island RESIDENTS and NONRESIDENTS**:**		
1 bull by drawing permit only. Up to 10 permits will be issued for the fall season and up to 50 for spring season; or 1 cow by registration permit only, with up to 60 cow permits issued on a first-come, first-served basis.	1 Sep–30 Sep 1 Feb–15 Mar	1 Sep–30 Sep 1 Feb–15 Mar

2006–2007 and 2007–2008 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 18, Nelson Island RESIDENTS and NONRESIDENTS 1 muskox by registration permit only; up to 42 permits will be issued on a first-come, first-served basis.	1 Feb–25 Mar	1 Feb–25 Mar
Remainder of Unit 18	No open season	No open season

Board of Game Actions and Emergency Orders. No new action was adopted by the board during this report time.

Human Harvest. Hunting of Nunivak Island muskoxen is regulated by drawing and registration permits for fall and spring hunts for both years of the reporting period. The history of total harvest of bulls and cows for the period 1992–2008 is shown in Table 5. In general, permits for hunting Nunivak Island bulls are distributed through the statewide drawing permit process. When drawing permit winners decline to hunt and have not been issued a permit, we select an alternate permittee from the spring list of permit applicants. The 2006–2007 harvest from drawing permits was 29 bulls. The 2007–2008 harvest from drawing permits included 3 bulls in the fall 35 and in the spring.

We distribute registration permits for hunting Nunivak Island cows on a first-come, first-served basis. There were 5 permits available in Bethel for the fall hunt, 5 for the spring hunt, and 40 permits available in Mekoryuk for the spring hunt for both the 2006–2007 and 2007–2008 regulatory years.

We distribute Nelson Island registration permits on a first-come, first-served basis. The location from which these registration permits are distributed rotates through the local villages from Newtok to Tooksok Bay, to Tununak, Nightmute, and Chefornak. The history of total applicants, total permits issued and total harvest of bulls and cows for the period 1981–2008 is shown in Table 6. In 2006–2007, 15 bull and 15 cow permits were distributed in Chefornak, and in 2007–2008, 24 bull and 18 cow permits were distributed in Newtok. Fourteen bulls and 14 cows were harvested in 2006–2007. Twenty-three bulls and 17 cows were harvested in 2007–2008.

We occasionally receive reports of muskoxen taken illegally. However, the number of animals taken is difficult to determine because we may hear of the same animals from more than one source and we are sure that some muskoxen are taken illegally that we do not hear of. During 2006–2007 and 2007–2008 there were approximately 5–15 muskoxen reported to be illegally harvested on the mainland.

Permit Hunts. All hunts for muskoxen in Unit 18 are either by drawing permit or registration permit; the Human Harvest section includes specific information regarding issued permits.

Hunter Residency and Success. Most drawing permittees for Nunivak Island are residents of Alaska. Two nonresident was drawn in 2006–2007 and one nonresidents in 2007–2008. All registration hunters were residents. For information on hunter success, see the Human Harvest section of this report.

Harvest Chronology. Most cow hunters on Nunivak Island harvested their muskox between late February and mid March during periods of increasing daylight hours and milder weather. Nelson Island hunters also take most of their animals late season. Bull hunters on Nunivak Island usually hunted with guides or transporters. These hunters must fit their hunts into the times available with a particular guide or transporter and consequently, are evenly distributed throughout the season.

Transport Methods. In fall most hunters use a boat, all-terrain vehicle (ATV), or a small aircraft to access the hunting areas. All access in the winter season was by snowmachine.

Other Mortality

No natural predators of muskoxen are present on Nunivak Island, and large predators are rare on Nelson Island. The few mainland muskoxen are in areas that have a few wolves, black, and brown bears, but we have received no reports of predation on muskoxen in Unit 18. Most natural mortality is from illegal harvest, fallowed by accidents, and weather: such as freezing rain, stranding, falling off cliffs, and falling through thin ice.

HABITAT

Assessment

No direct study of habitat was undertaken during the report period. On Nunivak Island we believe the reindeer have overgrazed the lichen range, yet muskoxen taken by hunters in recent years are reported to be in good condition with adequate body fat and high pregnancy rates. The muskoxen taken on Nelson Island are also reported in good condition with similar pregnancy rats in cow harvested in the spring. The habitat for both islands seems in excellent condition. A recent study was conducted using liver tissue of hunter harvested animals and preliminary results show that both islands population have healthy level of minerals and trace elements. The musk ox habitat on the mainland is extensive and could support a much larger population.

Enhancement

We are meeting our muskox population goals because of the habitat on Nelson and Nunivak Island. The habitat on the mainland is essentially unused. We are not considering habitat enhancement projects.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

There were no activities related to nonregulatory muskox management issues in Unit 18 during the reporting period.

CONCLUSIONS AND RECOMMENDATIONS

The Nunivak Island muskox population is characterized by high productivity and low natural mortality. We will reduce the harvest of bulls and cows when the posthunt, precalving population is below 500 animals. With the existing population, high harvest levels are warranted. The management goals for Nunivak Island muskoxen include maintaining a minimum population of 500–550 muskoxen, translocation of muskoxen to other areas of Alaska, and providing opportunities to hunt muskoxen.

Fluctuations in the observed size of the Nelson Island population are influenced by snow and ice conditions and the availability of escape terrain and forage. The Nelson Island population is not confined to the island because animals can reach the mainland. The drop in population on Nelson Island from 297 in 1999 to 233 in 2000 is probably due to a combination of emigration and illegal harvests, both of which were reported in the winter of 1999–2000.

Variable annual harvests are needed to effectively manage the population in response to emigration and other natural losses. Although the population is between 500 and 550 animals, we are harvesting variable numbers of muskoxen at a rate not exceeding 10% of the population to maintain healthy age and sex components in the population. The Nelson Island Muskox Herd Cooperative Management Plan calls for the cessation of hunting when the population is below 250 animals.

We continue to receive reports of mainland muskoxen, but illegal take of these animals is a key factor in preventing establishment of a reproductively viable population. Fewer than 100 muskoxen inhabit the extensive areas of mainland habitat. Although low numbers for mainland muskoxen are discouraging, there is still potential for a population to become established, particularly with the concern and cooperation shown by villagers from Nelson Island and with continued growth of the Nelson Island muskox population.

A comprehensive information and education program explaining the benefits of a larger muskox population on the mainland of Unit 18 should be prepared for the benefit of local residents. We may want to pursue a cooperative project with the Yukon Delta National Wildlife Refuge and village councils to develop an educational program that encourages local residents to foster the establishment of a viable, harvestable mainland muskox population.

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Please cite any information taken from this section, and reference as:

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TABLE 1 Unit 18 Nelson Island muskox population, 1981–2008

Year	No harvest/precalving	Prehunt/post calving	Post hunt/precalving
1981		265	245
1982		217	190
1983		230	206
1984		200	176
1985		225	195
1986		287	263
1987		180	150
1988		213	183
1989		234	205
1990		239	208
1991		232	207
1992		214	182
1993		198	168
1994		149	123
1995	217		
1996	233		
1997		265	
1998		293	
1999		297	
2000	233		
2001		306	
2002		293	
2003		327	
2004		318	
2005		No Survey	
2006		No Survey	
2007		374	
2008		No Survey	

TABLE 2 Unit 18 Nunivak Island muskox composition, July 2004

Age	Nr male	% male[a]	Nr female	% female[a]	Nr Unknown	Nr total	% composition
Adults[b]	156	42	177	47		333	52
3 years	40	11				40	6
2 years					113	113	18
Yearlings					112	112	18
Unknown					40	40	6
Total	196	53	177	47	265	638	100

[a] Percent male and female does not include unclassified animals.
[b] Adults are considered 3-year-old and older cows, and 4-year-old and older bulls.

TABLE 3 Unit 18 Nunivak Island muskox composition, July 2005

Age	Nr male	% male[a]	Nr female	% female[a]	Nr Unknown	Nr total	% composition
Adults[b]	161	51	143	45		304	52
3 years	13	4				13	2
2 years					91	91	15
Yearlings					110	110	19
Unknown					70	70	12
Total	174	29	143	24	271	588	100

[a] Percent male and female does not include unclassified animals
[b] Adults are considered 3 year old and older cows, and 4 year old and older bulls

TABLE 4 Unit 18 Nelson Island muskox composition, July 2007

Age	Nr male	% male[a]	Nr female	% female[a]	Nr Unknown	Nr total	% composition
3 + years	61	37	106	63		167	45
2 years							
Yearlings							
Calves						99	27
Unknown					201	102	28
Total	61	37	106	63	201	368	100

[a] Percent male and female does not include unclassified animals

TABLE 5 Unit 18 harvest of Nunivak Island muskoxen, 1992–2008

Year	Males	Females	Unknown	Total
1992	45	31		76
1993	47	26		73
1994	35	23		58
1995	20	5		25
1996	20	19		39
1997	25	24		49
1998	26	30		56
1999	43	45[a]		88
2000	46[b]	40		86
2001	45	42		87
2002	43	41		84
2003	45	43		88
2004	45	42		87
2005	43	44		87
2006	37	38		75
2007	29	39	1	69
2008	38[b]	35	6	79
Total	632	567	7	1206

[a] Includes cow(s) taken by hunters issued a bull permit
[b] Includes bull(s) taken by hunters issued a cow permit

TABLE 6 Unit 18 permits and hunting harvest of Nelson Island muskoxen, 1992–2008

	Number permits available		Muskoxen harvested		Number of
Year	Female	Male	Female	Male	Applicants
1992	15	15	15	15	30
1993	0	30	0	30	37
1994	5	25	5	21	31
1995	0	0	0	0	0
1996	0	0	0	0	0
1997	10	10	7	10	20
1998	10	10	10	10	20
1999	15	15	15	15	30
2000	15	15	14	15	30
2001	0	0	0	0	0
2002	2	1	1	2	30+
2003	15	23	14	22	30+
2004	15	24	14	24	30+
2005	15	23	14	21	38
2006	15	23	11	15	38
2007	15	15	14	14	30+
2008	24	18	17	23	42+
Total	171	247	151	237	274+

WILDLIFE MANAGEMENT REPORT

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO Box 115526
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2009 MUSKOX MANAGEMENT REPORT

From: 1 July 2006
To: 30 June 2008

LOCATION

GAME MANAGEMENT UNIT: 22 (25,230 mi^2) and southwest portion of 23 (1920 mi^2)

GEOGRAPHIC DESCRIPTION: Seward Peninsula and that portion of the Nulato Hills draining west into Norton Sound

BACKGROUND

Historical accounts indicate muskoxen disappeared from Alaska by the late 1800s and may have disappeared from the Seward Peninsula hundreds of years earlier. In 1970, 36 muskoxen were reintroduced to the southern portion of the Seward Peninsula from Nunivak Island. An additional 35 muskoxen from the Nunivak Island herd were translocated to the existing population in 1981 Machida 1997). Since 1970 the population has grown steadily and in April 2007 was estimated at 2688 animals, excluding 78 animals found outside the previously established Seward Peninsula count area (Figure 1, Tables 1 and 2).

Muskoxen have extended their range to occupy suitable habitat throughout the Seward Peninsula. Herds are well established in Units 22C, 22D, 22E, western Unit 22B and southwestern Unit 23 (Figure 2). Eastward migration has occurred and muskoxen have been reported in the northern portion of Unit 22A, in Unit 23 along the Tagagawik River drainage and in the Purcell Mountains, in Unit 21 along the Yukon River drainage as far east as Ruby, and in the vicinity of Huslia in Unit 24.

MANAGEMENT DIRECTION

Muskox management on the Seward Peninsula is guided by recommendations from the Seward Peninsula Muskox Cooperators Group (The Cooperators) and local Advisory Committee groups. The Cooperators group is comprised of staff from the department, National Park Service (NPS), U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (FWS), Bering Straits Native Corporation, Kawerak Inc., Reindeer Herders Association, Northwest Alaska Native Association, residents of Seward Peninsula communities, and representatives from other interested groups or organizations. The following management goals form the basis of a cooperative interagency management plan for Seward Peninsula muskoxen developed during 1992 through 1994 (Nelson 1994) and follow the guidelines of the departmental Muskox Management Policies (ADF&G 1980).

MANAGEMENT GOALS

- Allow for continued growth and range expansion of the Seward Peninsula muskox population.

- Provide for a limited harvest in a manner consistent with existing state and federal laws by following the goals/objectives endorsed by the Seward Peninsula Muskox Cooperators Group and the Seward Peninsula Cooperative Muskox Management Plan.

- Manage muskoxen along the Nome road systems of Units 22B and 22C for viewing, education, and other nonconsumptive uses.

- Work with local reindeer herding interests to minimize conflicts between reindeer and muskoxen.

- Protect and maintain the habitats and other components of the ecosystem upon which muskoxen depend.

- Encourage cooperation and sharing of information among agencies and users of the resource in developing and executing management and research programs.

MANAGEMENT OBJECTIVES

- Complete censuses at 2-year intervals to document changes in population and distribution.

- Complete composition surveys on an annual basis in at least one subunit on the Seward Peninsula to document changes in age and sex structure of the population.

- Participate in the Muskox Cooperators Group meetings and facilitate exchange of information and ideas among agencies and user groups.

- Administer a resident drawing hunt in Unit 22C, Unit 22D, Unit 22E and Tier I subsistence hunts in Units 22B, 22C, 22D, 22E, and 23SW (the portion of Unit 23 west of and including the Buckland River drainage) in cooperation with federal managers of federal subsistence hunts in these units.

METHODS

A Seward Peninsula muskox census was completed 1 March – 20 April 2007 in Units 22B, 22C, 22D, 22E and 23SW. Staff from the department, NPS, BLM, FWS, participated in the census. We divided the area into 16 survey units and searched these areas thoroughly, using primarily Cessna 185, Cessna 207 and Super Cub type aircraft. We completed a minimum count of muskoxen in the census area using the total coverage/direct count census method used in previous surveys. When muskoxen were located, we made a visual count, noted the number of short yearlings when possible, and recorded GPS coordinates.

Muskox composition surveys were completed in Unit 22B and 22C during April 2007 using helicopter access to previously identified groups. At each group, a team of two trained observers used binoculars and spotting scopes to classify muskox into 7 sex-age groups based on body size, conformation, and horn size/shape characteristics. Muskox were classified as bulls 4-years-or-older, 3-year-old bulls, 2-year-old bulls, cows 4-years-or-older, 3-year-old cows, 2-year-old cows, and yearlings. We used a Robertson R-44 helicopter to visit 51 muskox groups in Unit 22B and 22C where we classified 317 and 412 muskox respectively. We also collected urine and fecal samples for analysis.

In March 2008, staff placed 15 VHF radio collars on adult cows in or near the periphery of Unit 22C near Nome, Alaska, and in October 2008 staff placed an additional 9 VHF collars on adult cows in Unit 22B, Unit 22C, and Unit 22D. Staff used a PA-12 aircraft to locate muskoxen groups and used Robinson R-44 based chemical immobilization to capture muskoxen. This project expands the Unit 22 muskoxen survey and inventory program to include radiocollaring of adult muskoxen to supplement annual composition surveys and biennial census work. We utilized the sample of VHF collared muskoxen to estimate adult female mortality rate.

Muskox composition surveys were completed in Unit 22C during April 2008 using helicopter access to previously identified groups. Emphasis was given to groups that had radio collars placed in them one month prior to composition surveys. Nineteen groups were located in Unit 22C and the periphery of Unit 22B and staff classified 279 muskoxen.

The Cooperators met in Nome in November 2006 and 2008 to develop recommendations to the Alaska Board of Game (BOG). In 2006 the Cooperators' primary objective was to develop recommendations for amounts necessary for subsistence, which were presented to the BOG during the 2007 meeting. In 2008 they met to develop recommendations for state hunting seasons and bag limits and concluded the amount necessary for subsistence was 100–150 muskoxen; these recommendations were presented to the BOG during the January 2008 meeting.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The 2007 Seward Peninsula muskox census found 2688 animals in 186 groups in the historically surveyed area of the Seward Peninsula. We counted 329 muskox in Unit 22B, 445 muskox in Unit 22C, 746 muskox in Unit 22D, 949 muskox in Unit 22E, and 219 muskox in Unit 23 Southwest (Table 1). We expanded the census area east of the Seward Peninsula to include the entire Selawik National Wildlife Refuge and found 6 muskox groups totaling 78 muskox and for the first time documented eastward emigration of muskoxen from the Seward Peninsula in large numbers.

Snow cover and sightability varied greatly across the census area. There was complete snow cover and conditions were excellent across the northern and interior Seward Peninsula, but there was very light and incomplete snow cover in coastal areas of the southern Seward Peninsula and in parts of the Selawik National Wildlife Refuge. Moose censuses in which observers were instructed to also watch for and record muskoxen occurred in Unit 22C and in the Selawik

Refuge in addition to the muskox census flights. In those areas where there was double coverage it is likely that few groups were missed. In western Unit 22B and in parts of the Selawik Refuge where double coverage did not occur, there is a greater likelihood that groups on mottled or bare ground were missed.

The total Seward Peninsula count (*N*=2688) shows a 12.6% total increase since the 2005 census count of 2387 muskoxen. The 2007 count represents a 6.1% annual rate of increase since 2005 and a 5.9% annual rate of increase since 2000. The population grew 14% annually from 1970 to 2000, and since 2000 annual growth has slowed to 6%.

Unit 22B: Muskoxen are now well established in Unit 22B west of the Darby Mountains. During the 2007 census staff counted 329 muskoxen which is similar to what we found during the 2005 census when 326 muskoxen were counted. However, the population grew 24% annually between 2002 and 2005 which was the highest average annual growth rate among subunits documented in the 2005 census. This growth rate cannot be accounted for by calf production alone because cows produce only 1 calf annually. Thus, muskox population growth in Unit 22B had to be due in part to immigration from other subunits.

Unit 22C: We found 445 muskoxen in Unit 22C which doubled the population found there in 2005 when 220 muskoxen were counted. The rate of increase between 2005 and 2007 cannot be explained by Unit 22C calf production alone. The evaluation of census results, composition survey results, and harvest from Unit 22C, Unit 22B, and Unit 22D all support the idea that muskoxen from Unit 22B and Unit 22D moved into Unit 22C sometime between 2005 and 2007.

