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CHAPTER 2: MUSKOX MANAGEMENT REPORT

From: 1 July 2012
To: 30 June 2014[1]

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).

From 1970 through 2007, the initial population of 71 animals experienced high annual growth rates across broad areas of the Seward Peninsula, followed by moderate stability 2007–2010, and reached a peak population of 2,903 animals in 2010 (Fig. 1). Since 2010, the population status has been characterized by variable stability and decline depending on the area, portion of range, or subunit being considered. The range of the population has been expanding steadily. For comparative purposes, the population in the 'core count area' of the early population has been consistently assessed as census methods have evolved and as the population has colonized peripheral areas termed the 'expanded count area.' During the recent period of decline, hunt structures were changed and harvest quotas were reduced to promote population recovery. A population assessment in April 2015 shows the population has stabilized at 2,287 (95% CI: 1,895 to 2,832) animals (Fig. 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 (Fig. 2). Survey flights and observations from members of the public have also documented groups of muskoxen in distant areas from the Seward Peninsula, including eastern areas of Unit 23, western portions of Unit 24 and western portions of Unit 21.

[1] Information from outside the reporting period may be included at the discretion of the Area Biologist.

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, U.S. National Park Service (NPS), U.S. Bureau of Land Management (BLM), U.S. Fish and Wildlife Service (USFWS), 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 follow muskox management policy guidelines developed by the department (ADF&G 1980).

MANAGEMENT GOALS

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

- Provide for sustained yield 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 population surveys at 2-year intervals to document changes in population and distribution.

- Complete rangewide composition surveys at 2-year intervals to document large scale patterns in age and sex structure of the population. Complete supplemental composition surveys on an annual basis to track trends of sex-age cohorts in selected areas.

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

- Administer Tier I/II 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. Additional areas, including northern Unit 22A, southeastern Unit 23, and western Unit 24 were added during 2010 and 2012 surveys in response to population expansion into previously unoccupied and unsurveyed habitat. In 2015 the survey area was further expanded to include additional areas of the Nulato Hills (western portions of Unit 21D) to cover an area of continuous habitat at the boundary of Units 21D and 22 (Fig. 2). For comparative consistency, survey results corresponding to previous minimum count population survey efforts (1970–2007) are defined as the 'core count area' and include Units 22B, 22C, 22D, 22E, and 23SW. Survey results that include the 'core count area,' northern Unit 22A, Unit 23 Southeast, and Unit 21D are grouped together and defined as the 'expanded count area.' Staff from the department, NPS, BLM, and USFWS participated in the population survey. We adapted distance sampling techniques (Buckland et al. 2001, 2004) to estimate abundance. Methods for aerial survey coverage and subsequent analyses to estimate the population have not changed since 2010 and follow Schmidt et al. 2010, Schmidt and Gorn 2013, and Gorn and Dunker 2013.

Survey Coverage. No population counts were completed during the reporting period due to off-year scheduling in 2013 and inadequate snow cover in 2014. A Seward Peninsula muskox population survey was completed 9–13 March 2015. A survey summary can be found in Appendix A.

Abundance Estimation. Protocols for abundance estimation have been previously defined in Gorn and Dunker 2013. A summary of these methods can be found in Appendix B.

Population Composition. No composition counts were completed during the reporting period due to off-year scheduling in 2013 and inadequate snow cover in 2014. A Seward Peninsula muskox composition survey was completed 7 April–3 May 2015. Muskoxen were classified into 8 age/sex classes: bull ≥ 4yrs, bull = 3yrs, bull = 2yrs, cow ≥ 4yrs, cow = 3yrs, cow = 2yrs, short yearlings (15 months ≥ muskox ≥ 10 months), and calves (newly born animals) based on body size, horn characteristics and body conformation at the time of observation. The short yearling (SY) age class included yearlings to 15 months-old to make the survey comparable to previous composition surveys that were completed after the typical muskoxen calving period. Composition ratios were reported for mature bulls (MB) per 100 cows (C) and defined as MB:100C (males ≥ 4yrs/100 females ≥ 3yrs). Composition ratios were also reported for short yearlings (SY) per 100 cows defined as SY:100C (SY 15 months ≥ muskox ≥10 months/100 females ≥ 3yrs). Composition proportion estimates (expressed as percentages) were calculated for MB ($\hat{p}_{MB}$) and SY ($\hat{p}_{SY}$) and reported with 95% confidence. Percent recruitment was calculated as short yearlings per all muskox sampled, excluding calves [SY/(*N*-calves)]. A 2015 composition survey summary can be found in Appendix C.

Collaring, distribution, mortality. In 2008, the department began collaring muskoxen in Units 22B, 22C, and 22D to understand distribution, movement patterns, and mortality rates. A sample of 20–30 collared muskoxen has been maintained by deploying radio collars on cow muskox (≥ 3 years of age). Eight cow muskox and 7 cow muskox were collared in 2012 and 2013, respectively. Ground-based capture methods were used instead of helicopter-based methods. The

choice was made to minimize concerns over helicopter-based captures negatively affecting the health of other individuals within the target group as well as potentially biasing the selection of animals for capture. The majority of captures took place in the fall (September–October) allowing staff to use the Nome road system to gain access to muskox groups. Cooler fall temperatures (<45°F) allowed for the safe capture of muskox. One animal was collared using ground-based capture methods in March following composition surveys.

Aerial radiotracking flights were based out of Nome using a Piper PA-12 with either a solo pilot or a dual pilot/observer team. The location, distribution, and status of collared muskox were monitored with a scheduled frequency of at least 2 flights per month. Annual mortality estimates were calculated for a 12-month collar-year period (October–September) as the percentage of collared animals lost to non-hunting mortality compared to the total number of collared animals known to be active during the collar-year period. Collars with unknown fate (not mortality) and hunting mortalities were censored from the sample and not included when estimating mortality. The proportion of muskox that died annually is reported with 95% confidence.

Harvest data are available via the ADF&G website (https://secure.wildlife.alaska.gov/index.cfm?adfg=harvest.main)

Data are summarized by regulatory year (RY), which begins 1 July and ends 30 June (e.g., RY12 = 1 July 2012–30 June 2013). Harvests were monitored through Tier I and Tier II hunt reports during RY12 and RY13 and added to the department database during the reporting period.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The 2015 Seward Peninsula muskox population survey estimated 1,853 (95% CI: 1,541 to 2,285) animals in the 'core count area' and 2,287 (95% CI: 1,895 to 2,832) animals in the 'expanded count area.' We calculated unit and hunt area estimates for all areas (Table 1 and Appendix A). Additional information related to population status and trend can be found in Appendix A.

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 during distance sample surveys 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, but for the purposes of administering Seward Peninsula muskox hunts, point estimates from the distance sample technique are used in the same manner as previous minimum count abundance estimates. Despite different methodology, past minimum count survey results and distance-based estimates 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 improve.

The Seward Peninsula muskox population experienced 13% annual growth between 1970 and 2007. The population was stable between 2007 and 2010. The 2012 population estimate of 1,992 muskoxen in the 'core count area' represented a 13% annual rate of decline when compared to the 2010 population estimate, and the 2012 population estimate of 2,223 muskoxen in the 'expanded count area' represented a 1.8% annual rate of increase since 2000, when a minimum count survey found 1,797 muskoxen (Fig. 1). The 2015 population estimate represents a stable population between 2012 and 2015 (a 3 % increase during that time) in the 'expanded count area.' However, it should be noted that additional areas covered during the 2015 'expanded count area' were not covered during the 2012 count. The 2015 'core count area' estimate indicated a 7% decline between 2012 and 2015.

The 2015 population estimate found a southern and eastward movement pattern of muskox groups compared to groups detected during the 2012 survey (Fig. 2, Appendix A). We understand from past population surveys that muskox groups move between subunits in relatively short time periods, and the continued decreases in abundance since 2012 in Unit 22E (-32%) and Unit 22D Remainder (-25%) are likely due to eastward emigration and not primarily a function of mortality or overharvest of the subpopulation alone. Increases found during the same time period in Unit 22A (+131%), Unit 22B east of the Darby Mountains (+126%), and Unit 22C (+24%) are not likely caused by high productivity, reduced hunter harvest, or natural population growth; instead, they may be the result of redistribution of neighboring animals. Past population surveys documented high rates of increase in Unit 22C (42% annual rate of increase between 2005 and 2007) followed by the redistribution of animals into adjacent subunits (Units 22B and 22D). The history showing lack of neighboring animals available for redistribution in Unit 22B east of the Darby Mountains and Unit 22A may indicate the beginning of long-term natal increases in abundance and range expansion east of the 'core count area.'

The next population survey of the Seward Peninsula muskoxen population is scheduled for March 2017.

Population Composition

The results of composition surveys in Units 22A, 22B, 22C, 22D, 22E, 23SW and the Seward Peninsula expanded count area are summarized below. During the 2015 Seward Peninsula muskox population composition survey we classified 164 muskox in Unit 22A, 218 muskox in Unit 22B, 155 muskox in Unit 22C, 287 muskox in Unit 22D, 142 muskox in Unit 22E and 96 muskox in Unit 23 SW. Based on results from previous surveys, mature bulls are likely to be undercounted in composition surveys relative to other segments of the population, primarily because an unknown number occur as solitary animals and are less likely to be detected during incidental flights (e g., moose censuses) or pre-survey flights used to locate muskox groups for composition counts. However, we used group locations from the Seward Peninsula muskox population survey which included solitary animals and likely reduced some of this potential bias, thereby improving the precision of our estimate of bulls in the population.

