Muskox
Management Report
of survey-inventory activities
1 July 2008–30 June 2010

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

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Funded through
Federal Aid in Wildlife Restoration
Grants W-33-7 and W-33-8
2011

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

MUSKOX MANAGEMENT REPORT

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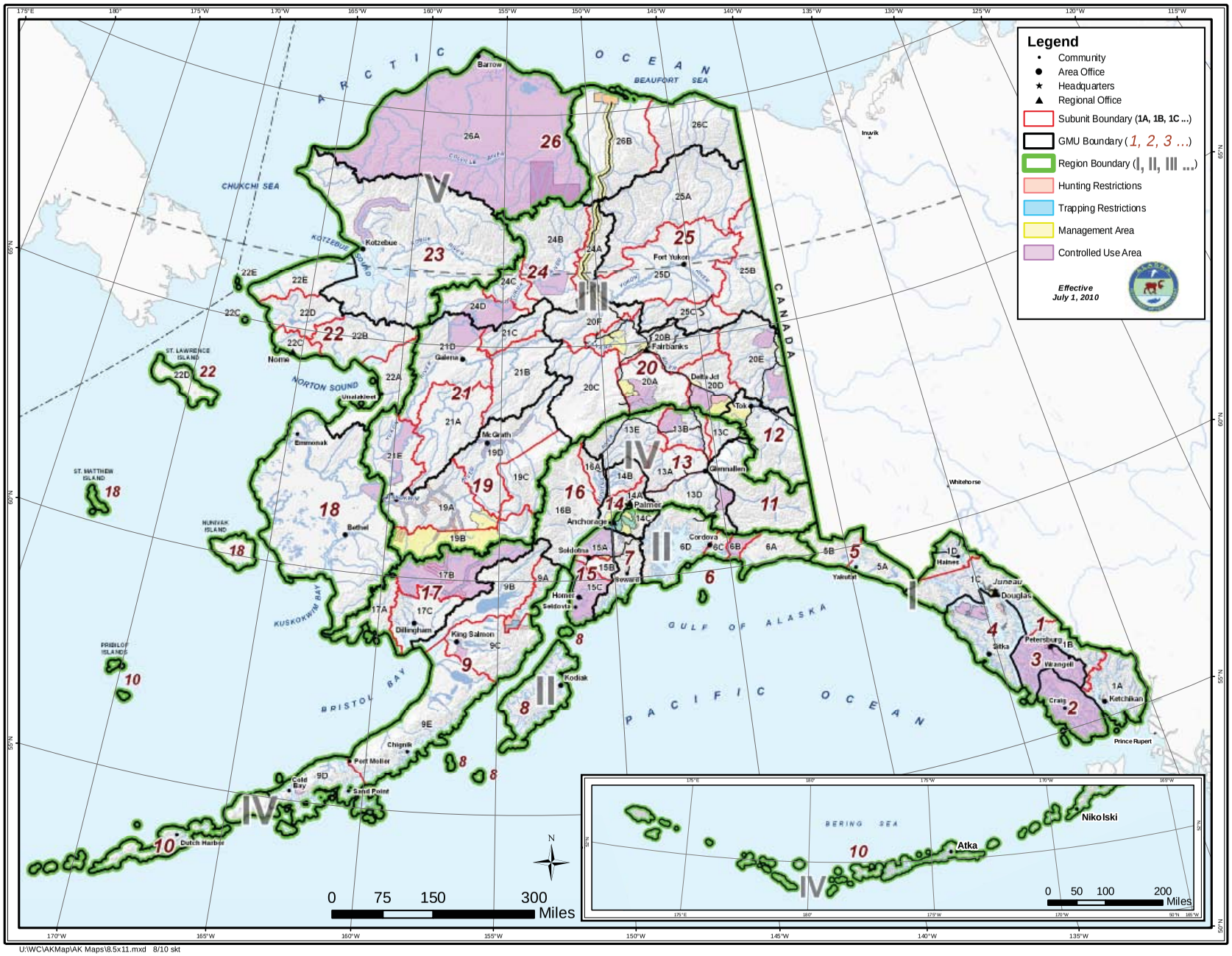
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KOTZEBUE SOUND
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Bethel
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Yakutat
Haines
Juneau
Douglas
Sitka
Petersburg
Wrangell
Craig
Ketchikan
Prince Rupert
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WILDLIFE MANAGEMENT REPORT

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MUSKOX MANAGEMENT REPORT

From: 1 July 2008
To: 30 June 2010

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 drafted and used to guide management beginning in 1995. The plan has a minimum population goal of 250 animals. For approximately 20 years, the Nelson Island muskox population has fluctuated between a high of 561 animals prehunt postcalving in 2010 and a low of 123 precalving in 1994.

YUKON–KUSKOKWIM DELTA

Having originally emigrated from Nelson Island, a minimum of 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. Muskoxen are most consistently observed in the area around the mud volcanoes, Askinak and Kusivak mountains, that are south and east of Baird Inlet. Poaching is the major factor preventing the mainland population from becoming firmly established. Marked

muskoxen have been documented leaving Nelson Island for a period of up to two years before returning. 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 precalving 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 in a timely and accurate manner.
- 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 Husky A1-C fixed-wing aircraft on Nunivak Island in September 2009 and July 2010 (after the reporting period). Population census flights were flown using Maul and Husky A1-C aircraft on Nelson Island in June 2009 and September 2010 (after the reporting period). No surveys were completed during 2008. On all flights we classified muskoxen into 6 categories as: calves, yearlings, 2-year-olds, 3-year-old and older bulls, 3-year-old and older cows, or unknown classification.

Since fixed-wing aircraft (with inherently higher flight speeds) were used to conduct surveys, animals were clumped into broad classes of age-sex composition. Within the time available to study each animal, group size, and terrain on each pass, it becomes impractical to determine more detailed age-sex classification. Broader categories of composition allow for fewer numbers of passes to classify each group, resulting in less disturbance to groups during surveys.

The terminology describing composition cohorts is somewhat unorthodox and is explained by the history, timing, and methods used for muskox surveys. Initially, composition counts were conducted during the precalving period using snowmachines in late winter. In this survey period the youngest cohort was called “short yearling” or “yearling,” while the next older cohort being nearly 2 years old was called 2-year-olds, and so forth for older cohorts. In subsequent years, as surveys were completed earlier and earlier in the year, the older terminology was retained with the addition of a classification for calves. For comparison with surveys from 1996 and all surveys prior to 1994, the actual age of animals in the age classes for the current, midsummer surveys (postcalving) is about 6 to 9 months younger than the named classes. At times when

muskoxen were counted with a helicopter or snowmachine, the cohort classifications were more precisely aligned with actual age in years compared to broader classifications made from surveys using fixed-wing aircraft. Current census and composition surveys are completed after the calving period and before hunting commences so they are described as 'prehunt/postcalving' surveys. To express to results as 'posthunt/precalving' levels, the number of calves is subtracted from the prehunt/postcalving census counts.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Throughout the reporting period, the population on Nunivak Island remained healthy and productive. The trend is a slightly declining population falling below the targeted range of 500–550 animals posthunt precalving in both 2009 and 2010. We decreased the number of permits issued for cow muskox while maintaining a larger harvest of bull muskox throughout the reporting period. We used drawing and registration permits to take 66–74 animals a year.

The population on Nelson Island fluctuates significantly more than the Nunivak Island population. Several factors contribute to the variability in numbers of muskoxen, including human-induced mortality and movements on and off the island. The population during the reporting period showed steady growth and remained healthy and productive.

Population Size

During a fixed-wing census of Nunivak Island conducted in September 2009, we counted 567 muskoxen. During a fixed-wing census conducted in July of 2010, we counted 517 muskoxen. This means that when calves are excluded from the counts, the Nunivak Island population was at 469 and 433 posthunt precalving levels in 2009 and 2010, respectively. Both years were below the management goal of 500–550 posthunt precalving population for Nunivak Island (Table 1).

In June 2009, a census of Nelson Island muskoxen using a fixed-wing aircraft counted 541 muskoxen. A census on Nelson Island in September 2010 counted 561 muskoxen. Table 2 shows the history of population size on Nelson Island during the period of 1981–2010.

We do not have survey information to estimate the population of mainland muskoxen. Incidental observations from March 2010 indicate a minimum of 100 animals of mixed age and sex on the mainland. The population remains small and widely dispersed in Unit 18, with single animals and small groups now being observed in parts of Unit 19. Muskoxen have been observed moving on and off of Nelson Island to and from the mainland, confounding census data in both areas.

Population Composition

In 2009 we classified muskoxen censused on Nunivak as 203 three-year-old or older bulls, 177 three-year-old or older cows, 35 two-year-old-bulls, 41 yearlings, 98 calves and 13 of unknown age (Table 3). In 2010 muskoxen were classified as: 172 three-year-old or older bulls, 125 three-year-old or older cows, 32 two-year-old-bulls, 65 yearlings, 84 calves and 39 unknown (Table 4).

Muskoxen censused on Nelson Island in June 2009 were classified as 113 three-year-old or older bulls, 107 three-year-old or older cows, 22 two-year-old bulls, 61 yearlings, 88 calves, and 150 of unknown age (Table 5). In September of 2010, observed animals were classified as 110 three-

year-old or older bulls, 191 three-year-old or older cows, 20 two year old bulls, 61 yearlings, 126 calves and 52 of unknown age (Table 6).

Distribution and Movements

Nunivak Island is a closed system. In the winter muskoxen are distributed throughout the island but are concentrated along the south and west sides of the island. In the summer muskoxen 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.

Mainland muskoxen have been reported in the Kilbuck Mountains. In March 2011, an opportunistic flight from Bethel to Tuntutuliak, Kongiganak, Kipnuk, Chefornak, and Kasigluk and back to Bethel revealed 93 muskoxen in 5 separate mixed age-sex groups. Illegal harvest also confirms the distribution of animals elsewhere in Unit 18. In the winter of 2009 a single animals was poached on the Eek River. In the winter of 2009–2010 a bull muskox was taken in defense of life and property (DLP) by a dog musher close to Russian Mission. Several muskoxen were poached near the village of Kwigillingok.

Locations of mainland muskoxen collared during a 1989 cooperative collaring project by the department and federal staff (U.S. Fish and Wildlife Service [USFWS]) show additional areas of distribution in Unit 18. Five collars were deployed in 2 groups of 9 and 12 animals south of the Yukon River between Bethel and Pilot Station. A mature cow collared south of the Yukon River near Pilot Station in 1989 moved approximately 160 miles east to a location near the village of Lower Kalskag, north of the Kuskokwim River. Then, in 1990, a hunter legally shot this muskox near Toksook Bay on Nelson Island, approximately 200 miles west of its last known location.

MORTALITY

Harvest

Season and Bag Limit.

2008–2009 and 2009–2010 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	1 Sep–30 Sep 1 Feb–15 Mar	1 Sep–30 Sep 1 Feb–15 Mar

2008–2009 and 2009–2010 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
up to 60 cow permits issued on a first-come, first-served basis.		
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 regulatory action was adopted by the board during the reporting period. The department issued 3 emergency orders in 2009 to allow additional hunting opportunity in Unit 18. Emergency Order 05-05-09 extended the spring hunting season by 10 days to accommodate hunters thwarted by numerous bad weather events occurring during the regular hunting season and resulting in low harvest rates. The season ended 25 March instead of 15 March. Emergency Order 05-06-09 was issued to open a season for 7 stranded muskoxen on Triangle Island just northeast of Mekoryuk. Season dates were 13 June–30 June 2009. Emergency Order 05-07-09 opened a season on Abaramiut Island for 4 stranded muskoxen, in addition to extending the season for the remaining stranded muskoxen on Triangle Island. Season dates were from 18 July–31 August 2009.

Human Harvest. On Nunivak Island we are using hunt management strategies to meet the population goals outlined in the "Nunivak Island Reindeer and Muskox Management Plan" adopted by ADF&G, USFWS, and the Village of Mekoryuk (ADF&G 1992). In general, hunting is regulated by drawing and registration permits for fall and spring hunts. Hunters wishing to harvest bulls obtain permits 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. Harvest of cows is regulated primarily using registration permits. Occasionally, when harvestable surplus allows, auction permits are made available to qualified organizations for fundraising purposes.

The history of total harvest of bulls and cows on Nunivak Island for the period 1992–2010 is shown in Table 7. Most bulls taken during this period were harvested under the drawing permit system. In 2008–2009, 38 bulls were harvested by hunters who had drawing permits and an additional bull was harvested by a hunter who was issued a cow registration permit. The 2009–2010 bull harvest included 5 bulls in the fall and 39 in the spring through the drawing permit

system; 7 taken under an emergency order opening the harvest of stranded animals; and 1 taken by a hunter with an auction permit.

The 2010–2011 harvest included 6 bulls in the fall and 41 in the spring taken by hunters with drawing permits, and 2 taken by hunters with auction permits.

Registration permits for hunting Nunivak Island cows are distributed on a first-come, first-served basis in Bethel and Mekoryuk. There were 5 permits available in Bethel for the fall hunt and 5 for the spring hunt in each regulatory year 2008–2009 through 2010–2011. Forty cow registration permits were available in Mekoryuk for the spring hunt in 2008–2009, 30 cow permits in 2009–2010, and 20 cow permits in 2010–2011. Thirty-five cows were harvested in 2008–2009, 30 in 2009–2010, and 20 in 2010–2011 (Table 7).

The "Nelson Island Muskox Herd Cooperative Management Plan" is used to guide hunting when the population is at or above 250 animals. When the population is below 250 animals, the Plan calls for the cessation of hunting. 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 among Newtok, Toksook Bay, Tununak, Nightmute, and Chefornak. The history of permits issued and harvest of bulls and cows for the period 1981–2010 is shown in Table 8. In 2008–2009, 25 bull and 14 cow permits were distributed in Toksook Bay, and in 2009–2010, 25 bull and 17 cow permits were distributed in Tununak. In 2010–2011, 25 bull and 17 cow permits were distributed in Nightmute. Twenty-two bulls and 13 cows were harvested in 2008–2009. Twenty-one bulls and 15 cows were harvested in 2009–2010. Twenty-one bulls and 15 cows were harvested in the 2010–2011 regulatory year (Table 8).

We occasionally receive reports of muskoxen taken illegally. However, the number of animals taken is difficult to determine because we may receive reports of the same animal(s) from more than one source. We believe that some muskoxen taken illegally go undetected, so tallies of illegal harvest are considered minimum estimates. During 2008–2009 through 2010–2011 a minimum of 5 muskoxen were reported to be illegally harvested on the mainland and one was killed in defense of life and property by a dog musher.

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

Hunter Residency and Success. Most drawing permittees for Nunivak Island are residents of Alaska. Four nonresidents were drawn in 2008–2009, 1 nonresident in 2009–2010, and 4 nonresidents in 2010–2011. One registration permit hunter on Nelson Island was a nonresident in 2009-2010; all other registration permit hunters were residents.

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 in the 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 the 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 bears, brown bears and occasionally polar bears. The only report of predation on muskox in Unit 18 was in the spring of 2009, when witnesses from Scammon Bay said a polar bear killed several small, presumably calf, muskoxen in the area between Scammon Bay and Hooper Bay. Most mortality is from illegal harvest, followed by accidents—stranding, falling off cliffs, and falling through ice—and weather such as freezing rain.

In 2009, 11 bull muskoxen were stranded on Triangle and Abaramiut Island off the coast of Nunivak Island. After an emergency order was issued to open hunting, between 5 and 7 of these muskoxen were harvested. There was no interest in the remaining animals and they remained on the island through the fall. It was not observed if they were able to return to Nunivak Island the following winter or if they died of natural causes, the latter being more likely as they were in poor shape when last observed.

HABITAT

Assessment

No direct study of habitat was undertaken during the report period. On Nunivak Island we believe reindeer have historically overgrazed the lichen range, yet the herd was within the management goal of no more than 2,000 animals precalving during this reporting period. In 2009, USFWS counted 1,192 reindeer postcalving on Nunivak Island in August (Wald 2009). In 2010, review of photographs of the reindeer simultaneously taken from the plane during the muskox survey conducted by ADF&G yielded a count of 1,605 reindeer on Nunivak Island. Previous to 2009, the last estimate was from March 2006 of 3,250 animals, well above the management goal in the "Nunivak Island Reindeer and Muskox Management Plan" (1992).

Muskoxen taken by hunters on Nunivak Island 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 rates in cows harvested in the spring. A recent study conducted by department staff using analysis of liver tissue of hunter harvested animals in 2007–2008 and 2008–2009 shows preliminary results that both Island populations have healthy level of minerals and trace elements (unpublished data, ADF&G files). Muskox habitat on the mainland is extensive and could support a much larger population.

Enhancement

No enhancement activities were planned or completed during the reporting period. On Nunivak Island we are using hunt management strategies to meet muskox population goals and no enhancement is needed. On Nelson Island we are using hunt management strategies to meet muskox population goals and no enhancement is needed. Currently there are no habitat enhancement goals for the mainland.

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 continue to reduce the harvest of bulls and cows when the posthunt, pre-calving population is below 500 animals, or when bull:cow ratios warrant such actions. Close monitoring of cow harvest is warranted with the existing population size and structure. The management goals for Nunivak Island muskoxen include maintaining a maximum population of 500–550 muskoxen, translocation of muskoxen to other areas of Alaska, and providing opportunities to hunt muskoxen. It would continue to be of minimum cost and of high benefit to continue photographing Nunivak Island reindeer (simultaneously) while conducting muskox surveys. It adds approximately 1 hour of survey time to the muskox survey, and benefits all three parties involved in the Nunivak Island management plan.