Unit 22D: We found 746 muskoxen in Unit 22D which represents a 3% rate of decrease since 2005 when 796 muskoxen were counted. Population growth was initially fastest in Unit 22D, but between 1998 and 2000 average annual growth slowed to 4% and there has been little growth in Unit 22D since 2000 (Table 2) (Persons 2003). Since composition surveys completed in 2002 and 2006 found a healthy number of yearlings, 19% and 16% respectively, it is likely that during 2005–2007 muskoxen from Unit 22D moved into areas of Units 22C and 22B west of the Darby Mountains. This movement was documented in 2008 when a radio collared muskoxen moved from the upper Niukluk River in Unit 22B to the western edge of the lava beds in Unit 22D.

Unit 22E: We counted 949 muskoxen in Unit 22E which is now the subunit with the largest number and the highest density of muskoxen; 0.23 muskoxen/mi^2. The rate of increase between 2005 and 2007 was 4.8%.

Unit 23SW: We counted 219 muskoxen in Unit 23SW which is a 20.3% rate of increase since 2005. We suspect movements between Unit 23SW, Unit 22D, and Unit 22E. Emigration from Unit 23SW is also likely responsible for colonization of areas to the east of the Seward Peninsula in the Nulato Hills and Selawik, Kobuk, and Yukon River drainages.

The next census of the Seward Peninsula muskoxen population is scheduled for March 2010.

Population Composition

The results of composition surveys in Units 22B, 22C, 22E, and 23 SW are shown in Table 3. In April 2007 we sampled 29 groups in Unit 22C, classified 412 of the 445 muskoxen in Unit 22C,

and found the ratio of mature bulls (4-years-or-older) to mature cows (cows 3- or 4-years-or-older) was 57:100. The yearling:cow ratio was 37:100 and 16% of the classified animals were yearlings. Thirteen percent of the muskoxen in Unit 22C were 2-year-olds (6% bulls and 7% cows), and approximately 10% were 3-year-olds (7% bulls, 4% cows).

In April 2008 we revisited Unit 22C and sampled 279 muskoxen in 19 groups. We focused on groups of muskoxen that had radio collars placed on adult females during a March 2008 capture project. We found the ratio of mature bulls (4-years-or-older) to mature cows (cows 3- or 4-years-or-older) was 30:100, lower than in 2007, but because group selection for this survey was almost exclusively mixed sex muskoxen groups the bull: cow ratio would be expected to be lower than what is found during normal survey conditions. However, the decrease in mature bulls should be noted and compared carefully to surveys scheduled for April 2009 to ensure there is not a decline in the number of mature bulls. The yearling:cow ratio was 30:100 and 15% of the classified animals were yearlings. Twelve percent of the muskoxen in Unit 22C were 2-year-olds (6% bulls and 6% cows), and 11% (6% bulls, 5% cows) were 3-year-olds.

The percentage of muskoxen in the 2- and 3-year-old age classes have declined since composition surveys were first completed in Unit 22C in 2002. We found >20% 3-year-old females during 2002 and 2004 surveys and 11% in surveys completed during 2007 and 2008. We also observed a decline in the 2-year-old age class when we found 18% in 2002 and 13% in 2004, 2007, and 2008. The percent of 2- and 3-year-old muskoxen from other areas of the Seward Peninsula found during the same time period range from 10–21% (Table 2).

In 2007 we visited Unit 22B and classified 317 of the 329 muskoxen found during the 2007 census located in 22 different groups. The ratio of mature bulls (4-years-or-older) to mature cows (cows 3- or 4-years-or-older) was 48:100, and 15% of the classified animals were yearlings. Sixteen percent of muskoxen classified in Unit 22B were 2-year-olds (6% bulls and 10% cows), and 16% were 3-year-olds (6% bulls, 10% cows). Composition surveys completed in Unit 22B during 2002, 2004, and 2007 found consistent 2- and 3-year-old age class results within ±3% which is an indication animals are surviving to maturity to the 4-year-old and older age classes.

We completed composition surveys in Unit 23SW during July of 2008. The ratio of mature bulls (4-years-or-older) to mature cows (cows 3- or 4-years-or-older) was 32:100, 11% of the classified animals were yearlings, and 14% calves. Eleven percent of muskoxen classified in Unit 23SW were 2-year-olds (5% bulls and 6% cows), and 12% were 3-year-olds (6% bulls, 6% cows).

In August of 2008 we completed composition surveys in Unit 22E. The ratio of mature bulls (4-years-or-older) to mature cows (cows 3- or 4-years-or-older) was 51:100 or 19% of the muskoxen sampled. The percent of mature bulls found in Unit 22E is important for Unit 22E management because it is used to determine the number of drawing permits for the area due to the Board of Game's decision that mature bull muskoxen are managed as a distinct and separate population. Composition surveys completed in 2002, 2005, and 2008 found 18% mature bulls ±1% during each survey. In the 2008 survey, 10% percent of the classified animals were yearlings, and 18% calves. Eleven percent of muskoxen classified in Unit 22E were 2-year-olds (5% bulls and 6% cows), and 14% were 3-year-olds (7% bulls, 7% cows).

Mature bulls are undercounted in composition surveys relative to other segments of the population because they are often alone and difficult to spot during censuses or pre-survey flights used to locate muskoxen groups. Although bull:cow ratios are minimums they are useful to show trends through time. Focus should be placed on classifying as many muskoxen as time and money allow in any given area.

Distribution and Movements

The Seward Peninsula census area was expanded in 2007 to include the Selawik National Wildlife Refuge. The expanded effort was intended to further document range expansion of muskoxen emigrating east of the Seward Peninsula. Census participants found 6 groups totaling 78 muskoxen in the expanded census area during the census. Figure 2 shows the distribution of muskoxen on the Seward Peninsula in spring 2007 during the most recent census.

Staff monitored radiocollared muskoxen using fixed-wing aircraft during telemetry flights on a biweekly schedule beginning April 2008; however, several flights were missed due to poor flying weather common along the southern Seward Peninsula coast. Radiocollared muskoxen were observed during calving and after snow melt when groups moved from winter habitat, which generally consisted of wind-swept ridge tops free of deep snow, down slope to lush and more fertile river bottoms to browse on grasses and willows exposed from melting snow and ice. Initial movements during the reporting period were minimal and generally consisted of muskoxen moving to side slopes and river bottoms within several miles of their winter habitat, but telemetry flights completed outside the reporting period found radiocollared muskoxen movements increased throughout the summer. An adult cow collared near Venetia Creek in the Eldorado River drainage during March 2008 was observed on a ridge top between the Casadepaga River and Niukluk River drainages in October 2008 approximately 22 miles to the east from the original capture location. A second adult cow collared during March 2008 near Council, Alaska in the Niukluk River drainage was observed approximately 35 miles to the north in the upper Kuzitrin River in Unit 22D near the lava beds during an August 2008 telemetry flight. The remaining 23 collared animals stayed within 15 miles of their capture site. These movements support census results that suggest muskoxen groups make annual movements between subunits and that managers should consider a broader based geographical approach to hunt management if human harvest patterns allow.

MORTALITY

Harvest

Season and Bag Limit. During this reporting period the State of Alaska (State)administered Tier II subsistence and Tier I subsistence registration hunts in Unit 22B, Unit 22C, Unit 22D, Unit 22E, and Unit 23SW and a resident drawing hunt in Unit 22E. State Tier II and Tier I hunts are conducted in combination with federal subsistence hunts for federally qualified subsistence users on federal public lands in Units 22B, 22D, 22E and 23SW.

2006-2007 and 2007-2008 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A	No open season	No open season
Unit 22B, within the Fox River drainage upstream of the Fox River bridge, and within one mile of the Fox River bridge, and within one mile of the Council Road east of the Fox River bridge: One bull by Tier II subsistence hunting permit only	1 Nov–15 Mar (Subsistence hunt only)	No open season
Remainder of **Unit 22B** One bull by Tier II subsistence hunting permit only	1 Aug–15 Mar (Subsistence hunt only)	No open season
Unit 22C, excluding the eastern portion of the Penny River drainage (east of the east bank), the Snake river drainage, the portion of the Nome River drainage downstream from and including Hobson Creek drainage and Rocky Mountain Creek drainage, and the western portion of the Flambeau River drainage (west of the west bank) extending along Safety Sound to Safety bridge, and all additional drainages flowing to Norton Sound between Safety bridge and the mouth of the Penny River: One bull by Tier II subsistence hunting permit only	1 Jan–15 Mar (Subsistence hunt only)	No open season
Remainder of **Unit 22C**	No open season	No open season

2006-2007 and 2007-2008 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22D Southwest, west of the Tisuk River drainage, west of the west bank of the unnamed creek originating at the unit boundary opposite the headwaters of McAdam's Creek to its confluence with Canyon Creek, and west of the west bank of Canyon Creek to its confluence with Tuksuk Channel: One musk ox per regulatory year by Tier II subsistence hunting permit only; however, cows may be taken only during the period Jan. 1–Mar. 15.	1 Sep–15 Mar (Subsistence hunt only)	No open season
Unit 22D, Pilgrim River drainage: One musk ox per regulatory year by Tier II subsistence hunting permit only; however, cows may be taken only during the period Jan 1 –Mar. 15.	1 Nov–15 Mar (Subsistence hunt only)	No open season
Remainder of **Unit 22D:** One musk ox per regulatory year by Tier II subsistence hunting permit only; however, cows may be taken only during the period Jan 1 –Mar. 15	1 Aug–15 Mar (Subsistence hunt only)	No open season
Unit 22E One bull musk ox per regulatory year by Tier II subsistence hunting permit available in person in Shishmaref and Wales beginning July 24th. However, cows may be taken only during the period Jan 1 –Mar. 15. Season will be closed by emergency order when quota is reached. Trophy destruction required if skull removed from Unit 22. Use of aircraft prohibited.	1 Aug–15 Mar (Subsistence hunt only)	No open season
One bull 4-year-old or older by drawing permit only	1 Aug–15 Mar	1 Aug–15 Mar

2006-2007 and 2007-2008 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 23 SW- that portion on the Seward Peninsula west of and including the Buckland River drainage 1 muskox per regulatory year by Tier II subsistence hunting permit only; however, cows may be taken only during the period 1 Jan–15 Mar; up to 17 muskoxen may be taken; of which, not more than 7 may be cows	1 Aug-15 Mar (Subsistence hunt only)	No open season

Board of Game Actions and Emergency Orders. In November 2007 the Board of Game (BOG) made three changes that went into effect in the 2008–2009 regulatory year. The Board adjusted the amount necessary for subsistence (ANS) for Seward Peninsula muskoxen and adopted an ANS of 100–150, with 40–50 muskoxen in Unit 22E. Since the harvestable surplus of muskoxen now exceeded the ANS determination the BOG recommended staff meet with the Seward Peninsula Muskoxen Cooperators group and identify options for Tier I subsistence registration seasons, bag limits, and hunt conditions in combination with drawing permit hunts for consideration at the January 2008 BOG meeting. The board adopted a proposal to increase the number of drawing permits in the Unit 22E drawing permit hunt to "up to" 50 permits and to also allocate "up to 10%" of the permits to nonresident hunters.

In January 2008 the BOG adopted regulation changes that changed the framework of Seward Peninsula muskoxen hunt types. The board adopted a combination of Tier I Subsistence registration hunts in combination with drawing permit hunts which ended the Tier II permit hunt system that began in 1998 for hunts managed by the State of Alaska. The adopted regulatory changes resulted in registration permit hunts in Units 22B, Unit 22C, Unit 22D, Unit 22E, and Unit 23SW (available to all Alaska residents), and drawing permit hunts that offered a limited amount of drawing permits for trophy animals in Units 22C, Unit 22D, Unit 22E, and 23 SW.

An emergency order was issued on 13 March 2007 closing Tier II hunt TX099 in Unit 22C when the harvest quota of 18 bull muskoxen was reached.

Human-Induced Harvest. In 2006–2007, 64 bulls and 8 cows were harvested by Tier II permit, 9 bulls and 1 cow were harvested by a Tier I subsistence registration permit, 8 bulls were taken by drawing permit and 5 bulls and 4 cows were taken with federal permits for a total harvest of 100 muskoxen (87 bulls and 13 cows). Table 4 shows the number of permits issued and filled in 2006–2007 for state and federal hunts in each subunit and community.

In 2007–2008, 85 bulls and 5 cows were harvested by Tier II permit, 24 bulls and 6 cows were harvested by a Tier I subsistence registration permit, 13 bulls were taken by drawing permit and 7 bulls were taken with federal permits for a total harvest of 140 muskoxen (129 bulls and 11

cows). Table 5 shows the number of permits issued and filled in 2007–2008 for state and federal hunts in each subunit and community.

Permit Hunts. Hunting during this reporting period was by Tier I Subsistence registration Permit, Tier II Subsistence Hunting Permit, or by Drawing Permit (Unit 22E only) on State- managed lands and by Federal Subsistence permit on federal public lands. Trophy destruction of muskoxen taken in Tier II hunts is required if the skull is removed from Unit 22 or Unit 23 to insure applicants are primarily subsistence hunters. See the previous section for a harvest summary of permit hunts.

Hunter Residency and Success. During 2006–2007, 79 Tier II permits were issued for Seward Peninsula muskoxen hunts and 39 muskox were harvested for a 49% success rate. Fifty-one federal permits were issued and 18 muskox were harvested, resulting in a 35% success rate. In 2005–2006, 134 Tier II permits were issued. Seventy-seven of 134 Tier II permit holders harvested muskox for a 57% success rate. Eight of 52 federal permit holders harvested muskox for a 15% success rate. Tables 4 and 5 show the number of permits issued and hunter harvest during this reporting period in the state and federal hunts in each subunit and community.

In 2006–2007, 100% of hunters issued State Tier II permits for Seward Peninsula hunts were residents of Unit 22 or Unit 23 communities. Eighty-eight (88%) of Unit 22E Tier I registration hunters were Unit 22 residents and twelve (12%) of hunters were Alaska residents living outside of Unit 22. Nintey-one percent (91%) of drawing permit hunters were Alaska residents living outside of Unit 22 and 9% of hunters were nonresidents.

In 2007–2008 98% of hunters issued State Tier II permits for Seward Peninsula hunts were residents of Unit 22 or Unit 23 communities and 2% were Alaska residents living elsewhere. Fifty-six (56%) of Unit 22E Tier I registration hunters were Unit 22 or Unit 23 residents and twelve (44%) of hunters were Alaska residents living outside of Unit 22. All drawing permit hunters (100%) were Alaska residents living outside of Unit 22.

Harvest Chronology. Muskox hunt effort and chronology in northwest Alaska is driven by both weather and hours of available daylight in subunits with winter hunting seasons. First time permit holders often hunt early in the season during colder temperatures and shorter, darker days to ensure hunting opportunity before the season is closed by emergency order, but given the opportunity by drawing permit which ensures hunting opportunity throughout the season or hunting in hunt areas with historically high harvest quotas, hunters prefer to take advantage of milder temperatures and longer hours of daylight found during the end of February and March to harvest their muskox.

In 2006–2007 the proportion of harvest in each subunit showed variation throughout the season: Unit 22B – August (5%), February (21%), March (74%); Unit 22C – January (42%), February (16%), March (42%); Unit 22D - August (11%), September (17%), October (22%), November (14%), December (6%), February (11%), March (17%), Unknown (2%); Unit 22E - August (17%), September (4%), October (4%), February (42%), and March (33%); and Unit 23 – January (17%), February (11%), March (50%), September (17%), and October (6%).

In 2007–2008 the proportion of harvest in each subunit showed variation throughout the season: Unit 22B – January (18%), March (77%), Unknown (5%); Unit 22C – January (19%), February (50%), March (27%), and Unknown (4%); Unit 22D – August (23%), September (17%), October (6%), December (3%), January (3%), February (8%), and March (40%); Unit 22E – August (2%), September (10%), October (14%), January (2%), February (31%), and March (40%) and Unit 23 – January (17%), February (11%), March (50%), September (17%), and October (6%).

Transport Methods. Snowmachines were used by 70% of hunters reporting their transportation method, while other hunters used 3- or 4-wheelers (17%), highway vehicles (6%), boats (4%), off-road vehicles (2%), and aircraft (1%). Three (3%) of transportation is unknown because hunters failed to report it.

Other Mortality

Three collared adult females died between April 2008 and April 2009, and no collars failed or were missing during the radio-tracking interval. The 13% annual mortality rate 90% C.L. (4.7–37.67% n=18) is likely conservative from the perspective of the population as a whole as adult females are likely to have a higher survival rate than any other age-sex grouping. This small sample of collared muskoxen represents less than 1% of the Seward Peninsula population as of 2007 (Fig. 1), and is not randomly distributed throughout the population, so localized events such as icing or different predator regimes may preclude the use of this mortality rate as representative of the entire population. Lastly, the selection of animals for capture is not truly random, as obviously injured or diseased animals were intentionally not selected.

We frequently observe old muskoxen, and believe mortality from disease and predation has been relatively low. However, there is increasing evidence that predation is becoming more common as bears learn to prey on muskoxen and wolf numbers increase on the Seward Peninsula. As more Seward Peninsula bears learn to prey on muskoxen, we can expect predation to have a greater impact on growth of the muskoxen population. Increasing numbers of wolves associated with the wintering range of the Western Arctic caribou herd are also likely to increase predation on muskoxen (Persons 2005).

