

# OPERATIONAL PLAN FOR UNIT 26B MUSKOX RECOVERY

2012–2018

## INTRODUCTION

This operational plan has been prepared by the Alaska Department of Fish and Game (ADF&G) to: 1) provide supporting information for the Unit 26B Muskox Recovery Plan in 5 AAC 92.126 which authorizes a muskoxen recovery program in Unit 26B during 2012–2018, and 2) provide guidance to staff whose job it will be to implement the recovery program. Based on the biological and management information for this area, this operational plan describes rationale for evidence of limiting factors; choice of indices for evaluating treatment response; and decision frameworks for predation control and prey harvest strategies.

## AREA

Unit 26(B) muskoxen recovery area consists of all lands within Unit 26(B); except bear control will not be conducted on any National Park Service or National Wildlife Refuge lands unless approved by these federal agencies (Fig. 1).

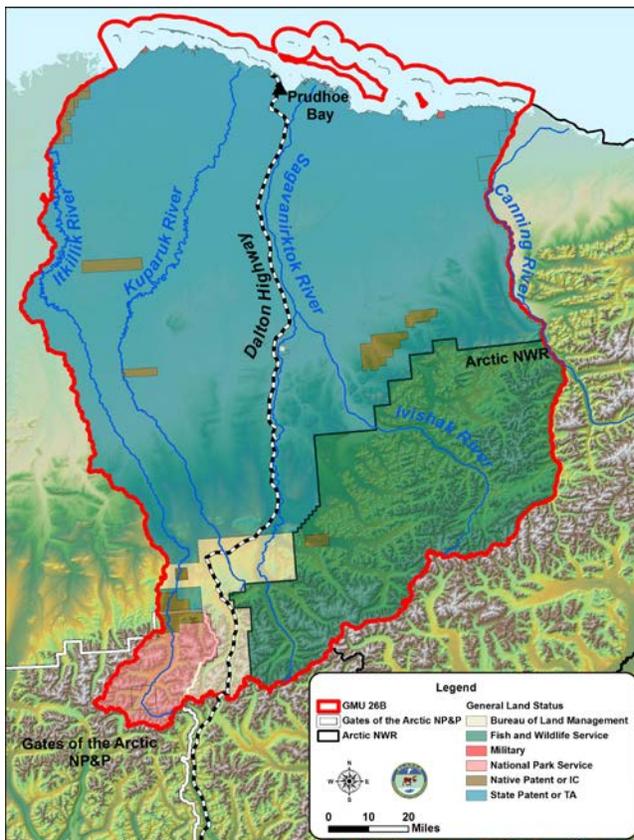


FIGURE 1. Unit 26B muskoxen recovery area.

## BACKGROUND

### MUSKOXEN POPULATION SIZE

ADF&G reintroduced muskoxen from Nunivak Island to the eastern North Slope when 51 animals were released in 1969 on Barter Island and 13 were released in 1970 at Kavik River. The number of muskoxen increased steadily during the 1970s and 1980s in Unit 26C, 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 believed to be stable during the mid-1990s at around 600 muskoxen in Units 26B and 26C with an additional 100 animals in Yukon, Canada (Fig. 2). Beginning in 1999, numbers of calves, yearlings, and adults declined substantially in Unit 26C. During 2004–2008, the number of muskoxen observed in Unit 26C was 1–44 (Reynolds 2008). Muskox numbers in Unit 26B remained stable to slightly increasing from the mid 1990s through 2003 when they reached 302 individuals. The population declined to 216 by 2006, and during 2007–2010, it stabilized at a reduced size of just below 200 muskoxen. ADF&G was concerned about the decline in Unit 26B during 2003–2006. Furthermore, we recognized that the Unit 26C population essentially disappeared in a relatively short time period and not all of the decline could be attributed to emigration. Therefore, beginning in 2007, ADF&G initiated a research project to 1) estimate annual birth rates for muskox cows, 2) estimate annual calf recruitment through late June, and 3) determine rates and causes of mortality of muskox. Since 2007, research staff has documented that brown bear predation on muskoxen is the primary source of mortality for muskoxen in Unit 26B.