Seward Peninsula Expanded Count Area: In April and May of 2015 we classified 1,062 muskox in 76 groups detected in the 'expanded count area'. Mature bull (MB) ratios and short yearling (SY) ratios per 100 cows (C) were as follows: 39 MB:100C ($\hat{p}_{MB}$=20% [18–22% at 95% CI]) and 17 SY:100C ($\hat{p}_{SY}$=8% [7–9% at 95% CI]).

Units 22A and 21D: In May 2015 we visited Unit 22A north of the Unalakleet River and a portion of Unit 21D in the Nulato Hills. This was the second time muskox composition surveys were conducted in Unit 22A and the first time surveys were completed in Unit 21D Nulato Hills. We classified 164 muskoxen in 18 groups and found: 64 MB:100C ($\hat{p}_{MB}$=24% [21–27% at 95% CI]) and 21 SY:100C ($\hat{p}_{SY}$=8% [6–10% at 95% CI]).

Unit 22B: In April 2015 we visited both Unit 22B West and Unit 22B East and classified 218 muskoxen in 20 groups. We found 44 MB:100C ($\hat{p}_{MB}$=22% [18–26% at 95% CI]) and 21 SY:100C ($\hat{p}_{SY}$=6% [4–8% at 95% CI]).

Unit 22C: In April 2015 we visited Unit 22C and classified 155 muskoxen in 8 groups. We found 45 MB:100C ($\hat{p}_{MB}$=26% [21–31% at 95% CI]) and 7 SY:100C ($\hat{p}_{SY}$=4% [2–6% at 95% CI]). This is the lowest recruitment observed in Unit 22C since 2002. This is also the lowest individual subunit recruitment rate observed during the 2015 composition survey.

Unit 22D: In April 2015 we visited Unit 22D and classified 287 muskoxen in 17 groups. We found 26 MB:100C ($\hat{p}_{MB}$=15% [12–18% at 95% CI]), and 19 SY:100C ($\hat{p}_{SY}$=11% [9–13% at 95% CI]).

Unit 22E: In April 2015 we visited Unit 22E and classified 142 muskoxen in 7 groups. We found 29 MB:100C ($\hat{p}_{MB}$=18% [13–23% at 95% CI]) and 21 SY:100C ($\hat{p}_{SY}$=10% [6–14% at 95% CI]).

Unit 23SW: In April 2015 we visited Unit 23SW and classified 96 muskoxen in 6 groups. We found 32 MB:100C ($\hat{p}_{MB}$=17% [12–22% at 95% CI]) and 26 SY:100C ($\hat{p}_{SY}$=14% [9–19% at 95% CI]).

Overall, rangewide estimates of MB:100C increased from 2012 to 2015. A similar trend was observed in the MB:100C estimates of individual subunits. Recruitment range-wide continues to be low (<10%) and remains a serious concern. Additional analysis of these results can be found in Appendix C.

Distribution and Movements

The Seward Peninsula population survey area was expanded in 2015 to include portions of Unit 21D (Fig. 2). The expanded effort was intended to further document range expansion of muskoxen emigrating east of the Seward Peninsula, and to provide survey coverage of all areas of known muskox habitat east of the Seward Peninsula.

Radio collars are primarily used to estimate natural mortality and exact locations of groups are not determined during every flight. However, radiotracking flights completed during the previous reporting period (Gorn and Dunker 2013) and current data continue to document the movement of collared cow (≥3 years old) muskox between Unit 22 subunits. A collared cow previously located in the Casadepaga drainages (Unit 22B) has recently been located in the vicinity of Deering (Unit 23 Southwest). Similarly, a collared cow previously located near the Sinuk River was found deceased in Unit 22E along the Nuluk River. In both instances the animals had traveled approximately 75 miles from the previous location.

MORTALITY

Harvest

Season and Bag Limit. During this reporting period ADF&G administered Tier I subsistence registration permit hunts in Unit 22E and, Tier II subsistence permit hunts in Units 22B, 22C, 22D, and 23SW authorized by the State of Alaska's Board of Game. 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:

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	 Nonresident Open Season
Unit 22(A) and Unit 23 that portion south and west of the Kobuk River drainage and North and east of the Buckland River drainage	No open season	No open season
Units 22(B), 22(C), and 22(D) and Unit 23, Southwest, that portion on the Seward Peninsula west of and including the Buckland River drainage, as follows:		
If the harvestable portion is 99 muskoxen or less:		
1 muskox by Tier II subsistence hunting permit only	1 Aug–15 Mar (Subsistence hunt only)	No open season
If the harvestable portion is greater than 99 muskoxen but less than 151 muskoxen:		
1 muskox by registration permit only	1 Aug–15 Mar (Subsistence hunt only)	No open season
If the harvestable portion is greater than 150 muskoxen:		
1 muskox by registration permit only;	1 Aug–15 Mar (Subsistence hunt only)	No open season
or		
1 bull 4-year-old or older by drawing permit only; up to 60 permits may be issued; 10	1 Aug–15 Mar	1 Aug–15 Mar

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	Nonresident Open Season
percent of animals may be issued to nonresident hunters, in combination with Unit 22(E)		
Unit 22(E) If the harvestable portion is 9 muskoxen or less:		
1 muskox by Tier II subsistence hunting permit only	1 Aug–15 Mar (Subsistence hunt only)	No open season
If the harvestable portion is greater than 9 muskoxen, but less than 26 muskoxen:		
1 muskox by registration permit only	1 Aug–15 Mar (Subsistence hunt only)	No open season
If the harvestable portion is greater than 25 muskoxen:		
1 muskox by registration permit only; or	1 Aug–15 Mar (Subsistence hunt only)	No open season
1 bull 4-year-old or older by drawing permit only; up to 60 permits may be issued; 10 percent of the permits will be issued to nonresident hunters, in combination with Units 22(B), (C), and (D) and Unit 23, that portion on the Seward Peninsula west of and including the Buckland River drainage	1 Aug–15 Mar	1 Aug–15 Mar

Specific hunts administered in RY12 and RY13:

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	Nonresident Open Season
Unit 22A	No open season	No open season

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	Nonresident Open Season
Unit 22B, that portion east of the Darby Mountains, including drainages of Kwiniuk, Tubutulik, Koyuk and Inglutalik rivers		
1 bull by Tier II permit only (TX105; harvest quota is 1 bull)	1 Aug–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22B		
1 bull by Tier II permit only (TX105; harvest quota is 7 bulls)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Unit 22C Inner Nome Area, that portion of the Snake River drainage downstream of the Glacier Creek confluence and including the Glacier Creek drainage, that portion of the Nome River drainage downstream of and including the Basin Creek and Shephard Creek drainages, and all drainages flowing directly to Norton Sound between the mouths of the Nome River and the Snake River.		
1 bull, by bow and arrow, muzzleloader or shotgun only, by Tier II permit only (TX095; harvest quota is 3 bulls)	1 Jan–15 Mar (Subsistence hunt only)	No open season

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	Nonresident Open Season
Unit 22C Outer Nome Area, that portion of drainages flowing to Norton Sound: 1) between the east bank of the Penny River and the Snake River drainage, 2) the Snake River drainage up stream of the Glacier Creek confluence and excluding the Glacier Creek drainage, 3) the Nome River drainage upstream of and excluding the Basin Creek and Shepard Creek drainages and 4) between the Nome River drainage and the west bank of the Flambeau River extended along Safety Sound to the Safety Bridge.		
1 bull by Tier II permit only (TX096; harvest quota is 2 bulls)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22C	No open season	No open season
Unit 22D Southwest, that portion west of the Tisuk River drainage, west of the west bank of Canyon Creek beginning at McAdam's Creek continuing to Tuksuk Channel		
1 bull by Tier II permit only (TX103; harvest quota is 1 bull)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Unit 22D, Kuzitrin River drainage		
1 bull by Tier II permit only (TX102; harvest quota is 4 bulls)	1 Jan–15 Mar (Subsistence hunt only)	No open season
Remainder of Unit 22D		
1 bull by Tier II permit only (TX102; harvest quota is 7 bulls)	1 Aug-15 Mar (Subsistence hunt only)	No open season

RY12 and RY13 Units and Bag Limits	Resident Open Season Subsistence and General Hunts	Nonresident Open Season
Unit 22E		
1 bull by Tier I registration permit only (RX104; harvest quota is 10 bulls)	1 Aug–15 Mar (Subsistence hunt only)	No open season
Unit 23 Southwest, that portion on the Seward Peninsula west of and including the Buckland River drainage		
1 bull by Tier II permit only (TX106; harvest quota is 4 bulls)	1 Aug–15 Mar (Subsistence hunt only)	No open season

Subsistence hunt conditions:
1. Subsistence hunts open to Alaska residents only.
2. Tag fee waived for subsistence hunting.
3. One muskox permit per hunter per calendar year.
4. Season will be closed by emergency order when quota is reached.
5. All Skulls require trophy destruction be completed at the kill site subject to permit conditions
6. Aircraft may not be used to transport muskox hunters, muskox, or muskox hunting gear.

Board of Game (BOG) Actions and Emergency Orders. In November 2011, the BOG adopted regulation changes to allow the department flexibility to manage subsistence Tier II permit hunts, subsistence Tier I permits hunts, or a combination of subsistence Tier I or Tier II permit hunts along with drawing permit hunts based on the relationship of harvestable surplus of muskox and the amount necessary for subsistence. The adopted regulatory changes resulted in Tier II permit hunts in Units 22B, 22C, 22D, 22E, and 23SW (available to all Alaska residents).