Disease. Blood, fecal, and hair samples were collected from 9 Seward Peninsula muskoxen during October 2008 capture work and tested for presence of minerals, parasites, and disease. Results show the Seward Peninsula muskoxen population tested negative for zoonotic diseases and is a healthy population and subsistence resource. Samples tested negative for *Toxoplasma*, *Neospora*, *Giardia*, and *Cryptosporida* which can decrease reproduction in muskox populations. Two of nine animals tested found elevated levels of larvae from lungworm or gastrointenstine parasites. Exposure to respiratory disease complex viruses and *Leptospirosis* was less than moose or caribou in the area or other populations of muskoxen (Beckmen 2009). Three muskoxen tested positive for *Chlamydiophila*, a pathogen known to negatively impact reproduction in other wildlife species; however these 3 as well as the 4 other muskoxen tested for pregnancy were positive (2 muskoxen were not tested for pregnancy). All muskoxen tested negative for *Mycoplasma*, a type of pneumonia and *Coxiella* which can have negative reproductive effects. Muskox serums were tested for copper levels and results found levels between 0.78 ppm–1.1 ppm (= 0.95 ppm), which suggest the potential for copper deficiency exists. However, Seward Peninsula muskoxen tested negative for additional trace elements (iron, zinc, selenium) present in other Alaskan muskox populations adversely impacted by trace

element deficiencies (Beckman 2009). Six liver samples were collected from hunter-harvested animals to compare trace element (i.e., copper, iron, zinc, selenium) levels between different Alaska muskox populations, and are awaiting results. Results from all testing did not find disease exposure or parasite prevalence that indicates Seward Peninsula muskoxen health is at risk, however, disease surveillance should continue to monitor population health.

HABITAT

Assessment

There were no activities undertaken to directly assess muskox habitat on the Seward Peninsula during the reporting period.

Enhancement

There were no muskox habitat enhancement activities on the Seward Peninsula during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Seward Peninsula Muskox Cooperators Group

In November 2006 representatives of The Cooperators met in Nome to develop recommendations to the Alaska Board of Game (BOG) on the amount necessary for subsistence (ANS) for muskoxen in each Seward Peninsula game management subunit, and to identify options and develop recommendations for a transition out of Tier II when the harvestable surplus exceeds the ANS (except in Unit 22E where transition from Tier II has already occurred). The meeting produced a BOG proposal that asked the BOG to consider an increased Seward Peninsula ANS determination of 200–250 muskoxen. The BOG did not adopt the Cooperators recommendation but instead determined the ANS value to be 100–150 muskoxen which includes a nested ANS of 40–50 muskoxen in Unit 22E.

The Cooperators met in January 2008 to consider hunting season and bag limit proposal ideas to the BOG. Through a facilitated discussion, approximately 50 people considered a variety of hunt areas and hunt conditions to transition from Tier II subsistence hunting to broader-based hunting opportunity for muskoxen across the Seward Peninsula. The group developed recommendations for hunting seasons, bag limits, hunt areas, and hunt conditions for proposed registration (Tier I) and drawing permit hunts across the entire Seward Peninsula. The two-day meeting produced landmark regulatory language proposed to the BOG that for the first time created guidelines to make muskox permits available to all Alaska residents. The BOG adopted the framework proposed by the Cooperators for Tier I hunts across the Seward Peninsula that went into effect during the 2008 regulatory year.

Conflicts with Humans and Wildlife

More Seward Peninsula residents have come to value muskoxen as a subsistence resource since hunting has been allowed and negative attitudes toward muskoxen have decreased. Some Seward Peninsula residents, especially in Teller and Shishmaref, favor capping or reducing the population in their immediate areas. Subsistence gatherers complain that muskoxen compete

with them for greens and trample traditional berry picking areas and repeated instances of muskoxen rubbing against grave markers in the Deering cemetery have angered Deering residents. Although there are no reports of anyone being harmed by muskoxen, their presence near villages, camps, and berry picking areas is often frightening. When threatened, muskoxen generally hold their ground rather than flee; this behavior contributes to people's dislike of them because it is sometimes impossible to drive them from areas where they are not wanted (Persons 2005).

Muskox and Reindeer

For many years after muskoxen were introduced to the Seward Peninsula, reindeer herders complained that muskoxen compete with and displace reindeer. There is widespread concern across the Arctic about displacement of caribou by muskoxen, and these concerns cannot be dismissed. However, habitat and diet selection studies have found that although caribou, reindeer, and muskoxen often occupy the same feeding areas, they select different forage species (Ihl and Klein 2001). Neither interspecies avoidance or competition for habitat has been documented on the Seward Peninsula or Nunivak Island. It is not uncommon on the Seward Peninsula to observe reindeer and muskoxen occupying the same ridge top, and single reindeer have been observed in the middle of large groups of muskoxen.

Muskox Viewing

The Unit 22 road system provides a unique opportunity to view muskoxen in their natural habitat. There are few places where wild muskoxen are so easily accessible and where local residents, tourists, photographers, cinematographers, and wildlife enthusiasts from around the world seek out and enjoy watching these unusual animals. The Cooperators have maintained their commitment to protect viewing opportunities in Unit 22C and along much of the Nome road system (Persons 2005). The cooperators have worked with staff to create hunt areas and set season dates that promote wildlife viewing opportunities. In areas closest to Nome the hunting season opens January 1 when most wildlife viewing has ended due to inaccessible snowed-in roads, and muskoxen located close to town are protected by a no hunt area that includes the eastern portion of the Penny River drainage, the Snake River drainage, the Nome river drainage, and the western portion of the Flambeau river drainage.

CONCLUSIONS AND RECOMMENDATIONS

Growth of the Seward Peninsula muskox population increased during this reporting period, averaging 12.6% annual rate of change between 2005 and 2007, however the 6% annual rate of growth since 2000 is a significant decrease compared to introduction in 1970 until 2000 when the population grew 14% annually.

Throughout the Peninsula, composition surveys have shown a decrease in yearling/cow ratios since 2002. Yearling/cow ratios have remained near or above 30 yearlings:100 cows (except in Unit 22C), and mature bull/cow ratios have stayed above our management objective of 30 mature bulls:100 cows. Slowing of the overall population growth rate and the declining yearling/cow ratio suggest densities may be approaching an upper limit. However, additional effort should be made to better understand eastward emigration from central areas of the Seward Peninsula into Unit 23SW and Unit 22A. These areas are searched less intensively throughout

the year because of their distant proximity to Nome and Kotzebue, but new mixed-sex and age groups were documented in the Selawik Wildlife Refuge and Unit 22A during this reporting period which indicates groups continue to successfully establish east of the western and central Seward Peninsula.

It is important to determine what factors are limiting growth so we can insure that our management strategy is appropriate. Current regulatory language will allow for increased harvest compared to those previously recorded and it will be important to consider changes in population structure and levels in relation to realized human harvest. Other factors affecting population growth could include limited suitable wintering areas, density-dependent behavioral factors, predation, weather or snow conditions, and human disturbance unrelated to harvest. Wolf numbers on the Seward Peninsula have increased since 1996 when caribou began wintering in larger numbers, and reports of bear predation on muskoxen groups have also increased. We also know herd disturbances by people or predators near calving time can cause calf separation and mortality. Close attention should be given to all these factors and harvest rates adjusted appropriately.

Muskox viewing continues to be a high priority in areas near Nome and along much of the road system, and The Cooperators have attempted to structure hunts to ensure that hunting does not affect the animals in areas most important for viewing. Near Nome and on the road system, we must watch for changes in behavior and distribution of muskoxen that are attributable to hunting and recommend adjustments to hunt areas boundaries or timing of hunts, as necessary (Persons 2005).

Some local residents continue to be upset by muskoxen occurring near villages and camps and by competition between muskoxen and subsistence users for greens and berries at traditional gathering sites. Hunting has been the best antidote for resentment toward muskoxen. Now that hunting muskoxen is allowed, more people are learning to value this new resource for its meat and qiviut, the warm wool undercoat (Persons 2005).

There have been many biological, regulatory, and social changes influencing muskoxen management since the Seward Peninsula Cooperative Muskox Management Plan was written in 1994 when the population was 994 muskoxen. Although parts of the plan are pertinent to current management there are sections obsolete to current understanding of muskoxen. While management through The Cooperators has generally followed the basic goals of the plan, the plan should be updated to serve as a blueprint for future social and biological management decisions.

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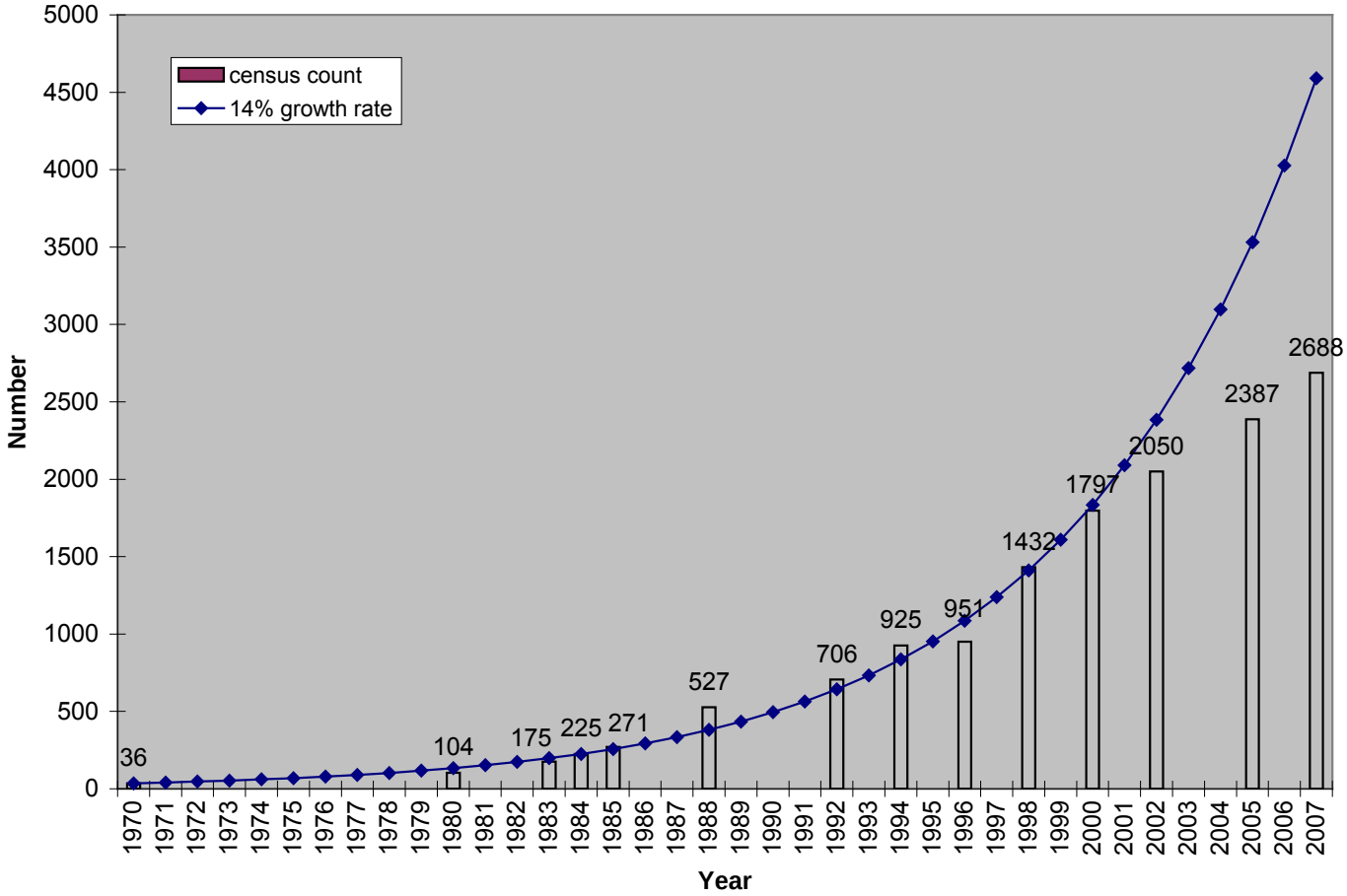

FIGURE 1 Estimated and counted number of Seward Peninsula muskoxen, 1970–2007

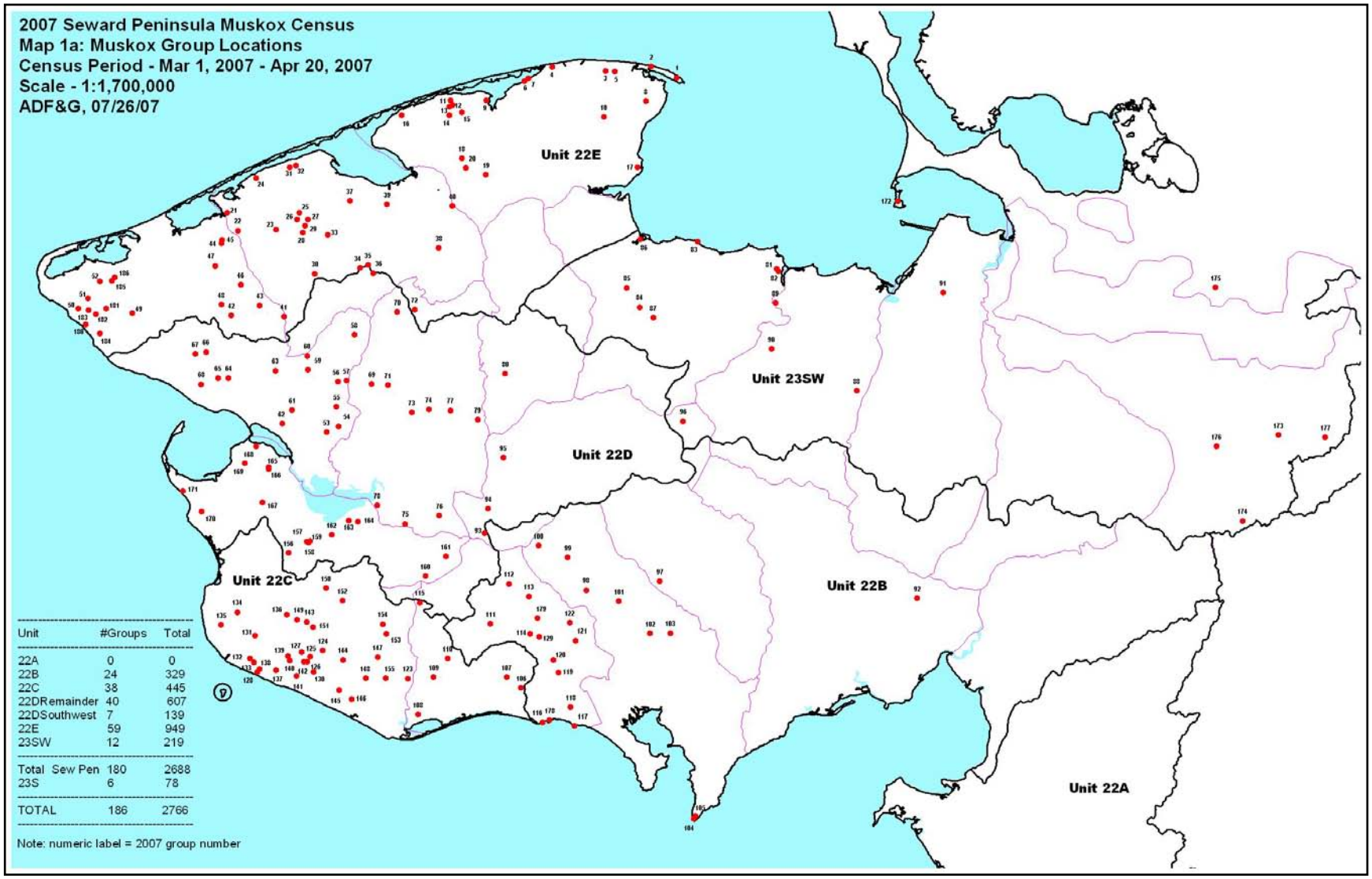

FIGURE 2 Location of Seward Peninsula muskox groups, spring 2007 census

TABLE 1 Seward Peninsula muskox census results, Units 22, 23 Southwest, and 23 Southeast, spring 2007

Unit	Groups	Adults	Yearlings	Unclassified	Total
22B	24	243	26	60	329
22C	38	90	10	345	445
22D	47	654	77	15	746
22E	59	387	38	524	949
23SW	12	191	28	0	219
23SE	6	22	5	51	78
Total	186	1587	184	995	2766[a]

[a] The total for units on the Seward Peninsula (not including 23SE) was 2688

TABLE 2 Seward Peninsula muskox census results, Units 22 and 23 Southwest, 1992–2007

	Unit						
Year	22B	22C	22D	22E	23SW	23SE[a]	Total
1992	3	49	340	180	134		706
1994	11	79	405	184	246		926
1996	51	87	308	327	178		951
1998	27	124	714	362	205		1432
2000	159	148	774	461	255		1797
2002	189	257	771	632	201		2050
2005	326	220	796	863	182		2387
2007	329	445	746	949	219	78	2766[b]

[a] This count area was not counted during 1992–2005 census counts, and is east of the Seward Peninsula
[b] The total for units on the Seward Peninsula (not including Unit 23SE) was 268

TABLE 3 Age and sex composition of Seward Peninsula muskox groups, 2002–2009

				Age																				Ratio	
				≥4 years old				3 or 4 years old		3 years old				2 years old											
				Male		Female		Female		Female		Male		Male		Female		Yearling		Calf		Unknown		per 100 cows	
Unit	Month	Year	N	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	Nr	%	B:C	Y:C
22B		2002	178	39	22	38	21	10	6	19	11	13	7	13	7	13	7	32	18			1	1	58/100	48/100
		2004	236	42	18	86	36	0	0	23	10	11	5	16	7	15	6	43	18			0	0	39/100	39/100
		2007	317	65	21	103	32	0	0	32	10	18	6	19	6	31	10	47	15			2	0.6	48/100	35/100
22C		2002	209	49	24	35	17	5	2	30	14	14	7	20	10	16	8	40	19			0	0	70/100	57/100
		2004	217	70	32	56	26	0	0	25	12	18	8	10	5	17	8	21	10			0	0	86/100	26/100
		2007	412	101	25	151	37	0	0	27	7	15	4	25	6	28	7	65	16			0	0	57/100	37/100
		2008[c]	283	43	15	123	44	4	1	15	5	18	6	16	6	18	6	42	15			4	1	30/100	30/100
		2009	313	51	16	93	30	0	0	49	16	29	9	15	5	33	11	30	10			13	4	36/100	21/100
22D		2002	455	70	15	157	35	9	2	49	11	17	4	30	7	33	7	88	19			2	0.4	33/100	41/100
		2006	516	99	19	193	37	0	0	41	8	32	6	28	5	26	5	84	16			13	3	42/100	36/100
22E		2002	313	57	18	84	27	3	1	29	9	19	6	32	10	32	10	57	18			0	0	49/100	49/100
		2005	501	83	17	161	32	0	0	69	14	28	6	43	9	34	7	77	15			6	1	36/100	33/100
	Aug	2008	199	37	19	59	30	0	0	14	7	13	7	9	5	12	6	19	10	35	18	1	1	51/100	26/100
23SW		2002	170	33	19	52	31	0	0	20	12	8	5	15	9	20	12	22	13			0	0	46/100	31/100
	July	2008	141	19	13	52	37	0	0	8	6	8	6	7	5	8	6	16	11	20	14	3	2	32/100	27/100

[a] Number of males ≥4 years old/100 cows ≥3 years old.
[b] Number of yearlings/100 cows ≥3 years old.
[c] Emphasis was given to muskox groups that had collars in them one month prior to composition surveys.