### MUSKOXEN HUNTING AND HARVEST HISTORY

Hunting for muskoxen in the eastern North Slope in Alaska has only been allowed by permit. 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). Beginning in 1992, muskoxen hunting in Unit 26C has been by federal permit. Since 1999, The *North Slope Muskox Harvest Plan* (1999, ADF&G files, Fairbanks) has been the template for managing harvest of muskoxen in Unit 26B. Consistent with that plan, in March 1998, the Board of Game (Board) established an amount necessary for subsistence (ANS) of 20 muskoxen in Unit 26B, west of the Dalton Highway and established a Tier II subsistence permit hunt. The Board also determined an ANS of 4 muskoxen in Unit 26B, east of the Dalton Highway and established a Tier I registration permit hunt for residents only. A resident only drawing permit hunt east of the Dalton Highway was also established and 3 permits were issued annually. The \$25 resident muskox tag fee was waived for subsistence hunters in Units 26B and 26C. Beginning in regulatory year 2003–2004, permits to hunt muskoxen were not issued for federal lands in Unit 26C, except in regulatory year 2008–2009 when 1 permit was issued. In regulatory year 2005–2006, ADF&G did not issue permits for the drawing and Tier I registration hunts east of the Dalton Highway in Unit 26B; however, the Tier II subsistence hunt west of the Dalton Highway remained open. Since regulatory year 2009–2010, no permits to hunt muskoxen have been issued for state and federal lands in eastern Unit 26A, Unit 26B, and Unit 26C.

Harvest rates of muskoxen averaged 2% annually (range: <1–4.5%) of the estimated population during 1990–2005 (Table 2). Ninety-three percent of the reported harvest was male muskoxen. It is unlikely that reported harvest caused the recent population decline.

## CAUSES OF MORTALITY 2007–2011

Results from the research study conducted during 2007–2011 in Unit 26B indicated 67% of the documented adult cow mortality ( $n = 45$ ) was caused by brown bear predation (Table 1; Arthur, 2007, 2008, 2009, in prep). This represented an average of 6 adult cows annually. Fifty-six percent of the documented adult bull mortality was caused by brown bears ( $n = 16$ ) representing an average of 2 adult bulls annually. Total documented adult muskoxen mortality caused by brown bear predation was 62% ( $n = 73$ ) representing an average of 9 adult muskoxen annually. The remaining documented causes of death for adults included unknown cause (11%), starvation/other non predation (8%), vehicle collision/shot (11%), disease (3%), and drowning (1%). During the same time period, 58% ( $n = 45$ ) of the documented calf mortality was caused by brown bear predation. This resulted in an average of 5 calves annually. The remaining documented causes of death for calves included perinatal (18%), abandoned (11%; often due to a brown bear scattering the group), disease (7%), starvation (2%), vehicle collision (2%), and gored (2%). Over the 5 years, a total 74 calves were classified as “missing”; their fates were unknown and not included in the above calculations.