The BOG lowered the muskox amount necessary for subsistence in Unit 22E to 10–25 muskox, and then added new muskox ranges in Unit 22A and in that portion of Unit 23 south and west of the Kobuk River drainage as the population area basis for the Seward Peninsula Amount Necessary for Subsistence (100–150, including 10–25 in Unit 22E).

No actions that affect Seward Peninsula muskox were taken by the BOG during the reporting period. Detailed meeting information and board actions affecting Seward Peninsula muskox can be found at the Alaska Department of Fish and Game website (

http://www.adfg.alaska.gov/index.cfm?adfg=gameboard.meetinginfo).

One emergency order (EO) was issued during the reporting period to close the Tier II muskox hunt, TX102, in the Unit 22D remainder area (the American and Agiapuk River drainages). The EO was issued on 9 October 2012 following the illegal harvest of 7 muskoxen. No other EOs were issued during the reporting period.

Human-Induced Harvest. Seward Peninsula muskox hunts utilize 2 harvest guidelines for hunt management. Hunt area harvest quotas are calculated to harvest approximately 10% of the estimated number of mature bulls in each area, and the range-wide harvest rate is 2% of the population point estimate (Fig. 2). Detailed analysis of specific hunt type (Tier I Registration, Tier II), harvest history, transportation methods used, harvest by residency, and seasonality of harvest is not presented in this report but is available to the public for hunt planning on the ADF&G website (https://secure.wildlife.alaska.gov/index.cfm?adfg=harvest.main).

Permit Hunts. Hunting during this reporting period was by Tier I subsistence registration permit and Tier II subsistence permit on state managed lands, and by federal subsistence permit on federal public lands. Trophy destruction at the kill site is required for muskoxen taken in Tier I and Tier II hunts.

Hunter Success. During RY12, 39 permits (10 Tier I, and 29 Tier II) were issued for state managed Seward Peninsula muskoxen hunts. An additional 8 federal permits were issued. Harvest reports indicate 22 state and 2 federal hunters were successful for a 51% success rate. During RY13, 40 permits (10 Tier I, 30 Tier II) were issued for state managed hunts. One additional Tier II permit was issued for a cow muskox located near Buckland, Alaska that was tangled in a subsistence fish net. An additional 15 federal permits were issued. Harvest reports indicate 20 state and 10 federal hunters were successful for a 55% success rate.

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. Although Tier II hunt management can make it more difficult for hunters to secure a permit, hunters have a longer season to hunt because seasons generally are not closed early by emergency orders. This allows hunters the opportunity to take advantage of good weather and long hours of daylight during February and March.

Other Mortality

Natural mortality rates calculated from radiotracking flights since 2008 have been as low as 4% in 2009 and as high as 26% in 2011 (Table 3). Several factors may preclude the use of collar-based mortality rates as representative of the entire population. The average number of collars deployed in the SPP ($\bar{x}$ = 24) since 2008 represents 1% of the Seward Peninsula population based on the 2015 population estimate (Fig. 1). Collars are not randomly distributed throughout the population, so localized events such as icing, deep snow, or different predator regimes may influence observed mortality rates. Also, the selection of animals for capture is not truly random, as obviously injured or diseased animals were intentionally not selected for collaring.

Based on aerial radiotracking flights during 2008–2014, observed mortality events (n = 24, 2 unknown) occurred at a frequency of 88% between April and October. The timing of these events suggests brown bears may be partially responsible for muskox mortality, but detecting the primary cause of mortality is difficult due to the low frequency of radiotracking flights (≤2

flights per month April–October). Causative agents are not easily determined because the period of time between detection on radiotracking flights and investigation of kill sites may be days, weeks, or even months apart, making it hard to distinguish causes of mortality from actions by scavengers found on the Seward Peninsula.
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).

Disease. Seward Peninsula blood serum samples collected since 2008 during capture projects have tested negative for zoonotic diseases and the muskox population is considered a healthy population and subsistence resource (Gorn 2009). Samples have tested negative for Toxoplasma, Neospora, Giardia, and Cryptosporida, which all may lead to decreased reproduction in muskox populations. Animals tested since 2008 have had elevated levels of larvae from lungworm and gastrointestinal 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, out of 9 samples, these 3, as well as those from 4 other muskoxen, tested positive for pregnancy (2 muskoxen were not tested for pregnancy). All muskoxen tested negative for Mycoplasma, a type of pneumonia. They also tested negative for Coxiella, which can have negative reproductive effects.

Muskox serum samples were tested for copper levels and results found levels of 0.8–1.1 ppm (mean = 1.0 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 Alaska muskox populations adversely impacted by trace element deficiencies (Beckman 2009). Six liver samples were collected from hunter-harvested animals to compare trace element (i.e., copper, iron, zinc, selenium) levels between different Alaska muskox populations, and we are awaiting results.

None of the results from testing found disease exposure or parasite prevalence that would indicate Seward Peninsula muskoxen health is at risk; however, disease surveillance should be continued to monitor population health.

Results from blood samples collected during the reporting period are not yet available from ADF&G's Division of Wildlife Conservation Wildlife Health program.

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

The Seward Peninsula Muskox Cooperators Group did not meet during the reporting period.

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 Nome, 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 there are repeated instances of muskoxen rubbing against grave markers in the Deering cemetery that have angered community 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 or hazed, muskoxen generally hold their ground rather than flee; this behavior contributes to people's dislike of them because it is sometimes impossible to (permanently) move them from areas where they are not wanted (Persons 2005).

The redistribution of muskox groups in the Nome area observed between 2005 and 2007, and continued increased abundance (Appendix A) have caused considerable angst with an increased number of Nome residents. The historically positive outlook towards muskox being visible from the Nome Road system has changed for some local residents because, beginning in 2005, muskox are now located near homes, in town, and near the two Nome airports. The department spends a considerable amount of time each summer moving muskox groups from airports, residential sites, and plush habitat immediately surrounding Nome. There have been several instances of domestic dog injuries and fatalities when muskoxen have encountered pets as they moved through residential areas of Nome. Also, muskoxen are commonly found near airport runways, and during the fall of 2011, airport staff removed a section of willows at Nome City Field Airport to discourage the presence of muskox along the runway. While the willow removal proved largely ineffective to deterring muskox presence along the runway, it did increase visibility for vehicle traffic along the road that parallels the runway. From 21 May 2014 to 9 September 2014 department staff responded to 17 after hours (5:30PM to 7:00AM) nuisance muskox calls in the Nome area. Department staff issue public service announcements informing the public on ways to live and interact with muskox, and staff attended public meetings to relay information and discuss solutions for local area muskox issues. Hunting season dates in Unit 22C were changed during the reporting period to open 1 August at the request of the public to help mitigate the presence of local muskox groups. At this point, harvesting muskox at current low levels (2% harvest rate) does not appear to affect local muskox abundance or cause muskox groups to emigrate from the local area.

Muskox and Reindeer

For many years after muskoxen were introduced to the Seward Peninsula, reindeer herders complained that muskoxen competed with and displaced 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 ridgetop, 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 or where local residents, tourists, photographers, cinematographers, and wildlife enthusiasts from around the world can 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.

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. Additional effort was 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 by expanding the survey area. These areas are searched less intensively throughout the year because of their distant proximity to Nome and Kotzebue. The 2012 population survey area was expanded to gather additional information on muskoxen located east of the Seward Peninsula, and the 2015 survey area was increased further to monitor eastward range expansion of the SPP. The 2015 survey area encompasses all known areas of muskox habitat in proximity to the Seward Peninsula, and it is not anticipated that the survey area will be increased for future surveys.

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 has been evident in all areas although declines occur at different rates between units. Collecting composition data has become increasingly important for Seward Peninsula hunt administration. As hunter harvest has increased through time (Fig. 3) and recent population growth has apparently slowed compared to earlier periods of rapid growth (e g., 1970–2000), staff now considers the number of mature bulls in the population as the primary basis for establishing hunt area harvest rates; the previous method used population counts and abundance estimates for the entire population. To supplement this change in metrics to determine harvest, composition is now collected using a sampling protocol across the entire range of the herd (Schmidt and Gorn 2013), rather than using earlier methods where composition

surveys were based on drainages or unit boundaries. This revised protocol to collect composition data should be continued to better understand range-wide composition and recruitment of the SPP.

Following 3 years of decreased harvest the 2015 composition survey identified a range-wide increase in the proportion of mature bulls in the population. Since 2012, the annual realized harvest rate has been below 2% and is the likely cause of this apparent increase in mature bulls (Fig. 3).

It is important to determine the factors influencing growth so we can ensure our management strategy is appropriate for conservation of the herd. Current regulatory language allows for increased flexibility of hunt management and it is important to consider changes in harvest rates and their subsequent effect on population structure. Other factors affecting population growth could include limited extent of 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 in response to caribou wintering in the area in larger numbers, and reports of bear predation on muskoxen groups have also increased. We also know disturbance by people or predators during calving periods can cause calf separation and mortality. Close attention to these factors should be given high priority and harvest rates adjusted appropriately in the future.

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 recommend hunt structures that would help ensure 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 working with 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.

REFERENCES CITED

Alaska Department of Fish and Game. 1980. Muskox management policies. Pages X-1–X-4 [*In*] Alaska Wildlife Management Plans: Species Management Policies. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Project W–20–2, Juneau.

Beckmen, K. 2009. Wildlife health and disease surveillance in Alaska. Alaska Department of Fish and Game, Federal Aid Annual Research Performance Report 1 July 2008–30 June 2009, Federal Aid in Wildlife Restoration Project 18.74, Juneau.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press.

Buckland, S. T., D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas, Eds. 2004. Advanced distance sampling. Oxford University Press.