TABLE 4 Results of state and federal muskox hunts on the Seward Peninsula, 2006–2007

Hunt Area	Muskox Harvest Quota 1	Cow Muskox Harvest Quota	No. of State Permits Issued 2	No. of State Permits Filled Bulls	No. of State Permits Filled Cows	No. of Federal Permits Issued 2	No. of Fed. Permits Filled, Bulls	No. of Fed. Permits Filled, Cows	Total Bull Harvest	Total Cow Harvest	Total Harvest
22B											
TX105	**16**	**0**	**24**	**15**	**0**	**8**	**2**	**0**	**17**	**0**	**17**
Elim	NA	NA	8	3	NA			NA			
Golovin	NA	NA	5	4	NA		1	NA			
Koyuk	NA	NA	3	1	NA			NA			
Shaktoolik	NA	NA	1	1	NA	NA		NA			
Unalakleet	NA	NA	1	1	NA	NA		NA			
White Mtn	NA	NA	6	5	NA		1	NA			
22C											
TX099	**18**	**0**	**22**	**18**	**1**	**0**	NA	NA	**18**	**1**	**19**
Kotzebue			1		1						
Nome	NA	NA	20	17							
Unalakleet			1	1							
22D											
TX102	**32**	**13**	**45**	**18**	**6**	**6**	**0**	**0**	**18**	**6**	**24**
Brevig	NA	NA	10	3	2	4					
Elim	NA	NA	1			NA					
Kotzebue	NA	NA	1			NA					
Nome	NA	NA	28	14	3	NA	NA	NA			
Shaktoolik	NA	NA	1		1	NA					
Teller	NA	NA	2			2					
Unalakleet	NA	NA	2	1		NA	NA	NA			
TX103	**13**	**6**	**21**	**12**	**0**	**0**	NA	NA	**12**	**0**	**12**
Teller	NA	NA	5	1		NA	NA	NA			
Nome	NA	NA	14	9		NA	NA	NA			
Unalakleet	NA	NA	2	2		NA	NA	NA			
22E											
RX104	**60**	**35**	**24**	**9**	**1**	**12**	**2**	**4**	**11**	**5**	**16**
Shishmaref	NA	NA	11	0		12	2	4			
Wales	NA	NA	10	7		0					
Homer	NA	NA	1		1	**NA**					
Big Lake	NA	NA	1	1		**NA**					
Fairbanks	NA	NA	1	1		**NA**					
Drawing	**9**	**0**	**11**	**8**	**NA**	**NA**	**NA**	**NA**	**8**	**0**	**8**
23SW											
TX106	**15**	**7**	**13**	**2**	**1**	**6**	**1**	**0**	**3**	**1**	**4**
Buckland	NA	NA	7	1		4					
Deering	NA	NA	2	1	1	2	1				
Kotzebue	NA	NA	4								
[1] based on a 5% harvest rate in Units 22B and 22D remainder and an 8% harvest rate in Units 22C, 22D SW and 23SW									**87**	**13**	**100**

[2] Based on previous success rates additional permits were issued.

TABLE 5 Results of state and federal muskox hunts on the Seward Peninsula, 2007–2008

Hunt Area	Muskox Harvest Quota 1	Cow Muskox Harvest Quota	No. of State Permits Issued 2	No. of State Permits Filled Bulls	No. of State Permits Filled Cows	No. of Federal Permits Issued 2	No. of Fed. Permits Filled, Bulls	No. of Fed. Permits Filled, Cows	Total Bull Harvest	Total Cow Harvest	Total Harvest
22B											
TX105	**16**	**NA**	**24**	**20**	**NA**	**7**	**2**	**NA**	**22**	**NA**	**22**
Council			1	1							
Elim			3	2							
Golovin			6	5							
Koyuk			4	3							
Shaktoolik			2	1							
Unalakleet			1	1							
White Mountain			7	7							
22C											
TX099	**36**	**NA**	**43**	**25**	**NA**	**0**	**NA**	**NA**	**25**	**NA**	**25**
Nome			42	25							
Unalakleet			1	0							
22D											
TX102	**30**	**12**	**53**	**23**	**3**	**3**	**1**	**0**	**24**	**3**	**27**
Brevig Mission			14	6	0						
Council			1	0	0						
Dutch Harbor			1	0	0						
Elim			1	0	1						
Kotzebue			1	0	0						
Noatak			1	1	0						
Nome			37	15	2						
Teller			1	1	0						
TX103	**11**	**6**	**19**	**9**	**0**	**3**	**0**	**0**	**9**	**0**	**9**
Nome			8	6	0						
Teller			8	1	0						
Unalakleet			3	2	0						
22E											
RX104	**69**	**34**	**57**	**24**	**6**	**18**	**2**	**0**	**26**	**6**	**32**
Anchorage			12	8	2						
Brevig Mission			2	0	0						
Chugiak			1	1	0						
Eagle River			4	2	0						
Fairbanks			1	0	1						
Glenallen			1	1	0						
Kotzebue			1	0	1						
Nome			13	0	0						
Palmer			1	0	0						
Seward			1	1	0						
Shishmaref			10	5	2						
Sitka			3	3	0						
Wales			4	2	0						
Wasilla			1	1	0						
DX097/Gov. Permit	**20**	**0**	**21**	**13**	**NA**	**NA**	**NA**	**NA**	**13**	**NA**	**13**
Anchor Point			1	0							
Anchorage			5	4							
Chugiak			1	0							
Fairbanks			4	4							
Juneau			2	2							
Kodiak			1	0							
Nonresident			1	0							
North Pole			1	1							
Prudehoe Bay			1	0							
Unalakleet			1	0							
Valdez			1	1							
Wasilla			2	1							
23SW											
TX106	**18**	**9**	**30**	**8**	**2**	**10**	**2**	**0**	**10**	**2**	**12**
Anchorage			1	0	0						
Big Lake			1	0	0						
Buckland			8	1	1						
Deering			5	2	1						
Healy			1	0	0						
Kianna			1	0	0						
Kotzebue			7	4	0						
Noorvik			1	1	0						
Willow			1	0	0						

WILDLIFE MANAGEMENT REPORT

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO Box 115526
Juneau, AK 99811-5526

MUSKOX MANAGEMENT REPORT

From: 1 July 2006
To: 30 June 2008[1]

LOCATION

GAME MANAGEMENT UNIT: 23 (43,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Western Brooks Range and Kotzebue Sound

BACKGROUND

Muskoxen are indigenous to northwest Alaska; however, they disappeared before or during the nineteenth century for unknown reasons. The North Pacific whaling fleet is often credited with decimating muskoxen in this region. However, muskoxen may have already disappeared from Alaska (but not northwestern Canada) by the time whalers arrived. Although there is ample evidence of several genera of muskox in northwest Alaska from the Pleistocene period (McDonald and Ray 1989), there is little evidence that muskoxen existed south of the Brooks Range during the last several hundred years.

Two muskox populations currently inhabit Unit 23, and both are products of translocations from Nunivak Island. The department released 36 muskoxen on the southwestern portion of the Seward Peninsula near Teller in 1970. In 1981 the department released an additional 35 muskoxen in the same area. Muskoxen inhabiting Unit 23 Southwest, the portion of Unit 23 between the Buckland and Goodhope rivers, are part of the Seward Peninsula population that resulted from these translocations near Teller. The Unit 22 muskoxen management report covers the Seward Peninsula muskox population and includes information for Units 22 and 23 Southwest.

In 1970 the department also released 36 muskoxen near Cape Thompson, and in 1977 the department released an additional 34 muskoxen at the same site. Of the 4 translocations of muskoxen to Alaska, the Cape Thompson population has grown the least. Currently, the 'Cape Thompson' muskox population inhabits that portion of Unit 23 from the mouth of the Noatak River to Corwin Bluff within 15–20 miles of the Chukchi Sea.

[1] This report also contains information collected outside the reporting period at the discretion of the reporting biologist.

In addition to the relatively discrete Seward Peninsula and Cape Thompson populations that occupy stable, core ranges, a few muskoxen are also widely scattered throughout the remainder of the unit. Most of these scattered muskoxen occur in small groups of 1–4 individuals, and most are bulls. However, mixed sex-age groups have been observed in the Selawik, middle Noatak, and upper Noatak drainages during recent years, as well as in the southwestern portion of Unit 26A. Muskoxen in the Noatak drainage and in Unit 26A probably emigrated from the Cape Thompson area while those in the Selawik and Kobuk drainages probably came from the Seward Peninsula.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

1. To allow for growth and expansion of muskoxen into historic ranges.
2. To initially provide for subsistence hunting and eventually provide for recreational hunting of muskoxen on a sustained yield basis.
3. To provide for nonconsumptive uses of muskoxen; e.g., viewing and photography.

MANAGEMENT OBJECTIVES

1. To census the Cape Thompson population at least once every 3 years.
2. To monitor the sex and age composition of the Cape Thompson muskoxen population.
3. To minimize effects of development (e.g., mines and roads), hunting, and tourism on muskoxen and their habitat.

METHODS

POPULATION STATUS AND TREND

Population Size

The Cape Thompson muskoxen population has been censused irregularly since 1987, using fixed-wing aircraft. The census area includes that portion of Unit 23 between the mouth of the Noatak River and Corwin Bluff within approximately 20 miles of the Chukchi Sea coast. It also includes the lower 10 miles of the Aggie River. Search efforts have focused on known areas of use and prime muskoxen habitat along ridgelines and riparian areas; other areas have been searched less intensively. To minimize disturbance, we approach groups of muskoxen at 1000–2000 ft above ground level and repeatedly count them during a gradual, low power, spiral descent. These censuses have provided minimum direct count population counts with no estimates of sightability or confidence intervals.

Population Composition

Composition information was collected each August in 2006, 2007, and 2008 in partnership with the National Park Service. A helicopter was used for transportation to the groups where ground-based observations of muskoxen were performed. We classified as many muskoxen as possible, sometimes using 1 or 2 fixed-wing planes to help search the area between the Noatak River mouth and Cape Lisburne. For ratio estimates we defined ‘cow’ as any female $\geq$3 yrs old and ‘bull’ as any male $\geq$4 yrs old.

Distribution and Movements

Locations of muskoxen observed during censuses were recorded using Global Positioning System (GPS) coordinates. Locations of muskoxen observed opportunistically during other work were also recorded using GPS coordinates. In addition, casual conversations between department staff and local residents, commercial operators, hunters, and nonconsumptive users provided information regarding the distribution of muskoxen in Unit 23.

MORTALITY

No radio collars were deployed in this population by department staff during the reporting period; therefore, we did not estimate annual population mortality rates. When possible, kill sites were examined to attempt to determine causes of muskoxen mortality.

Harvest

Harvest during the 2006–2007 and 2007–2008 regulatory years was monitored through the Tier II hunt report system.

HABITAT

Assessment

The department did not monitor muskoxen range condition in Unit 23 during the reporting period.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

From 1970 to 1998 the Cape Thompson muskoxen population grew approximately 8% annually (Figure 1, Table 1). Since 1998, this population has probably been stable. The size of the core range of this population has slowly increased since 1970; however, it has not increased in proportion to population size. Opportunistic observations during 2006 and 2007 of mixed-sex age groups in the vicinity of the upper Kokolik River and Meat Mountain in Unit 26A, and in the middle and upper Noatak River, suggest muskoxen may be emigrating from their core range to new areas.

Population Composition

We located only 30–47% of the entire estimated population during composition surveys in 2007–2008. Because we did not sample the entire population, actual composition may differ somewhat from our results.

We observed 25, 36, and 9 calves:100 cows ($\geq$2 yrs old) in 2006, 2007, and 2008, respectively (Table 2). Bull:cow ratios (all age categories combined but excluding calves and yearlings) for these years were 63, 83, and 65:100. We may underestimate bull:cow ratios because search intensity during composition surveys is low compared to censuses and mature bulls are often alone or in very small groups that could easily be missed. Additionally, composition surveys are

performed in the summer when a single muskox can be difficult to see. With only 5 years of data, little can be said regarding the survival of individual cohorts. Additionally, the entire population has not been sampled in any year. Composition data suggests calf production has varied substantially among years, and that there is no biologically significant shortage of bulls. Low calf production combined with observations of mixed sex-age groups emigrating from the core range may suggest this population is beginning to experience density dependent limitations. However, the low sample size in 2008 is the most likely factor affecting observed calf ratios. Observing calf ratios over a more prolonged time period will, hopefully, illuminate any trends.

Distribution and Movements

The historical distribution and movements of this population have been previously described (Dau 2005). Based on 9 censuses conducted since 1988, the proportion of this population in the southern portion of its range has increased (Fig. 2). For example, 24% of the total population was observed within Cape Krusenstern National Monument during the 1988 census while in 2008 this percentage increased to 75% (Fig. 3). Several things could be contributing to this change in distribution. The strong fidelity muskoxen exhibit for coastal areas is probably attributable to their dependence on high winds to minimize snow depth on exposed ridges during winter. Although snow in these areas is minimal, the quantity and quality of forage appears to be limited. Muskoxen may be attracted to coastal areas during summer by cooler conditions than occur inland.

Muskoxen in the northern portion of their range may be moving along the coast and either emigrating into Unit 26A or moving southeast toward the Igichuk Hills. For example, 48 animals were observed in the spring of 2009 at Cape Sabine, outside the traditional census area. Presence or absence of a group this size can have substantial effects on census results.

Illegal harvests may have reduced muskoxen numbers in the northern portion of this area. For example, since 2003 we have found (occasionally with reports from Cape Lisburne Long Range Radar staff) 14 muskoxen illegally killed and abandoned north of and including Cape Thompson. Many residents of northwest Alaska have long resented the presence of muskoxen in areas they have used to hunt caribou, gather greens, and pick berries for generations. Agency staff spend little time in the northern portion of this muskoxen range so we do not know the magnitude of illegal harvests. Additionally, weather can present challenges to surveying in the northern coastal regions and may affect search intensity. However, this factor is actively mitigated.

After several years of being almost totally absent from the Tahinichok Mountains, muskoxen resumed using this area in 2004 though to a lesser degree than during the late 1980s. Even so, most muskoxen within Cape Krusenstern National Monument occurred in the Igichuk Hills or along the coast between the mouth of Killikmak Creek and the Noatak River delta.

Despite their fidelity to the Chukchi Sea coast, for many years bulls in groups numbering 1–6 individuals have been observed scattered throughout the western Brooks Range and its foothills. The slight decline in census results from 2005 to 2007 may be attributable to these groups emigrating from the core range. In 2009, a mixed-sex age group containing neonates was observed in the upper Noatak where only small groups of bulls had been previously observed.

MORTALITY

Harvest

Season and Bag Limit. Since its inception during the 2000–2001 regulatory year, 6 permits have been issued annually for the Tier II muskoxen hunt in northwest Unit 23 (TX107), the season has been 1 August–15 March, and the bag limit has been 1 bull.

Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
2006–2007 and 2007-2008		
Unit 23, Southwest, that portion on the Seward Peninsula west of and including the Buckland River drainage	(see Unit 22 report)	(see Unit 22 report)
Unit 23, that portion north and west of the Noatak River		
1 bull by Tier II subsistence hunting permit only; up to 15 bulls may be taken.	1 Aug–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 23	No open season	No open season

In addition to the state Tier II hunt (TX107), the Federal Subsistence Board established a federal subsistence muskoxen hunt on Cape Krusenstern National Monument for residents of the monument that went into effect during the 2005–2006 regulatory year. The total annual quota has been 2 bulls with a 1-bull bag limit. The federal season is identical to the Tier II hunt. Under this quota, one bull was taken in the 2005–2006 season and one bull was taken in 2007–2008.

Board of Game Actions and Emergency Orders. None during this reporting period.

Human-Induced Harvest. Few muskoxen have been harvested under TX107 since this hunt was established (Table 3). Until the 2004–2005 season all permits went to residents of Point Hope, Kivalina or Noatak. Few residents of these communities have applied for a permit recently and now residents of Kotzebue who have consistently applied since this hunt was established have begun to receive most or all of the permits each year. This shift in permits has happened despite efforts to encourage residents outside of Kotzebue to apply. A consequence of this shift is that recent harvests have been concentrated in the vicinity of the Noatak Hatchery. For example, during the 2008–2009 hunt, all 5 individuals in a group of bulls were harvested and the 6th bull was taken only a short distance away.

Permit Hunts. See section above.

Hunter Residency and Success. See section above regarding residence of hunters. Annual success rates for TX107 in most recent years have been 100%. Most or all hunters who fail to harvest a muskoxen simply did not hunt.

Harvest Chronology. Since the beginning of this hunt, most harvests have occurred during August–September and January–March.

Transport Methods. Most hunters have accessed the hunting area via snowmachine; however, hunters that have taken muskoxen in the fall mainly used boats.

Natural Mortality

Although wolves and brown bears in this area may be learning to take muskoxen (Dau 2005), losses to predators still appear to be low based on the lack of kills observed or reported. Brown bears seem to be a more significant source of mortality on the Seward Peninsula (J. Dau, ADF&G wildlife biologist, Kotzebue, Alaska, unpublished observations) and on the North Slope (Reynolds 2003, Reynolds et al. 2002) than in northwestern Unit 23.