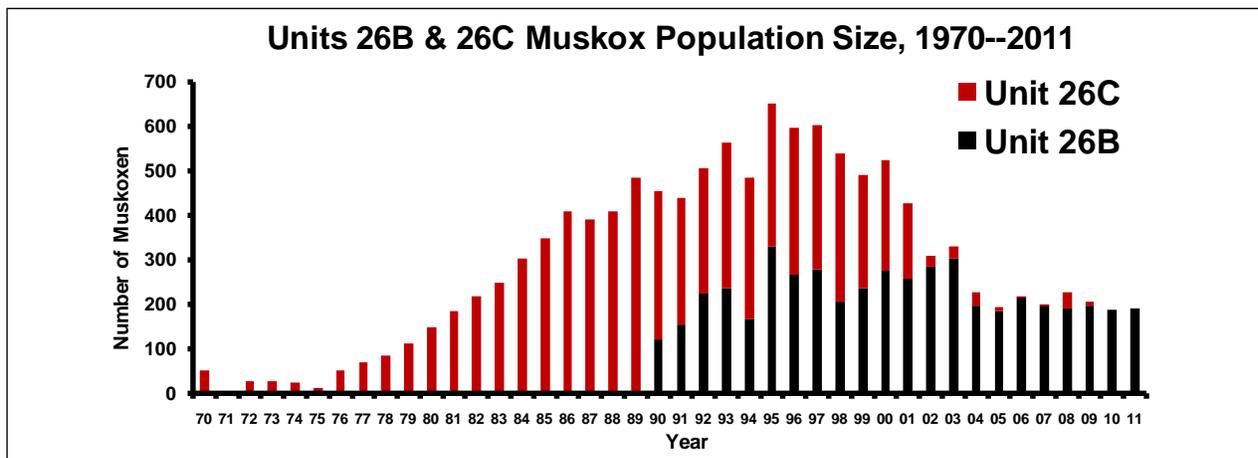


Figure 2. Unit 26B & 26C muskoxen population size, 1970–2011.

Table 1. Causes of muskoxen mortality in Unit 26B, by percent, 2007–2011.

Age/Sex	Bear	Disease	Starvation/ non-pred	Vehicle/ shot	Drown	Perinatal	Abandoned	Gored	Unknown	n
Calf	58	7	2	2	0	18	11	2	na	45
Adult cow	67	0	7	13	9	na	na	na	4	45
Adult Bull	56	13	19	13	0	na	na	na	0	16

Total Adults	62	3	8	11	5	na	na	na	11	73
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Table 2. Units 26B and 26C muskoxen harvest data by unit, regulatory years 1990–1991 through 2005–2006.

Regulatory year	Unit	Bulls	Cows	Unknown	Total harvest	Estimated Population Size	Harvest Rate
1990–1991	26B	2	0	0	2	122	2%
	26C	8	0	0	8	332	2%
1991–1992	26B	0	0	0	0	156	na
	26C	5	0	0	5	282	2%
1992–1993	26B	0	0	0	0	224	na
	26C	10	0	0	10	283	3.5%
1993–1994	26B	1	0	0	1	237	<1%
	26C	8	0	0	8	326	2%
1994–1995	26B	0	0	0	0	166	na
	26C	9	0	0	9	318	3%
1995–1996	26B	3	0	0	3	330	1%
	26C	8	1 <sup>d</sup>	0	9	321	3%
1996–1997	26B	3	0	0	3	266	1%
	26C	12	3 <sup>d</sup>	0	15	332	4.5%
1997–1998	26B	3	0	0	3	279	1%
	26C	9	1 <sup>d</sup>	0	10	324	3%
1998–1999	26B	9	1	0	10	207	5%
	26C	8	0	0	8	331	2%
1999–2000	26B	3	0	0	3	237	1%
	26C	8	0	0	8	254	3%
2000–2001	26B	13	1	0	14	277	5%
	26C	5	1	0	6	246	2%
2001–2002	26B	9	0	0	9	286	3%
	26C	2	0	0	2	168	1%
2002–2003	26B	4	0	5	9	281	3%
	26C	0	0	0	0	35	na
2003–2004	26B	3	0	0	3	302	1%
	26C	0	0	0	0	29	na
2004–2005	26B	7	1	0	8	198	4%
	26C	0	0	0	0	30	na
2005–2006	26B	2	2	0	4	186	2%
	26C	0	0	0	0	9	na

## ADAPTIVE MANAGEMENT FRAMEWORK

### TREATMENTS

#### *Predation control*

The proposal to selectively remove brown bears that are observed threatening or killing muskoxen, thereby reducing predation, is an experimental approach. It is based on the hypotheses that relatively few individual bears, predominately males, commonly kill muskoxen during late winter and spring and that mortality as a result of predation is mostly additive. Brown bear radiotracking data collected during 1991–2011 indicated that several radiocollared adult males were responsible for multiple predation events in early spring, and a few individuals were observed killing muskoxen over multiple years (R. Shideler, ADF&G unpublished data; Reynolds et al. 2002a). In addition, research conducted by ADF&G and Arctic National Wildlife refuge staff indicated that some adult male brown bears that reside near muskoxen herds do not kill muskoxen, especially during periods when caribou are wintering in the area or other natural food is available (Reynolds et al. 2009). This evidence suggests that targeting individual bears may be effective, especially for reducing the incidence of multiple kills in spring, and that most of the documented predation was caused by male bears.