Czaplewski, R. L., Crowe, D. M., and McDonald, L. L. 1983. Sample sizes and confidence intervals for wildlife population ratios. Wildlife Society Bulletin 11:121–128.

Cochran, W. G. 1977. Sampling techniques. John Wiley and Sons. New York, New York.

Gorn, T. 2009. Unit 22 muskox. Pages 13–33 [*In*] P. Harper, editor. Muskox management report of survey and inventory activities 1 July 2006–30 June 2008. Alaska Department of Fish and Game, Division of Wildlife Conservation, Project 16.0, Juneau.

Gorn, T. and W. R. Dunker. 2013. Unit 22 muskox. Pages 17–51 [*In*] P. Harper, editor. Muskox management report of survey and inventory activities 1 July 2010–30 June 2012. Alaska Department of Fish and Game, Division of Wildlife Conservation, Species Management Report ADF&G/DWC/SMR-2013-2, Juneau.

Ihl, C. and Klein R. 2001. Habitat and diet selection by muskoxen and reindeer in western Alaska. Journal of Wildlife Management 65(4):964–972.

Machida, S. 1997. Muskox survey-inventory management report. Pages 16–20 [*In*] M. V. Hicks, ed. Annual report of survey-inventory activities, muskox. Alaska Department of Fish and Game, Division of Wildlife Conservation, Federal Aid in Wildlife Restoration Progress Report Grant W23–4, W–23–5, Study 16.0. Juneau.

Nelson, R. 1994. Seward Peninsula Cooperative Muskox Management Plan [unpublished agency document]. Alaska Department of Fish and Game, Division of Wildlife Conservation, Nome, Alaska.

Persons, K. 2005. Muskox survey-inventory management report. Pages 13–37 [*In*] C. Brown, ed. Annual report of survey-inventory activities. Muskox. Alaska Department of Fish and Game, Division of Wildlife Conservation, Federal Aid in Wildlife Restoration Progress Report Grant W27–4, W–27–5, Juneau.

Schmidt, J. H., and T. S. Gorn. 2013. Possible secondary population-level effects of selective harvest of adult male muskoxen. PLoS ONE 8(6): e67493. doi:10.1371/journal.pone.0067493

Schmidt, J. H., T. S. Gorn, and C. Westing. 2010. Using distance sampling to estimate muskoxen abundance on the Seward Peninsula, Alaska. Summary report prepared for

2010 Seward Peninsula muskox census participants, April 27, 2010 [unpublished]. National Park Service, Fairbanks, and Alaska Department of Fish and Game, Nome and Kotzebue.

Schmidt, J. H., K. L. Rattenbury, J. P. Lawler, and M. C. MacCluskie. 2012. Using distance sampling and hierarchical models to improve estimates of Dall's sheep abundance. Journal of Wildlife Management 76:317–327.

Spiegelhalter, D. J., A. Thomas, N. G. Best, and D. Lunn. 2004. WinBUGS Version 1.4.1. User manual. MRC (Medical Research Council) Biostatistics Unit, Cambridge, United Kingdom.

Thomas, L., J. L. Laake, E. Rexstad, S. Strindberg, F. F. C. Marques, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnham, M. L. Burt, S. L. Hedley, J. H. Pollard, J. R. B. Bishop, and T. A. Marques. 2009. Distance 6.0. Release 2. Research Unit for Wildlife Population Assessment, University of St. Andrews, UK. <http://www.ruwpa.st-and.ac.uk/distance/>

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

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While this unit report was actually published in 2017, it is part of the set of 2015 unit species management reports, so we suggest citing the report as a 2015 report to maintain its relationship to the other 2015 unit reports.

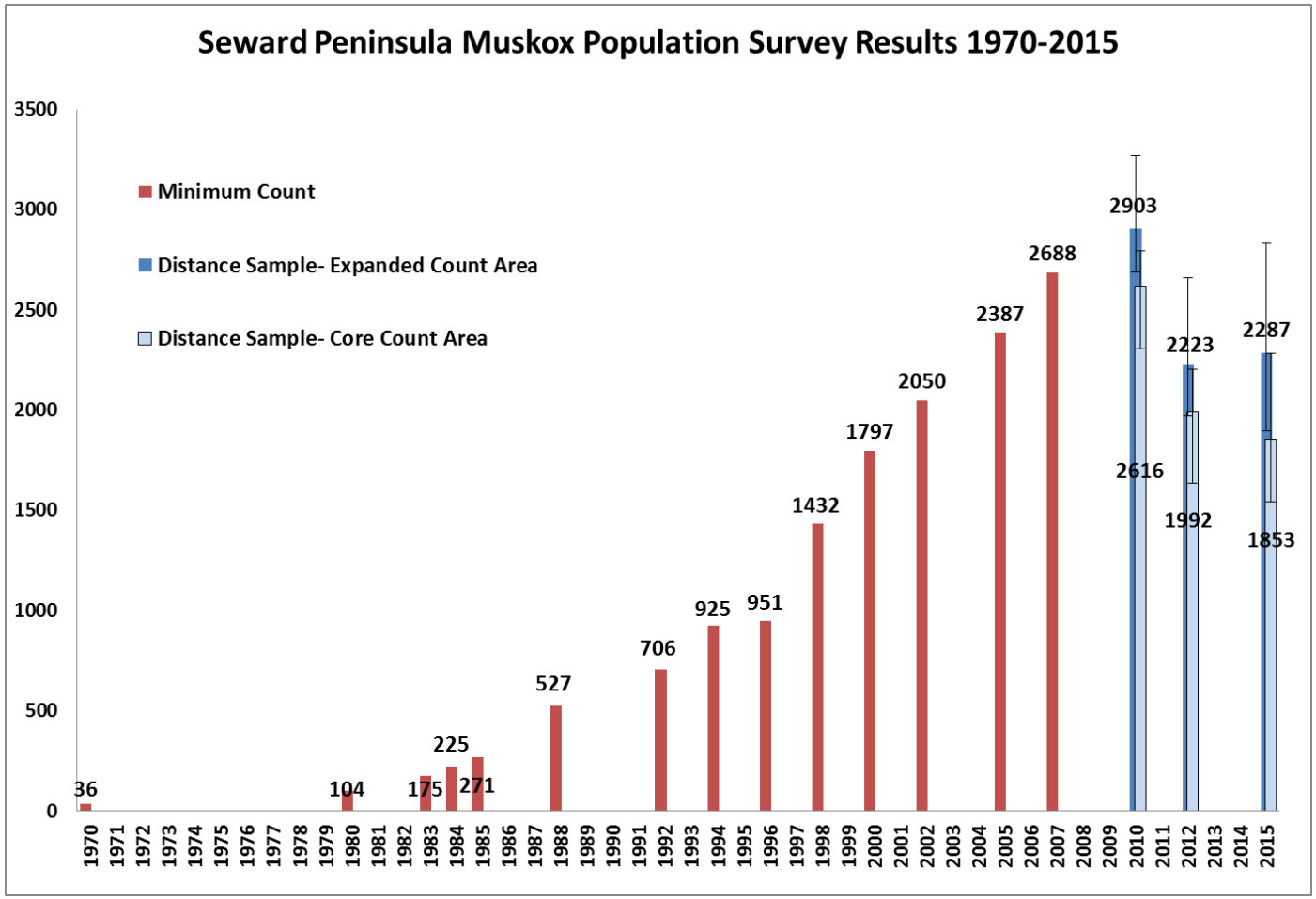

Figure 1. Census results from minimum count and distance sampling surveys of Alaska Seward Peninsula muskoxen, 1970–2015.