Other Mortality

During late August 2006 a seasonal resident of Shesaulik killed a mature bull muskox in defense of life and property after unsuccessfully attempting to chase it out of his dog yard. Unfortunately, he did not salvage the meat. Daily afternoon ambient temperatures were warm so the carcass quickly spoiled and attracted a brown bear. The National Park Service used a helicopter to sling the carcass away from his camp. Although justified in killing the bull, this individual was subsequently cited by the Department of Public Safety for failing to salvage the meat. Given the propensity for muskoxen to travel along beaches during summer and their increasing numbers in the southern portion of their range, human–muskox conflicts between Sealing Point and Shesaulik will likely continue and could become more frequent in the future. Indeed, in the summer of 2008 another muskox was taken in defense of property. At least 2 other muskoxen, both bulls, have been shot and left in the vicinity of Shesaulik over the past 5–6 years.

Illegal harvests have been a source of muskoxen mortality in northwest Unit 23 since at least the late 1980s. The significance of illegal harvests to the dynamics of this population is unknown.

HABITAT

Assessment

There were no muskox habitat assessment activities in Unit 23 during the reporting period.

Enhancement

There were no muskox habitat enhancement activities in Unit 23 during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Conflicts among muskoxen, caribou, and reindeer

Many local residents of northwest Alaska still feel that muskoxen displace caribou and reindeer through behavioral interactions and the presence of muskoxen qiviut (undercoat) and feces in

areas where they are sympatric. Until this concern is adequately addressed, it will continue to impede muskox management in northwest Alaska (see also 'Other Mortality' section above). Details of these conflicts have been previously reported (Dau 2005).

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Two distinct populations of muskoxen inhabit Unit 23. One population ranges within 15–20 miles of the coast between the mouth of the Noatak River and Corwin Bluff. The other population inhabits the southwestern portion of Unit 23 as part of the Seward Peninsula population. Both populations stem from translocations initiated by the department in 1970. Small groups of bulls are scattered throughout much of the remainder of Unit 23. Additionally, mixed-sex age groups may be becoming established in the southwestern portion of Unit 26A, in the middle Noatak drainage, and in the Selawik drainage.

2. The Cape Thompson population grew approximately 8% annually during 1970-1998. Since then, it has been stable or slowly declining. Therefore, the harvest strategy for TX107 should remain conservative with a 6-bull quota.

3. Muskoxen in the northwest portion of Unit 23 exhibited strong fidelity to their core range. This fidelity was most pronounced for large mixed sex/age groups. Even so, more muskoxen now inhabit the southern portion of their range than in previous years.

4. Harvests of muskoxen in the northwest portion of Unit 23 should be cooperatively managed by the department and NPS, as they are on the Seward Peninsula. That would better allow state and federal quotas to be based on the relative abundance of muskoxen on these lands. Currently, although roughly 75% of the total population inhabits Cape Krusenstern, only 25% of the total harvest is allowed to be taken there under the federal hunt. Composition data does not suggest this has affected the sex or age structure of this population. Even so, a cooperative management approach would still probably benefit muskoxen and hunters.

5. Muskoxen use riparian areas during summer and exposed, sparsely vegetated domes and ridges where snow cover is minimal during winter. Muskoxen use body-fat reserves and extremely conservative behavior to survive through winter. Disturbance to muskoxen during winter should be minimized.

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TABLE 1 Muskoxen census results for the northwest portion of Unit 23, 1988–2008

	May 1988	June 1994	March 1997	June 1997	June 1998	June 1999	June/July 2000	July 2001	Jan. 2004	Feb. 2005	Feb. 2007	Jan. 2008
Groups	14	19	24	26	39	34	41	37	43	41	40	38
Individuals[a]	106	215	291	212	322	299	327	236	363	369	347	324
Calves[b]	17	18		49	65	75	97	23				
Total	123	233	291	261	387	374	424	259	363	369	347	324
Calves:100 Adults	16	8		23	20	25	30	10				

[a] "Individual" defined as any muskox >2 months old (i.e., excluding calves)

[b] "Calf" defined as any muskox ≤2-3 months old

TABLE 2 Sex and age composition of the Cape Thompson muskoxen population during July 2006-2008, Game Management Unit 23 (percentage of total observed in parentheses; however, percent of total population classified in parentheses following 'year')[a]

	Males (%)	Females (%)	Unknown (%)	Total (%)
2006 (N/A) [b]				
Adults (4+ yrs old)	49 (26)	69 (36)		118 (62)
3-yrs old	4 (2)	15 (8)		19 (10)
2-yrs old	4 (2)	1 (1)		5 (3)
Yearlings			27 (14)	27 (14)
Calves			21 (11)	21 (11)
Unknown age				
Total	57 (30)	85 (45)	48 (25)	190
2007 (47%)				
Adults (4+ yrs old)	40 (25)	51 (31)		91 (56)
3-yrs old	9 (6)	8 (5)		17 (10)
2-yrs old	12 (7)	7 (4)		19 (12)
Yearlings			14 (9)	14 (9)
Calves			21 (13)	21 (13)
Unknown age			0 (0)	0 (0)
Total	61 (38)	66 (40)	35 (22)	162
2008 (30%)				
Adults (4+ yrs old)	18(19)	39 (40)		57 (59)
3-yrs old	10 (10)	4 (4)		14 (14)
2-yrs old	4 (4)	6 (6)		10 (10)
Yearlings			12 (12)	12 (12)
Calves			4 (4)	4 (4)
Unknown age				
Total	32 (33)	49 (50)	16 (16)	97

[a] Composition surveys were paid for by the National Park Service and conducted cooperatively with department staff.
[b] Percent observed not available due to incomplete census information.

TABLE 3 Harvest data for the Tier II muskoxen hunt, TX107 (6 permits issued annually) and the Federal muskoxen hunt FX120 (up to 2 permits available annually), 2000-2001 through 2007-2008

					Hunter Residency				
Year	# Permits	# Bulls	# Cows	Total harvest	Point Hope	Kivalina	Noatak	Kotzebue	Other
2000-2001	6	1	0	1	4	2	0	0	
2001-2002	6	0	0	0	2	0	4	0	
2002-2003	6	4	1	5	1	2	3	0	
2003-2004	6	0	0	0	0	0	6	0	
2004-2005	6	2	1	3	0	0	3	3	
2005-2006[a]	6 (1)	(1)	0	1	0	1	3	2	(1)
2006-2007	6 (1)	4	0	4	1	1	1	3	(1)
2007-2008	6 (2)	6 (1)	0	7	0	0	0	6	(2)

[a] Season closed by emergency order. Quota taken illegally.

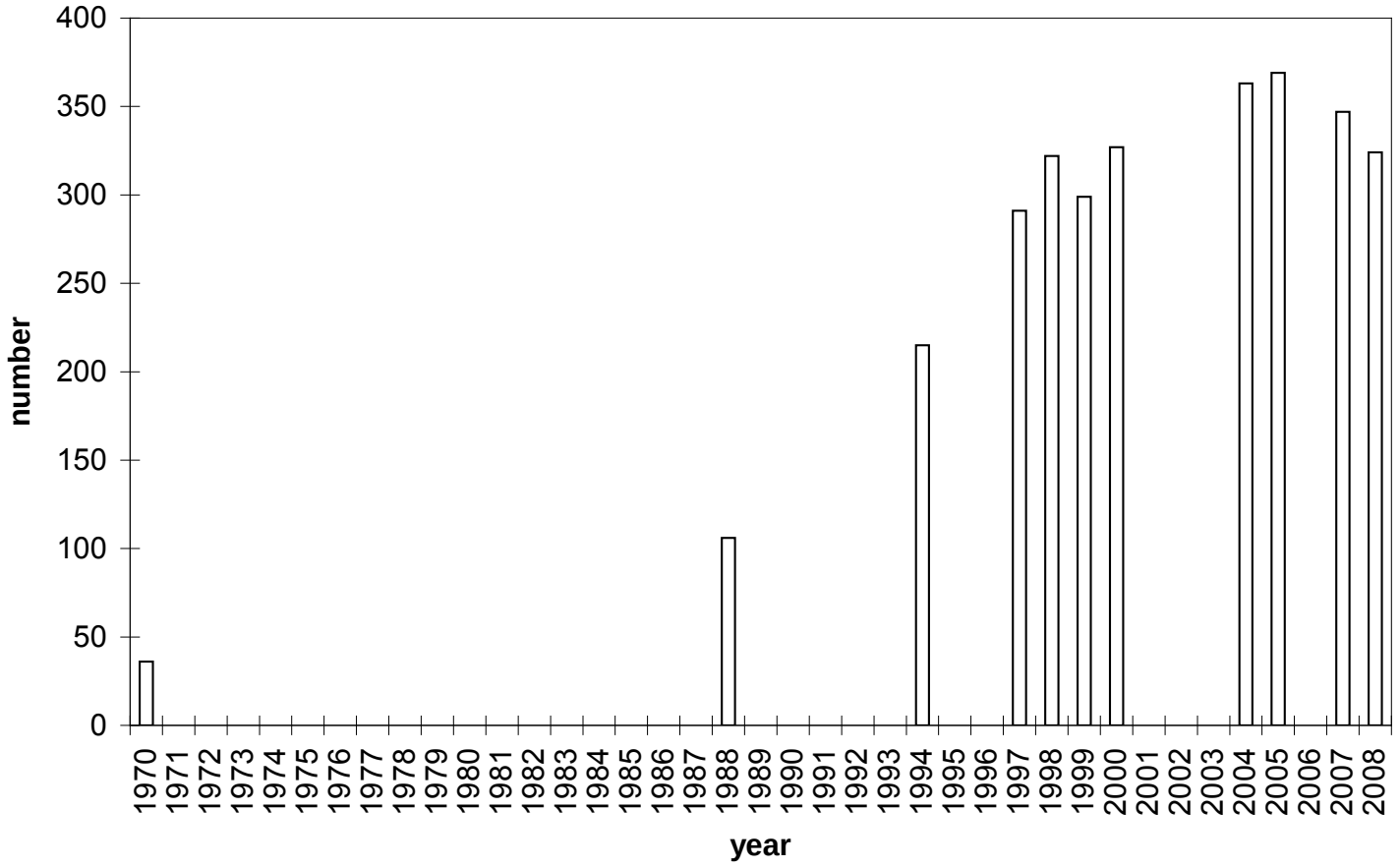

FIGURE 1 Muskoxen census results in the northwestern portion of Game Management Unit 23 during 1970–2008.

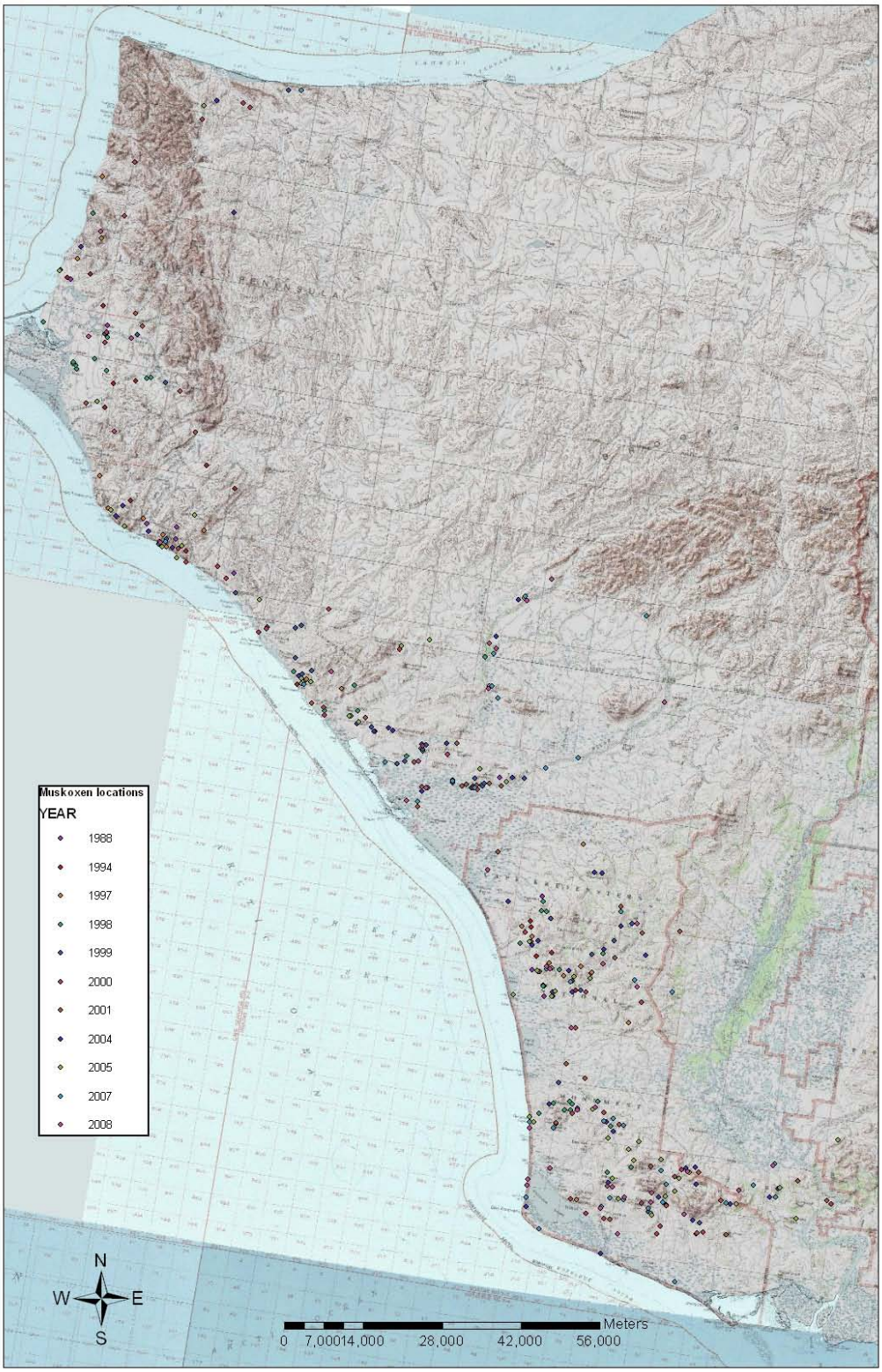

FIGURE 2 Locations of muskoxen groups observed during population censuses, 1988–2008 (sample units shown as well).

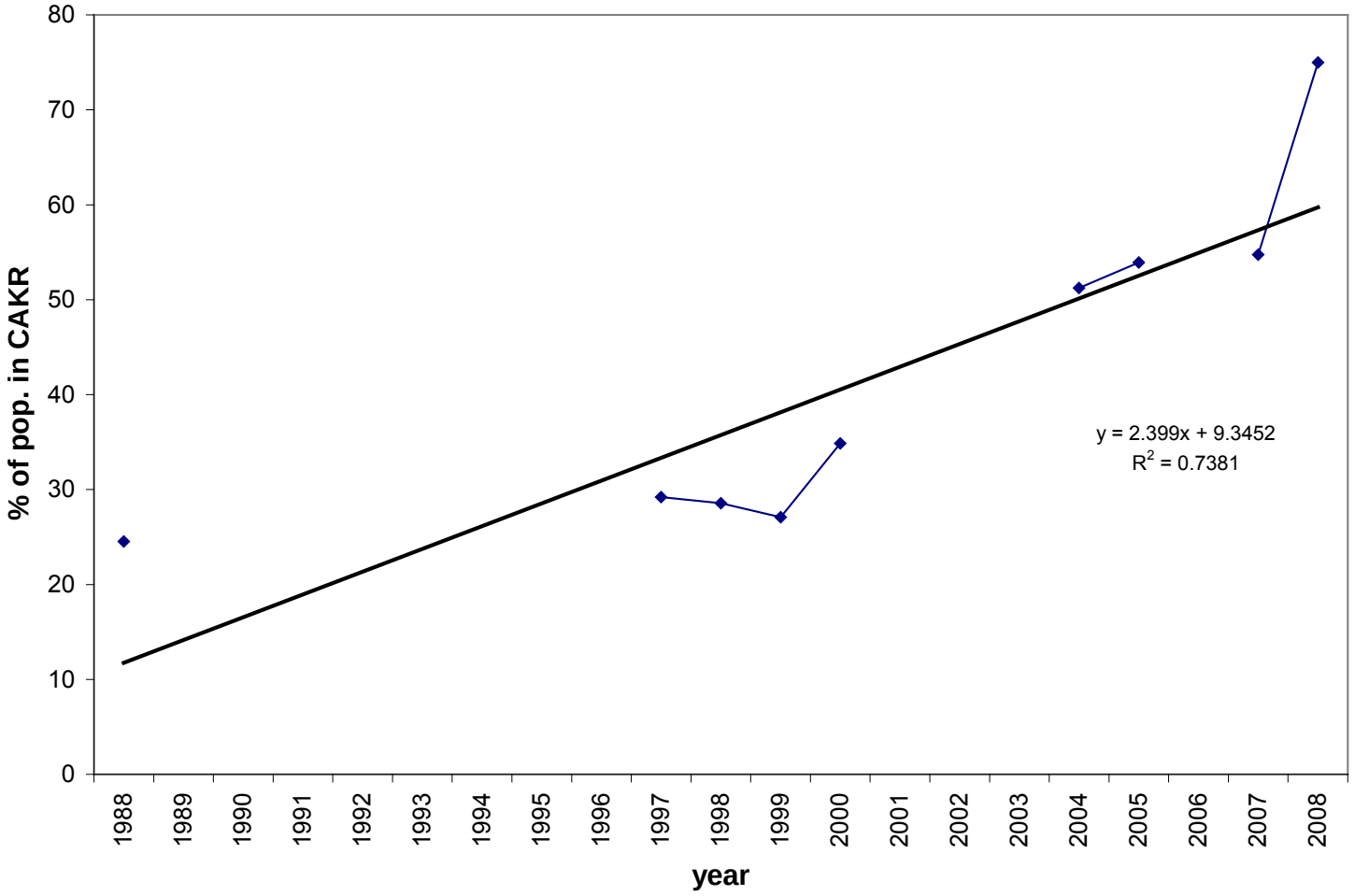

FIGURE 3 The percentage of muskoxen observed within Cape Krusenstern National Monument (CAKR) during population censuses, 1988–2008.