Fluctuations in the observed size of the Nelson Island population are influenced by snow and ice conditions, 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 was probably due to a combination of emigration and illegal harvests, both of which were reported during this reporting period. In recent years the Nelson Island population has continued to grow and appears healthy.

Variable annual harvests are needed to effectively manage the Nelson Island population in response to emigration and other natural losses. The population is between 500 and 550 animals, and 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. Currently we are offering the legal maximum of 42 permits and have reached a population size that can support higher harvests. However, instead of seeking higher harvest rates on Nelson Island, the surplus animals are being used to seed and expedite growth of the mainland muskox herd.

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. A minimum of 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. The greatly successful moose moratoriums in the area on both the Kuskokwim and Yukon Rivers further demonstrate people's ability to work together to benefit local wildlife 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. We have purchased and intend to deploy three GPS collars in the fall of 2011 to further understand mainland areas

important for calving, feeding and migration of muskox. This will help promote the feasibility and importance of a large and healthy mainland population.

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Table 1. Unit 18 Nunivak Island muskox population, 1981–2010.

Year	No harvest/precalving	Prehunt/postcalving	Posthunt/precalving
1981			494
1982			510
1983			483
1984		552	
1985			547
1986			487
1987			586
1988			609
1989			577
1990			568
1991			439
1992			407
1993			435
1994		438	
1995		488	
1996			435
1997		593	
1998		643	
1999		620	
2000		628	
2001		609	
2002		527	
2003		657	
2004		638	
2005		588	
2006		615	
2007	No survey	No survey	No survey
2008	No survey	No survey	No survey
2009		567	
2010		517	

Table 2. Unit 18 Nelson Island muskox population, 1981–2010.

Year	No harvest/precalving	Prehunt/postcalving	Posthunt/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	No Survey	No Survey
2006	No Survey	No Survey	No Survey
2007		374	
2008	No Survey	No Survey	No Survey
2009		541	
2010		561	

Table 3. Unit 18 Nunivak Island muskox composition, September 2009.

	Male		Female		Unknown		Total	
Age	N	%[a]	N	%[a]	N	%[a]	N	%[b]
+3 years[c]	203	53	177	47			380	67
2 years	35	100					35	6
Yearlings					41	100	41	7
Calves					98	100	98	17
Unknown					13	100	13	2
Total	238	57[d]	177	43[d]	152		567	

[a] Percentage of age-sex specific cohort based on number in sample.
[b] Percent of total sample classified.
[c] Adults are considered 3 years and older.
[d] Percentage based on known males and females, N=415.

Table 4. Unit 18 Nunivak Island muskox composition, July 2010.

	Male		Female		Unknown		Total	
Age	N	%[a]	N	%[a]	N	%[a]	N	%[b]
+3 years[c]	172	58	125	42			297	57
2 years	32	100					32	6
Yearlings					65	100	65	13
Calves					84	100	84	16
Unknown					39	100	39	8
Total	204	62[d]	125	38[d]	188		517	

[a] Percentage of age-sex specific cohort based on number in sample.
[b] Percent of total sample classified.
[c] Adults are considered 3 years and older.
[d] Percentage based on know males and females, N=329.

Table 5. Unit 18 Nelson Island muskox composition, June 2009.

	Male		Female		Unknown		Total	
Age	N	%[a]	N	%[a]	N	%[a]	N	%[b]
+3 years[c]	113	51	107	49			220	41
2 years	22	100					22	4
Yearlings					61	100	61	11
Calves					88	100	88	16
Unknown					150	100	150	28
Total	135	56[d]	107	44[d]	299		541	

[a] Percentage of age-sex specific cohort based on number in sample.
[b] Percent of total sample classified.
[c] Adults are considered 3 years and older.
[d] Percentage based on know males and females, N=242.

Table 6. Unit 18 Nelson Island muskox composition, September 2010.

	Male		Female		Unknown		Total	
Age	N	%[a]	N	%[a]	N	%[a]	N	%[b]
+3 years[c]	110	37	191	64			301	54
2 years	20	100					20	4
Yearlings					61	100	61	11
Calves					126	100	126	23
Unknown					52	100	52	9
Total	130	41[d]	191	60[d]	239		561	

[a] Percentage of age-sex specific cohort based on number in sample.
[b] Percent of total sample classified.
[c] Adults are considered 3 years and older.
[d] Percentage based on know males and females, N=321.

Table 7. Unit 18 harvest of Nunivak Island muskoxen, 1992–2010.

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	39[b]	35	6	80
2009	51[cd]	30		81
2010	47[d]	20		67
Total	731	617	7	1355

[a] Includes cow(s) taken by hunters issued a bull permit.
[b] Includes bull(s) taken by hunters issued a cow permit.
[c] 7 bulls taken during emergency order opening for stranded animals on Triangle and Abaramiut islands.
[d] Years that muskoxen were harvested with auction permits SX001 or SX003.

Table 8. Unit 18 permits and hunting harvest of Nelson Island muskoxen, 1992–2010.

	Permits issued		Muskoxen harvested	
Year	Female	Male	Female	Male
1992	15	15	15	15
1993	0	30	0	30
1994	5	25	5	21
1995	0	0	0	0
1996	0	0	0	0
1997	10	10	7	10
1998	10	10	10	10
1999	15	15	15	15
2000	15	15	14	15
2001	0	0	0	0
2002	2	1	1	2
2003	15	23	14	22
2004	15	24	14	24
2005	15	23	14	21
2006	15	23	11	15
2007	15	15	14	14
2008	14	24	13	22
2009	17	25	15	21
2010	17	25	15	21
Total	195	303	177	278

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 2008
To: 30 June 2010

LOCATION

GAME MANAGEMENT UNIT: 22 (25,230 mi^2) and southwest portion of 23 (1,920 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 and in April 2010 was estimated at 2,903 (95% CI: 2,690 to 3,271) animals (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 22A, 22B West, 22C, 22D, 22E, and 23 Southwest (Figure 2).

MANAGEMENT DIRECTION

Muskox management on the Seward Peninsula is guided by recommendations from the Seward Peninsula Muskox Cooperators Group (The Cooperators) and local Fish and Game Advisory Committee groups. The Cooperators group is composed 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 management goals listed below form the basis of a cooperative interagency management plan for Seward Peninsula muskoxen developed during 1992 through 1994 (Nelson 1994) and following muskox management policy guidelines developed by the department (ADF&G 1980). Department staff updated the muskox management plan in 2011 to better reflect current management and population status, and the draft is currently being reviewed by federal cooperators.

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 (Nelson 1994)
- 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

Surveys for muskoxen have historically covered the entire Seward Peninsula to provide a minimum count of the entire population. In 2010, additional areas including northern Unit 22A, southeastern Unit 23, and western Unit 24 were added in response to an expansion of the population into previously unoccupied and unsurveyed habitat. The 2010 survey coverage corresponding to the previous minimum count census area was defined as the 'core count area' and the total 2010 survey area including the additional areas covered in Units 22A, 23SE and 24 was defined as the 'expanded count area'. Staff from the department, NPS, BLM, and FWS participated in the census. We adapted distance sampling techniques (Buckland et al. 2001, 2004) to estimate abundance. The following methods, described in a census summary to agency

participants (unpublished agency report, Schmidt, Gorn and Westing, 2010), were used during aerial survey coverage and subsequent analyses to estimate the Seward Peninsula muskox population (see also Schmidt et al. *In pres*s):

Survey Coverage. A Seward Peninsula muskox census was completed 31 January–25 March 2010 in Units 22, 23SW, 23SE, and a small portion of Unit 24 (Figure 2). The area was divided into 17 survey units based on past survey protocols and topography. Survey units 1 through 13 corresponded to historically surveyed 'core count area', while units 14 through 17 were assigned to the 'expanded count area', added in 2010. Parallel transects were drawn at 3 mi (4.8 km) intervals throughout each survey unit to provide complete coverage of the entire survey area. This resulted in 341 total transects, all of which were surveyed by one of six pilot/observer teams using one of 4 types of aircraft: PA-12, PA-18, C185, and Found Bush Hawk. Pilots were instructed to maintain 1000 ft AGL (above ground level) while on transect, although this altitude did vary in more mountainous terrain and during inclement weather. The survey aircraft followed each transect using GPS equipment until a group of muskoxen was detected. After detection, and after scanning ahead to check for additional groups, the aircraft left the transect line to mark the location of the group and count the number of individuals present. This included making a visual count, noting the number of short yearlings (when possible), and recording latitude/longitude through GPS coordinates. Groups first detected while off-transect were excluded from the analysis to prevent negative bias in abundance estimates. Observers were instructed to concentrate on the area in closest proximity to the aircraft flight line to ensure detection probability approached 1.0 near the centerline of the transect. Because transects were 4.8 km apart, observers generally only recorded groups observed within ~2.4 km. Groups observed at distances >2.4 km were recorded on the next transect, unless they had already been missed during a previous pass on that transect.

Aircraft and observer teams collected data from January 31- March 25 with most data collection occurring March 1- 25. Careful attention was placed on completing transect lines to prevent double counting groups due to small scale winter movements for the 'core count area' (minimum count) component of the survey. Snow conditions during the survey were classified as complete, excluding the last flight on March 25 when southern facing mountain slopes were incompletely covered due to spring melt. Post survey radio tracking flights occurred April 1-5 and found two additional groups of muskox in eastern Unit 22B missed during the survey. These groups were excluded from population estimation analysis because their detection did not follow sampling protocol.

Population Estimation. Distances to each observed group were measured using ArcMap 9.3.1. Appropriate detection functions for these data were then identified using program Distance 6.0 (Thomas et al. 2009) which allows the user to compare several detection functions using Akaike's Information Criterion (AIC) and select the best approximating model for the detection process. Histograms of the observed data produced in Distance can also be used to assess the validity of critical assumptions. Because the width of the obstructed strip beneath the aircraft was unknown, we used these tools to select a left-truncation distance to eliminate the portion of the transect where detection probability was <1.0. The data were right truncated at 2.4 km because observers typically did not search past that distance and the few observations at greater distances contributed little information.

We refit the best approximating model (identified using program Distance) in a Bayesian framework using R (R Development Core Team 2009) and WinBUGS (Spiegelhalter et al. 2004), which also allowed us to include spatially autocorrelated random effects on the probability of presence on each transect. The inclusion of this term helped to account for variables such as habitat suitability and quality that were not available for the entire survey area. Using autocorrelation among adjacent transects helped estimate local abundances more accurately. We also included transect length as a covariate based on the assumption that longer transects would have a higher probability of muskoxen presence due to the additional area surveyed. We did not include covariates for detection probability (e.g. weather, snow cover, pilot/observer), although this could be done in the future. Population estimates for each traditional hunt area were produced by weighting the abundance estimate for each individual transect by the proportion of that transect that was within the hunt area.

Each year muskox composition surveys were completed in numerous locations. Composition surveys are completed on a rotating schedule in Unit 22 and often coincide with the same areas where incidental muskox locations are identified on moose counts completed in February and March, making muskox composition surveys more cost effective. The exception during this reporting period was Unit 22E where NPS is conducting a research project and staff from ADF&G and NPS visited the area more frequently than previous reporting periods.

In 2008, surveys were completed during August in Unit 22E. In 2009, surveys were completed during March and April in Units 22B and 22C, during July in Unit 23 Southwest, and during August in Unit 22E. In 2010, surveys were completed during March in Units 22B, 22D, 22E, and 23SW. A Robertson R-44 helicopter was used to access previously identified groups. At each group, a team of 2 trained observers used binoculars and spotting scopes to classify muskoxen into 7 sex-age groups based on body size, conformation, and horn size/shape characteristics. Muskoxen 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. MB:100 C (mature bull to 100 cows) ratios were calculated by expressing the number of mature bulls (4-years-or-older) per 100 cows 3- or 4-years-or-older. Y:100 C (yearling to 100 cows) ratios were calculated by expressing the number of yearlings per 100 cows 3- or 4-years-or-older.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The 2010 Seward Peninsula muskox census estimated 2,616 (95% CI: 2,436 to 2,924) animals in the ‘core count area’ and 2,903 (95% CI: 2,690 to 3,271) animals in the ‘expanded count area’. We calculated unit and hunt area estimates for all areas (Table 1).

Snow cover and sightability varied greatly across the census area, but conditions were generally favorable across the census window. There was complete snow cover and aircraft flew when winds and lighting allowed for optimal sightability of muskoxen.

It is difficult to make direct comparisons between abundance estimates using different data collection protocols. Prior to 2010, a minimum count method assuming 100% coverage was used

with varying effort between years, so individual minimum counts may not be directly comparable. Starting in 2010, we implemented a distance sampling protocol with 100% coverage of an expanded survey area. Because of constraints on search technique imposed by distance sampling protocol, the minimum count derived for the 2010 survey is expected to be lower than previous minimum counts. It is unknown how comparable previous minimum counts are to point estimates generated by distance sampling methods in 2010, but for the purposes of administering Seward Peninsula muskox hunts, point estimates from the 2010 distance sample technique are used in the same manner as previous abundance estimates. Despite the differences in methodology, past minimum count survey results and the 2010 distance-based estimate were used in a similar manner to determine population growth rates, changes in abundance between units, and long-term changes to the entire Seward Peninsula population. Because the new methodology allows future changes in effort to be quantified, the continuity of the data stream should be improved.

The 2010 population estimate of 2,616 muskoxen in the 'core count area' represents a stable population since 2007 and a 3.8% annual rate of increase since 2000 (Figure 1). This represents a marked change in the apparent growth rate between 1970 and 2000 when the population grew 14% annually.

The 2010 population estimate of 2,903 muskoxen in the 'expanded count area' represents a 5% annual rate of increase since 2000, when a minimum count survey found 1,797 muskoxen (Figure 1). However, it should be noted that the additional areas covered during the 2010 count were not covered during the 2000 count.

Unit 22A: This area has not been surveyed in prior years. After completing surveys in 2010, we estimated 86 (95% CI: 62 to 128) muskoxen in Unit 22A north of the Unalakleet River.

Unit 22B: We used the Darby Mountains to divide Unit 22B into 2 count areas during the 2010 census. Muskoxen are now well established in Unit 22B west of the Darby Mountains (Unit 22B West) and the 2010 census estimated 364 (95% CI: 320 to 430) muskoxen, which represents a 15.5% increase in the population since 2007. It is unlikely that natal calf production alone resulted in the increase, and the increase is most likely a product of calf production combined with immigration of animals from adjacent units to the west (Unit 22C) and north (Unit 22D). We estimated 56 (95% CI: 33 to 106) muskoxen east of the Darby Mountains. This heavily forested area is unlike western Seward Peninsula units and usually receives deep snow during the winter. Muskoxen occur along the southern edge of the Darby Mountains and along coastal beaches during snow free months. The area appears to serve as transitional habitat to the treeless, windswept ridges of the Nulato Hills found further to the east.

Unit 22C: We estimated 402 (95% CI: 357 to 464) muskoxen in Unit 22C. The Unit 22C population doubled between 2005 and 2007, which we believe was influenced by movement of animals from adjacent units. The 2010 estimate suggests stability in the local population.

Unit 22D: We calculated 3 separate estimates for hunt areas in Unit 22D based on historical hunt areas. We estimated 237 (95% CI: 207 to 285) muskoxen in Unit 22D Kuzitrin River drainage; 160 (95% CI: 135 to 191) muskoxen in Unit 22D Southwest; and 481 (95% CI: 433 to 546) muskoxen in Unit 22D Remainder; totaling 878 muskoxen (Tables 1 and 2). The Unit 22D

muskoxen population appeared to remain stable from 1998–2007, when staff completed 5 separate minimum count surveys that averaged 760 muskox. During the same time period, populations in adjacent units (Unit 22B, Unit 22C, and Unit 22E) experienced consecutive years of population growth (Table 2). Composition surveys completed in Unit 22D between 2002 and 2006 show the proportion of yearlings (19% and 16%, respectively; Table 3) were indicative of population growth in this unit. While the population within Unit 22D exhibited growth, it is likely that during 2005-2007 muskoxen from Unit 22D moved into areas of Units 22C and 22B West, as composition counts in those units were not indicative of the growth found in those areas. A similar 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. Movement between units and hunt areas can preclude meaningful comparison of population change at scales below the full population levels.

Unit 22E: We estimated 879 (95% CI: 801 to 992) muskoxen in Unit 22E. Unit 22E has the largest number and highest density of muskoxen; 0.26 muskoxen/mi^2 on the Seward Peninsula. The population has experienced 11% annual growth since 1992.

Unit 23SW: We estimated 175 (95% CI: 137 to 241) muskoxen in Unit 23SW. This is 12% lower than the minimum count in 2007 of 219 muskoxen. However, the value for 2007 minimum count falls within the range of the confidence intervals for the distance sampling estimate, which suggests stability in the population. We suspect movements occur between Units 22D, 22E, and 23SW. Emigration from Unit 23SW is likely responsible for the colonization of areas to the east of the Seward Peninsula in the Nulato Hills and Selawik, Kobuk and Yukon River drainages. This movement may also account for some variability in the numbers from year to year within Unit 23SW.