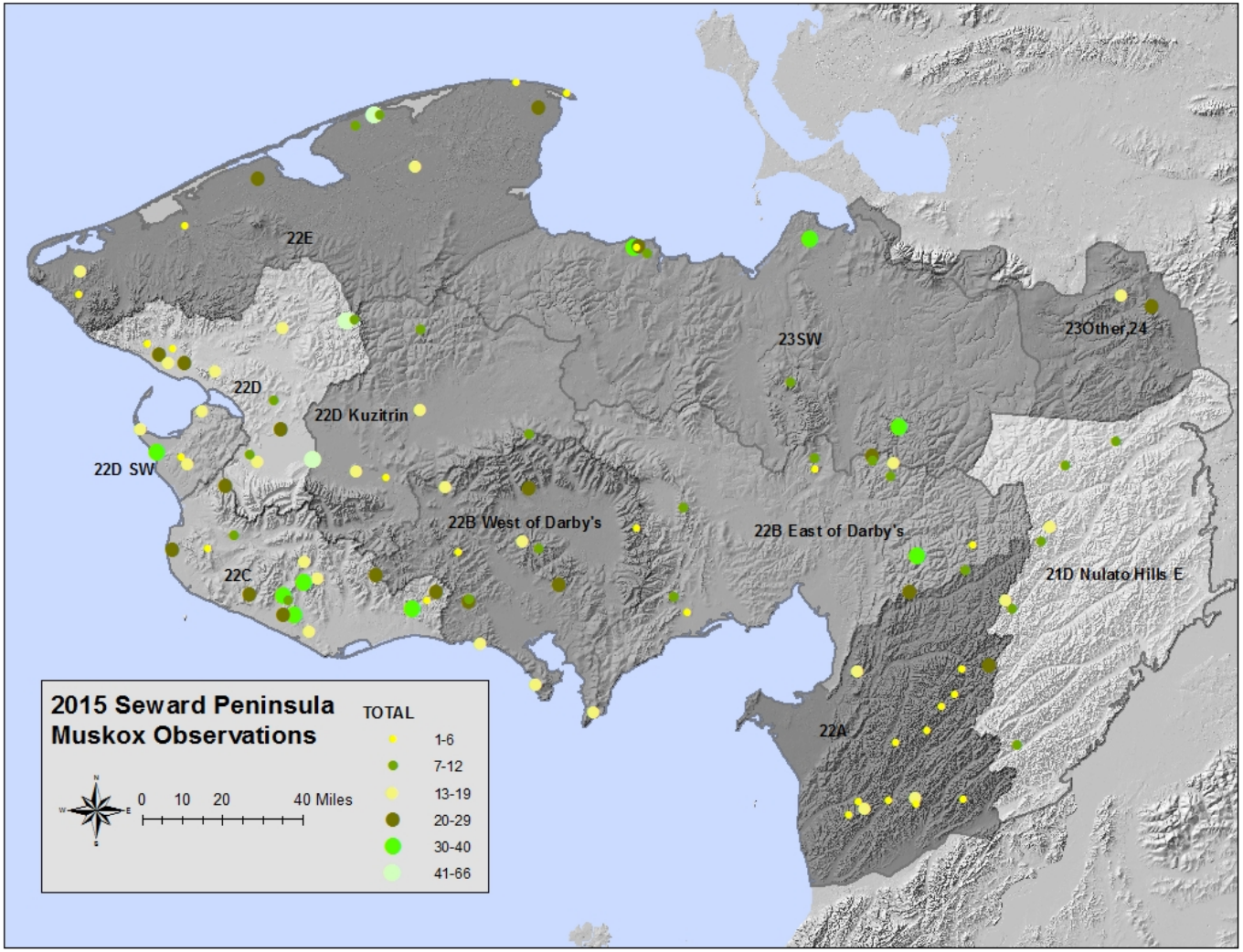

Figure 2. Location of Alaska Seward Peninsula muskox groups, spring 2015 census.

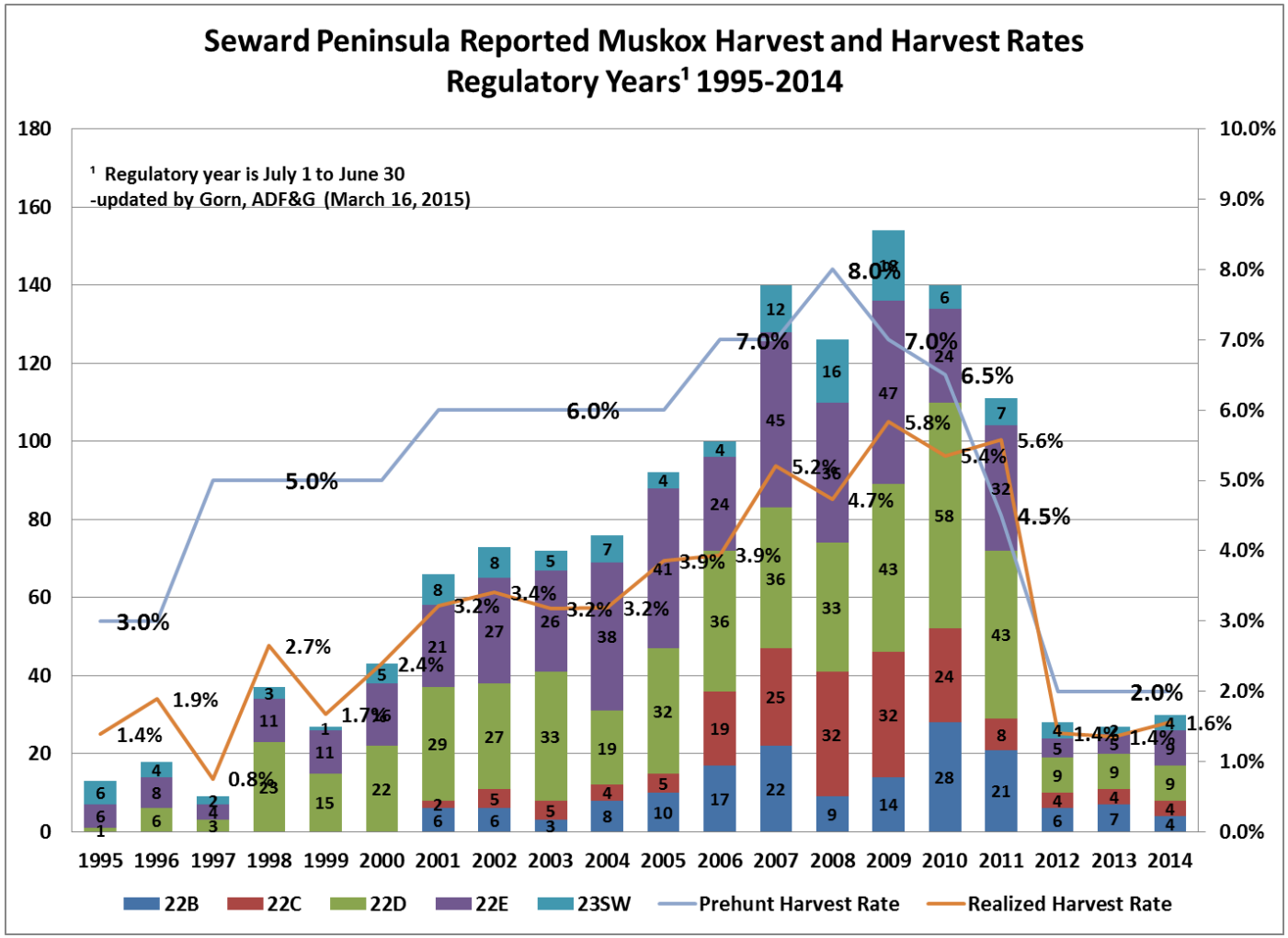

Figure 3. Alaska Seward Peninsula muskox harvest and harvest rates, regulatory years 1995–2014.

Table 1. Alaska Seward Peninsula muskox census results with coefficients of variation and 95% confidence intervals for select subunits of GMUs 21, 22, 23, and 24; spring 2015.

Unit	Mean	CV	2.5%	97.50%
21D	146	36%	78	278
22A	194	23%	136	306
22B East of Darby Mtns.	181	27%	112	305
22B West of Darby Mtns.	274	15%	216	377
22C	358	11%	302	456
22D Kuzitrin Drainage	187	22%	131	290
22D Southwest	78	24%	57	129
22D Remainder	258	15%	207	352
22E	291	20%	204	433
23 Southwest	192	32%	104	340
23 Southeast and 24	71	41%	39	149

Table 2. Alaska Seward Peninsula muskox census results for select subunits of GMUs 21, 22, 23, and 24; 1992–2015.

	Unit								
Year	21D	22A[a]	22B	22C	22D	22E	23SW	23SE/24[b]	Total[c]
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		1,432
2000			159	148	774	461	255		1,797
2002			189	257	771	632	201		2,050
2005			326	220	796	863	182		2,387
2007			329	445	746	949	219	78	2,766
2010		86	420	402	878	879	175	120	2,903
2012		84	460	289	629	431	222	110	2,223
2015	146	194	455	358	523	291	192	71	2,287

[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. Annual mortality rate (percent and range) of collared cows ≥ 3 years of age, Seward Peninsula muskox population, 2008–2014.

Year	Active Collars	Survived	Mortality rate, %	Mortality range, % (95% CI)
2008	23	21	9	1.1–28.0
2009	23	22	4	0.1–22.0
2010	22	17	23	7.8–45.4
2011	27	20	26	11.1–46.3
2012	19	16	16	3.0–39.6
2013	22	21	5	0.1–22.8
2014	25	19	24	9.4–45.1

APPENDIX A. 2015 muskox survey results memo, 6 May 2015 ERRATUM.

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MEMORANDUM

TO: Distribution (see below)

DATE: May 6, 2015 ERRATUM

FROM: Tony Gorn
Wildlife Biologist
Wildlife Conservation
Nome

PHONE: 907-443-8189

SUBJECT: 2015 muskox survey results

ERRATUM: Short yearling (SY) defined as 10–15 months-old for comparison to previous surveys.

This memo summarizes the 2015 Seward Peninsula muskox population and composition surveys.

In 2010 and 2012 the distance sampling survey method required approximately 4 weeks to complete because of the Seward Peninsula's strong winds and unfavorable weather systems. During the 2015 survey period the survey area received heavy snow fall between 6 Mar- 8 Mar, followed by a week of clear weather and light winds. We were able to complete the population survey between 9 Mar- 13 Mar, and survey conditions were excellent with complete snow cover throughout the survey area, including the normally wind swept Nulato Hills. Several maps, tables, and figures are provided at the end of this document for reference to information provided in this summary.

The population survey was completed with contributions from the Alaska Department of Fish & Game, the National Park Service, the Bureau of Land Management, and the U.S. Fish & Wildlife Service. Staff and aircraft (Cessna 185 and PA-18 type) were based in Nome, Kotzebue, and Galena during the project.

Population Survey Area
The population survey area included portions of Unit 22A, Unit 21D, Unit 23, Unit 24 and all of subunits 22B, 22C, 22D, and 22E (Fig. 1). Transects were spaced at 4 mile intervals throughout the survey area (Fig. 2). The survey area included 263 transects that totaled 8,290 transect miles. Transect length varied between 3 miles - 68 miles in length with an average transect length of 32 miles.

Population Survey Results
Several considerations should be made when reviewing population survey results found in Table 1: 1) the distance sampling method is strongest when used to estimate the entire population (SewPen all), and 2) we provide hunt area estimates to guide hunt managers when establishing harvest quotas for Tier II and Tier I subsistence hunts. We acknowledge that individual subunits and hunt areas (management areas) do not represent unique "populations" of muskox.