Monitoring Muskoxen. ADF&G will maintain radio collars in as many groups of muskoxen as possible and will intensively monitor them with fixed-wing aircraft and helicopters during early April through June. Monitoring periods will consist of 2–7 day periods of intensive radiotracking of muskoxen groups and will be followed by 2–4 day periods of inactivity. The following procedures will be used during the monitoring period: 1) small fixed-wing aircraft equipped with VHF radiotracking equipment will locate all radiocollared muskoxen groups and search to locate potential groups of muskoxen without radio collars, 2) for each group of muskoxen a GPS location, total count, and composition (adults and calves) will be recorded as well as the presence of brown bears, brown bear tracks, carcasses, and kill sites at or within the vicinity of groups, 3) if a brown bear is detected at or near muskoxen, the Selective Brown Bear Removal Plan (see below) will be implemented.

Selective Brown Bear Removal Plan. Selectively targeting bears and lethally removing them would be more effective at quickly and efficiently minimizing predation on muskoxen than would reducing the bear population through liberalized hunting seasons and bag limits or other means that remove random bears. Removing specific individual brown bears that are known or identified predators of muskoxen as soon as they are detected is necessary to have an immediate effect of reducing predation on muskoxen. ADF&G staff anticipates that fewer than 20 bears may need to be removed annually during the control program.

The preferred option for conducting selective brown bear removal is by shooting from a helicopter. In the event that a helicopter is not available, brown bears may be removed by landing in fixed-wing aircraft and shooting from the ground. All of brown bears identified as threatening or killing muskoxen will be removed, regardless of sex or age.

The following procedures will be used to lethally remove brown bears: 1) shooting from a large caliber rifle or shotgun slug from a helicopter in accordance with Animal Care and Use Committee (ACUC)

protocol and 2) shooting with a large caliber rifle from the ground after landing with fixed-wing aircraft or helicopter in accordance with ACUC protocol.

#### *Habitat enhancement*

No habitat enhancement is being considered because the habitat appears capable of supporting a larger muskoxen population. Adult female productivity and body condition was used as an index of habitat quality. Data collected during 2007–2011 indicating captured muskoxen were generally in good condition, and birth rates were sufficient to provide for population growth, if survival had been higher. The minimum estimated birth rate averaged 63 calves per 100 mature cows ( $n= 52$  calves,  $n= 82$  mature cows). It was based on the number of 3 year old or greater cows observed during the April composition surveys and the number of calves observed between April and the end of June. Some calves may not have been observed; thus, this is a minimum estimated birth rate.

However, it is possible that habitat limitations may have been obscured by high mortality due to predation. An imbalance of trace minerals (particularly low copper and selenium with elevated concentrations of zinc and iron) was detected in some muskoxen tissues. This imbalance can negatively affect immune systems and make muskoxen more susceptible to diseases and potentially more vulnerable to predation. However, we have not observed any indication of a negative effect on the population. Also, some diseases and parasites were detected, but mortality attributed to this cause was only 3% of adults found dead. Deep snow and icing events may also result in lower survival and less successful reproduction of muskoxen (Reynolds et al 2002a; 2002b).

#### *Prey harvest*

Hunting seasons for Unit 26B muskoxen will remain closed during brown bear removal. Hunting will not resume until the population has reached at least 300 animals  $\geq 1$  year old during April surveys, and other criteria for establishing a harvestable surplus have been met. Most likely hunting will initially occur under a Tier II permit system.

### **ANTICIPATED RESPONSES TO TREATMENTS**

#### *Predator abundance*

The objective of this treatment is to selectively remove individual bears, not substantially reduce the brown bear population size. The brown bear population objective for Unit 26(B) is to maintain the current estimated population of 200–320 (midpoint 265 bears, based on 2003 estimate) while annually removing up to 20 brown bears identified as threatening or killing muskoxen. Limiting the number of bears removed will assure that human-caused mortality of brown bears are managed within sustained yield principles and will assure long-term brown bear hunting and viewing opportunities in the treatment area.

The removal objective for brown bears in Unit 26B is to maintain a 3-year mean annual human-caused mortality of  $\leq 8\%$  of bears  $\geq 2$  years old, with no more than 40% females (21 bears; 8 females). This

includes human-caused mortality from all sources. To achieve this objective, the hunting season may be adjusted or closed by emergency order.