Units 23SE and 24: We estimated 120 (95% CI: 93 to 159) muskoxen in the portion of Unit 23 east of the Buckland River and south of the Selawik Hills and the western portion of Unit 24. This area was enlarged to include western Unit 24 based on and increased number of incidental observations of muskoxen expanding their range eastward from Unit 23SW. In 2007, the sum of animals in Unit 23SE was determined to be 78 muskoxen based on eliminating duplicate observations of animals found during minimum count surveys (n=23) and Selawik moose surveys (n=72). The presence of mixed sex/ age groups and the increasing number of animals seen in this area are raising interesting questions about range expansion and acceptable muskoxen habitat.

The next census of the Seward Peninsula muskoxen population is scheduled for March 2012.

Population Composition

The results of composition surveys in Units 22B, 22C, 22D, 22E and 23SW are shown in Table 3. During the 2-year reporting period we classified 391 muskoxen in Unit 22B (two separate counts), 348 muskoxen in Unit 22C, 259 muskoxen in Unit 22D, 844 muskoxen in Unit 22E (three separate counts), and 274 muskoxen in Unit 23 SW (two separate counts). Mature bulls are undercounted in composition surveys relative to other segments of the population. An unknown number of mature bulls in the Seward Peninsula muskox population are often solitary animals and less likely to be detected during moose censuses or pre-survey flights used to locate groups. Although bull:cow ratios are minimums, they show useful trends through time.

Unit 22B: In April 2009 we visited Unit 22B West and classified 176 muskoxen. We found 34 MB:100 C, and 28 Y:100 C. In April 2010 we revisited Unit 22B West and classified 215 muskoxen. We found 30 MB:100 C, and 25 Y:100 C. There is a decreasing trend in MB:C and Y:C ratios since 2002 when we found 58MB:100C and 48 Y:100 C (Figure 3).

Unit 22C: In April 2009 we visited Unit 22C and classified 348 muskoxen. We found 35 MB:100 C, and 19 Y:100 C. There is a decreasing trend in MB:C and Y:C ratios since 2002 when we found 70MB:100C and 57 Y:100 C (Figure 4).

Unit 22D: In April 2010 we visited Unit 22D Remainder (excluding the Kuzitrin River drainage) and classified 259 muskoxen. We found 54 MB:100 C, and 18 Y:100 C. The MB:C ratio has increased since 2002 when staff found 33 MB:100 C. Comparatively, composition surveys completed in 2006 found 42 MB:100 C. In contrast, the is a steep decreasing trend in the Y:C ratio since 2002 when we found 41 Y: 100 C (Figure 5).

Unit 22E: In August 2008 staff from the NPS and ADF&G visited Unit 22E and classified 199 muskoxen. We found 51 MB:100 C, and 26 Y:100 C. In August 2009 we revisited Unit 22E, classified 282 muskoxen, and found 39 MB:100 C, and 35 Y:100 C. In March 2010 we revisited Unit 22E and classified 363 muskoxen, and found 51 MB:100 C, and 32 Y:100 C (Figure 6). Results from composition surveys beginning in 2002 indicate the number of mature bulls and yearlings in Unit 22E are apparently more stable than surveys completed in the Southern Seward Peninsula where surveys indicate a decreasing trend in MB:100C and Y:100 C.

Unit 23 SW: We completed composition surveys in Unit 23SW during July of 2009 and classified 117 muskoxen. We found 22 MB:100 C, and 28 Y:100 C. We revisited Unit 23SW in March of 2010 and classified 157 muskoxen. We found 19 MB:100 C and 18 Y:100 C (Figure 7).

Distribution and Movements

The Seward Peninsula census area was expanded in 2010 to include the Selawik National Wildlife Refuge and the northern portion of Unit 22A (Figure 2). The expanded effort was intended to further document range expansion of muskoxen emigrating east of the Seward Peninsula. Staff found 86 muskoxen in the northern portion of Unit 22A, and 120 muskoxen in Units 23SE and 24 (Table 1).

MORTALITY

Harvest

Season and Bag Limit. During this reporting period the State administered Tier I subsistence registration hunts in Units 22B, 22C, 22D, 22E, and 23SW. During the 2008-2009 regulatory year the department administered drawing hunts in Units 22C, 22D SW, 22D Remainder, Unit 22E, and 23SW. State 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.

Generalized regulatory language in 5 AAC 85.050 (2) for the reporting period follows:

2008-2009 and 2009-2010 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A:	No open season	No open season
Remainder of Unit 22, and Unit 23 Southwest, that portion on the Seward Peninsula west of and including the Buckland River Drainage:		
1 muskox by registration permit only;	1 Aug–15 Mar (Subsistence hunt only)	
or		
1 bull by drawing permit only; up to 60 permits may be issued; 10 percent of animals may be issued to nonresident hunters	1 Aug–15 Mar	1 Aug–15 Mar

Specific hunts administered in 2008-2009:

2008-2009 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A	No open season	No open season
Unit 22B, that portion east of the Darby Mountains, including drainages of Kwiniuk, Tubutulik, Koyuk and Inglutalik rivers		
1 bull by Tier I registration permit only (RX105; harvest quota is 5 bulls)	1 Aug–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22B		
1 bull by Tier I registration permit only (RX105; harvest quota is 11 bulls)	1 Jan–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		

2008-2009 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
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:		
1 bull by Tier I registration permit only (RX099; harvest quota is 34 bulls), or	1 Jan–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX099)	1 Jan–15 Mar	1 Jan–15 Mar
Remainder of Unit 22C	No open season	No open season
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:		
1 muskox by Tier I registration permit only (RX103; harvest quota is 7 muskox including up to 5 cows), or	1 Jan–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX103)	1 Jan–15 Mar	1 Jan–15 Mar
Unit 22D, Kuzitrin River Drainage		
1 muskox by Tier I registration permit only (RX102; harvest quota is11 muskox including up to 4 cows)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22D:		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX102; harvest quota is16 muskox including up to 7 cows); or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX102)	1 Aug–15 Mar	1 Aug–15 Mar

2008-2009 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22E		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX104; harvest quota is 50 muskox including up to 31 cows); or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX097)	1 Aug–15 Mar	1 Aug–15 Mar
Unit 23 Southwest, that portion on the Seward Peninsula west of and including the Buckland River drainage		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX106; harvest quota is 16 muskox including up to 8 cows); or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX106);	1 Aug–15 Mar	1 Aug–15 Mar

Subsistence hunt conditions:
1. Subsistence hunts open to residents only.
2. Tag fee waived for subsistence hunting.
3. No-fee subsistence tag required.
4. One muskox permit per hunter per calendar year.
5. Permits issued 24 July-31 December.
6. Season will be closed by emergency order when quota is reached.
7. Trophy destruction required if skull removed from Units 22 or 23. A 3-inch piece of horn is removed from each horn by the department.
8. Aircraft may not be used to transport muskox hunters, muskox, or muskox hunting gear.
9. Only one registration permit (in possession by hunter) is allowed at a time for moose and muskoxen in Unit 22

Specific hunts administered in 2009-2010 follow:

2009-2010 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A	No open season	No open season
Unit 22B, that portion east of the Darby Mountains, including drainages of Kwiniuk, Tubutulik, Koyuk and Inglutalik rivers		
1 bull by Tier I registration permit only (RX105; harvest quota is 5 bulls)	1 Aug–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22B		
1 bull by Tier I registration permit only (RX105; harvest quota is 11 bulls)	1 Jan–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:		
1 bull by Tier I registration permit only (RX099; harvest quota is 34 bulls), or	1 Jan–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX099)	1 Jan–15 Mar	1 Jan–15 Mar
Remainder of Unit 22C	No open season	No open season
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		

2009-2010 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Canyon Creek to its confluence with Tuksuk Channel:		
1 muskox by Tier I registration permit only (RX099; harvest quota is 7 muskox including up to 5 cows), or	1 Jan–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX103)	1 Jan–15 Mar	1 Jan–15 Mar
Unit 22D, Kuzitrin River Drainage		
1 muskox by Tier I registration permit only (RX099; harvest quota is 11 muskox including up to 4 cows)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22D:		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX104; harvest quota is 16 muskox including up to 7 cows); or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX102)	1 Aug–15 Mar	1 Aug–15 Mar
Unit 22E		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX104; harvest quota is 62 muskox including up to 31 cows); or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4 years old or older by drawing permit (DX097)	1 Aug–15 Mar	1 Aug–15 Mar
Unit 23 Southwest, that portion on the Seward Peninsula west of and including the Buckland River drainage		
1 muskox by Tier I registration permit only; however, cows may be taken only during the period 1 Jan–15 Mar (RX106; harvest quota is 16 muskox including up to 8 cows);	1 Aug–15 Mar (Subsistence hunt only)	No open season

2009-2010 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters

Subsistence hunt conditions:
1. Subsistence hunts open to residents only.
2. Tag fee waived for subsistence hunting.
3. No-fee subsistence tag required.
4. One muskox permit per hunter per calendar year.
5. Permits issued 24 July-15 March.
6. Season will be closed by emergency order when quota is reached.
7. In hunts RX099 and RX106, head must be presented to ADF&G within 72 hours of harvest and horn will be removed and retained by the department at the position of the eye on bulls with boss horn.
8. Trophy destruction required if skull removed from Units 22 or 23. The distal portion of each horn will be cut at or above the position of the eye on the skull.
9. Aircraft may not be used to transport muskox hunters, muskox, or muskox hunting gear.

Board of Game Actions and Emergency Orders. 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 State managed hunts. The adopted regulatory changes resulted in registration permit hunts in Units 22B, 22C, 22D, 22E, and 23SW (available to all Alaska residents), and drawing permit hunts that offered a limited amount of drawing permits for trophy animals in Units 22C, 22D, 22E and 23SW.

In January 2009 at the Alaska Legislature, Senator Olson introduced Senate Bill 144 to change Statute 16.05.340(a)(16)(B) to authorize the BOG to reduce or eliminate the resident big game tag fee for muskoxen for all or a portion of a game management unit. The bill alleviates the current no-fee tag required by regulation for subsistence hunts through BOG authority to eliminate the resident tag requirement similar to the tag exemption applied to subsistence brown bear hunts. After one legislative session with no action, the bill was passed by the Alaska Legislature and became effective June 2010. This change to Statute means that the resident tag requirement will be eliminated for subsistence muskox hunts in Units 22 and 23 in future regulatory years.

In November 2009 the BOG adopted a regulation that changed the allocation of drawing permits in Unit 22E and authorized 10% of the annual Unit 22E drawing permits be issued to nonresident hunters.

There were 6 emergency orders (EO) issued during the reporting period to close subsistence registration muskox hunts because harvest quotas were either reached, or expected to be reached, by the closure date on the EO:

1. Staff issued an EO on December 1, 2008 to close RX106 in Unit 23 Southwest. The Unit 23 Southwest hunting season opened August 1, 2008.

2. Staff issued an EO on January 8, 2009 to close RX099 in Unit 22C. The hunting season opened January 1, 2009 and closed 8 days later.

3. Staff issued an EO on January 12, 2009 to close RX102 in Unit 22D Remainder. The Unit 22D Remainder hunting season opened August 1, 2008.

4. Staff issued an EO on October 13, 2009 to close RX104 in Unit 22D Remainder. The Unit 22D remainder hunting season opened August 1, 2009.

5. Staff issued an EO on January 18, 2010 to close RX099 in Unit 22D Southwest. The Unit 22D Southwest hunting season opened January 1, 2010.

6. Staff issued an EO on February 2, 2010 to close RX099 in Unit 22D Kuzitrin River drainage. The Unit 22D Kuzitrin hunting season opened January 1, 2010.

Human-Induced Harvest. In 2008–2009, 98 bulls and 6 cows were harvested by Tier I permit, 22 bulls were taken by drawing permit, and 0 muskoxen were taken with federal permits for a total harvest of 126 muskoxen (120 bulls and 6 cows). Table 4 shows the number of permits filled in 2008–2009 for state and federal hunts in each unit.

In 2009–2010, 106 bulls, 19 cows, and 1 animal of unreported sex were harvested by Tier I permit, 26 bulls were taken by drawing permit, and 2 bulls were taken with federal permits for a total harvest of 154 muskoxen (134 bulls, 20 cows, and 1 unknown). Table 5 shows the number of permits filled in 2009–2010 for state and federal hunts in each unit.

Permit Hunts. Hunting during this reporting period was by Tier I subsistence registration permit and drawing permit on state managed lands and by federal subsistence permit on federal public lands. Trophy destruction of muskoxen taken in Tier I hunts is required if the skull is removed from Unit 22 or Unit 23.

Hunter Residency and Success. During 2008–2009, 165 Tier I registration permits were issued for Seward Peninsula muskoxen hunts and 104 were filled for a 63% success rate. Thirty-two (32) drawing permits were issued and twenty-two (22) were filled for a 69% success rate. Thirty-seven (37) federal permits were issued, but none were filled. During 2009–2010, 216 Tier I registration permits were issued for Seward Peninsula muskoxen hunts and 126 were filled for a 58% success rate. Thirty-four (34) drawing permits were issued and twenty-six (26) were filled for a 76% success rate. Eighteen (18) federal permits were issued and two (2) were filled for an 11% success rate.

In 2008–2009, 66% of hunters issued state Tier I permits for Seward Peninsula hunts were local residents of Unit 22 or Unit 23 communities. Thirty percent of hunters were Alaska residents living outside of Unit 22 or Unit 23, 3% hunters living outside of Alaska, and 1% residency was unknown.

In 2009–2010, 61% of hunters issued State Tier I permits for Seward Peninsula hunts were residents of Unit 22 or Unit 23 communities. Thirty-eight percent of hunters were Alaska residents living outside of Unit 22 or Unit 23, less than 1% were hunters living outside of Alaska, and less than 1% residency was unknown.

Harvest Chronology. Muskox hunt effort and chronology in northwest Alaska is driven by both weather and hours of available daylight in units 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. When given the opportunity by drawing permit to hunt throughout the entire season or when hunting by registration permit 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 2008–2009, the proportion of harvest in each unit showed variation throughout the progression of the season: Unit 22B – September (29%), January (42%), March (29%); Unit 22C – January (97%), February (3%); Unit 22D – August (15%), September (15%), October (15%), November (3%), December (3%), January (37%), March (12%); Unit 22E – August (19%), September (12%), February (50%), March (19%); Unit 23 – August (62%), September (19%), November (19%).

In 2009–2010, the proportion of harvest in each unit showed variation throughout the progression of the season: Unit 22B – August (15%), December (8%), January (77%); Unit 22C – September (3%), January (72%), February (14%), March (11%); Unit 22D – August (18%), September (18%), October (10%), January (44%), February (5%), March (5%); Unit 22E – August (11%), September (9%), December (2%), January (2%), February (49%), March (25%), Unknown (2%); Unit 23 – August (17%), September (22%), October (5%), January (17%), February (17%), March (22%).

Transport Methods. Hunters reported snowmachines were used to hunt 63%, 3 or 4 wheelers 15%, boat 7%, plane 5%, off road vehicles 5%, other 2%, and highway vehicles, foot travel each 1%. Transportation is unknown for 1% of hunters because method was not reported.

Other Mortality

The department collared 25 adult cow (cows > 4 years and older) muskoxen in 2008. Collars were deployed on muskoxen located in Units 22B, 22C, and 22D. Following deployment, we found 5 mortalities in June, 2 mortalities in July, and 1 mortality in April. Since 2008, the average annual mortality rate for adult cow muskoxen located in Units 22B, 22C, and 22D is 13% (95% CI: 0.05 to 0.21). The US Geological Survey, in collaboration with the NPS**,** collared 35 cow muskoxen in Bering Land Bridge National Preserve in Unit 22E between March 2009 and December 2010. They found 1 mortality in May, 1 mortality in June, 3 mortalities in July, 3 mortalities in August, 2 mortalities in September, and 2 mortalities in October. Since 2009, the average annual mortality rate for cow muskoxen in Unit 22E is 24% (95% CI: 0.12 to 0.36). When all collared muskoxen data from the northern and southern Seward Peninsula are combined, the annual mortality rate is 18% (95% CI: 0.11 to 0.25) (Adams personal comm.). This small sample of collared muskoxen (n=60) represents 2% of the western Seward Peninsula population as of 2010 (Fig. 1) and is not randomly distributed throughout the population, so localized events such as icing, deep snow events, or different predator regimes may preclude the use of this mortality rate as representative of the entire population. However, combining collar data from the northern and southern Seward Peninsula begins to shed light on natural mortality rates on Seward Peninsula muskoxen. Lastly, the selection of animals for capture is not truly random, as obviously injured or diseased animals were intentionally not selected for collaring.

We frequently observe old muskoxen, and believe mortality from disease 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).

Department staff completed in-season radio tracking flights and found unreported muskox mortality presumably caused by hunting. Staff found three (3) dead muskoxen (age and sex unknown) during the 2008-2009 hunting season located in herds commonly accessed by local hunters in close proximity to Nome. The timing of aerial surveys suggests that mortality resulted from hunting activities, probably caused by pass through shooting resulting in wounding loss. An additional wounded, but alive, muskox was reported by a local hunter, but staff was unable to relocate the animal. Staff found an additional two (2) muskox mortalities (1 bull and 1 cow) during the 2009-2010 hunting season that were believed to be caused by hunting wounding loss. The dead muskox found during the reporting period were all located within 15 miles of Nome, and it is reasonable to suggest additional muskoxen are killed at an unknown rate in other areas of the Seward Peninsula during annual hunting seasons.