WILDLIFE MANAGEMENT REPORT

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO Box 115526
Juneau, AK 99811-5526

MUSKOX MANAGEMENT REPORT

From: 1 July 2006
To: 30 June 2008[1]

LOCATION

GAME MANAGEMENT UNITS: 26B and 26C (26,000 mi^2)

GEOGRAPHIC DESCRIPTION: Central and Eastern Arctic Slope

BACKGROUND

Muskox populations in Alaska disappeared in the late 1800s or early 1900s (Lent 1998). The Alaska Department of Fish and Game (ADF&G) reintroduced muskoxen to Nunivak Island during 1935–1936. During 1969 and 1970, 51 animals from Nunivak Island were released on Barter Island and 13 were released at Kavik River on the eastern North Slope. The number of muskoxen in this area (Unit 26C) increased steadily during the 1970s and 1980s, and expanded eastward into Yukon, Canada, and westward into Unit 26B and eastern Unit 26A during the late 1980s and early 1990s. The population was considered stable during the mid 1990s at around 500–600 muskoxen in Units 26B and 26C with perhaps an additional 100 animals in Yukon, Canada. Beginning in 1999, calf production, yearling recruitment, and number of adults declined substantially in Unit 26C and by 2003, only 29 muskoxen were observed in this unit. Muskox numbers in Unit 26B appeared stable to slightly increasing from the mid 1990s through 2003.

ADF&G first opened a hunting season in Unit 26C in 1982 and in Unit 26B in 1990. Several regulatory scenarios have been in effect since then (Lenart 2003). The *North Slope Muskox Harvest Plan* (1999, ADF&G files, Fairbanks) is the template for managing muskoxen in Unit 26B. Consistent with that plan, in March 1998, the Alaska Board of Game determined that a harvest of no more than 20 muskoxen (Tier II hunt TX108) was necessary to provide a reasonable opportunity for subsistence use in Unit 26B, west of the Dalton Highway. The board also decided that no more than 5 muskoxen were required to meet subsistence needs in Unit 26B, east of the Dalton Highway. Tier I Hunt RX110 replaced Tier II Hunt TX110. Permits were made available in Nuiqsut and Kaktovik, and the season was announced by emergency order when snow conditions, weather, or other factors were suitable for hunting muskoxen. A drawing permit hunt (DX112) was also established; 3 permits were issued annually for taking bull muskoxen in Unit 26B, east of the Dalton Highway. The board determined that it was possible to

[1] At the discretion of the reporting biologist, this unit report may contain data collected outside the reporting period.

have subsistence and drawing hunts in the same area because the population could be managed as 2 subpopulations: bulls and cows. The $25 resident muskox tag fee was waived for subsistence hunters in Units 26B and 26C. Hunters have harvested small numbers of muskoxen annually in Units 26C and 26B when the seasons were opened. Some season and boundary changes were made since 1998 (Lenart 2003).

MANAGEMENT DIRECTION

In April 1996 we initiated a management planning process on the North Slope to address concerns by North Slope residents about possible interactions between muskoxen and caribou and about the future management of muskoxen. Participants of the North Slope Muskox Working Group included representatives from local villages, ADF&G, the North Slope Borough, and affected federal agencies. The group developed the *North Slope Muskox Harvest Plan*, and all agencies, including ADF&G, signed the plan in February 1999. Some goals and objectives in this report were adopted directly from the plan.

During the previous reporting period (1 Jul 2004–30 Jun 2006), the muskoxen population in Unit 26B was declining (Lenart 2007). Therefore, management objectives for this report period (1 Jul 2006–30 Jun 2008) were temporarily revised while research on Unit 26B muskoxen is being conducted. The objectives of the research project are to collect detailed information concerning distribution, group sizes, movements, and habitat uses; estimate annual birth rates and calf recruitment through late June; and determine rates and causes of mortality during April–June. Results from this project could help identify potential causes in changes of muskox abundance, direct possible management actions that need to be taken, and aid us in forming new management objectives in the near future.

MANAGEMENT GOALS

1. Provide opportunities to harvest muskoxen while maintaining healthy, stable muskox populations.

2. Minimize any detrimental effects that muskoxen may have on caribou and caribou hunting.

3. Cooperate and share information about muskoxen among users (e.g., local and nonlocal residents and local, state, and federal agencies) to develop and implement harvest, management, and research programs.

4. Provide opportunities to view and photograph muskoxen.

MANAGEMENT OBJECTIVES AND ACTIVITIES

1. Maintain a stable population of ≥200 muskoxen for 4 to 5 years in Unit 26B and eastern Unit 26A.

2. Maintain a bull (≥3 year old):cow (≥2 year old) ratio of ≥35:100 in Unit 26B and eastern Unit 26A.

   - When objectives 1 and 2 have been met, permits for a bulls-only hunt may be issued. The number of permits to be issued would depend on population size, composition, recruitment, distribution, group size, mortality rates, and health of the population.

In addition, ongoing activities to measure when we meet the above objectives include:

- Conduct a census during precalving surveys in early April every 2–3 years.
- Conduct a precalving census across the eastern North Slope every 3–5 years in cooperation with Arctic National Wildlife Refuge (ANWR) and Canada.
- Conduct ground-based composition counts in June to determine herd composition annually.
- Maintain 15–20 radiocollars on adult female muskoxen to assist in locating groups of muskoxen during precalving surveys and composition counts.
- Administer permit hunts and monitor results of the hunts if a hunt is opened.
- Test for the presence of potentially population-regulating diseases including *Chlamydia*, contagious ecthyma, trace mineral deficiencies, lungworm, and stomach worm.

When the first 2 objectives have been met, our third objective and associated activity will be to:

3. Maintain a harvest rate of no more than 3% per year of the spring precalving population in Unit 26B while the population is less than 500 muskoxen.
    - Administer permit hunts and monitor results of the hunts.

METHODS

POPULATION SIZE AND COMPOSITION

Population Size

ADF&G and U.S. Fish and Wildlife Service–ANWR biologists cooperated to collect population data. To obtain a minimum count of muskoxen, we conducted precalving surveys in late March or early April by flying transects and drainages in Units 26B and 26C using a Cessna 185, 206, or a Super Cub. Bright, sunny days provided the best survey conditions. Transects were flown at approximately 90 mph at 500–1000 ft above ground level, depending on visibility. In addition to flying transects and drainages, we tracked radiocollared females to locate groups of muskoxen.

In Unit 26C, surveys began in 1978 when ANWR staff surveyed major drainages and smaller adjacent tributaries and bluffs. During 2002–2005, refuge staff flew approximately 1400 miles along 50 north–south transects, spaced at 3-mile intervals, across the coastal plain from the Arctic Ocean to the mountains of the Brooks Range, from the Canning River to Canada (Reynolds 2002, 2005, 2007, 2008).

In Unit 26B, east of the Dalton Highway (Unit 26B East), we surveyed major drainages and some of the smaller adjacent tributaries and bluffs beginning in 1986. Systematic surveys were not initiated in Unit 26B, west of the Dalton Highway (Unit 26B West), until March 1997. Six-mile wide transects oriented north–south were distributed from 70ºN to 69º15'N. Beginning in April 1999, transects extended farther south to 69ºN, and transects were also flown in the area approximately halfway between the Itkillik and Colville Rivers. In April 2000 and 2003 the 6-mile wide transect method also was applied to Unit 26B East. No surveys were conducted in 2001, but we estimated a minimum population of 258 from a composition count completed in June by excluding calves and including observations of adults not classified. In years 2002,

2004, and 2005, we only surveyed major drainages and smaller adjacent tributaries and bluffs in all of Unit 26B and located groups by radiotracking.

In April 2006 we conducted a complete survey across the eastern North Slope in cooperation with ANWR and Gates of the Arctic National Park and Preserve. The survey included the area on the coastal plain east of Judy Creek in eastern Unit 26A, all of Units 26B and 26C, and the western Yukon Territory as far east as the Babbage River. Transects, oriented approximately north–south and spaced 3 miles apart, were flown from the foothills of the Brooks Range mountains to the Arctic Ocean. The easternmost transect extended from 68.910°N, 138.384°W to 69.241°N, 138.503°W in Canada; the westernmost extended from 68.402°N, 149.995°W to 70.429°N, 150.260°W near the Itkillik Hills in Unit 26B. Additional transects beginning at 68.419°N, 150.115°W to 70.434°N, 150.379°W in the Itkillik Hills, were flown every 2–6 miles to just west of the Colville River at 69.432°N, 152.110°W to 70.418°N, 152.110°W. We assumed 90–100% coverage for transects that were spaced at 3 miles. The mountains were surveyed by flying suitable muskox habitat along the valleys of major drainages and parts of their tributaries from the Etivuluk River to the Kongakut River. The survey area included approximately 33,000 mi^2 (85,470 km^2).

In April 2007 and 2008, no surveys were conducted; however, research staff estimated a minimum population size. Staff conducted frequent radiotracking flights to locate groups and these repeated observations of known groups were used to obtain population estimates in April (S. M. Arthur, ADF&G files, Fairbanks). Although methods differed from previous population estimates, we believe the estimates are comparable to estimates derived from surveys accomplished in years that complete censuses were not conducted and can provide information on population trend.

We grouped population data as 1) Unit 26B, 2) Unit 26C, and 3) Units 26B and 26C combined. In previous reports, we further grouped population data as Unit 26B West (west of the Dalton Highway) and Unit 26B East (east of the Dalton Highway). However, recent redistribution and movements of muskoxen and a smaller population size mean this distinction is no longer useful, mainly because a large proportion of the population (>50%) has resided along the dividing line since 2004.

Population Composition

To determine herd composition, we conducted ground-based composition counts in Units 26B and 26C in late June or early July. We first located groups of muskoxen by radiotracking from a fixed-wing aircraft or helicopter, then classified animals from the ground as ≥4 years old, 3 years old, 2 years old, yearling, or calf, and as male or female. In 2003 and 2005, some groups were classified from an R-44 or R-22 helicopter, but it proved difficult to classify animals from helicopters.

Radiocollaring

During 1997–2008, we monitored 3–28 radiocollared adult females each year to locate muskoxen in precalving surveys in April and composition counts in June. Radiocollared muskoxen that were monitored prior to 1999 were captured by ANWR. In April 1999, ADF&G deployed radiocollars on 12 adult (≥3 years old) female muskoxen in 11 groups distributed

between the Itkillik River and the Ivishak River in Unit 26B using methods described by Lenart (1999). During 1999–2006, adult female muskoxen were captured and radiocollared in June or July by darting them with a CO_2 powered short-range projector pistol using the same drug protocol described by Lenart (1999). The following numbers of radiocollars were deployed on muskoxen in June: 2 in 2001, 1 in 2002, 2 in 2003, 5 in 2004, 2 in 2005, and 4 in 2006. In March and October 2007, ADF&G research staff captured and radiocollared 9 and 10 adult female muskoxen, respectively. Four of these were captured using the drug protocol described by Lenart (1999) and 13 were captured using various combinations of medetomidine hydrochloride, ketamine hydrochloride, tolazoline hydrochloride, and zolazepam. Due to inconsistent results, we discontinued use of the latter combination for muskox captures. Two additional muskoxen were captured and radiocollared in June using methods described by Lenart (1999). No radiocollars were deployed on muskoxen in 2008.

HARVEST

For Unit 26B we monitored harvest and hunting effort through harvest reports submitted by hunters. Total harvest, residency, success rates, chronology of harvest, and methods of transportation were summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY07 = 1 Jul 2007 through 30 Jun 2008). We obtained harvest data from ANWR for Unit 26C.

Based on the *North Slope Muskox Harvest Plan*, harvest data were grouped as 1) Units 26B and 26C combined, 2) Unit 26B, 3) Unit 26C, 4) Unit 26B West (west of the Dalton Highway), and 5) Unit 26B East (east of the Dalton Highway). Since 1998, Unit 26B West has included the Tier II permit hunt TX108. In 2002 the eastern portion of Unit 26A (east of 153°W longitude) was included in TX108 because the population had expanded into eastern Unit 26A. Since 1998, Unit 26B East has included registration Tier I (RX110) and drawing (DX112) permit hunts.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Unit 26B and eastern Unit 26A. In Unit 26B and eastern Unit 26A, the number of muskoxen observed during precalving surveys (late Mar or early Apr) increased steadily during the early 1990s and fluctuated slightly during the mid 1990s before stabilizing at approximately 250–300 muskoxen from 1999 through 2003 (Table 1). In 2004 and 2005, partial surveys indicated that the population had declined, and may have totaled approximately 200 muskoxen (Lenart 2007).

In April 2006, during an eastern North Slope census, we observed only 216 muskoxen (including a minimum of 44 yearlings) in 12 groups in Unit 26B and eastern Unit 26A. During the 2003 census, we observed 302 muskoxen in Unit 26B and eastern Unit 26A (Table 1). This indicates that the muskox population in Unit 26B and eastern Unit 26A declined.

In April 2007 and 2008, population size was estimated based on frequent radiotracking flights and repeated observations of known groups. In 2007 and 2008, 196 and 192 muskoxen were observed in Unit 26B and eastern Unit 26A (S. M. Arthur, ADF&G files, Fairbanks). These

numbers are slightly lower than the census in 2006 (216 muskoxen), but some lone animals or small groups may have been present but not counted. Thus, the population was likely stable during 2006–2008. Muskoxen are long-lived, yet because this population is not increasing and some calves are being recruited into the population (See Population Composition section below), it suggests that mortality closely tracked or exceeded recruitment during 2003–2008.

Observed causes of mortality included predation by brown bears, disease, drowning, starvation due to being stranded on sea ice, and the combined effects of poor nutrition and winter weather (See Mortality section below). In addition to possible higher rates of mortality, some distributional changes have probably occurred. Some muskoxen may have emigrated from Unit 26B and eastern Unit 26A and/or moved into the mountains where it is more difficult to locate them.

Unit 26C. The number of muskoxen observed in Unit 26C during precalving surveys was stable or increasing during 1990–1998 (range: 282–332; Table 1). Population counts indicate a decline began in 1999. The decline continued and only 9 muskoxen were observed in Unit 26C in March 2005 and 1 near the Canning River in April 2006 (Table 1). In 2007, 5 muskoxen were observed on the Canning River. In 2008, 44 muskoxen were observed in 3 groups: 7 on the Canning River, 10 on the Aichilik River, and 27 on the Kongakut River (Reynolds 2008). Initially, emigration into Unit 26B and Yukon, Canada, could have caused fewer muskoxen to be observed in Unit 26C. However, number of calves observed in early June and yearling recruitment also were lower in Unit 26C beginning in 1999. Thus, Reynolds (2002, 2008) suggested factors other than emigration alone may have influenced the population, including 1) effects of weather on quality, quantity, and availability of winter habitat (e.g., crust forming on snow and long winters with deep snow making foraging difficult and late green-up); 2) predation by brown bears; and 3) disease and mineral deficiencies making muskoxen more vulnerable to environmental conditions. These factors would likely affect calf recruitment, adult survival, and shifts in distribution.

Unit 26B, eastern Unit 26A and 26C. The combined number of muskoxen observed during precalving surveys in Units 26B and 26C declined considerably; 491–603 were observed during 1995–2000, but only 331 muskoxen were observed in 2003 (Table 1). Complete surveys in Unit 26B were not conducted in 2004 and 2005; but only 217 were observed in 2006. In 2007 and 2008, totals of 201 and 236 muskoxen were observed in Units 26C, Unit 26B, and eastern Unit 26A. It is likely that the combined population of Unit 26B, eastern Unit 26A, and Unit 26C is less than 300 muskoxen.

Eastern North Slope including Northwestern Canada. We observed 296 muskoxen during the 2006 census compared with an estimated 700–800 muskoxen during the mid 1990s. Additionally during summer 2006, Canadian biologists observed 2 groups of muskoxen estimated to total 99 animals in the Richardson Mountains, Yukon, Canada (these muskoxen were not located during the Apr 2006 survey; Reynolds 2006). However, in 2007; Canadian biologists reduced their estimate to 56 muskoxen in the Richardson Mountains. We estimate the total population on the North Slope in northeastern Alaska and northwestern Canada at approximately 350 muskoxen. This suggests that the muskox population on the eastern North Slope declined substantially since the mid 1990s. The population likely remained stable during 2007 and 2008.

Population Composition

Unit 26B and eastern 26A. Although the overall number of muskoxen in Unit 26B had decreased by 2006, the number of calves observed in early June was relatively high during 2000–2006, indicating good productivity (Table 1). In Unit 26B, the ratio of calves:100 females >2 years old ranged 36–60:100. It is interesting to note that in 2005 the calf:cow ratio was the highest value observed (65:100) since 1991 (Table 1). However as noted above, the population was likely declining in 2005 and 2006. Therefore, either calf mortality after the composition survey, overall adult mortality, or a combination of both was probably high during 2005. In 2006 the calf:cow ratio was the one of the lowest observed (37:100) since 2000. The difference in calf:cow ratios between 2005 and 2006 suggests that female muskoxen that calve may not become pregnant the following year, perhaps due to nutritional limitations. Alternate year calving was observed in the Unit 26C muskox population during the late 1980s and early 1990s (P. Reynolds, U.S. Fish and Wildlife Service–ANWR, personal communication). However, the calf:cow ratio was even less in 2007 (20 calves:100 females >2 years). By 2008 this ratio had increased to 42:100 (Table 1).

During 2000–2005, percent calves in the population was moderately high, ranging 16–26%, following the same trend observed in the ratio of calves:100 females >2 years old (Table 1). In 2006 and 2007 percent calves was lower (12% and 8%, respectively), and by 2008 percent calves increased to 18%, similar to values observed during 2000–2005 (Table 1).