The 2015 Seward Peninsula muskox population survey estimated 2,287 ±10% (95% CI: 1,895 to 2,832) animals for the entire range (SewPen.all) and suggests the population stabilized (1% annual increase) between 2012 and 2015. The population estimate within the entire range that includes hunting (SewPenOld) is 1,853 ±10% (95%CI: 1,541 to 2,285) and also suggests this portion of the survey area stabilized (2% annual decrease) during the same time period (Table 1) (Fig. 4).

Prior to the 2015 survey we added additional transects in the eastern portion of the 2012 survey area that included the eastern portion of the Nulato Hills (Fig. 2). Seven (7) muskox groups were detected on these transects during the 2015 survey. All areas of suitable habitat were covered during the survey, excluding the foothills of/and the Purcell Mountains located along the Unit 23/ Unit 24 boundary, however we have no evidence the Purcell Mountains contain large numbers of muskoxen.

The spatial distribution of muskox groups has changed since 1992 when a higher proportion of the population were detected in western, northern, and central areas of the Seward Peninsula (Units 22E and 22D) compared to the 2015 survey when greater proportions of the population were detected in southern and eastern areas of the Seward Peninsula (Units 22B, 22C, and 22A)(Fig. 3).

Mortality

Our sample (n= 20-30) of collared cow muskoxen indicates natural mortality rates between 5%- 24% during 2008 – 2014. However, the collared sample of muskox are not distributed equally across the survey area and it may not be appropriate to assume consistent mortality rates throughout the survey area. Additionally, muskox composition surveys completed between 2002- 2012 found long term declining trends in the number of short yearlings in subunit based composition surveys suggesting a population decline was likely, at some point, across the Seward Peninsula.

Although it is difficult to understand the composition of bull harvest due to limitations in current harvest reporting methods, discussions with hunters and the collection of horn specimens required by hunt conditions indicate a high proportion of harvested males are mature bulls (≥4 years old and older). Preseason harvest rates ranged between 2.0% and 8.0% between 1995 and 2014. The average realized harvest rate, 1995- 2011, was 3.6%. In 2012 we lowered harvest rates to help increase the number of mature bulls in the population. Average realized harvest rates, 2012- 2015, was 1.5%.

Composition Survey Results

Composition surveys were conducted following the completion of the population survey. The overall sample included a subsample of individuals from each Seward Peninsula muskox management area within the population survey count area. Previous range-wide surveys were conducted in 2002 and 2012. Subunit based surveys were conducted in 1-3 subunits annually in 2000, 2001, 2003- 2011 and 2013.

Muskox groups observed during the 2015 Seward Peninsula muskox population survey were divided into three classes based on group size; small (1-16 muskox), medium (17-33 muskox) and large (≥34 muskox). Within each management area, our goal was to sample a proportionate number of individuals from each group class with an overall sampling objective of 150 muskox per management area. In management areas where <150 muskox were observed, all groups were selected to be sampled. This new sampling protocol was adopted following biometric review of previous surveys and allowed for a reduction in sampling effort.

Composition surveys were completed during 7 Apr- 3 May to minimize conflict with subsistence muskox hunting. A total of 76 muskox groups comprised of 1,062 individuals, 46% of the 2015 population estimate (SewPen.all), were sampled. The range-wide composition survey results are 39MB: 100C[i], 17 SY:100C[ii], and 9% SY[iii].

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[i] Bulls ≥ 4 years of age: 100 Cows ≥ 3 years of age

[ii] 15mo ≥ Muskox ≥ 10mo: 100 Cows ≥ 3 years of age

[iii] 15mo ≥ Muskox ≥ 10mo /All Muskox Sampled (Excluding Calves)

*Minimum Count

For the second time (2012 and 2015), we were able to survey Unit 22A, a management area without an established hunting season for muskox. Groups located in the eastern portion of the Nulato Hills were included in this portion of the survey. A total of 18 groups comprised of 143 individuals were classified, and the survey results are 64MB: 100C[i], 21SY:100C[ii], and 9% SY[iii].

Composition survey results within most management areas indicate stable or increasing bull cow ratios, while range-wide bull: cow ratios have increased from 29MB: 100C (2012) to 39MB: 100C (2015). As in 2012, the highest bull: cow ratios observed during 2015 existed in un-hunted portions of the population in the Nulato Hills with 64MB: 100C. The percent of short-yearlings classified (recruitment) remains low and composition data indicate all management areas below 14%. The range-wide recruitment rate is 8%.

We will provide further analysis and additional composition results in a separate report. Comparative composition survey results from all range-wide surveys can be found in Table 2. For the purposes of this summary several management areas were combined to allow for comparison among years (22B: 22B West and 22B East, 22A: 22A and 21D Nulato Hills, 22D: 22D Remainder, 22D Kuzitrin and 22D SW).

Distribution List:
Steve Machida, ADF&G- Anchorage
Peter Bente, ADF&G- Nome
Jim Dau, ADF&G- Kotzebue
Brandon Saito, ADF&G- Kotzebue
Letty Hughes, ADF&G- Nome
Bill Dunker, ADF&G- Nome
Adam Craig, ADF&G- Anchorage
Geoff Carrol, ADF&G- Barrow
Phil Perry, ADF&G- Bethel
Patrick Jones, ADF&G- Bethel
Beth Lenart, ADF&G- Fairbanks
Jim Lawler, NPS- Fairbanks
Jeanette Koelsch, NPS- Nome
Ken Adkisson, NPS- Nome
Josh Schmidt, NPS- Fairbanks
Marci Johnson, NPS-Kotzebue
Susan Georgette, USFWS- Kotzebue
Brad Scotton, USFWS- Galena
Bruce Seppi, BLM- Anchorage
Tom Sparks, BLM- Nome

Table 1. Estimated number of muskoxen in each game management subunit on the Seward Peninsula in March 2015. Estimated population change was calculated using the difference between the point estimates (based on distance sampling) from the two years. Although there were large apparent changes in several subunits, all 2015 estimates overlapped those from 2012. Change since 2012 represents the difference between the annual point estimates.

GMU	2012	CV	2015	CV	Change since 2012
21d	—	—	146 (78-278)	36%	—
22a	84 (58-139)	25%	194 (136-306)	23%	+131%
22b.e	80 (49-150)	33%	181 (112-305)	27%	+126%
22b.w	380 (332-452)	8%	274 (216-377)	15%	-28%
22c	289 (247-355)	9%	358 (302-456)	11%	+24%
22d.kuz	208 (169-279)	14%	187 (131-290)	22%	-10%
22d.rem	344 (298-414)	9%	258 (207-352)	15%	-25%
22d.sw	77 (58-108)	16%	78 (57-129)	24%	1%
22e	431 (362-549)	11%	291 (204-433)	20%	-32%
23other	110 (84-159)	17%	71 (39-149)	41%	-35%
23sw	222 (171-319)	17%	192 (104-340)	32%	-14%
SewPen.all	2223 (1971-2660)	8%	2287 (1895-2832)	10%	+3%
SewPenNew	—		422 (296-621)	20%	—
SewPenOld	—		1853 (1541-2285)	10%	—

Table 2. Range-wide composition survey results.

Year	Total Grps	Total Sample	% Of Pop. Sampled	MB:100C[i]	SY:100C[ii]	%SY[iii]
2002*	76	1317	64%	44MB:100C	44SY:100C	18%
2012	89	1447	65%	29MB:100C	23SY:100C	12%
2015	76	1040	46%	39MB:100C	17SY:100C	8%

Figure 1. Muskox group locations found during the 2015 Seward Peninsula muskox population survey.