Disease. Blood, fecal, and hair samples were collected from nine Seward Peninsula muskoxen during October 2008 capture work and tested for presence of minerals, parasites, and disease. Results show the Seward Peninsula samples tested negative for zoonotic diseases and the muskoxen population is considered 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 gastrointenstinal 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 three samples, as well as the four other muskoxen, tested positive for pregnancy (two 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 serum were tested for copper levels and results found levels between 0.78 - 1.11ppm (mean=0.95 ppm), which suggests 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 Alaskan 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 unit, 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 this 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 land mark 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 nor 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 deer 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

In 2010 we adapted the distance sampling survey technique to estimate abundance of Seward Peninsula muskoxen. We believe distance sampling estimates will provide more useful data and improve long term monitoring efforts of Seward Peninsula muskoxen compared to minimum count survey methods completed prior to 2010. Unfortunately, the change in methodology does not allow direct comparisons of 2010 distance sample estimates with minimum counts completed prior to 2010. The 2007 minimum count survey result falls within the confidence interval of the 2010 distance sample estimate of 2903 muskox, and considering the recent downward trend in recruitment in a large segment of the population it is likely that population growth of muskoxen found within the 'core count area' of the Seward Peninsula will decrease in the near future. Additional effort should be made to better understand eastward emigration from central areas of the Seward Peninsula into Unit 22A, Unit 23 east of the Buckland River, and Unit 24. These areas are searched less intensively throughout the year because of their distant proximity to Nome and Kotzebue, and although incidental observations of muskox groups in these areas exist from staff since 1993 (J. Dau, ADF&G, personal comm.). Additional formal survey efforts will better monitor eastward range expansion of Seward Peninsula muskoxen.

Since 2002 composition survey results indicate an apparent decrease in mature bulls and yearlings throughout an expanding area of the Seward Peninsula, which now includes Units 22C, 22B, 22D, and 23SW. The downward trend is evident in all areas although declines occur at different rates between units. Composition data has become increasingly important to collect for

Seward Peninsula hunt administration. As hunter harvest has increased though time (Figure 8) and recent population growth has apparently slowed compared to growth observed during 1970-2000, staff now consider the number of mature bulls found in the population as the primary factor for establishing harvest rates in Seward Peninsula hunt areas compared to the previous weight given to population count results alone. Staff has historically conducted composition surveys based on drainages or unit boundaries, but additional effort is needed to develop a sampling strategy to collect composition of muskoxen across the entire range of the herd.

It is important to determine what factors are limiting growth so we can ensure our management strategy is appropriate. Current regulatory language allows for increased flexibility of hunt management and it is important to consider changes in harvest rates and their effect to population structure. Other factors effecting 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 scenarios, there are many sections that are obsolete to the 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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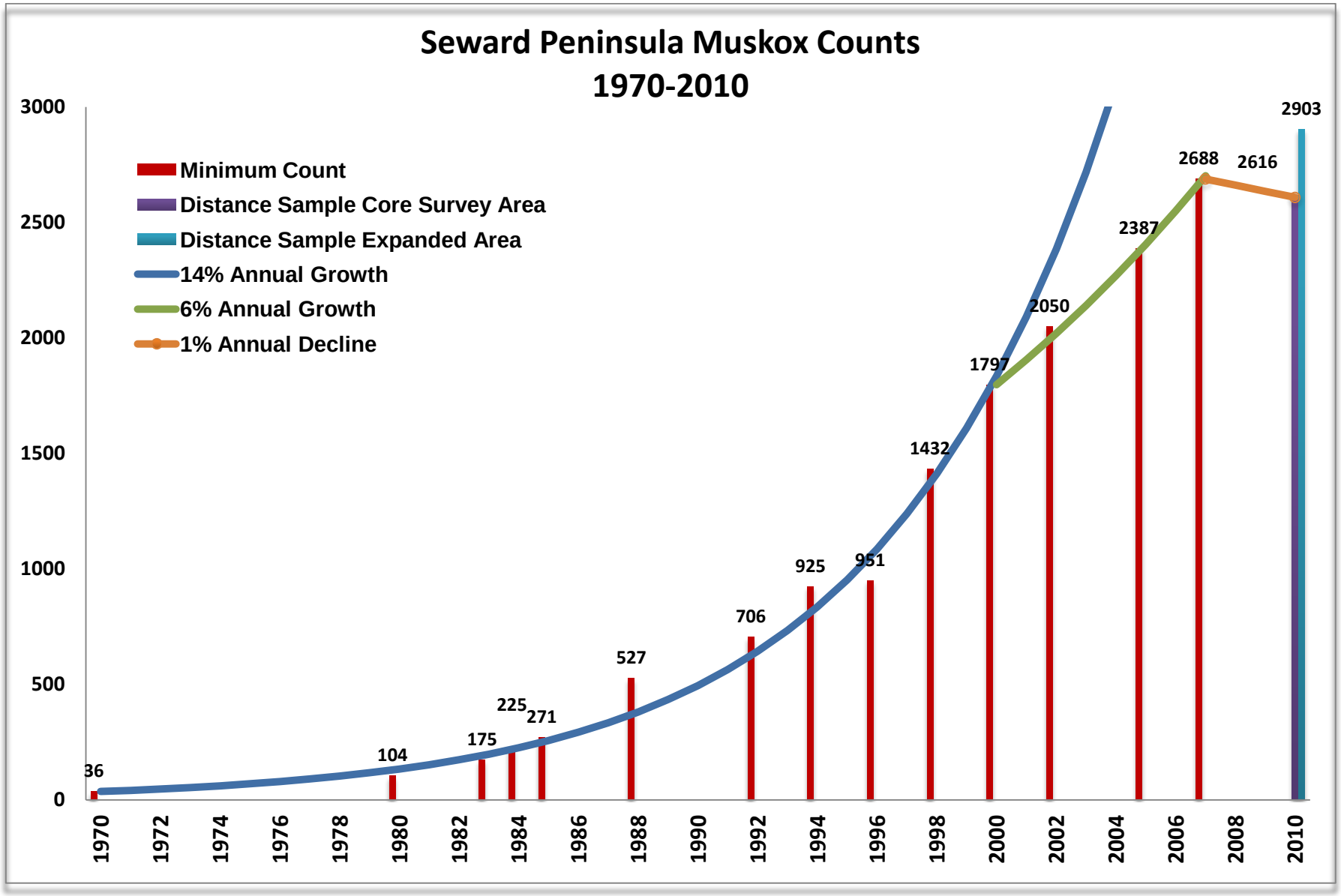
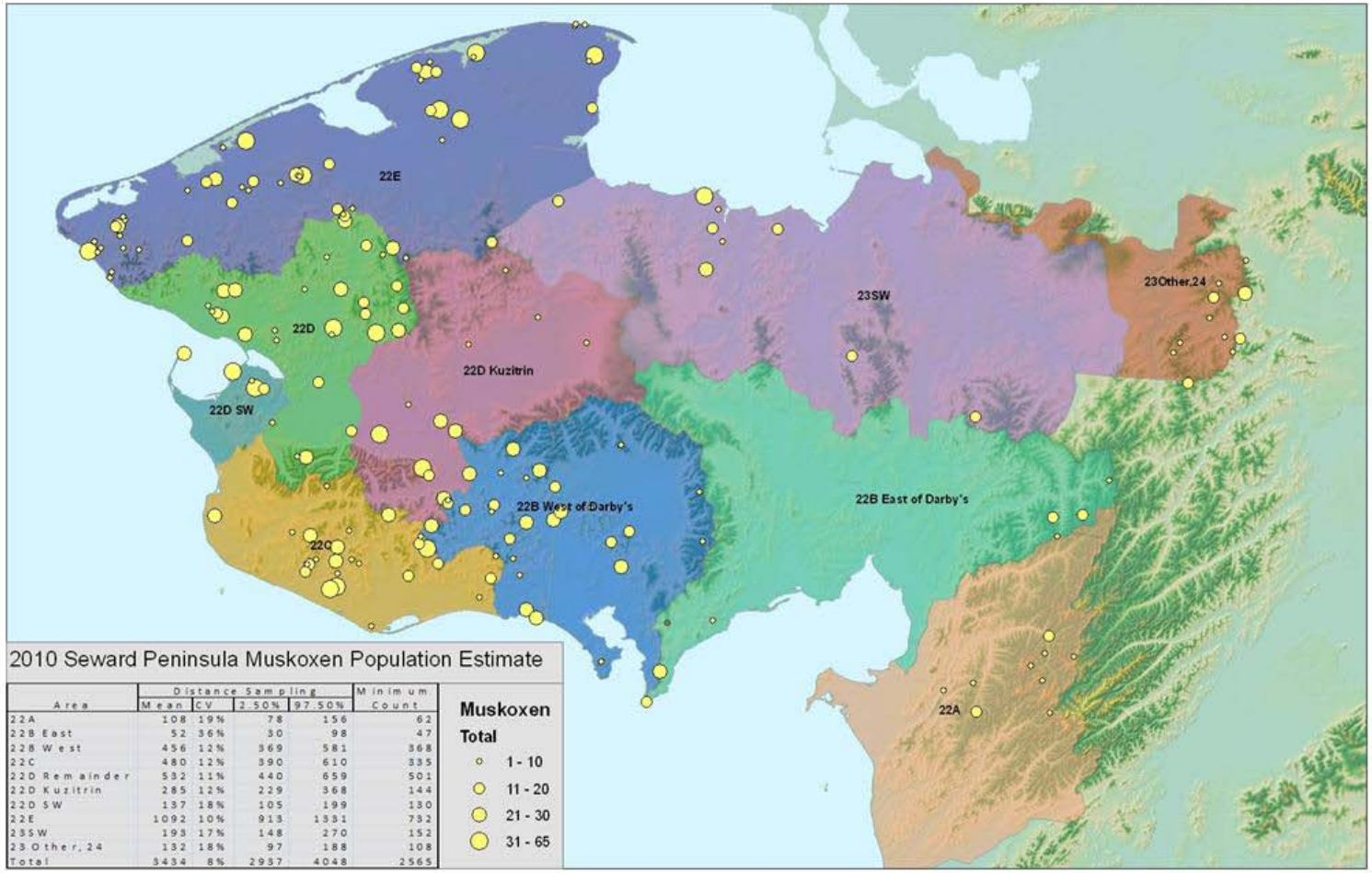


Figure 1. Census results and annual population growth rates from minimum count and distance sampling surveys of Seward Peninsula muskoxen, 1970–2010.



2010 Seward Peninsula Muskoxen Population Estimate

Area	Distance Sampling				Minimum Count
	Mean	CV	2.50%	97.50%	
22A	108	19%	78	156	62
22B East	52	36%	30	98	47
22B West	456	12%	369	581	368
22C	480	12%	390	610	335
22D Remainder	532	11%	440	659	501
22D Kuzitrin	285	12%	229	368	144
22D SW	137	18%	105	199	130
22E	1092	10%	913	1331	732
23SW	193	17%	148	270	152
23Other,24	132	18%	97	188	108
Total	3434	8%	2937	4048	2565

Figure 2. Location of Seward Peninsula muskox groups, spring 2010 census.

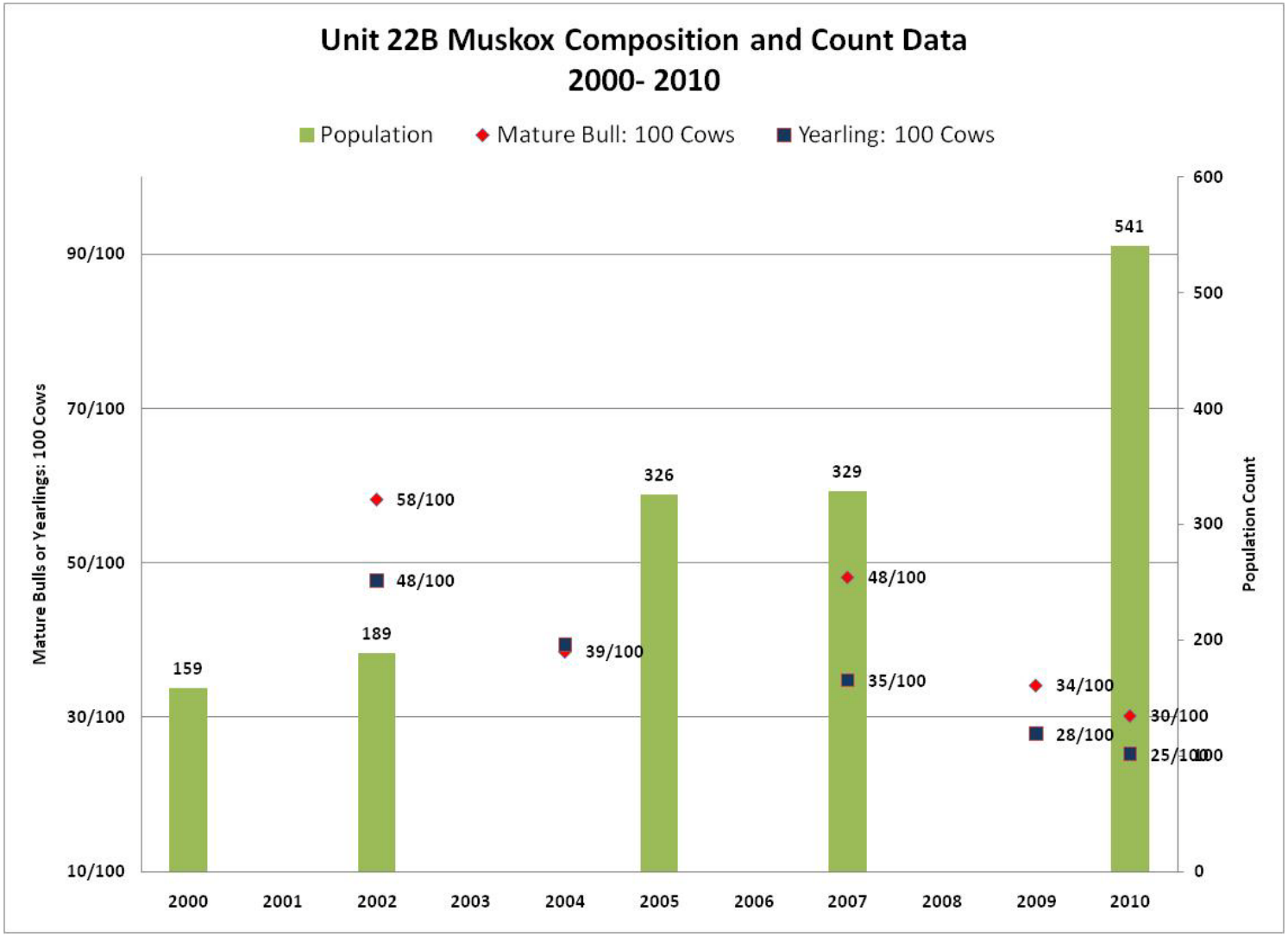


Figure 3. Unit 22B muskox composition data, 2000 and 2010.

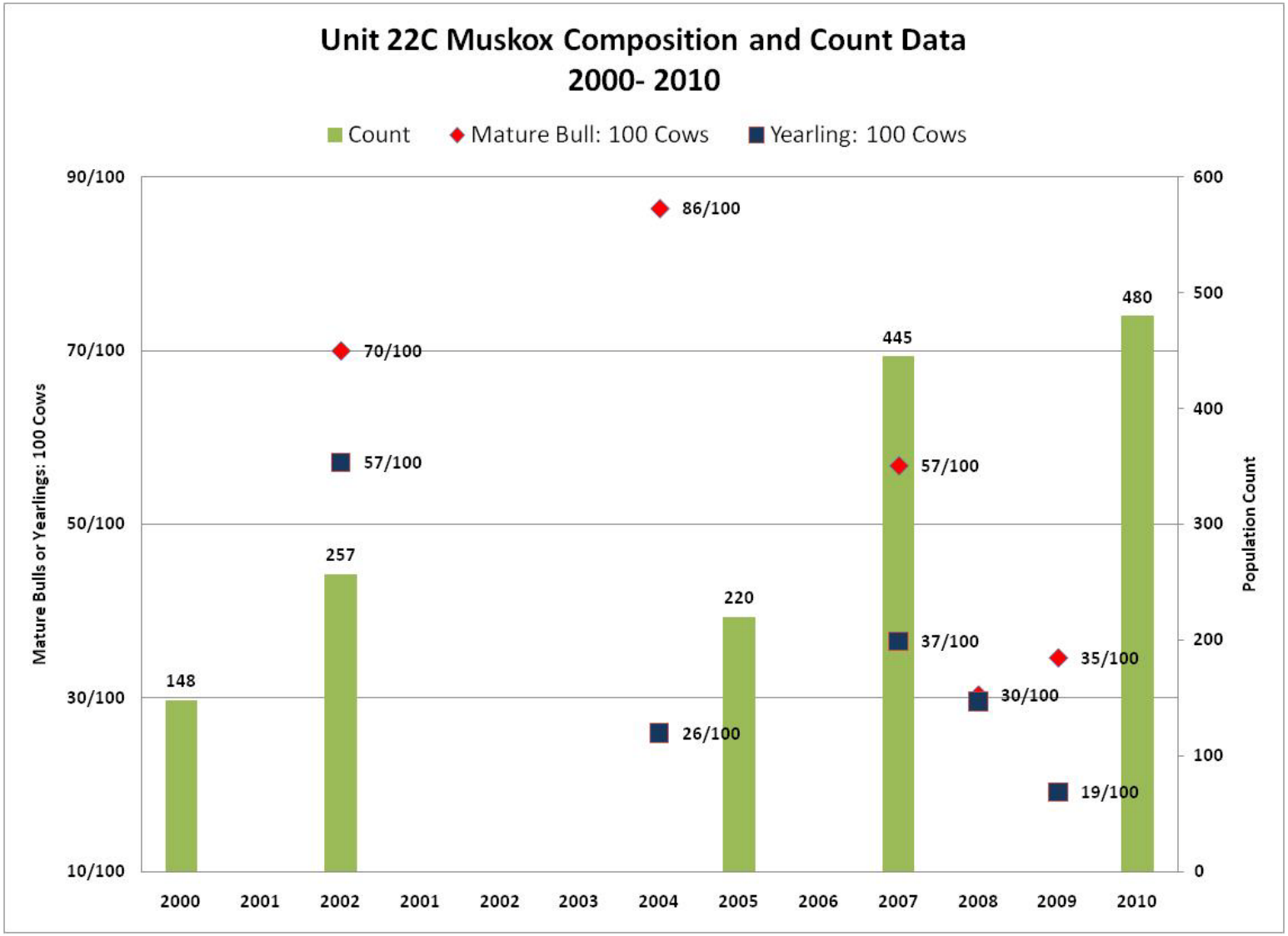


Figure 4. Unit 22C muskox composition data, 2000 and 2010.