#### *Predation Rate*

The rate of predation is expected to be reduced following removal of brown bears.

#### *Prey Abundance*

Results from aerial surveys and radiotracking indicate that the number of yearling muskoxen being recruited annually approximately equaled the number of adult muskoxen >1 year old dying annually. If survival rates of either adults, yearlings, or calves increase, the muskoxen population is expected to increase. Estimating population growth rate as a result of the selective removal treatment is difficult. However, during 1987–1995, the annual rate of increase for the population was 7%. This growth rate may reasonably represent the population growth potential if bear predation is reduced and habitat is not limiting. Under this scenario, it would take approximately 7 years for the muskoxen population to increase from 190  $\geq$  1 year old (the 2011 estimated population size) to 300  $\geq$  1 year old. If the muskoxen population reaches 300, a hunt could be established for the harvestable surplus.

#### *Prey Recruitment*

Following predator control treatments, an increase in adult, yearling, and calf survival will be reflected in the total number of muskoxen counted annually in April. Because annual survival of adults is more stable than calves, a change in population size would most likely be the result of increased or decreased calf survival and yearling recruitment. Composition surveys conducted annually in April will be used as an index of yearling recruitment.

#### *Prey Productivity or Nutritional Condition*

During 2007–2011, muskoxen in Unit 26B were producing calves at a rate comparable to other muskoxen populations that were considered to be increasing (Reynolds et al. 2002b, Larter and Nagy 1999), therefore, poor nutrition was not considered to be a primary limiting factor. During 2007–2011, an estimated minimum birth rate was determined based on the number of 3-year-old or older females observed during the April composition surveys and the minimum number of calves observed during calving between April and the end of June. The birth rate averaged 63 calves per 100 mature cows ( $n= 52$  calves,  $n= 82$  mature cows). (Table 4 this document; Arthur, 2007, 2008, 2009, in prep).

#### *Harvest*

The harvest objective is 3–9 muskoxen annually, once the population reaches 300 muskoxen  $\geq$ 1 year old and a harvestable surplus is available.

### *Use of Nontreatment Comparisons*

There will be no nontreatment comparisons of muskox predation by bears outside the treated area. A single group of muskoxen occupies eastern Unit 26A and sometimes joins the groups in Unit 26B, and a few animals move between Alaska and Yukon in eastern Unit 26C. The closest non-treatment group in Alaska is on the Seward Peninsula (Unit 22).

Table 3. Yearling:100 cows>2 years old ratio for muskoxen in Unit 26B during April 2007–2011.

Location Year	Date	Muskoxen classified (no. cows >2 yr)	Yearling: 100 cows>2 yr (no. yearling)
2007	Apr 13	153 (73)	16 (12)
2008	Apr 21	165 (79)	18 (14)
2009	Apr 14–15	174 (82)	39 (32)
2010	Apr 15–16	187 (88)	35 (31)
2011	Apr 14–15	171 (84)	37 (33)

Table 4. Minimum estimated birth rates, 2007-2011.

Year	No. Cows	No. calves	Calves:100 cows
2007	77	35	45
2008	80	64	82
2009	82	56	72
2010	88	50	59
2011	84	55	67

### **EVALUATION CRITERIA AND STUDY DESIGN TO DOCUMENT TREATMENT RESPONSE**

Adaptive management with the intent to increase harvestable surplus of prey requires evaluating the biological response and achievable harvest after treatments are implemented. Evaluation will be reported to the Board on 1 February each year with an interim update of selected criteria on 1 August each year.

#### *Predator Abundance and Potential for Recovery*

Brown bears removed as part of the selective removal program are not expected to reduce the size of estimated population (200–320, midpoint 265 bears, based on 2003 estimate) in Unit 26B. The total removal rates will not exceed 8% of the population (21 brown bears) and are sustainable. Localized areas around muskoxen groups may experience decreased abundance due to selective removal. In these areas, recovery may occur quickly as a result of immigration.

#### *Habitat*

No habitat surveys will be conducted.