Percent yearling (proportion of 1-year-old muskoxen in the population per muskoxen ≥1-year old) was variable during 2000 through 2006 (range: 5–16; Table 1). Note that the population declined after 2003 and 2 years of low yearling recruitment in 2003 and 2004 may have influenced the decline; particularly if adult mortality was higher than recruitment. Although the population appeared stable in the April 2003 census, much of the adult mortality occurs during mid April through late June when brown bears have emerged from their dens (mid Apr), prior to other food resources being available (e.g., green plants, caribou). Therefore, the population decline may have begun in 2003 but we did not observe it. By 2005 we suspected a decline in Unit 26B. Low recruitment in 2004 supported this hypothesis, which was confirmed by the 2006 census. In 2007 and 2008, percent yearlings was 14% and 7%, respectively. The proportion of yearlings observed in 2007 was similar to previous years. The low value observed in 2008 can be correlated to the low the number of calves observed the previous year in that only 8% calves were observed in the population in 2007 and 7% yearlings in 2008. This indicated that 2007 produced a small cohort and subsequently poor yearling recruitment.

Bull (>3 years):100 cow (>2 years) ratios fluctuated annually with a low bull:cow ratio one year and a high bull:cow ratio the next year (Table 1). Variability in bull:cow ratios may be because bull groups were more difficult to locate because of smaller group size, so counts of bulls were more affected by differences in search effort among years.

Calf Production, Early Recruitment and Timing of Calving — In 2007 and 2008, ADF&G research staff collected data on number of calves and adults (>1 year old) observed during mid April through June (Arthur 2007, 2008). Repeated observations of muskox groups during this time indicated that in 2007, at least 31 calves were born by mid June, 16 calves were still alive, which represents 52% of the estimated births. In 2008 at least 61 calves were born. Thirty-nine calves survived until late June, representing 64% of the estimated births. Thus, calf production and early recruitment were notably higher in 2008 compared with 2007. Research staff also noted that the

first calves were observed on 18 April in both years, and the last births occurred about 17 June in 2007 and 27 June in 2008.

Unit 26C. In Unit 26C, the ratio of calves:100 females >2 years old was low (<14:100) during 1999–2001. The percent calves followed a similar trend (range: <1–7%) and yearling recruitment also was low (range: 0–8%; Table 1). Percent calves was slightly higher in 2002 (10%), and no data were available for percent yearlings because muskoxen were classified as calves or muskoxen older than calves. Muskoxen were difficult to locate in June 2001 and 2002 when only 47 and 71 muskoxen were classified, respectively. No data were available for 2003–2008 because too few muskoxen were located. Annual bull (>3 years):cow (>2 years) ratios ranged 40–60:100 during 1997–2001 (Table 1).

Unit 26B, eastern Unit 26A and 26C. We did not calculate combined composition data from Unit 26B, eastern Unit 26A and 26C during 2002–2008.

Distribution and Movements

During RY06–RY07, muskoxen were found primarily near Beechy Point, Deadhorse, and along the Sagavanirktok and Ivishak Rivers in Unit 26B. One group (<25) remained in eastern Unit 26A, another small group (<15) frequented the Canning River, and a group of approximately 45 animals traversed the Alaska–Canada border. During the 1990s through the early 2000s, muskoxen were common along the Colville, Itkillik, Kuparuk, Sagavanirktok, and Canning Rivers in Unit 26B and the Sadlerochit, Hulahula, Okpilak, Jago, and Aichilik Rivers in Unit 26C.

Since 1980, lone bulls and small groups of muskoxen have also been reported south of the Brooks Range in Unit 25A, near Arctic Village. In 1999, 3 muskoxen were illegally harvested from a group of 10 muskoxen located north of Arctic Village. Of the 3 harvested animals, 2 were cows. This was the first documentation of a mixed-sex group south of the Brooks Range. There also was a sighting of a lone bull on the Yukon River in Unit 25B, near Eagle. In March 2004 we observed a group of 3 bull muskoxen in the Wind River drainage in Unit 25A. In addition, there was a sighting of a lone bull near Coldfoot in summer 2004. A mixed group of 15 muskoxen was reported on the Coleen River in 2005 (H. Korth, local resident, personal communication). In August 2006, ADF&G staff observed a mixed-sex group of 13 muskoxen on the East Fork Chandalar River and 2 groups of 6 were reported on the Sheenjek and Chandalar Rivers in June 2006 (P. Reynolds, personal communication). Hunters have also reported lone muskoxen on the Porcupine and Coleen Rivers. We suspect that the animals found on the south side of the Brooks Range originated from the Units 26B and 26C population. In addition, a few bull muskoxen and some small groups have been sighted at the Gisasa, Kateel, and Hogatza Rivers in Units 21D and 24C beginning in 1999. Other reports of lone bulls have occurred in Nulato, Ruby, and on the Yukon River across from Galena. We do not know if these small groups are mixed-sex or males only. However, we suspect that these animals originated from the Seward Peninsula.

Muskoxen tend to form larger groups of 6–60 during winter and remain in one location for a long time. During summer they form smaller groups of 5–20 and move more frequently. Details of long range movements were noted in spring 1999 within Unit 26B (Lenart 2003).

Considerable shifts in distribution have occurred since 2003, and groups that were known to winter in specific areas wintered elsewhere (Lenart 2007; Reynolds 2007). Long range movements (e.g., 50+ miles) of groups and individual radiocollared animals have also been noted. Additionally, it has become increasingly difficult to locate groups in June and keep track of those groups until the arrival of a helicopter for composition counts. Groups are smaller and move long distances in a short amount of time.

MORTALITY

Harvest

Seasons and Bag Limits. The summary below lists seasons and bag limits for the various muskox hunts in Units 26B and 26C beginning in RY90. Seasons and bag limits for the Tier II (TX108) hunt in Unit 26B West remained the same during RY00–RY05, with a season of 1 August–31 March and a bag limit of 1 muskox. The season was closed for RY06. Seasons and bag limits for the Tier I (RX110) and the drawing (DX112) hunts in Unit 26B East remained the same during RY98–RY04. The Tier I hunt season opening was announced by emergency order when conditions were good for traveling and the season closed no later than 31 March with a harvest quota of 4 muskoxen. The DX112 season was 20 September–10 October and 10–30 March with a bag limit of 1 bull muskox. No permits were issued for the drawing hunt (DX112) and the Tier I hunt (RX110) in RY05. No permits were issued for any of the 3 hunts (Tier II hunt–TX108, DX112, RX110) in RY06, RY07, or RY08. No federal permits were issued in Unit 26C during RY03–RY07; however, 1 permit was issued for RY08. All hunts still remain in regulation.

Location/Regulatory year	Permits; Hunt type; Bag limit	Resident Open Season	Nonresident Open Season
Unit 26B			
1990–1991 through 1994–1995	2; Tier II; 1 bull	1–31 Oct; 1–31 Mar	No open season
Unit 26B, west of Dalton Hwy			
1995–1996	3; Tier II; 1 bull	1–31 Oct; 1–31 Mar	No open season
1996–1997 through 1997–1998	3; Tier II; 1 bull	15 Sep–15 Nov; 1–31 Mar	No open season
1998–1999 through 1999–2000	9; Tier II; 1 muskox	15 Sep–31 Mar	No open season
2000–2001 through 2005–2006	9[a]; Tier II; 1 muskox	1 Aug–31 Mar	No open season
2006–2007 through 2008–2009	0; Tier II; 1 muskox	No open season	No open season
Unit 26B, east of Dalton Hwy			
1995–1996	2; Tier II; 1 bull	1–31 Oct; 1–31 Mar	No open season
1996–1997 through 1997–1998	2; Tier II; 1 bull	15 Sep–15 Nov; 1–31 Mar	No open season
1998–1999 through 2004–2005	∞ (harvest quota of 4); Tier I; 1 muskox and 3; Drawing; 1 bull	To be announced; season closed no later than 31 Mar and 20 Sep–10 Oct; 10–30 Mar	No open season and No open season
2005–2006 through 2008–2009	0; Tier I; 1 muskox and 0; Drawing; 1 bull	No open season and No open season	No open season and No open season
Unit 26C			
1990–1991 through 1991–1992	9; Tier II/Federal; 1 bull	1–31 Oct; 1–31 Mar	No open season
1992–1993 through 1993–1994	10; Federal; 1 bull	1–31 Oct; 1–31 Mar	No open season
1994–1995 through 1995–1996	10; Federal; 1 bull	1 Oct–15 Nov; 1–31 Mar	No open season

Location/Regulatory year	Permits; Hunt type; Bag limit	Resident Open Season	Nonresident Open Season
Unit 26C continued			
1996–1997 through 1997–1998	15; Federal; 1 bull	15 Sep–15 Mar	No open season
1998–1999 through 2001–2002	15; Federal; 1 bull (3 permits for females)	15 Sep–31 Mar	No open season
2002–2003	2; Federal; 1 bull	15 Sep–31 Mar	No open season
2003–2004 through 2007–2008	0; Federal; 1 bull	No open season	No open season
2008–2009	1; Federal; 1 bull	15 Sep–31 Mar	No open season

[a] In RY00, 10 Tier II permits were issued because of a discrepancy in scoring.

Alaska Board of Game Actions and Emergency Orders. During the March 2004 meeting the Alaska Board of Game rescinded several of the regulations that were established in RY02 related to bow hunting along the Dalton highway. The North Slope Closed Area was eliminated, along with the requirement that hunters mark their arrows. In addition, limiting the use of licensed highway vehicles in the DHCMA to publicly maintained roads was more clearly defined to allow "no motorized vehicles, except licensed highway vehicles on the following designated roads: 1) Dalton Highway; 2) Bettles Winter Trail during periods when Bureau of Land Management and the City of Bettles announce that the trail is open to winter travel; 3) Galbraith Lake road from the Dalton Highway to the Bureau of Land Management campground at Galbraith Lake, including the gravel pit access road when it is open; 4) Toolik Lake road, excluding the driveway to Toolik Lake Research Facility; 5) the Sagavanirktok River access road 2 miles north of Pump Station 2; 6) any constructed roadway or gravel pit within ¼ mile of the Dalton Highway."

During the March 2006 and 2008 meetings, the Board of Game did not make any regulatory changes.

Federal Subsistence Board Actions — Beginning in RY03, the Federal Subsistence Board agreed that no permits would be issued until a minimum of 36 animals were observed in Unit 26C during April surveys. The number of permits that can be issued is 3% of the estimated muskox population in Unit 26C and for bulls only.

Harvest by Hunters. Hunting for muskoxen in the eastern North Slope has only been allowed by permit. The number of permits available and weather conditions such as cold, snow, and fog influenced the harvest. The total reported harvest in Units 26B and 26C has been 5–18 since RY90 when both units were opened to hunting and has been <4% of the estimated total population observed during precalving surveys (Lenart 2003; Tables 1 and 2). In all of Unit 26B, reported harvest was 0–14 during RY90–RY05 and was <5% of the Unit 26B segment of the population (Lenart 2003; Tables 1 and 2). For RY04 and RY05, harvest was 8 and 4, respectively. During RY96–RY05, harvest in Unit 26B West was 1–5 (≤6%) and in Unit 26B East it was 1–9 (≤6%; Table 2). No permits were issued for hunts in Unit 26B East in RY05 and no permits were issued for any of the hunts in Unit 26B in RY06, RY07, and RY08. Reported harvest in Unit 26C was 5–15 during RY90 through RY02 (<4%; Lenart 2005). No permits were issued in Unit 26C since 2002. Restrictions in regulations ensured a low harvest. Some hunters may not have reported their harvests, despite the permit systems.

Hunter Residency and Success. Before RY90, muskoxen were harvested under a registration permit system in which both residents and nonresidents could participate (Golden 1989; Lenart 1999). From RY90 through RY97, state Tier II or federal subsistence permits were issued only to

local residents of Unit 26 (Lenart 1999; Table 2). Beginning in RY98, nonlocal residents could participate in the registration and drawing hunts east of the Dalton Highway in Unit 26B; residency and success for these hunts are in Table 4. Success rates for all years in Unit 26B were high (Table 2). Success rates for Unit 26C were not available, but we suspect success rates were good for all the hunts (>50%). Hunters were predominantly local residents (Tables 3 and 4).

Transport Methods and Harvest Chronology. In most years, hunters relied primarily on snowmachines to hunt muskoxen. However, hunters also used aircraft in some fall hunts during the early 1990s. Hunters using the draw permit primarily used highway vehicles and recently more hunters have used boats in the Tier II hunt (Table 5).

Chronology of harvest depends mostly on weather (e.g., snow, fog, temperature, and rivers freezing). During RY95–RY05, approximately 50% of the harvest occurred in March for Units 26B and 26C combined. The remaining 50% was distributed between September, October, November, January, and in April after the season was closed.

Natural and Other Mortality

We have few data on natural mortality in the eastern Arctic. Brown bears kill both calf and adult muskoxen and have been a more important predator than wolves in Unit 26C (Reynolds et al. 1992). Reynolds et al. 2002 concluded that brown bear predation on muskoxen began to increase during the late 1990s. We have also noted a number of incidental observations that indicated some muskox mortality was caused by brown bears. In RY03 we observed 2 dead and 3 injured muskoxen caused by brown bear predation, and 5 of 11 radiocollared muskoxen were found dead. Evidence suggests that brown bear predation was the likely cause of death for 3 of the 5 dead radiocollared muskoxen. In 2006 we received reports of a brown bear chasing a small group of muskoxen on the sea ice off shore near Endicott; 2 calves and 1 adult were killed. In 2007, research staff noted that kill-site evidence suggested that 10 calves and 4 adults were killed by brown bears during April–June. In 2008, bears likely killed 11 calves and at least 8 adults. Additionally, multiple mortalities of muskoxen suspected to be caused by predation in Unit 26B have been reported since 2000 (Reynolds et al. 2002). Wolves seem to be more abundant in Unit 26B than in Unit 26C and may become a more important source of mortality in the future.

Late winter storms contribute to mortality of calves, yearlings, and adults, but these losses are generally low. However, in May 2004, during breakup, the Colville River flooded and killed at least 13 muskoxen in 2 groups (6 adults, 2 yearlings, 5 calves). In early June 2006, 1 adult radiocollared female muskoxen, 1 yearling female muskoxen, and 1 calf were reported stranded on the sea ice off Northstar and Endicott and likely died of starvation. During 2007 and 2008, a total of 6 calves were observed to have died during or immediately after birth. Other causes of death that were observed include disease, winter malnutrition, and falling through thin ice on lakes and rivers.

Some human-caused mortality occurs as a result of capture activities, and some muskoxen are killed by vehicles on the Dalton Highway. Causes of many of the mortalities are unknown. Mortality rate for radiocollared females ranged 0–50% during 1999–2007 (Table 6).

Disease

Zarnke et al. (2002) tested sera from 104 muskoxen from Alaska for evidence of exposure to malignant catarrhal fever viruses (MCFV) and determined that these muskoxen had a high serum antibody prevalence rate of 96%. However, there was no evidence that muskoxen were experiencing clinical signs of MCFV.

Fifty-six sera collected during 1980–2004 from muskoxen in Units 26B and 26C (ANWR population) were tested for the presence of *Chlamydia.* Four percent of the samples tested positive. The 2 samples that tested positive were collected in 2000, suggesting that this organism may have recently appeared in the population (K. Beckmen, ADF&G, personal communication). However, antibodies to *Chlamydia* were present in other populations of muskoxen in Alaska that are not declining (Nunivak Island, Seward Peninsula, and Cape Thompson) (K. Beckmen, ADF&G, personal communication). Occurrence rates in sera from these 3 populations averaged 22% (n = 41; range: 17–25%).

During 2006–2008, blood and tissue samples from captured muskoxen and from carcasses of muskoxen that died were analyzed by ADF&G staff veterinarian Kimberlee Beckmen, DVM, PhD for prevalence of various pathogens and concentrations of trace minerals. These data indicated the presence in this population of several diseases that may influence reproduction and survival, including *Chlamidiophila, Brucella suis*, *Leptospira, Neospora,* bovine viral diarrhea, and herpes virus. In addition, concentrations of copper reserves were insufficient to maintain healthy immune function, reproduction, or survival through weaning. Perturbations in other essential trace elements (e.g., selenium, zinc, iron, molybdenum, manganese) that affect copper absorption and mobilization were present, exacerbating the low copper reserve. Emerging parasites and pathogens, including lungworm, *Pasteurella*, and *Arcanbacterium* were also present and possibly influencing survival.

HABITAT

Various studies of the status of muskox habitat (O'Brien 1988) indicated forage was not limiting muskox population growth in Units 26B and 26C during the 1980s. Social factors were probably responsible for the apparent increased emigration from Unit 26C. There is some speculation that changes in forage quality and quantity on winter ranges in Unit 26C affected reproduction and survival (Reynolds 2002). These changes may be related to annual variability in weather and related to snow depth, length of snow season, and icing conditions (Reynolds 2002). Recently, muskox distribution in Unit 26B has changed, and it is possible some of the redistribution may be influenced by habitat, particularly during the winter. During 1997 through 2003, large groups of muskoxen (i.e., 50–60) wintered in the same location for several years. Since the herd declined after 2003, distribution has been different. Perhaps habitat in the earlier locations was overexploited, and muskoxen were searching for new wintering areas.

CONCLUSIONS AND RECOMMENDATIONS

The overall population size in Units 26B and 26C declined considerably beginning in 2001, but the population dynamics were different in the 2 units. Abundance of calves, yearlings, and adults declined in Unit 26C beginning in 1999. The major factors influencing the decline probably were annual variation in weather affecting female body condition, reproductive success, winter foraging, and predation by brown bears. However, to account for the low number of muskoxen

observed in Unit 26C, emigration was also most likely involved, and disease may also have played a role (Reynolds 2002). For example, in 2008, a total of 44 muskoxen were observed in Unit 26C with a large proportion moving between the Alaska and Canada border. In Unit 26B, abundance of calves and yearlings was stable during 1999–2006, but numbers of muskoxen declined during 2003–2006. Thus, mortality rates likely exceeded recruitment. Since 2006 the population in Unit 26B has remained stable at approximately 200 muskoxen. It is likely the entire eastern North Slope (including western Canada) remained stable the previous 2 years at approximately 350 muskoxen.

Harvest rates of muskoxen were below 5% of the entire population (Units 26B and 26C combined) and within each subunit (Unit 26B and Unit 26C) during years permits were issued. Thus, harvest did not limit population growth. Nonetheless, the population in Unit 26C essentially disappeared in a short time, and a decline occurred in Unit 26B. There is a possibility that muskoxen could become scarce on the eastern North Slope in the future.