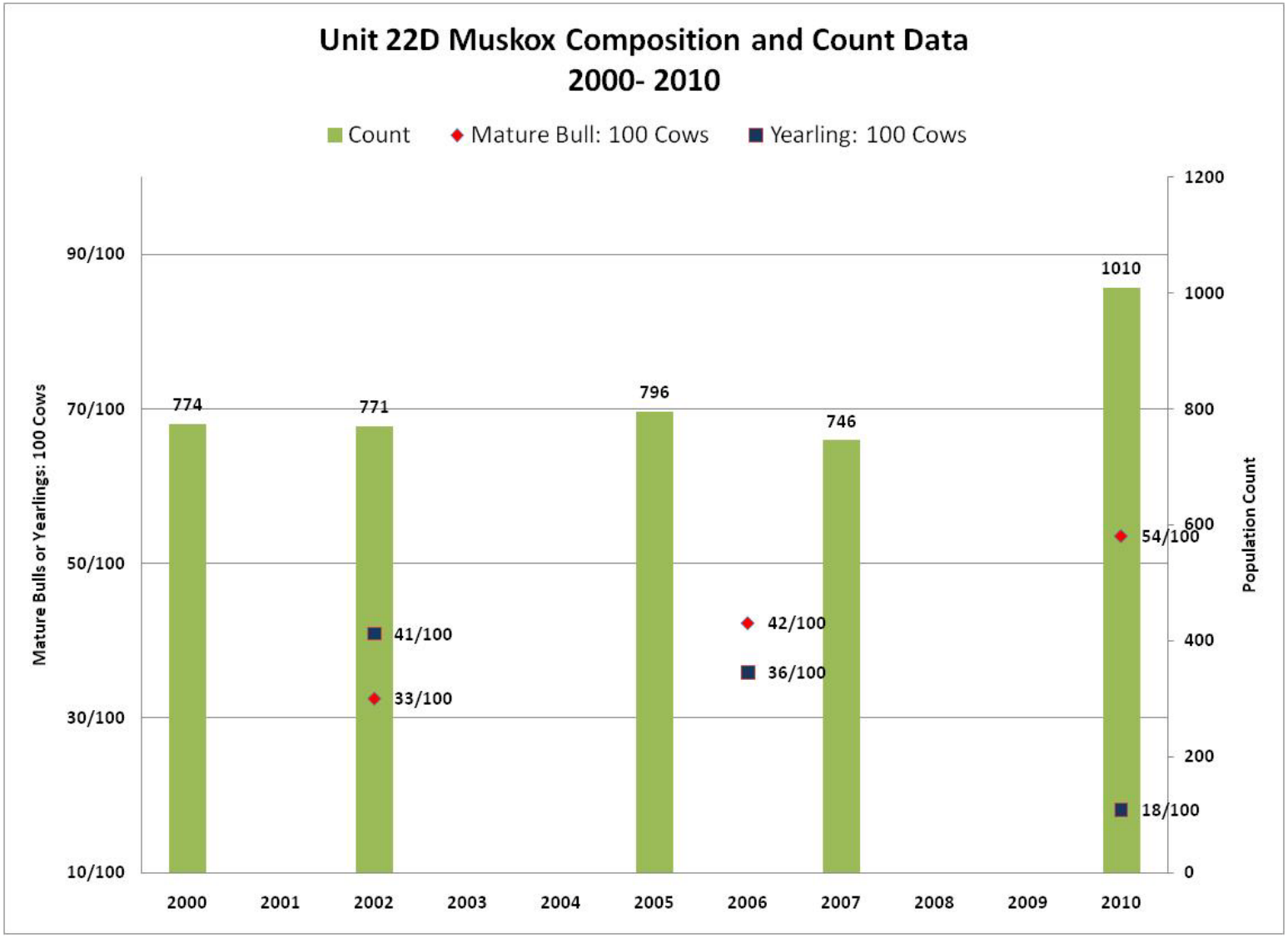


Figure 5. Unit 22D muskox composition data, 2000 and 2010.

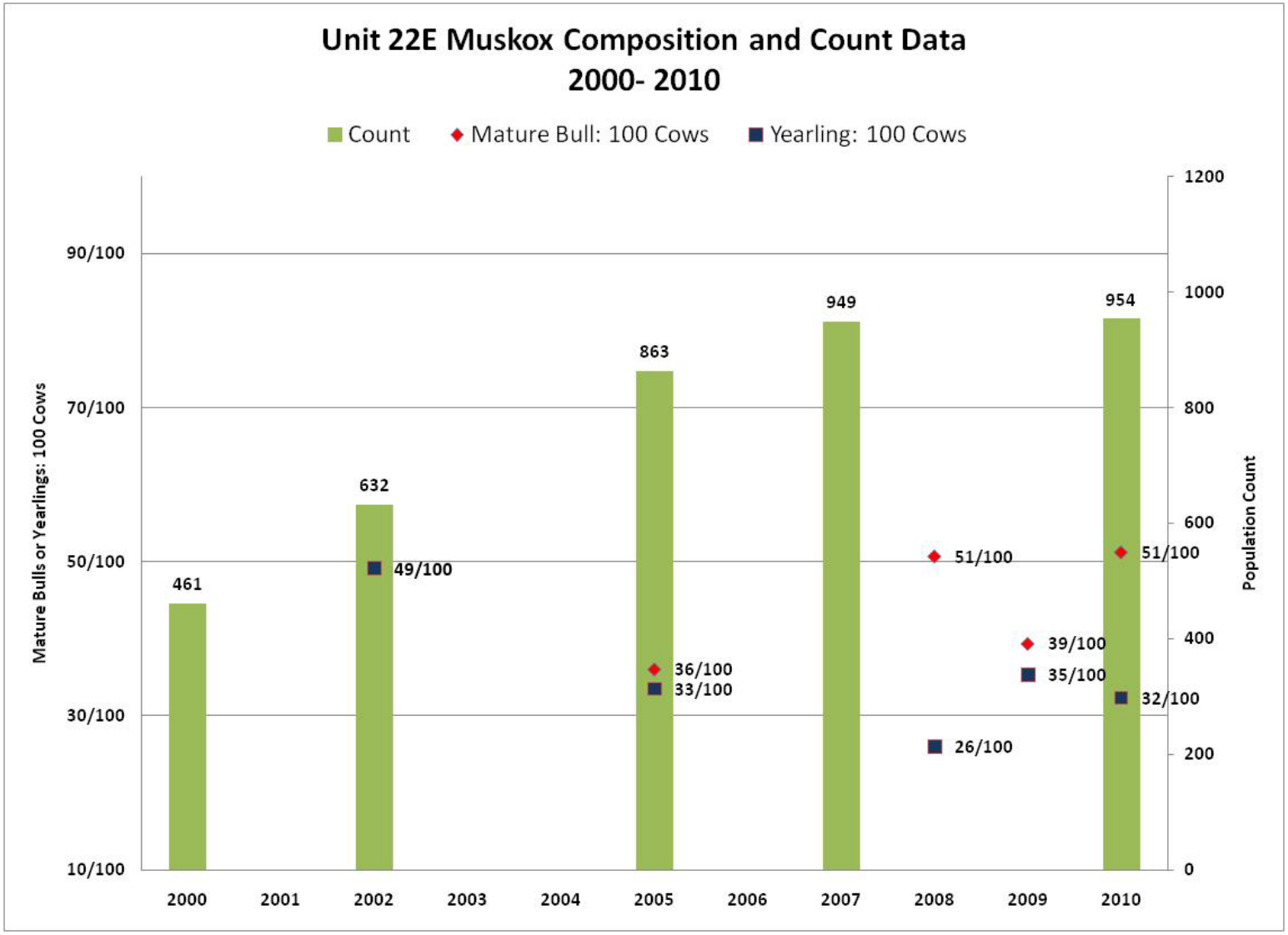


Figure 6. Unit 22E muskox composition data, 2000 and 2010.

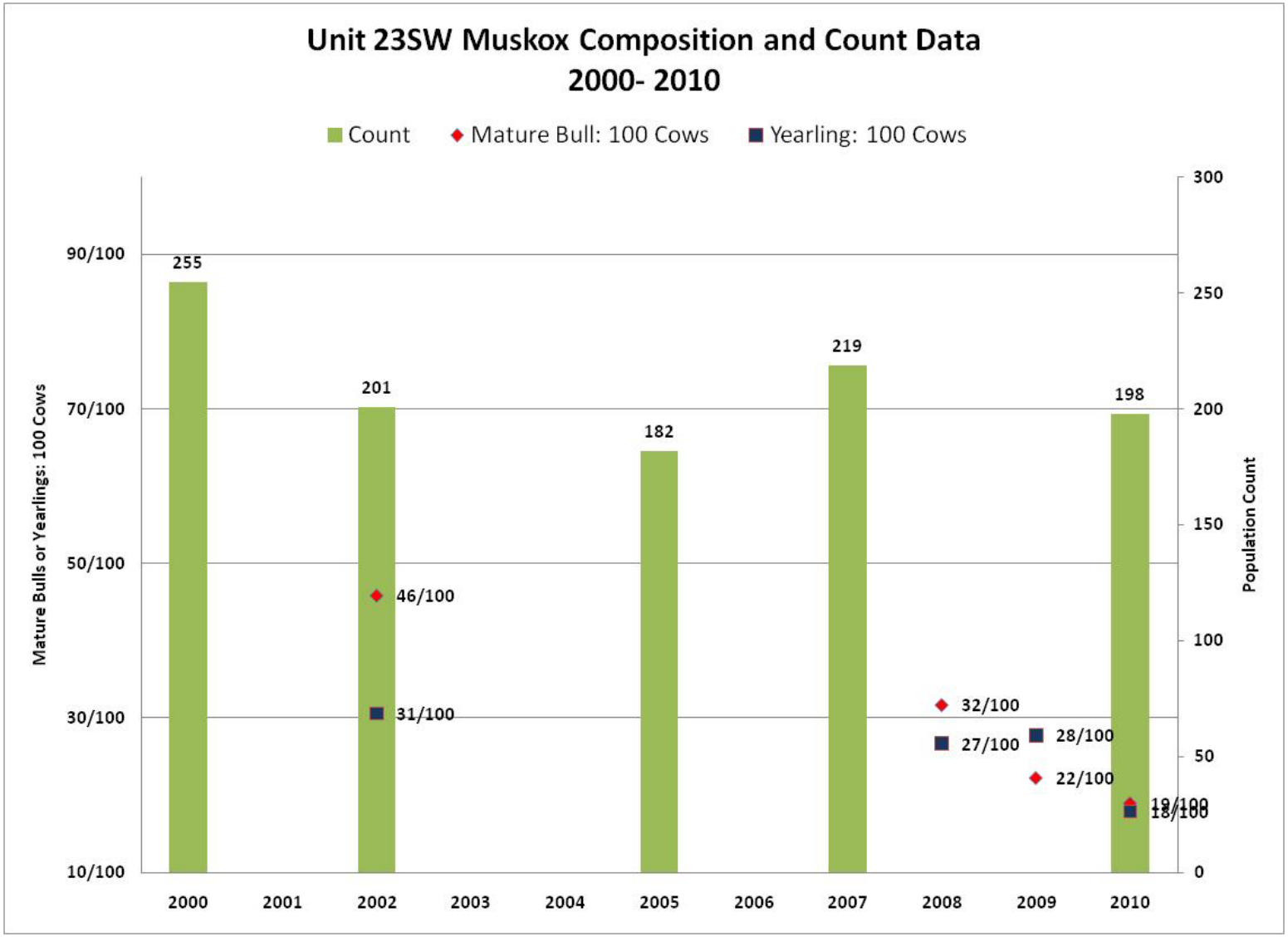


Figure 7. Unit 23 Southwest muskox composition data, 2000 and 2010.

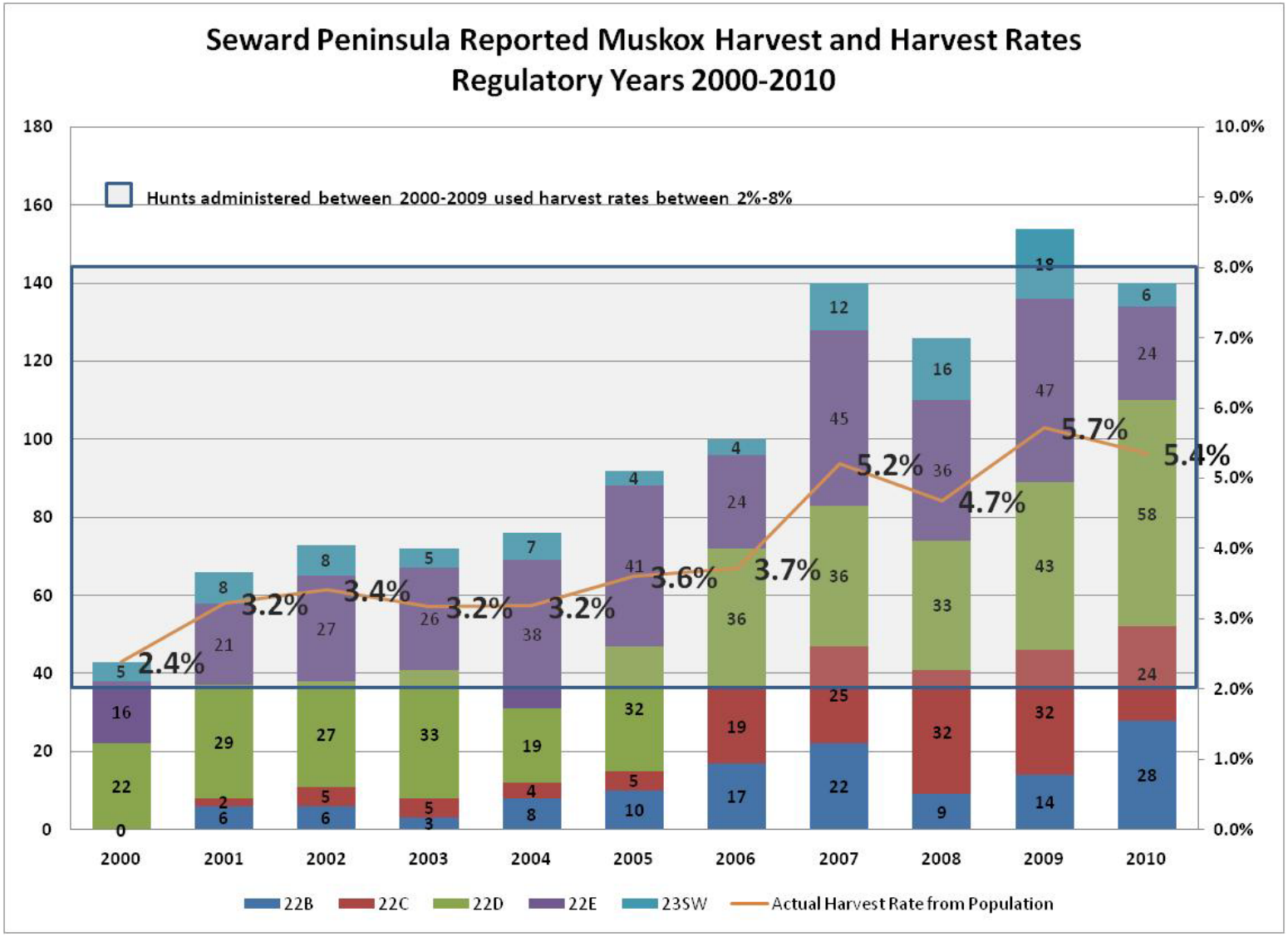


Figure 8. Seward Peninsula muskox harvest and harvest rates, 2000–2010.

Table 1. Seward Peninsula muskox census results; Units 22, 23 Southwest, 23 Southeast, and 24; spring 2010.

Unit	Mean	CV	2.5%	97.50%
22A	86	20%	62	128
22B East of Darby Mtns.	56	34%	33	106
22B West of Darby Mtns.	364	8%	320	430
22C	402	7%	357	464
22D Kuzitrin Drainage	237	8%	207	285
22D Southwest	160	9%	135	191
22D Remainder	481	6%	433	546
22E	879	5%	801	992
23 Southwest	175	15%	137	241
23 Southeast and 24	120	14%	93	159

Table 2. Seward Peninsula muskox census results; Units 22, 23 Southwest, 23 Southeast, and 24; 1992–2010.