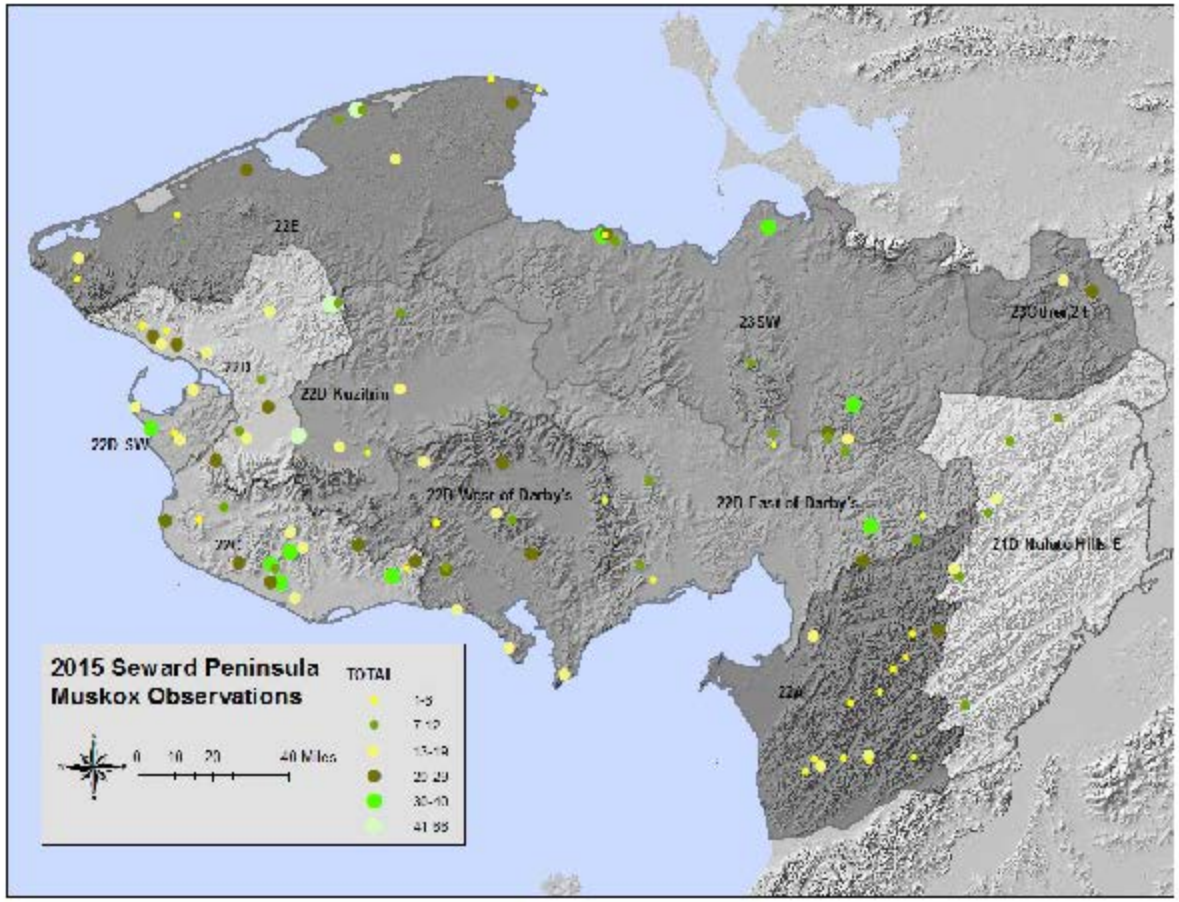


Figure 2. Distance sampling survey muskox transects (4 mile spacing) flown during the 2015 muskox population survey.

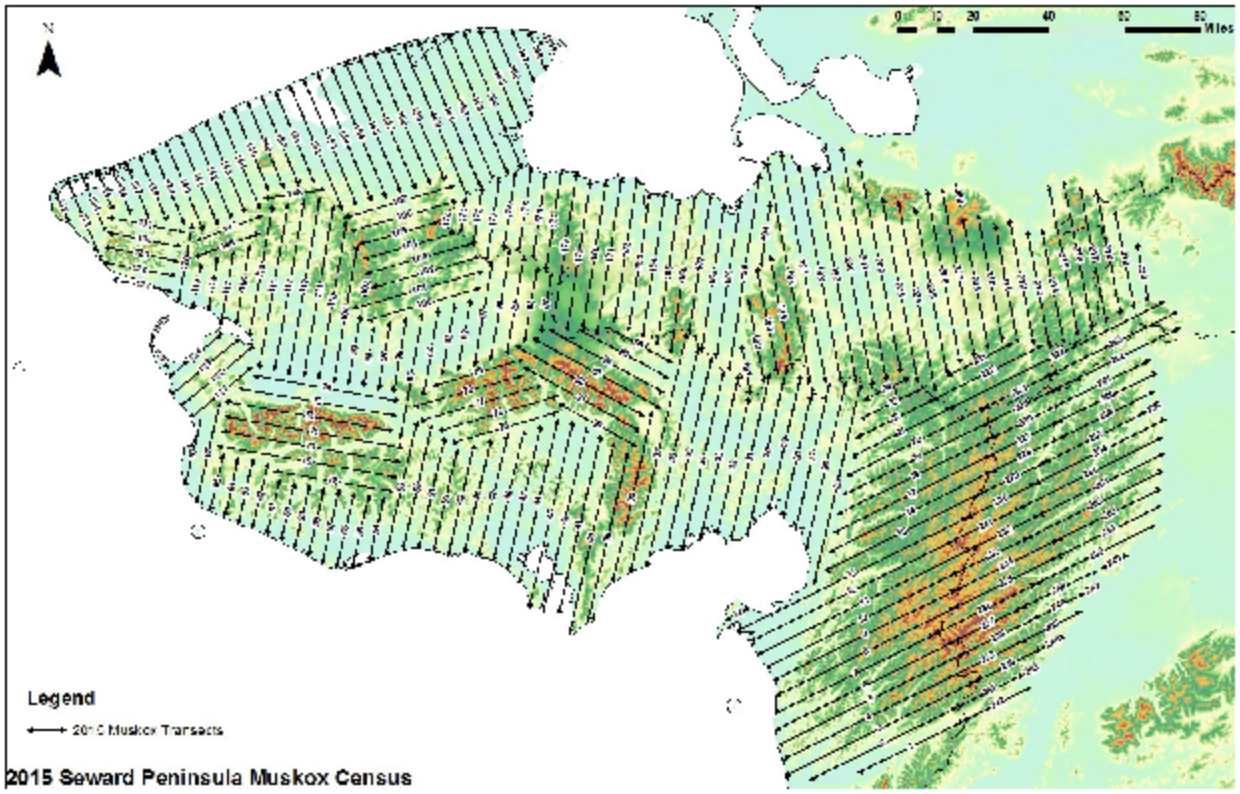


Figure 3. Proportional Distribution of Muskox Groups

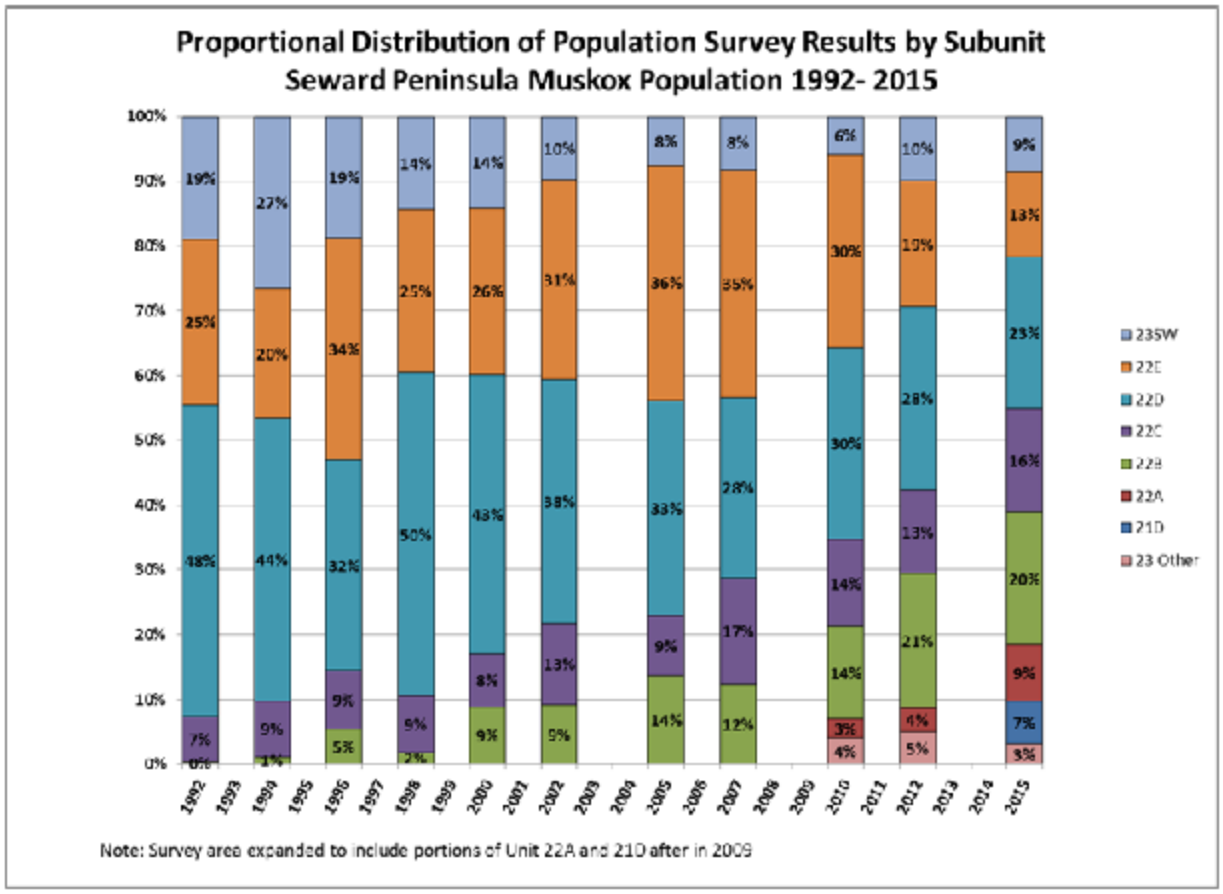
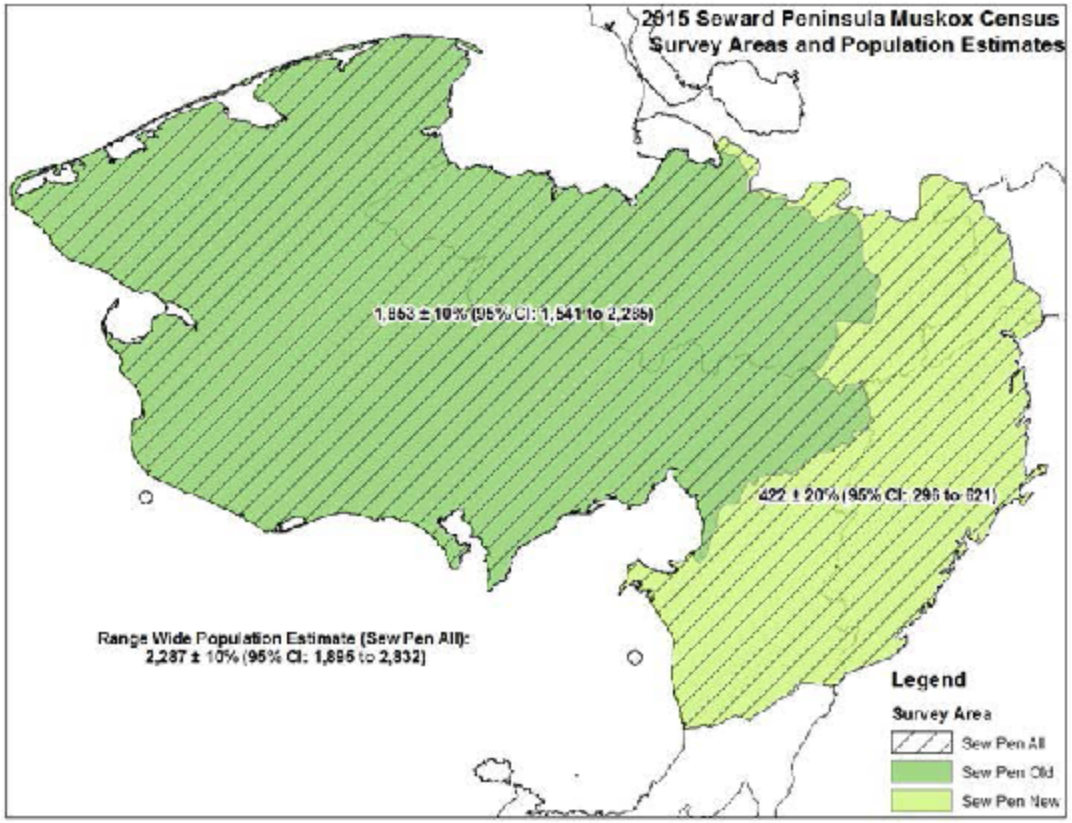