Muskoxen are adapted to arctic conditions, and changes in climate (particularly warmer winters) may have major effects on muskoxen in northeastern Alaska (Reynolds 2008). We believe increased monitoring of this population is important particularly while changes in climate may be occurring. We recommend continuing research on this muskoxen population to provide insight into the reasons for the decline and possible management actions to be taken. Specifically, we recommend continuing to determine rates and causes of mortality during April–June, estimating annual parturition rates for adult cows, investigating potential diseases and trace elements, and analyzing trace elements in plant and soil samples already collected.

GOALS AND OBJECTIVES

We did not meet our first goal to provide opportunities to harvest muskoxen while maintaining healthy, stable muskox populations. No permits were issued for muskoxen hunting during the report period (RY06–RY07) because the population had declined to approximately 200 animals. Members of the North Slope Muskox Working Group and the community of Kaktovik supported these decisions.

Goal 2 was to minimize detrimental effects that muskoxen may have on caribou and caribou hunting and no such effects were noted during RY06–RY07.

We met Goal 3 by cooperating with ANWR to share information on population data and interpretation of data, and by cooperating in the field to conduct composition counts and surveys, and developing research objectives. ANWR intends to continue to monitor muskox numbers, productivity, survival, and movements east of the Canning River in Unit 26C. ADF&G and ANWR will continue working cooperatively to collect and interpret muskox population and harvest data in Units 26B and 26C. We also worked with local users when deciding not to issue permits for muskox hunting.

We met our fourth goal of providing opportunities to view and photograph muskoxen. Viewing and photography were possible, particularly near the Dalton Highway where small groups congregate during summer and much of the muskoxen population resided along the highway during RY06–RY07. Improvements to the Dalton Highway have increased public use and resulted in increased traffic and greater interest in muskoxen by both hunters and nonhunters.

Objectives for this report period were written for a 4- to 5-year time period before taking action. Therefore, we will report on progress that was made toward these objectives. Progress toward our first objective to maintain a stable population of ≥200 muskoxen in Unit 26B and eastern Unit 26A has been made because the estimated population during 2006–2008 was approximately 200 muskoxen. Similarly, progress was made toward our second objective to maintain a bull (≥3 year old):cow (≥2 year old) ratio of ≥35:100 during the past 2 years.

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TABLE 1 Units 26B and 26C muskox precalving survey estimates and composition counts, 1990–2008[a]

Location[d]/ Year	Precalving survey estimate[b] Muskoxen observed	Unit 26B (West)[e]	Postcalving composition surveys[c] June date(s)	Muskoxen classified (excluding calves)	Bulls >3 yr:100 cows>2 yr (no. bulls >3 yr)[f]	Calves:100 cows>2 yr (no. cows >2 yr)	Percent yearling[g] (*n*)	Percent calves (*n*)
Unit 26B, eastern Unit 26A								
1990	122			83 (69)	41 (14)	41 (34)	16 (11)	17 (14)
1991	156			98 (75)	69 (24)	66 (35)	12 (9)	24 (23)
1992	224			193 (162)	43 (33)	40 (77)	19 (31)	16 (31)
1993	237			131 (103)	41 (21)	55 (51)	10 (10)	21 (28)
1994	166			91 (76)	46 (13)	54 (28)	25 (19)	17 (15)
1995	330			145 (123)	55 (29)	42 (53)	12 (15)	15 (22)
1996	266			44 (41)	35 (8)	13 (23)	12 (5)	7 (3)
1997	279[h]	92	30	123 (107)	49 (23)	34 (47)	22 (24)	13 (16)
1998	207[h]	79	26–27	97 (78)	24 (10)	45 (42)	13 (10)	20 (19)
1999	237[h]	96	22–23	194 (162)	62 (44)	45 (71)	14 (23)	17 (32)
2000	277[h]	90	7	172 (131)	35 (24)	60 (68)	13 (17)	24 (41)
2001	258[i]	107[i]	10–11	286 (239)	64 (63)	48 (98)	16 (39)	16 (47)
2002	284	102	8–9	241 (203)	39 (41)	36 (105)	12 (24)	16 (38)
2003	302[h]	115	26–28	172[j] (144)	94 (55)	48 (58)	5 (7)	16 (28)
2004	198	99	7–8	153 (123)	52 (37)	42 (71)	9 (11)	20 (30)
2005	186	62	5–7	151 (111)	46 (21)	65 (46)	14 (16)	26 (40)
2006	216[h]	67	4–5	175 (154)	37 (21)	37 (56)	15 (23)	12 (21)
2007	196	n/a	4–6	140 (129)	46 (25)	20 (54)	14 (18)	8 (11)
2008	192	n/a	19	203 (166)	48 (42)	42 (88)	7 (12)	18 (37)
Unit 26C								
1990	332			286 (242)	42 (42)	44 (101)	19 (46)	15 (44)
1991	282			377 (305)	36 (52)	50 (144)	15 (45)	19 (72)
1992	283			324 (273)	56 (64)	45 (114)	19 (51)	16 (51)
1993	326			404 (323)	43 (62)	57 (143)	16 (51)	20 (81)
1994	318			341 (285)	53 (63)	47 (120)	18 (51)	16 (56)
1995	321			240 (215)	58 (51)	28 (88)	15 (32)	10 (25)
1996	332			195 (157)	41 (31)	51 (75)	11 (17)	20 (38)
1997	324			362 (324)	48 (70)	26 (146)	14 (46)	11 (38)
1998	331			211 (186)	42 (38)	28 (90)	11 (20)	12 (25)
1999	254[h]			272 (257)	60 (76)	14 (127)	8 (21)	7 (15)
2000	246[h]			184 (183)	40 (39)	1 (97)	4 (17)	<1 (1)
2001	168[h]			47 (46)	48 (13)	<1 (27)	0 (0)	2 (1)
2002	35[h]			71 (64)				10 (7)
2003	29[h]							
2004	30[h]							
2005	9[h]							

Location[d]/ Year	Precalving survey estimate[b] Muskoxen observed	Unit 26B (West)[e]	June date(s)	Postcalving composition surveys[c] Muskoxen classified (excluding calves)	Bulls >3 yr:100 cows>2 yr (no. bulls >3 yr)[f]	Calves:100 cows>2 yr (no. cows >2 yr)	Percent yearling[g] (*n*)	Percent calves (*n*)
2006	1[h]							
2007	5[h]							
2008	44[h]							
Units 26B, eastern 26A, and 26C								
1990	454			369 (311)	41 (56)	43 (135)	18 (57)	16 (58)
1991	438			475 (380)	50 (76)	63 (179)	14 (54)	20 (95)
1992	507			517 (435)	51 (97)	43 (191)	19 (82)	16 (82)
1993	563			535 (426)	43 (83)	56 (194)	14 (61)	20 (109)
1994	484			432 (361)	51 (76)	48 (148)	19 (70)	16 (71)
1995	651			385 (338)	57 (80)	33 (141)	14 (47)	12 (47)
1996	598			239 (198)	40 (39)	42 (98)	11 (22)	17 (41)
1997	603			485 (431)	48 (93)	28 (193)	16 (70)	11 (54)
1998	538			308 (264)	36 (48)	33 (132)	11 (30)	14 (44)
1999	491			466 (419)	61 (120)	25 (198)	10 (44)	10 (47)
2000	523			356 (314)	38 (63)	25 (165)	11 (34)	12 (42)
2001	426[i]			333 (285)	41 (54)	36 (132)	8 (24)	14 (48)
2002	319			312 (267)				14 (45)
2003	331							
2004	228							
2005	195							
2006	217							
2007	201							
2008	236							

[a] Data source for Unit 26C for all years and for Unit 26B for 1987 through 1997; P. E. Reynolds, U.S. Fish and Wildlife Service, Arctic National Wildlife Refuge, Fairbanks.

[b] Precalving survey estimates were determined during late March or early April and based on total muskoxen observed.

[c] Postcalving composition classification was conducted during the second week of June through early July.

[d] Unit 26B surveys occurred east of the Sagavanirktok River until regulatory year 1996 when the entire subunit from Colville to Canning Rivers was surveyed. Unit 26C surveys encompassed the Canning to Clarence Rivers.

[e] Number of muskoxen observed west of the Dalton Highway in Unit 26B and eastern Unit 26A. This number is also included in total number of muskoxen observed.

[f] Beginning in 2000, 3-year-old bulls were included in the "Bulls >3 yr" category for Unit 26B.

[g] Percent yearling is the proportion of 1-year-olds in the population of muskoxen ≥1 year old.

[h] Censuses were conducted.

[i] Muskoxen observed for Unit 26B was estimated from June composition by excluding calves and including observations of adults not classified.

[j] Some groups of muskoxen were classified from an R-44 or R-22 helicopter. Groups were difficult to locate in Unit 26B East; thus, overall classification of the herd may not be representative.

TABLE 2 Units 26B and 26C muskox harvest data by permit hunt, regulatory years 1996–1997 through 2005–2006

Regulatory year	Hunt/ Area[a]	Unit	Permits available[b]	Returned reports	Total hunters	Successful hunters[c]	Bulls	Cows	Total harvest
1996–1997	TX108	26B (West)	3	3	3	2	2	0	2
	TX110	26B (East)	2	2	1	1	1	0	1
	RX113 (F)	26C	15	n/a	n/a	15	12	3[d]	15
1997–1998	TX108	26B (West)	3	3	3	2	2	0	2
	TX110	26B (East)	2	2	1	1	1	0	1
	RX113 (F)	26C	15	n/a	n/a	10	9	1[d]	10
1998–1999	TX108	26B (West)	9	9	4	4	3	1	4
	RX110	26B (East)	unlimited	9	5	3	3	0	3
	DX112	26B (East)	3	3	3	3	3	0	3
	RX113 (F)	26C	15	n/a	n/a	8	8	0	8
1999–2000	TX108	26B (West)	9	9	5	1	1	0	1
	RX110	26B (East)	unlimited	3	0	0	0	0	0
	DX112	26B (East)	3	3	2	2	2	0	2
	RX113 (F)	26C	15	n/a	n/a	8	8	0	8
2000–2001	TX108	26B (West)	10[e]	10	6	5	4	1	5
	RX110	26B (East)	unlimited	6	6	6	6	0	6
	DX112	26B (East)	3	3	3	3	3	0	3
	RX113 (F)	26C	15	n/a	n/a	6	5	1	6
2001–2002	TX108	26B (West)	9	9	3	3	3	0	3
	RX110	26B (East)	unlimited	5	4	4	4	0	4
	DX112	26B (East)	3	2	2	2	2	0	2
	RX113 (F)	26C	15	n/a	n/a	2	2	0	2
2002–2003	TX108	26B (West)	9	7	6	5	unk	unk	5
	RX110	26B (East)	unlimited	2	1	1	1	0	1
	DX112	26B (East)	3	3	3	3	3	0	3
	RX113 (F)	26C	2	n/a	n/a	n/a	0	0	0
2003–2004	TX108	26B (West)	9	9	5	2	2	0	2
	RX110	26B (East)	unlimited	0	0	0	0	0	0
	DX112	26B (East)	3	3	1	1	1	0	1
	RX113 (F)	26C	0	0	0	0	0	0	0
2004–2005	TX108	26B (West)	9	5	4	4	3	1	4
	RX110	26B (East)	unlimited	5	3	1	1	0	1
	DX112	26B (East)	3	3	3	3	3	0	3
	RX113 (F)	26C	0	0	0	0	0	0	0
2005–2006	TX108	26B (West)	9	9	7	4	2	2	4
	RX110	26B (East)	unlimited	0	0	0	0	0	0
	DX112	26B (East)	0	0	0	0	0	0	0
	RX113 (F)	26C	0	0	0	0	0	0	0

[a] Hunt areas: RX = registration; TX = Tier II; DX = drawing; F = federal hunt; 1007, 1013, 113 = Unit 26C; 1010, 110, and 112 = east of Dalton Highway and since regulatory year 1999 = east of Dalton Highway Management Corridor; 108 = west of Dalton Highway; 1012 = east of Jago River; 1014 = west of Jago River; Hunts RX1013(F) and RX113(F) are not registration hunts—they are lottery. Beginning in 2002, TX108 also included Unit 26A, east of 153°West longitude.

[b] Permits available may not always equal permits issued in federal hunts because unused permits are reissued. In hunt RX110, unlimited number of permits available; harvest quota = 4.

[c] Determined from returned reports.

[d] Illegal animal.

[e] Only 9 permits were supposed to be issued, but due to a mistake in scoring, 10 were issued and this was not considered a biological problem.

TABLE 3 Unit 26B East muskox hunter residency and success, regulatory years 1998–1999 through 2007–2008

Hunt[a]/ Regulatory year	Successful			Unsuccessful			Total hunters
	Local[b] resident	Nonlocal resident	Total (%)	Local[b] resident	Nonlocal resident	Total (%)	
RX110							
1998–1999	2	1	3 (60)	1	1	2 (40)	5
1999–2000	0	0	0 (0)	0	0	0 (0)	0
2000–2001	4	2	6 (100)	0	0	0 (0)	6
2001–2002	4	0	4 (100)	0	0	0 (0)	4
2002–2003	1	0	1 (100)	0	0	0 (0)	1
2003–2004	0	0	0 (0)	0	0	0 (0)	0
2004–2005	0	1	1 (33)	0	2	2 (67)	3
2005–2006[c]							
2006–2007[c]							
2007–2008[c]							
DX112							
1998–1999	0	3	3 (100)	0	0	0 (0)	3
1999–2000	0	2	2 (100)	0	0	0 (0)	2
2000–2001	0	3	3 (100)	0	0	0 (0)	3
2001–2002	0	2	2 (100)	0	0	0 (0)	2
2002–2003	0	3	3 (100)	0	0	0 (0)	3
2003–2004	0	1	1 (100)	0	0	0 (0)	1
2004–2005	0	3	3 (100)	0	0	0 (0)	3
2005–2006[c]							
2006–2007[c]							
2007–2008[c]							

[a] RX110 = Tier I registration hunt in Unit 26B, east of the DHCMA; DX112 = drawing hunt in Unit 26B, east of the Dalton Highway.
[b] Local resident is a resident of Unit 26.
[c] No permits were issued.

TABLE 4 Units 26B and 26C muskox hunter residency and success, regulatory years 1990–1991 through 2007–2008

Regulatory year[a]	Successful: Local resident[b]	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total	Unsuccessful hunters[c]	Total hunters[d]
1990–1991	10	0	0	10	0	10
1991–1992	5	0	0	5	0	5
1992–1993	10	0	0	10	1	11
1993–1994	9	0	0	9	0	9
1994–1995	9	0	0	9	2	11
1995–1996	12	0	0	12	0	12
1996–1997	18	0	0	18[e]	1	19
1997–1998	13	0	0	13	1	14
1998–1999	14	4	0	18	5	23
1999–2000	9	2	0	11	4	15
2000–2001	15	5	0	20	1	21
2001–2002	9	2	0	11	0	11
2002–2003	6	3	0	9	1	10
2003–2004	2	1	0	3	3	6
2004–2005	4	4	0	8	2	10
2005–2006	4	0	0	4	3	7
2006–2007[f]						
2007–2008[f]						

[a] Before regulatory year (RY) 1986 only Alaska residents were allowed to hunt muskoxen. In RY90 through RY97, muskox hunting was limited to local residents of Unit 26. In RY98 that portion of Unit 26B east of the Dalton Highway was opened to include all Alaska residents.
[b] Local resident is a resident of Unit 26.
[c] Incomplete residency data for "Unsuccessful" hunters because of lack of reporting in Unit 26C.
[d] From hunt reports received.
[e] One illegal muskox.
[f] No open season.

TABLE 5 Units 26B and 26C muskox harvest by transport method, regulatory years 1990–1991 through 2007–2008

Regulatory year	Harvest by transport method							Total
	Highway vehicle	Airplane	Dog team/ski	Snowmachine	Boat	Off road vehicle	Unk	
1990–1991	0	1	1	6	0	0	0	8
1991–1992	0	0	0	5	0	0	0	5
1992–1993	0	0	0	10	0	0	0	10
1993–1994	0	1	0	8	0	0	0	9
1994–1995	0	0	0	9	0	0	0	9
1995–1996	0	2	0	10	0	0	0	12
1996–1997	0	0	0	17	1	0	0	18
1997–1998	0	0	0	12	1	0	0	13
1998–1999	1	0	0	15	2	0	0	18
1999–2000	2	0	0	9	0	0	0	11
2000–2001	2	0	0	16	3	0	0	21
2001–2002	2	0	0	7	2	0	0	11
2002–2003	2	1	0	3	3	0	0	9
2003–2004	1	0	0	1	1	0	0	3
2004–2005	3	0	1	0	3	0	1	8
2005–2006	0	0	0	2	1	1	0	4
2006–2007[a]								
2007–2008[a]								

[a] No open season.

TABLE 6 Mortality rate for radiocollared female muskox, 1 June through 30 May 1999–2008[a]

Period (1 Jun–30 May)	No. of radiocollared muskoxen	No. of mortalities	Percent mortality
1999–2000	14	4	28
2000–2001	11	0	0
2001–2002	11	3	27
2002–2003	9	1	11
2003–2004	10	5	50
2004–2005	10	0	0
2005–2006	13	2	15
2006–2007	13 + 9 new = 22	5	n/a
2007–2008	19 +9 new = 28	7	n/a

[a] The number of radiocollared muskoxen is the number of active collars on 1 June and the new collars deployed during June. If a mortality was located in early June, but it could have occurred prior to 30 May (radiotracking had not taken place), it was included in the prior year's percent mortality calculation. Radiocollars deployed after July are identified as "+ new" and percent mortality for that year was not calculated.

The Federal Aid in Wildlife Restoration Program consists of funds from a 10% to 11% manufacturer's excise tax collected from the sales of handguns, sporting rifles, shotguns, ammunition, and archery equipment. The Federal Aid program allots funds back to states through a formula based on each state's geographic area and number of paid hunting license holders. Alaska receives a maximum 5% of revenues collected each year. The Alaska Department of Fish and Game uses federal aid funds to help restore, conserve and manage wild birds and mammals to benefit the public. These funds are also used to educate hunters to develop the skills, knowledge and attitudes for responsible hunting.

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