	Unit							
Year	22A[a]	22B	22C	22D	22E	23SW	23SE/24[b]	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
2010	86	420	402	878	879	175	120	2903[c]

[a] This count area was not counted during 1992-2007 census counts
[b] This count area was not counted during 1992-2005 census counts.
[c] Totals may not equal the sum of unit estimates. Each unit estimate column is an independent computer-generated estimate using the census method noted in the census method section of this report.

Table 3. Age and sex composition of Seward Peninsula muskox groups, 2002–2010.

			Males ≥4 years old		Females ≥4 years old		Females 3 or 4 years old		Females 3 years old		Males 3 years old		Males 2 years old		Females 2 years old		Yearlings		Calves		Unknown		Mature Bull:100 Cows[b]	Yearling:100 Cows[c]
Unit	Year	N	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]	No.	%[a]		
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
22B	2004	236	42	18%	86	36%	0	0%	23	10%	11	5%	16	7%	15	6%	43	18%			0	0%	39/100	39/100
22B	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
22B	2008																							
22B	2009	176	27	15%	54	31%	0	0%	25	14%	15	9%	8	5%	13	7%	22	13%	2	1%	7	4.0%	34/100	28/100
22BW	2010	215	36	17%	98	46%	0	0%	21	10%	7	3%	12	6%	8	4%	30	13%	0	0%	3	1.4%	30/100	25/100
22C	2002	209	49	23%	35	17%	5	2%	30	14%	14	7%	20	10%	16	8%	40	19%			0	0%	70/100	57/100
22C	2004	217	70	32%	56	26%	0	0%	25	12%	18	8%	10	5%	17	8%	21	10%			0	0%	86/100	26/100
22C	2007	412	101	25%	151	37%	0	0%	27	7%	15	4%	25	6%	28	7%	65	16%			0	0%	57/100	37/100
22C	2008	283	43	15%	123	43%	4	1%	15	5%	18	6%	16	6%	18	6%	42	15%			4	1%	30/100	30/100
22C	2009	348	56	16%	109	31%	0	0%	53	15%	31	9%	19	5%	33	9%	31	9%	2	1%	13	4%	35/100	19/100
22D	2002	455	70	15%	157	35%	9	2%	49	11%	17	4%	30	7%	33	7%	88	19%			2	0.4%	33/100 [d]	41/100
22D	2006	516	99	19%	193	37%	0	0%	41	8%	32	6%	28	5%	26	5%	84	16%			13	3%	42/100	36/100
22D Rem	2010	259	68	26%	105	41%	0	0%	22	8%	18	7%	12	5%	9	3%	23	9%			2	1%	54/100	18/100
22E	2002	313	57	18%	84	27%	3	1%	29	9%	19	6%	32	10%	32	10%	57	18%			0	0%	49/100 [d]	49/100
22E	2005	501	83	17%	161	32%	0	0%	69	14%	28	6%	43	9%	34	7%	77	15%			6	1%	36/100	33/100
22E	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
22E	2009	282	39	14%	93	33%	0	0%	6	2%	8	3%	21	7%	14	5%	35	12%	63	22%	3	1%	39/100	35/100
22E	2010	363	84	23%	137	38%	0	0%	27	7%	17	5%	19	5%	22	6%	53	15%	0	0%	3	1%	51/100	32/100
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
23SW	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
23SW	2009	117	12	10%	42	36%	0	0%	12	10%	7	6%	5	4%	5	4%	15	13%	19	16%	0	0%	22/100	28/100
23SW	2010	157	18	11%	66	42%	0	0%	29	18%	4	3%	5	3%	13	8%	17	11%			5	3%	19/100	18/100

[a] Percentage of age-sex specific cohort based on total composition sample size (N).
[b] Number of males ≥4 years old/100 cows ≥3 years old.
[c] Number of yearlings/100 cows ≥3 years old.
[d] Mature bull:Cow ratios are probably underestimated due to sampling regime that favored selection of large groups for comp counts.

Table 4. Results of state and federal muskox hunts on the Seward Peninsula, 2008–2009.

	Harvest quota		State permits filled			Federal permits			Hunter harvest			Total
Hunt Area	Total	Cow	Bulls	Cows	Unknown	Issued	Bulls filled	Cows filled	Bull	Cow	Unknown	harvest
22B												
RX105 East	5	0	2	0	0	0	0	0	2	0	0	2
RX105 West	11	0	7	0	0	4	0	0	7	0	0	7
22C												
RX099	34	0	29	2	0	0	0	0	29	2	0	31
DX099	2	NA	1	0	0	0	0	0	1	0	0	1
22D SW												
RX103	7	5	4	0	0	7	0	0	4	0	0	4
DX103	6	NA	2	0	0	0	0	0	2	0	0	2
22D Kuz												
RX102	11	up to 4	7	2	0	7	0	0	7	2	0	9
22D Rem												
RX102	16	up to 7	15	0	0	7	0	0	15	0	0	15
DX102	3	NA	3	0	0	0	0	0	3	0	0	3
22E												
RX104	62	31	19	1	0	12	0	0	19	1	0	20
DX097	20	NA	15	0	0	0	0	0	15	0	0	15
SX097	1	NA	1	0	0	0	0	0	1	0	0	1
23SW												
RX106	16	8	15	1	0	0			15	1	0	16
DX106	up to 2	NA	0	0	0	0	0	0	0	0	0	0
Harvest total									120	6	0	126

Table 5. Results of state and federal muskox hunts on the Seward Peninsula, 2009–2010.

	Harvest quota		State permits filled			Federal permits			Hunter harvest			Total harvest
Hunt Area	**Total**	**Cow**	**Bulls**	**Cows**	**Unknown**	**Issued**	**Bulls filled**	**Cows filled**	**Bull**	**Cow**	**Unknown**	
22B												
RX105 East	**5**	**0**	**3**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**3**
RX105 West	**11**	**0**	**11**	**0**	**0**	**0**	**0**	**0**	**11**	**0**	**0**	**11**
22C												
RX099	**34**	**0**	**29**	**1**	**0**	**0**	**0**	**0**	**29**	**1**	**0**	**30**
DX099	**2**	**NA**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**
22D SW												
RX099	**7**	**5**	**2**	**6**	**0**	**0**	**0**	**0**	**2**	**6**	**0**	**8**
DX103	**6**	**NA**	**5**	**0**	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**5**
22D Kuz												
RX099	**11**	**up to 4**	**8**	**2**	**0**	**8**	**0**	**0**	**8**	**2**	**0**	**10**
22D Rem												
RX104	**16**	**up to 7**	**17**	**1**	**0**	**0**	**0**	**0**	**17**	**1**	**0**	**18**
DX102	**3**	**NA**	**2**	**0**	**0**	**0**	**0**	**0**	**2**	**0**	**0**	**2**
22E												
RX104	**62**	**31**	**24**	**4**	**1**	**18**	**2**	**0**	**26**	**4**	**1**	**31**
DX097	**20**	**NA**	**15**	**0**	**0**	**0**	**0**	**0**	**15**	**0**	**0**	**15**
SX097	**1**	**NA**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**
23SW												
RX106	**16**	**8**	**12**	**5**	**0**	**0**			**12**	**5**	**0**	**17**
DX106	**up to 2**	**NA**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**
Harvest total									**134**	**19**	**1**	**154**

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MUSKOX MANAGEMENT REPORT

From: 1 July 2008
To: 30 June 2010[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. The majority of the Cape Thompson muskox population probably inhabits the portion of Units 23 and 26A from the mouth of the Noatak River to Corwin Bluff within 20–35 miles of the Chukchi Sea.

In addition to the relatively discrete Seward Peninsula and Cape Thompson populations that occupy stable, core ranges, muskoxen are also widely scattered throughout the remainder of the

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

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 provide for subsistence hunting and eventually 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 survey the Cape Thompson population at least once every 3 years.
2. Assess population level range expansion.
3. To monitor the sex and age composition of the Cape Thompson muskoxen population.
4. 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 surveyed irregularly since 1987 using fixed-wing aircraft.The sample 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 Agashashok River (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 1,000–2,000 ft above ground level and repeatedly count them during a gradual, low power, spiral descent. These surveys have provided minimum population counts with no estimates of sightability or confidence intervals.

Population Composition

Composition information was collected each August in 2008, 2009, and 2010 in partnership with the National Park Service. Additionally, composition information was collected in March 2010 to begin a transition to collecting data in a time when sightability is more optimal. 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 the Kivalina River. For ratio estimates we defined ‘cow’ as any female $\geq$3 yrs old and ‘bull’ as any male $\geq$4 yrs old. Data collected in the spring is based on “short” classifications; e.g., a 3 year old male is 2 years and 11 months old.

Distribution and Movements

Locations of muskoxen observed during surveys 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. However, the National Park Service (NPS) is engaged in a multi-year study that involves deploying 30 collars on animals in the Cape Thompson population. Preliminary results have found an 80% adult cow survival rate (L. Adams, U.S. Geological Survey [USGS], Anchorage, personal communication) All agency staff examine kill sites when possible to attempt to determine causes of muskoxen mortality and collect samples.

Harvest

Harvest during the 2008–2009 and 2009–2010 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 (Fig. 1, Table 1). Since 1998, the growth of this population slowed dramatically and the last 3 data points within the traditionally sampled core have indicated a decline. Since introduction, the Cape Thompson population of muskoxen has expanded its range. For many years the traditionally sampled area was sufficient to monitor the population. However, the number of muskoxen observed incidentally outside of the sample area has dramatically increased over the last 20 years, while counts throughout the traditional survey area have started to decline (Fig. 2). While observations inside the traditional core have increased with growing attention from the NPS and ADF&G, factors influencing opportunistic observations remain largely unchanged. Opportunistic observations of mixed sex and age groups in Unit 26A and the Upper Noatak totaled over 200 animals in 2009. The changing distribution of muskoxen on the landscape makes it difficult to determine population size.

Population Composition

We observed 9, 30, and 30 calves:100 cows (≥3 yrs old) in 2008, 2009, and 2010, respectively. Bull:cow ratios (bulls ≥4yrs:100 cows ≥3 yrs old) for these years were 65, 38, and 40. We may

underestimate bull:cow ratios because search intensity during composition surveys is low compared to population surveys, and mature bulls are often alone or in very small groups that could easily be missed. Additionally, composition surveys were performed in the summer when a single muskox can be difficult to see. As a result, in the spring of 2010, we began a transition to collecting these data when sightability is better. The bull:cow ratio for that survey was 68. With only 5 years of data, little can be said regarding the survival of individual cohorts. Additionally, we located only 30–58% of the entire estimated population during composition surveys in 2008–2010 (Table 2). Composition data suggest 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 and bull 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 population surveys conducted since 1988, the proportion of this population in the southern portion of its range has increased (Fig. 3). For example, 24% of the total population was observed within Cape Krusenstern National Monument (CAKR) during the 1988 census while in 2008 this percentage was 75% (Fig. 3). Several factors could be contributing to this change in distribution. The habitat in CAKR may be better, resulting in immigration to the area. Additionally, groups in CAKR may be more productive than those outside the area. Another factor that may be contributing is that the muskoxen were released at Cape Thompson, 50 miles north of CAKR. It may have taken some time for the population to find and fill optimal habitat.

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. Additionally, there were 3 groups just outside of the sample boundary and in the Kelly and Kugururok Drainages, with a combined total of 32 muskoxen. In 2006, a mixed-sex age group containing neonates was observed in the upper Noatak where only small groups of bulls had been previously observed. Moose surveys conducted in 2010 on the upper Noatak (upstream of the Kaluktavik) found 27 muskoxen. Collar data from the previously mentioned NPS study has also shown some impressive animal movement. One cow traveled 130 miles from the Igichuk Hills (summer 2009) to Corwin Bluff (February 2010) (L. Adams, USGS, Anchorage, personal communication). Another cow was observed on the Noatak River near the mouth of the Kaluktavik River wearing a radio collar from capture work in the core sample area.

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 spends

little time in the northern portion of this muskoxen range so we do not know the magnitude of illegal harvests.

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
2008–2009 and 2009-2010		
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

Tier II subsistence hunt conditions:
1. Subsistence hunts open to residents only.
2. Tag fee waived for subsistence hunting.
3. No-fee subsistence tag required.
4. One muskox permit per hunter per calendar year.
5. Trophy destruction required if skull removed from Unit 23. A 3-inch piece of horn is removed from each horn by the department.
6. Aircraft may not be used to transport muskox hunters, muskox, or muskox hunting gear.

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. There were no Board of Game actions or Emergency Orders during this reporting period.

In January 2009 at the Alaska Legislature, Senator Olson introduced Senate Bill 144 to change Statute 16.05.340(a)(16)(B) to authorize the BOG to reduce or eliminate the resident big game tag fee for muskoxen for all or a portion of a game management unit. The bill alleviates the current no-fee tag required by regulation for subsistence hunts through BOG authority to eliminate the resident tag requirement, similar to the tag exemption applied to subsistence brown bear hunts. After one legislative session with no action, the bill was passed by the Alaska Legislature and became effective June 2010. This change to the statute means that the resident tag requirement will be eliminated for subsistence muskox hunts in Unit 23 in future regulatory years.

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. However in the years since 2007–2008, all but one of the successful applicants has been from Kotzebue. This shift demonstrates that the Tier II process favors applicants that are experienced with and comfortable navigating a paper-based and formulaic application process. Applicants, from the villages especially, may be easily discouraged when they are not successful and may see the application as too difficult for an uncertain result. As a result, village hunters rarely accumulate a long hunt history that allows them to be competitive in securing Tier II permits. Additionally, applying for a hunt that takes place 8–12 months later is culturally counterintuitive for Inupiaq hunters. The shift in distribution of permits has happened despite educational efforts to encourage applications from villages and help offered to applicants as they navigate the Tier II process. Since successful applicants have a perfect score for the application/hunt history, it is impossible for new applicants (or those who do not apply every year) to establish enough history to receive enough points to win a permit. The shift of permits to Kotzebue hunters has resulted in nearly all recent harvest concentrated in the vicinity of the Noatak Hatchery. Since the 2006–2007 season, all harvest has occurred in the small area west of the Noatak River and east of Cape Krusenstern National Monument.

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%. However in 2009, one-third of the permit winners who hunted did not harvest a muskox. In 2010, half of the permit winners did not harvest a muskox. This was likely due to the dearth of muskoxen in the relatively small area where Kotzebue hunters focus their effort.

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

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

Natural Mortality

A significant amount of the mortality of NPS-collared muskoxen has been attributed to brown bear predation (J. Lawler, NPS, Fairbanks, personal communication). Even so, brown bears seem to be a more significant source of mortality on the Seward Peninsula and on the North Slope

(Reynolds 2003, Reynolds et al. 2002) than in northwestern Unit 23. Additionally, it can be difficult to discern predation by bears from scavenging by bears.

Other Mortality

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 occurring between Sealing Point and Shesaulik will likely continue and could become more frequent in the future. Indeed, in the summer of 2008 a muskox was taken in defense of property. At least 2 other muskoxen, both bulls, have been shot and left unsalvaged in the vicinity of Shesaulik over the past 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

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.

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

For many years, local residents have expressed concern about muskox displacing *Rangifer* (caribou and reindeer) from traditional hunting areas and worry about competition (between *Rangifer* and muskoxen) for food resources (Dau 2005). However, studies on caribou and muskoxen interactions in the Northwest Territories of Canada have shown that, at least when densities of both species were low in relation to relative abundance of food, there was no competition between the two species (Thomas et. al 1999.) Additionally, on the Seward Peninsula, although muskoxen and reindeer overlap in their use of feeding areas, they select forage plants differently from each other (Ihl and Klein, 2001). Although most published information indicates that competition is not a serious issue, traditional knowledge in many areas of the state indicates that indirect and direct competition may be an issue between *Rangifer* and muskox. Until this concern is adequately addressed, it will continue to impede muskox management in northwest Alaska (see also ‘Other Mortality’ section above).

CONCLUSIONS AND RECOMMENDATIONS

1. Two distinct populations of muskoxen inhabit Unit 23. One population ranges primarily within 20–35 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 are scattered throughout much of the remainder of northern Unit 23 and parts of Unit 26A. Additionally, mixed-sex age groups are becoming established in the Selawik drainage, in Unit 26A and possibly in the upper Noatak drainage.

2. As incidental observations outside of the traditionally sampled core have increased over the last 10 years, it has become increasingly important to try to evaluate the population size of the Cape Thompson herd with reference to the majority of its range. It is important to assess the overall status of the population and develop a better tool for monitoring changes in population size and distribution over time. In 2011, the department, in concert with the NPS, will use slight modifications of the distance sampling methods developed for the Seward Peninsula primarily by Josh Schmidt of NPS, Tony Gorn of ADF&G and Lincoln Parrett of ADF&G (Schmidt et al. 2010) to estimate the Cape Thompson muskox population.

3. A 2% harvest rate on a stable or slowly declining population allows subsistence opportunity without posing significant risk to the population. Therefore, the harvest strategy for TX107 should remain conservative with a 6-bull quota.

4. As an increasing number of mixed-sex age groups are observed in new areas, the department is considering ways to determine if natural range extensions of existing populations are occurring, or if discrete populations are becoming established. This will affect how harvest quotas are determined in the future and if new hunts should be established.

5. Harvests of muskoxen in the northwest portion of Unit 23 should be cooperatively managed by the department and NPS, similar to state-federal management occurring on the Seward Peninsula. That would better allow state and federal quotas to be based on the relative abundance of muskoxen on these lands. In most years, roughly 50% 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.

6. 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 population survey results for the northwest portion of Unit 23, 1988–2010.