### *Prey Abundance, Herd Composition, and Nutritional Condition*

The population will be estimated annually by radiotracking and searching for groups of muskoxen during the first 2 weeks of April. Composition surveys will be conducted during mid-April and muskoxen will be classified as newborn calves, yearlings, 2 year old bulls and cows, 3 year old bulls and cows, and adult bulls and cows. The ratio of yearlings per 100 cows >2 years old will be determined to estimate yearling recruitment. The number of adult bulls and cows will be monitored to aid in determining adult mortality.

### *Prey Harvest*

No harvest will occur until the population has grown to 300 muskoxen  $\geq 1$  year old and the population growth rate is sufficient to indicate that it can support a harvest.

## **DECISION FRAMEWORK TO IMPLEMENT OR SUSPEND A TREATMENT**

### *Predation Control*

Predator control will be implemented on 15 March 2012. The program will be reviewed and modified or suspended if there is no evidence of improved survival or a detectable increase in the Unit 26B muskoxen population following 3 years of bear removal.

### *Habitat Enhancement*

No habitat enhancement will be conducted.

### *Prey Harvest Strategy*

Muskoxen will be harvested when the population reaches at least 300 muskoxen  $\geq 1$  year old and a harvestable surplus is established. If the Board retains the same hunting regulations that were in effect when permits were last issued, hunting would likely be initiated as a Tier II hunt

## **PUBLIC INVOLVEMENT**

Public involvement will include:

1. Outreach via fish and game advisory committee and Board of Game processes.
2. Continued engagement with the public to review and confirm criteria chosen for evaluating success.
3. Participation in prey and predator harvest through standard hunting seasons and bag limits.
4. Monitoring and mitigation of hunter concerns that may occur because ADF&G removes all of the brown bear harvestable surplus as part of the recovery program and the bear hunting season is shortened or closed.

## **OTHER CONSIDERATIONS**

### *Liberalized Brown Bear Seasons*

The Board liberalized brown bear seasons in Unit 26B in regulatory years 2010 and 2011 as a management action to reduce predation. Although seasons were liberalized, hunters were still restricted within the Dalton Highway Management Corridor (DHMC, extending 5 miles either side of the Dalton Highway) to using a bow and arrow only and to no use of a motorized vehicles except boats. These regulations remained in place as required by statutes AS 16.05.789 and AS 19.40. Most of the current population of muskoxen in Unit 26B occurs within the DHCMA and the Prudhoe Bay Closed Area. In regulatory year 2010–2011, the Board opened the fall hunting season 15 days earlier in August, eliminated the requirement for a drawing permit for residents within the Dalton Highway Management Corridor, and issued all unused nonresident drawing permits on a first-come, first-served basis. A total of 28 bears were harvested in that year (2 were taken illegally by nonresidents). Of the 28 bears, 18 were males, 10 females. Twenty-seven were harvested in the fall 2010 (including 2 illegal), and 1 was taken in late spring 2011. Following the harvest of 27 bears in the fall, department staff documented 10 adult muskoxen and 9 calves that were killed by brown bears in April and May 2011. This indicated that predation continued to occur despite the increased harvest. However, 1 brown bear known to have killed muskoxen was harvested in late May 2011. Beginning March 2011, the Board opened a resident and nonresident registration hunt in a portion of Unit 26B (surrounding muskox groups) with no closed season. The remainder of Unit 26B, where nonresidents were required to have a drawing permit, opened 1 September. The registration hunt was put into effect to focus bear hunters near groups of muskoxen. In fall 2011, 23 bears were harvested (including 1 DLP) in Unit 26B (15 males, 8 females). One was a radiocollared bear known to have killed at least 5 muskoxen. In regulatory years 2008–2009 and 2009–2010, when the season opened 25 August and residents were required to have a drawing permit within the DHMCA, and all nonresidents were required to have a drawing permit, 18 (including 1 illegal) and 23 bears were killed respectively.