	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	Jan/Feb 2010
Groups	14	19	24	26	39	34	41	37	43	41	40	38	30
Individuals[a]	106	215	291	212	322	299	327	236	363	369	347	324	296
Calves[b]	17	18		49	65	75	97	23					
Total	123	233	291	261	387	374	424	259	363	369	347	324	296
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 2008-2010, Unit 23[a].

	Males (%[b])	Females (%[b])	Unknown (%[b])	Total (%[b])
Fall 2008 (30[c])				
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)
Total	32 (33)	49 (50)	16 (16)	97
Fall 2009[d]				
Adults (4+ yrs old)	23 (15)	60 (39)		83 (54)
3-yrs old	5 (3)	14 (9)		19 (12)
2-yrs old	9 (6)	4 (3)		13 (9)
Yearlings			15 (10)	15 (10)
Calves			22 (14)	22 (14)
Total	37 (24)	78(51)	37 (24)	152
Spring 2010 (51[c]) "short" classifications				
Adults (4+ yrs old)	36(24)	47 (31)		83 (55)
3-yrs old	10 (7)	21 (14)		31 (21)
2-yrs old	4 (3)	4 (3)		8 (6)
Yearlings			28 (18)	28 (18)
Unknown age			2(1)	2(1)
Total	50(34)	72 (48)	30(19)	152
Fall 2010 (58[c])				
Adults (4+ yrs old)	25(14)	65 (38)		90 (52)
3-yrs old	6 (3)	12 (7)		18 (10)
2-yrs old	2 (1)	7 (4)		9 (5)
Yearlings			32 (18)	32 (18)
Calves			23 (13)	23 (13)
Unknown age			1(1)	1(1)
Total	33(18)	84 (49)	56(32)	173

[a] Composition surveys were paid for by the National Park Service and conducted cooperatively with department staff.
[b] Percent of total observed in composition counts.
[c] Percent of total population classified.
[d] 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), Unit 23, 2000–2001 through 2009–2010.

		Harvest			Hunter Residency				
Year	# Permits TX107(FX120)	# 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)
2008–2009	6	5	0	5	0	0	1	5	
2009–2010	6	4	0	4	0	0	0	6	

[a] Season closed by emergency order; quota taken illegally.

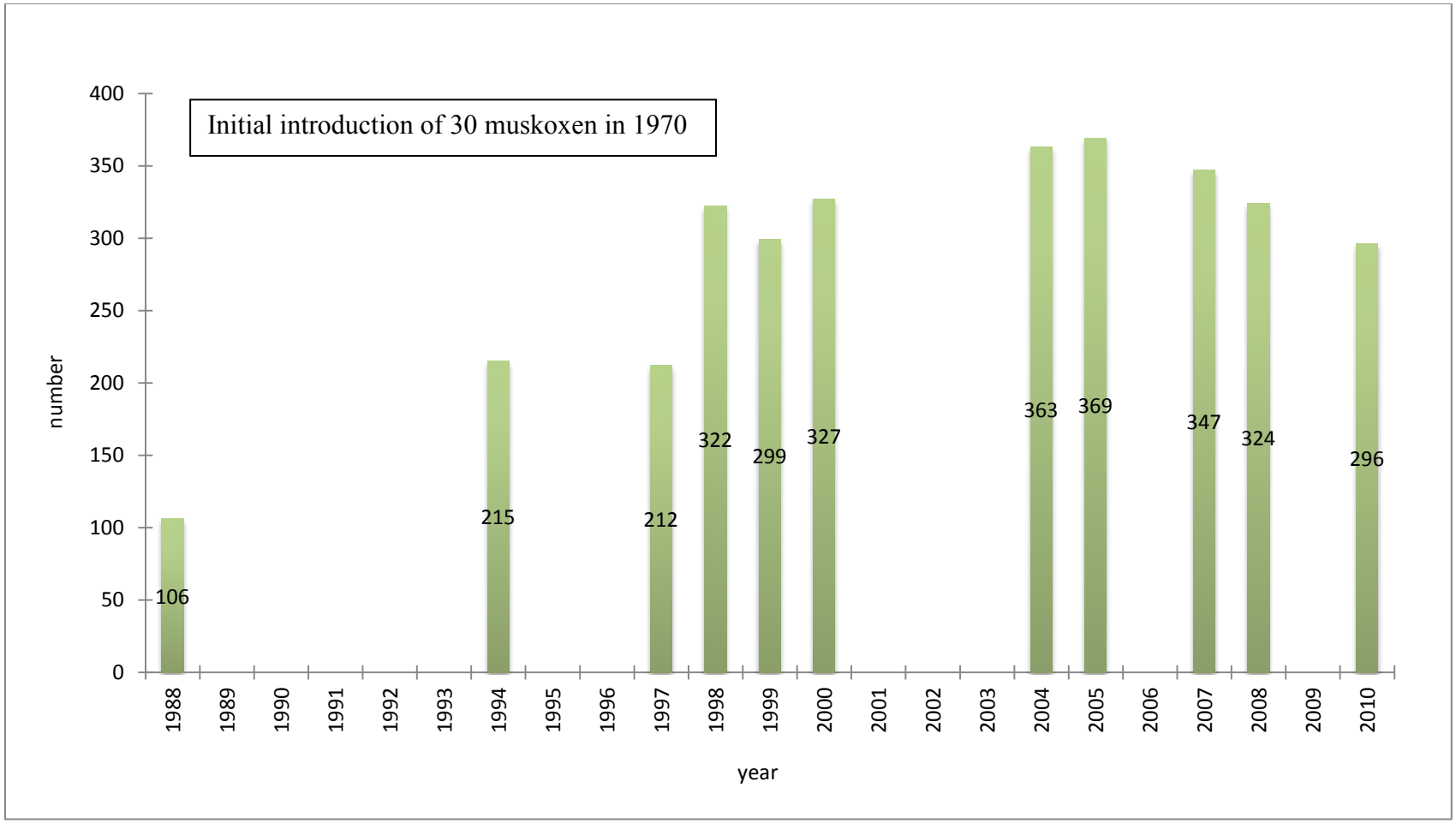

Figure 1. Muskoxen census results in the northwestern portion of Unit 23, 1970–2010.

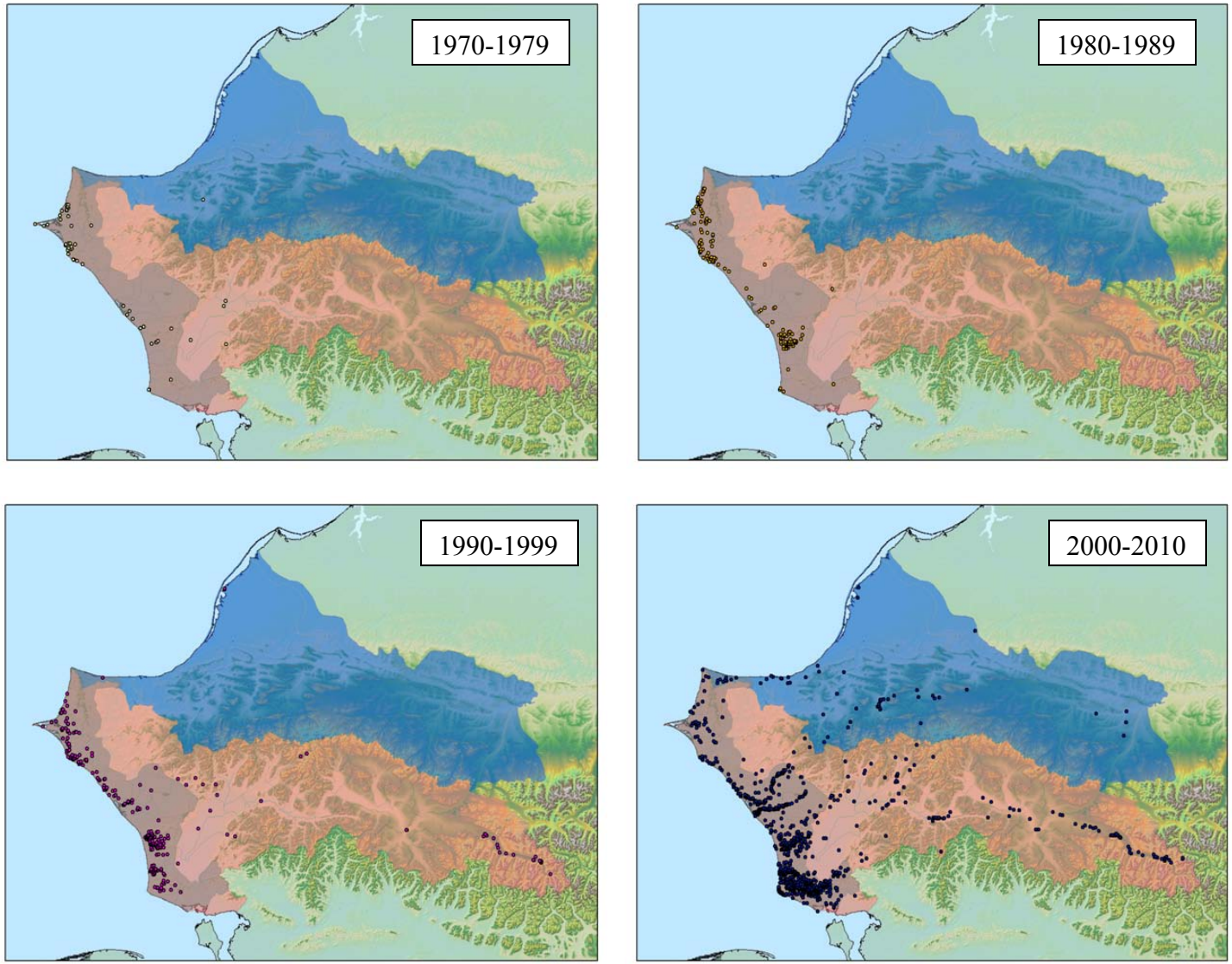

Figure 2. Locations of muskoxen observations (including incidental; census and composition efforts occurred in the traditional sample area only) by decade, 1970–2010. (Unit 26A is shown in blue, Unit 23 in pink, gray areas show the traditional sample area.)

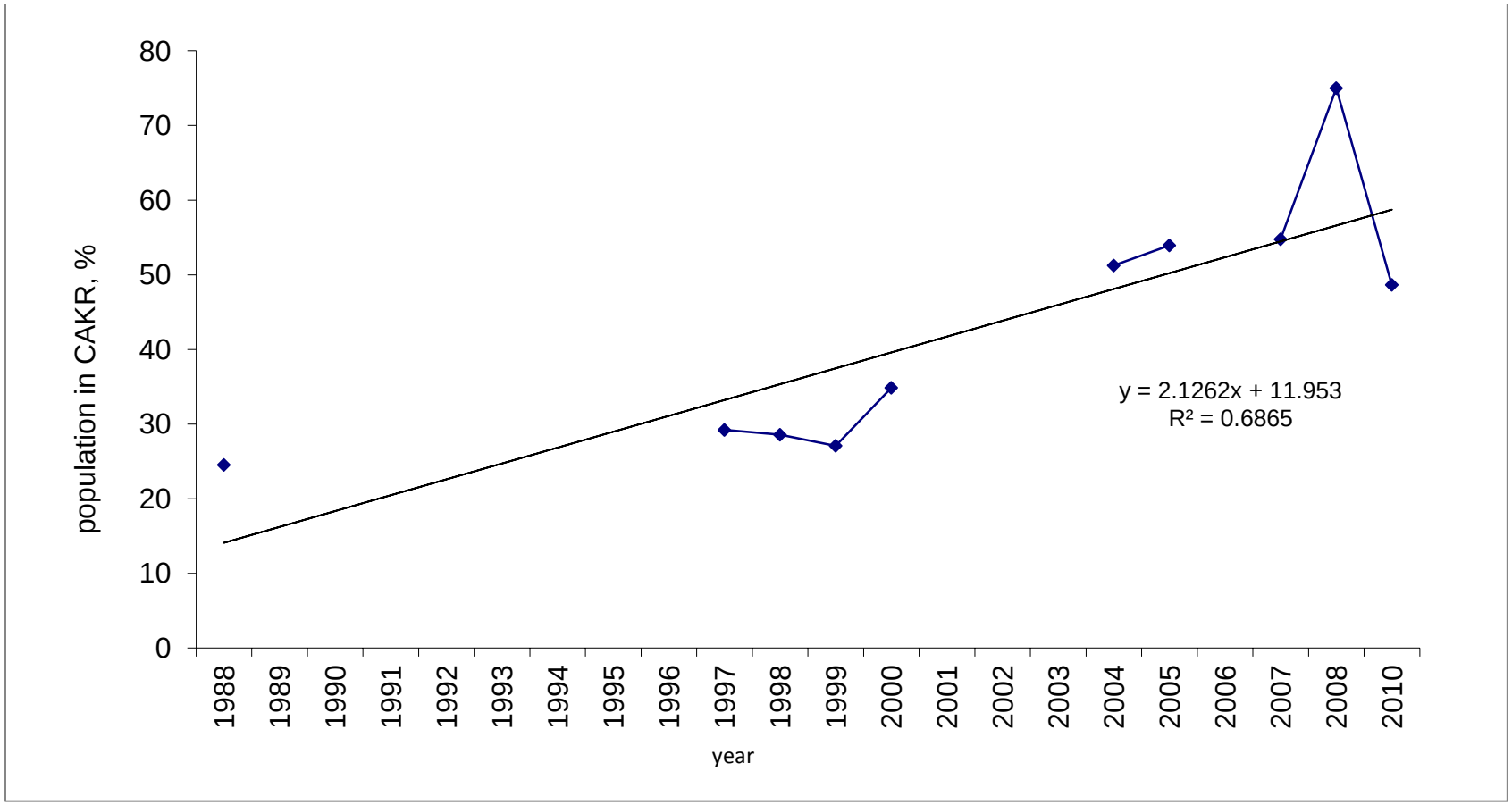

Figure. 3. Trend in percentage of muskoxen observed within Cape Krusenstern National Monument (CAKR) during population surveys, 1988–2010.

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MUSKOX MANAGEMENT REPORT

From: 1 July 2008
To: 30 June 2010[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. During 2004–2008, the number of muskoxen observed in Unit 26C ranged 1–44 (Reynolds 2008). Muskox numbers in Unit 26B appeared stable to slightly increasing from the mid 1990s through 2003 to approximately 302 muskoxen. The population declined to 216 by 2006, and during 2007–2010, the population in Unit 26B stabilized at a reduced population size of approximately 200 muskoxen.

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

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

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 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 harvested small numbers of muskoxen annually in Units 26C and 26B when the seasons were open. 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.

Current management objectives are listed below. These objectives were revised beginning 1 July 2006, while awaiting results of ongoing research on Unit 26B muskoxen. The research objectives 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 April to determine herd composition annually.
- Maintain 15–20 radio collars 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 Piper 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, 2006, 2007, 2008).

In Unit 26B, east of the Dalton Highway (eastern Unit 26B), 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 (western Unit 26B), 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 eastern Unit 26B. No surveys were conducted in 2001. In 2002, 2004, and 2005, we surveyed only major drainages and smaller adjacent tributaries and bluffs in all of Unit 26B, and located groups by radiotracking.

In April 2006 we conducted a systematic 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).

During 2007–2010, no systematic surveys were conducted; however, research staff estimated a minimum April population size by counting muskox observed during frequent radiotracking flights to locate all known groups of muskoxen (S. M. Arthur, ADF&G files, Fairbanks). Although these methods differed from previous population estimates derived from systematic surveys, these estimates are comparable to estimates derived from surveys accomplished in years when systematic surveys were not conducted and provide information on population trend.

In April 2011 we conducted a systematic survey of the eastern North Slope, similar to the 2006 effort; except the mountains were not searched. Details of the methods and miles flown will be reported during the next report period.

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 western Unit 26B (west of the Dalton Highway) including eastern Unit 26A, and eastern Unit 26B (east of the Dalton Highway). However, by 2004 this distinction was no longer useful, mainly because a large proportion of the population (>50%) resided along the dividing line because muskoxen redistributed and the population size was smaller.

Population Composition

To determine herd composition, we conducted ground-based composition surveys in Units 26B and 26C in late June or early July during 1990–2008. In 2007 and 2008, we also conducted composition surveys in April because muskoxen groups were more difficult to locate in June. In 2009 and 2010, composition surveys were conducted in April only. We 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, and as male or female. Calves were also classified in June composition counts. 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 1997–2010, 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 radio collars 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. A total of 21 radiocollars were deployed on muskoxen in 2007. 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 15 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 muskoxen were radiocollared in June using methods described by Lenart (1999). No radio collars were deployed on muskoxen in 2008 or 2009. We captured and radiocollared 4 adult female muskoxen in July 2010 using methods described by Lenart (1999).

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) western Unit 26B (west of the Dalton Highway), and 5) eastern Unit 26B (east of the Dalton Highway). Since 1998, western Unit 26B 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, eastern Unit 26B 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. During 2007–2010, the population in Unit 26B appeared to stabilize at a reduced population size of approximately 200 muskoxen. Minimum numbers of muskoxen observed by ADF&G staff in Unit 26B and eastern Unit 26A during April 2007–2010 were 196, 192, 196, and 184, respectively (S. M. Arthur, ADF&G files, Fairbanks). During these years, a small group was often found on the Canning River, on the boundary between Unit 26B and 26C, and this group was included in the Unit 26B totals.

Preliminary analysis of data collected during April 2011 indicated a minimum (precalving) population of 190 muskoxen (including 32 yearlings) in Unit 26B and eastern Unit 26A as of 1 April. This included 179 muskoxen in 16 groups seen along transects during the systematic

survey plus 3 bulls and a mixed-sex group of 8 muskoxen observed in the course of other work during the same period. Two of the bulls were killed by grizzly bears during April but are included in the population estimate because they were alive on 1 April. In late March 2011, just prior to the survey, 3 muskoxen were illegally shot and another from the same group died of heart failure (presumably due to the stress of the incident).

The numbers observed during 2007–2011 are slightly lower than survey results in 2006 (216 muskoxen). During all surveys, some lone animals or small groups may have been present but not counted, and precision of these estimates is unknown. Thus, the significance of the apparent decline from 2006 (216 muskoxen) through 2011 (190 muskoxen) cannot be determined. However, the population was relatively stable at approximately 200 animals during 2007–2011. Muskoxen are long-lived and some calves are being recruited into the population (See Population Composition section below), yet this population is not increasing. Thus, it is likely that mortality closely tracked or exceeded recruitment during 2003–2011.

Observed causes of mortality included predation by brown bears, disease, drowning, starvation, 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**.** In 2009 and 2010, 12 and 13 muskoxen were observed on the Canning River. As noted previously, during 2007–2010 this Canning River group crossed back and forth between Unit 26B and Unit 26C and these animals were included in the Unit 26B totals. 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 resulting in 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 and eastern Unit 26A combined with 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, 217 in 2006, and 190 in 2011 (Table 1).

Eastern North Slope including northwestern Canada**.** We estimate the total muskox population (eastern Unit 26A combined with Units 26B and 26C and northwestern Canada) at 300–350 animals. This suggests that the population has declined substantially since the mid 1990s, when the population was estimated at 700–800 muskoxen (Lenart 1999). The population likely remained stable at these reduced numbers during 2007–2011.

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 2000–2005, indicating good productivity (Table 1). In Unit 26B, the ratio of calves:100 females >2 years old ranged 37–65:100 during 2000–2005. In 2006 and 2007, the calf:cow ratio in June was notably lower, 25:100 and 20:100 compared to the previous 5 years. In 2008, this ratio was 42:100. After 2008, composition counts were not conducted in June; however, research staff collected data and information on productivity in 2009 and 2010 (see below).

The ratio of yearlings:100 females >2 years old was variable during 2000–2005 (range: 15–39; Table 1). Low recruitment observed in 2004 suggests that the population may have begun declining at that time; the decline was confirmed by the 2006 survey. In 2006, recruitment was good and the ratio of yearlings:100 females >2 years old was 41:100. During the June composition counts in 2007 and 2008, the ratio was 33:100 and 14:100, respectively. The ratio of yearlings observed in 2007 was similar to previous years; although we expected it to be lower because the 2006 calf cohort was small. The low yearling ratio in 2008 is correlated to the low the number of calves observed in 2007. Only 11 calves were observed in early June 2007, indicating that 2007 produced a small cohort and subsequently poor yearling recruitment.

Composition surveys conducted during April yielded different results for yearling recruitment compared with June composition surveys conducted in the same year. For example, the April 2007 ratio of yearlings:100 females >2 years old indicated poor recruitment (16:100) while the June survey indicated good recruitment (33:100) even though 2006 calf production was low (14 calves observed). These differences may have been because muskoxen are more dispersed during June; thus, it is more likely that some muskoxen were not observed at this time, which could distort the ratio. Because the April counts are probably more accurate, we discontinued June composition surveys in 2009. In general, we determined that recruitment was low in 2007 and 2008 because calf production was low in previous years. By 2009, yearling recruitment increased and ranged 37–39 yearlings:100 females >2 years old during 2009–2011. Although, yearling recruitment was good during 2009–2011, adult mortality remained high and may have slightly exceeded recruitment.

Ratios of bulls >3 years old:100 cows >2 years old 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 were likely affected by differences in search effort among years. Bulls are generally in smaller groups in spring and are therefore more difficult to locate; especially during the June surveys. However, bull:cow ratios in the April composition surveys were also variable (Table 1).

Calf Production, Early Recruitment and Timing of Calving — During 2007–2010, ADF&G research staff collected data on number of calves and adults (>1 year old) observed during mid April through October. Births per adult cow ≥3 years old ranged 45%–82% and calf survival through October ranged 37%–80%. Calves were born as early as 18 April and as late as 27 June. (Arthur and Del Vecchio, 2011, in prep). Calf production and early recruitment were notably higher in the years following 2007. There was no evidence that nutrition was limiting because birth rates were relatively high most years and most summer mortality was due to predation (S.A. Arthur, ADF&G, personal. communication, 2011).

Unit 26C. In Unit 26C the ratio of calves:100 females >2 years old was low (<14:100) during 1999–2001. Yearling recruitment also was low (range: 0–17:100 females >2 years old; Table 1). No data were available for 2002–2010 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 2002–2010.

Distribution and Movements

Muskoxen tend to form larger groups of 6–60 during winter and remain in one location for most or all of the winter. During summer they form smaller groups of 5–20 and move more frequently.

During 2006–2010, 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, but these areas were not occupied during this reporting period.

Considerable shifts in distribution have occurred since 2003, and some groups that were known to winter in specific areas wintered elsewhere (Lenart 2007; Reynolds 2007). Long range movements (≥50 miles) of groups and individual radiocollared animals have also been noted (Lenart 1999, 2003, 2005, 2007).

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 and a lone bull on the Chandalar shelf in the winter of 2010–2011. A mixed group of 15 muskoxen was reported on the Coleen River in 2005 (H. Korth, local resident, personal communication, 2005). 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, 2006). 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.

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, these animals likely originated from the Seward Peninsula.

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 western Unit 26B and eastern 26A 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 in RY06. Seasons and bag limits for the Tier I (RX110) and the drawing (DX112) hunts in eastern Unit 26B 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 in RY08. All hunts 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
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 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 Dalton Highway Corridor Management Area 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, 2008, and 2010 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 permits are 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 was 3–20 since RY90 when both units were opened to hunting and was <5% of the estimated total population observed during precalving surveys (Lenart 2003; Tables 1 and 2). In eastern Unit 26A and all of Unit 26B, reported harvest was 0–14 during RY90–RY05 for the Tier I, II, and drawing hunts combined and was <5% of the Unit 26B segment of the population (Lenart 2003; Tables 1 and 2). No permits have been issued for hunts (Tier I and drawing) in eastern Unit 26B since RY05 and no permits have been issued for the Tier II hunt in eastern Unit 26A and western Unit 26B since RY06. In March 2011, 3 muskoxen were harvested illegally near Nuiqsut, Alaska.

Annual reported harvest in Unit 26C ranged 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 data for these hunts are in Table 4. Success rates in Unit 26B were high for all years (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 who used drawing permit primarily used highway vehicles and hunters with Tier II permits primarily used boats (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 hunting season was closed.

Natural and Other Mortality

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. Multiple mortalities of muskoxen suspected to be caused by predation in Unit 26B have been reported since 2000 (Reynolds et al. 2002). During 2007–2010, ADF&G research staff documented both calves and adult muskoxen killed by brown bears during April–June, and hypothesized that bear predation on muskoxen was a primary cause of muskoxen mortality during those years (Arthur 2007, 2008, Arthur and Del Vecchio 2009).

Late winter storms contribute to mortality of calves, yearlings, and adults, but these losses are generally low. However, during breakup in May 2004, the Colville River flooded and killed at least 13 muskoxen in 2 groups (6 adults, 2 yearlings, and 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 rates for radiocollared females ranged 0–50% during 1999–2010 (Table 6). No notable trends were detected; but sample sizes were small (range: 9–28; 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 files, personal communication, 2009). 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 files, personal communication, 2009). 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 in many muskoxen were low and may have been 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. Thus, social behavior rather than nutritional limitation may have been responsible for the apparent increased emigration from Unit 26C in the late 1980s and early 1990s. However, little is known about many factors that influence forage quality for muskoxen, particularly with respect to trace nutrients, such as copper and other minerals. Reynolds (2002) speculated that changes in forage quality and quantity on winter ranges in Unit 26C may have affected reproduction and survival. These changes may have been related to annual variability in weather, snow depth, length of snow season, and icing conditions (Reynolds 2002).

CONCLUSIONS AND RECOMMENDATIONS

The overall population size in Units 26B and 26C declined considerably beginning in 2001, but the population dynamics differed between the 2 units. Abundance of calves, yearlings, and adults declined in Unit 26C beginning in 1999. Reynolds (2002) hypothesized at that time that the major factors influencing the decline in Unit 26C likely included weather (and its effects on female body condition, reproductive success, and winter foraging) and predation by brown bears. 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. The Unit 26B population declined after 2006, but has remained stable at just below 200 muskoxen. Since 2007, ADF&G research staff has documented that brown bear predation on muskoxen is a primary source of mortality for muskoxen in Unit 26B.

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 growth of the herd and during the decline. It is unlikely that this low harvest rate exacerbated the decline; however, most of the harvest was comprised of males (>80%) and it is possible that removal of the large bulls that protect herds may have had some effect on the success of brown bears predating on a group of muskoxen.

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 (RY08–RY09) because the population had declined to fewer than 200 animals. Members of the North Slope Muskox Working Group and the community of Kaktovik supported these decisions.

We met Goal 2 to minimize detrimental effects that muskoxen may have on caribou and caribou hunting. No such effects were noted during RY08–RY09.

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 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.

We met Goal 4 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 where much of the muskoxen population resided during RY08–RY09. Improvements to the Dalton Highway have increased public use and resulted in increased traffic and greater interest in muskoxen by both hunters and nonhunters.

We did not meet our first objective to maintain a stable population of ≥200 muskoxen in Unit 26B and eastern Unit 26A because the estimated population during 2006–2011 was slightly less than 200 muskoxen; although it appeared stable. In some years, we met our second objective to maintain a bull (≥3 year old):cow (≥2 year old) ratio of ≥35:100; however it was variable and ranged 25–52 during 2009–2011.

For the next reporting period, the objectives will be revised to the following:

MANAGEMENT OBJECTIVES AND ACTIVITIES

1. Increase the eastern 26A, Unit 26B, and Unit 26C contiguous muskoxen population to 300 muskoxen by reducing brown bear predation on muskoxen in Unit 26B.
   - In April and May 2012 and 2013, department staff will implement a program to selectively and lethally remove brown bears in Unit 26B that are known to prey on muskoxen or are observed on muskox kill sites, pursuing muskoxen, or stalking muskoxen.
   - Conduct precalving surveys in early April to determine population size.
   - Conduct ground-based composition counts in April to determine herd composition.
   - Maintain 15–20 radio collars on adult female muskoxen to assist in locating groups of muskoxen during precalving surveys and composition counts.
   - Test for the presence of potentially population-regulating diseases including *Chlamydia*, contagious ecthyma, trace mineral deficiencies, lungworm, and stomach worm.

2. When the population is at least 300 muskoxen, and is considered growing, maintain a harvest rate of 1–3% per year of the spring precalving population in eastern Unit 26A and Unit 26B while the population in Units eastern 26A, 26B, and 26C is less than 650 muskoxen.
   - Administer permit hunts and monitor results of the hunts

- Allow the population to grow to its historical high of 650 muskoxen distributed contiguously across eastern 26A, Unit 26B, and Unit 26C.

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TABLE 1 Units 26B (and eastern 26A) and 26C muskox precalving survey estimates and composition counts, 1990–2010[a]

Location[d]/ Year	Precalving Population Estimate[b] Muskoxen observed	June and April Composition[c] Date	Muskoxen classified (excluding calves)	Bulls >3 yr: 100 cows>2 yr (no. bulls >3 yr)	Calves: 100 cows>2 yr (no. cows >2 yr)	Yearling: 100 cows>2 yr (no. yearling)	No. Calves
Unit 26B, eastern Unit 26A							
1990	122		83 (69)	41 (14)	41 (34)	32 (11)	14
1991	156		98 (75)	69 (24)	66 (35)	26 (9)	23
1992	224		193 (162)	43 (33)	40 (77)	40 (31)	31
1993	237		131 (103)	41 (21)	55 (51)	20 (10)	28
1994	166		91 (76)	46 (13)	54 (28)	68 (19)	15
1995	330		145 (123)	55 (29)	42 (53)	36 (15)	22
1996	266		44 (41)	35 (8)	13 (23)	22 (5)	3
1997	279	Jun 30	123 (107)	49 (23)	34 (47)	51 (24)	16
1998	207	Jun 26–27	97 (78)	24 (10)	45 (42)	24 (10)	19
1999	237	Jun 22–23	194 (162)	62 (44)	45 (71)	32 (23)	32
2000	277	Jun 7	172 (131)	31[e] (21)	60 (68)	25 (17)	41
2001	–	Jun 10–11	286 (239)	64[e] (63)	47 (99)	39 (39)	47
2002	284	Jun 8–9	241 (203)	27[e] (28)	37 103)	23 (24)	38
2003	302	Jun 26–28	162 (134)	87[e] (46)	53 (53)	15 (8)	28
2004	198	Jun 7–8	153 (123)	44 (29)	45 (66)	17 (11)	30
2005	186	Jun 5–7	119 (89)	39 (18)	65 (46)	28 (13)	30
2006	216	Jun 4–5	133 (119)	29 (16)	25 (56)	41 (23)	14
2007	196	Apr 13	153	41 (30)	na	16 (12)	na
					(73)		
2007		Jun 4–6	131 (120)	35 (19)	20 (54)	33 (18)	11
2008	192	Apr 21	165	28 (22)	na (79)	18 (14)	n/a
2008		Jun 19–20	200 (163)	40 (35)	42 (88)	14 (12)	37
2009	196	Apr 14–15	174 (n/a)	52 (43)	n/a (82)	39 (32)	n/a
2010	187	Apr 15–16	187 (n/a)	25 (22)	n/a (88)	35 (31)	n/a
2011	190	Apr 1–20	171 (n/a)	32 (25)	n/a (78)	37 (29)	n/a
Unit 26C							
1990	332		286 (242)	42 (42)	44 101)	46 (46)	44
1991	282		377 (305)	36 (52)	50 144)	31 (45)	72
1992	283		324 (273)	56 (64)	45 114)	45 (51)	51
1993	326		404 (323)	43 (62)	57 143)	36 (51)	81
1994	318		341 (285)	53 (63)	47 120)	42 (51)	56
1995	321		240 (215)	58 (51)	28 (88)	36 (32)	25
1996	332		195 (157)	41 (31)	51 (75)	23 (17)	38
1997	324		362 (324)	48 (70)	26 146)	32 (46)	38
1998	331		211 (186)	42 (38)	28 (90)	22 (20)	25

Location[d]/ Year	Precalving Population Estimate[b] Muskoxen observed	June and April Composition[c] Date	Muskoxen classified (excluding calves)	Bulls >3 yr: 100 cows>2 yr (no. bulls >3 yr)	Calves: 100 cows>2 yr (no. cows >2 yr)	Yearling: 100 cows>2 yr (no. yearling)	No. Calves
1999	254		272 (257)	60 (76)	14 127)	16 (21)	15
2000	246		184 (183)	40 (39)	1 (97)	17 (17)	1
2001	168		47 (46)	48 (13)	<1 (27)	0 (0)	1
2002	35		71 (64)				7
2003	29						
2004	30						
2005	9						
2006	1						
2007[f]	0						
2008[f]	37						
2009–2011[f]	0						

[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 April and are based on total muskoxen observed during systematic surveys or radiotracking flights.

[c] Composition classification was conducted during the second week of June through early July during 1990-2008 and during mid April 2007–2011.

[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] During 2000–2004 some or all 3-year-old bulls were included in the "Bulls >3 yr" category for Unit 26B, In 2001, all 3 year old bulls were included.

[f] During 2007–2011, a group of muskoxen resided on the Unit 26B and 26C boundary on the Canning River. These muskoxen were included in the Unit 26B population estimate and are not reported in Unit 26C.

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 equal permits issued in federal hunts because unused permits were 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 10 were issued due to a mistake in scoring. This was not considered a biological problem.

TABLE 3 Unit 26B East muskox hunter residency and success, regulatory years 1998–1999 through 2004–2005

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
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

[a] RX110 = Tier I registration hunt in Unit 26B, east of the Dalton Highway Corridor Management Area; DX112 = drawing hunt in Unit 26B, east of the Dalton Highway.
[b] Local resident is a resident of Unit 26.

TABLE 4 Units 26B and 26C muskox hunter residency and success, regulatory years 1990–1991 through 2005–2006

Regulatory year[a]	Successful				Unsuccessful hunters[c]	Total hunters[d]
	Local resident[b]	Nonlocal resident	Nonresident	Total		
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

[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.

TABLE 5 Units 26B and 26C muskox harvest by transport method, regulatory years 1990–1991 through 2005–2006

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

TABLE 6 Mortality rate for radiocollared female muskox, 1 June through 30 May 1999–2010[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[b]	22	5	23
2007–2008[c]	28	7	25
2008–2009	20	2	10
2009–2010	18	3	17
2010–2011[d]	21	2	10

[a] The number of radiocollared muskoxen is the number of active radiocollars 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.
[b] Of the 22 total radio collars for regulatory year 2006–2007, 9 collars were deployed in April 2007, of which 3 were dead by 30 May 2007.
[c] Of the 28 total radio collars for regulatory year 2007–2008, 9 collars were deployed in October 2007.
[d] Of the 21 total radio collars for regulatory year 2010–2011, 2 collares were deployed in March 2011.

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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