Liberalizing the bear season is not the optimal management technique for reducing bear predation on muskoxen because it is nonselective and results in the random removal of bears. Although target bears may be taken by chance, the effects of 2 years of liberalized seasons were inconclusive. In addition, if the bear population was reduced, brown bear hunting opportunity would also be reduced for several years. In fall 2011, 437 hunters obtained a registration permit for the brown bear hunt in Unit 26B. Preliminary data indicated that of the 437 permits issued, 267 hunters returned reports, resulting in 153 who hunted and 114 who did not hunt. These numbers indicate a strong interest in brown bear hunting in Unit 26B. Most of this hunting occurs opportunistically by caribou and sheep hunters who are already in the field. However, hunters did have to make an effort to obtain a registration permit, thereby indicating their interest in the hunt.

### *Relocating Bears*

Relocation of bears is an alternative to lethal removal that would directly target bears identified as threatening or killing muskoxen. Department staff would immobilize bears from a helicopter and relocate

them to prevent them from returning to the area until after the critical time period during 15 April–15 June. Some challenges include 1) maintaining the welfare of bears during transport, 2) logistics of transporting bears, and 3) locating suitable drop-off sites. If bears are relocated a long distance from Unit 26B, it is possible that bears will not return to the area. However, past bear relocation projects conducted by the Department have demonstrated that some relocated bears, predominately adult males, return to the area from which they were removed. Bears that return to the area may need to be removed the following spring if they begin preying on muskoxen. Similar to the lethal removal program, this program would take place during April and May. However, it would incur substantially higher costs than lethal removal.

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**APPENDIX A.** Summary of supporting information.

<b>Geographic area and land status</b>	
Management area(s)	Unit 26B state, private, and BLM lands – see Figure 1
Land status	Most of Unit 26(B) is state land; the landownership pattern is 69% state, 29% federal, and 2% private; of the 29% federal lands, 12% is Bureau of Land Management, and these lands are available for bear control; total land available for bear control is 72–74% of the unit. See Figure 1
<b>Biological and management situation</b>	
Prey population	The management objectives is to increase the Unit 26B muskoxen population to at least 300 muskoxen $\geq 1$ year old by reducing brown bear predation on muskoxen in Unit 26B.
Prey harvest	When the muskox population has reached 300 muskoxen $\geq 1$ year old, establish a harvestable surplus.  In 1989, a positive C&T finding was established and Amounts Reasonably Necessary for Subsistence were established in 1998 and are 4 in Unit 26B, for that portion east of the Dalton Highway and 20 in Unit 26A and Unit 26B for that portion west of the Dalton Highway Corridor Management Area (DHCMA).
Feasibility of access for harvest	During winter and spring, Unit 26B is accessible via snowmachines outside the DHCMA, skis and foot in the DHCMA. During fall, in is accessible by boat, airplane, or foot.
Nutritional condition	During 2007–2011, the habitat appeared capable of supporting a larger muskoxen population; captured muskoxen were generally in good condition, and birth rates were sufficient to provide for population growth, but growth was not realized because of poor survival.  It is possible that habitat limitations may have been obscured by high mortality due to predation. An imbalance of trace minerals (particularly low copper and selenium with elevated concentrations of zinc and iron) was detected in some muskoxen tissues. This imbalance can negatively affect immune systems and make muskoxen more susceptible to diseases and potentially more vulnerable to predation. However, we have not observed any indication of a negative effect on the population. Also, some diseases and parasites were detected, but mortality attributed to this cause was only 3% of adults found dead. Deep snow and icing events may also result in lower survival and less successful reproduction of muskoxen (Reynolds et al

	2002 <i>a</i> ;2002 <i>b</i> ).
Habitat status and enhancement potential	See nutritional condition section above for information on habitat status. No habitat enhancement is planned.
Predator(s) abundance	200–320 (midpoint 265) brown bears in Unit 26B
Predator(s) harvest	Regulatory Year 2008–2009 = 23 (15 males, 8 females) Regulatory Year 2009–2010 =17 ( 14 males; 3 females) Regulatory Year 2010–2011=28 (18 male, 10 female) includes 2 illegal
Evidence of predation effects	See Arthur, in prep.
Feasibility of predation control	Selective, lethal removal of brown bears by department personnel using aircraft is expected to result in increased muskoxen survival.
Other mortality	Late winter storms contribute to mortality of calves, yearlings, and adults. Some muskoxen were also killed by vehicles on the Dalton Highway. Other causes of death that were observed include disease, winter malnutrition, and falling through thin ice on lakes and rivers.