Figure 4. Distance sample population estimates Seward Peninsula muskox population survey areas.



APPENDIX B: METHODS FOR MUSKOX POPULATION ESTIMATION ANALYSES

Gorn, T. and W. R. Dunker. 2013. Unit 22 muskox. Pages 17–51 [*In*] P. Harper, editor. Muskox management report of survey and inventory activities 1 July 2010–30 June 2012. Alaska Department of Fish and Game, Division of Wildlife Conservation, Species Management Report ADF&G/DWC/SMR-2013-2, Juneau.

Pg. 19-20:

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 programming language (http://www.r-project.org/) 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.

APPENDIX C. 2015 muskox composition survey results memo, 29 June 2015 ERRATUM.

THE STATE of ALASKA
GOVERNOR BILL WALKER

Department of Fish and Game
DIVISION OF WILDLIFE CONSERVATION
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MEMORANDUM

TO:	Distribution (see below)	DATE: June 29, 2015 ERRATUM	
FROM:	Bill Dunker Wildlife Biologist I Wildlife Conservation Nome	PHONE: 907-443-8189 SUBJECT: 2015 Muskox Composition Survey Results	

ERRATUM: Short yearling defined as 10–15 months-old for comparison to previous surveys.

Overview:

Composition surveys were completed between 7 Apr, 2015 and 3 May, 2015, following the completion of the 2015 Seward Peninsula muskox population abundance survey, with contributions from the Alaska Department of Fish & Game and the National Park Service. Surveys were completed throughout the range of the Seward Peninsula muskox population, this included portions of Unit 22A, Unit 21D, Unit 23, Unit 24 and all of Subunits 22B, 22C, 22D, and 22E (Figure 1). A total of 76 groups totaling 1062 muskox were sampled (46% of the 2015 abundance estimate).

Methods:

Muskox groups observed during the 2015 Seward Peninsula muskox population abundance survey were divided into three classes based on group size; small (1-16 muskox), medium (17-33 muskox) and large (≥34 muskox). Within each management area, our goal was to sample a proportionate number of individuals from each group class with an overall sampling objective of 150 muskox per management area. In management areas where <150 muskox were observed, all groups were selected to be sampled.

As with previous composition surveys (2001-2012), these were ground based surveys conducted in early spring (March-May). Several groups in close proximity to Nome were accessed by snowmachine, however the majority of groups were accessed using an R-44 helicopter. At each group 2 trained observers used binoculars and spotting scopes to classify muskoxen into one of 8 sex/age classes (bull≥4yrs, bull=3yrs, bull=2yrs, cow≥4yrs, cow=3yrs, cow=2yrs, short yearlings (SY) and calves) based on body size, horn characteristics and conformation. In some instances, small groups of mature bulls were identified from fixed wing aircraft, either during the population abundance survey or during subsequent reconnaissance flights to relocate groups. Groups of this nature were not revisited during composition survey flights, but were included in the composition survey.

Ratios of MB:100C (males ≥4yrs/100 females ≥3yrs) and SY:100C (15mo≥ muskox ≥10mo/100 females ≥3yrs) as well as proportion estimates $\hat{p}_{SY}$ and $\hat{p}_{MB}$ were calculated. A 95% CI is reported for $\hat{p}_{SY}$ and $\hat{p}_{MB}$. Several subunit estimates include multiple management areas; subunit 22A includes management areas 22A and 21D Nulato Hills E, subunit 22B includes management areas 22B East and 22B West, subunit 22D includes management areas 22D Kuzitrin, 22D Remainder and 22D SW.

Results:

2015 range wide composition survey results for the Seward Peninsula muskox population are presented in Table 1 and Figure 2 along with the results of previous surveys for comparison (2002-2015). Similarly, 2015 survey results by subunit are presented in Table 2 and Figures 3-9.

Discussion:

The 2015 composition survey is now the third time (2002, 2012, and 2015) range wide surveys have been conducted (Table 1). We successfully completed composition surveys in all management areas except 23 Other, 24. The presence of a relatively small muskox population, in conjunction with the logistical considerations of the project as a whole, prevented us from committing time and resources to this portion of the range. Approximately 8 survey days were needed to complete the surveys. Survey crews operated out of both Kotzebue and Nome in order to improve the efficiency of the survey. Conducting surveys in 22A was the most time intensive and costly due to its distance from both Nome and Kotzebue.

The 2012 and 2015 range wide composition survey estimated 29 MB:100C ($\hat{p}_{MB}$=15% (14%-16% 95% CI)) and 39 MB:100C ($\hat{p}_{MB}$=20% (18%-22% 95% CI)), respectively, indicating a probable increase in mature bulls (bulls≥4yrs). Individual subunit estimates also indicate an increase in mature bulls in most subunits. The increase in mature bulls is likely a result of 3 consecutive years (regulatory years 2012-2014) of reduced harvest intended to increase the number of mature bulls in the population. The realized annual harvest rate was less than 2% during this time (Figure 10).

Recruitment rates remain low throughout the range of the Seward Peninsula muskox population. The 2015 survey estimate was 8% $\hat{p}_{SY}$ (7%-9% 95% CI) range wide. Recruitment was lowest in subunit 22C and the highest in subunit 23SW with 4% $\hat{p}_{SY}$ (2%-6% 95% CI) and 14% $\hat{p}_{SY}$ (9%-19% 95% CI), respectively. Anecdotal evidence suggests that low recruitment may be a result of bear predation during the calving period though this may not be the only cause.

The Seward Peninsula muskox population survey area was expanded in 2015 to include the eastern half of the Nulato Hills (21D, Nulato Hills E, Figure 1). Composition surveys were also conducted in this area. This provides a more complete understanding of the population composition in this portion of the range. This area is of particular interest because no muskox hunting has taken place since the reintroduction of muskox to the Seward Peninsula. 2015 survey estimates include 64 MB:100C ($\hat{p}_{MB}$=24% (21%-27% 95% CI)) with 8% $\hat{p}_{SY}$ (6%-10% 95% CI). This indicates that the number of mature bulls has remained relatively constant in the area since 2012. In addition, the proportion of bulls in this area is greater than in any other management area. However, the recruitment rate decreased significantly from 2012 when 23% $\hat{p}_{SY}$ (15-31% 95% CI)) were found.

Assessing how well our sampling effort met the sampling objectives in each management area is twofold: (1) did we sample 150 muskox? and (2) was a proportionate number of animals sampled from

each group size class? In management areas 22A, 21D Nulato Hills, 22B West and 22C, both sampling objectives were achieved. In management areas 22D Rem and 22E, we successfully sampled approximately 150 animals but did not sample a proportionate number of animals from each group size class due to a limited number of small groups encountered. In the remaining management areas we did not meet either sampling objective because of a limited number of muskox (<150). However, the sample size obtained in each of these management areas is still more than adequate since it included >50% of the minimum count (Table 3).

The 2015 composition survey sampling protocol reduced sampling effort in each management area. For comparison, the 2012 sampling objective was to classify at least 15 selected groups or 200 individuals in each management area. These guidelines were based on historic variability, the sample sizes and confidence intervals of previous surveys, as well as a series of simulations. They were established to ensure that composition surveys could effectively estimate MB:100C and SY:100C ratios with a degree of precision that allowed us to monitor changes in the demographics of the herd, range wide, as well as within individual subunits.

Obtaining precise estimates of MB:100C and SY:100C requires a great deal of sampling effort due to compounding variance. Following biometric review of the composition survey protocol it was determined that the 2015 survey effort and all future surveys of this nature should focus on obtaining precise estimates of $\hat{p}_{SY}$ and $\hat{p}_{MB}$. Focusing on these metrics ultimately allows us to reduce our sampling effort while still: (1) ensuring estimates fall within the range of precision necessary to meet management objectives, (2) continuing to monitor the population, and (3) effectively administering hunts. MB:100C and SY:100C ratios will continue to be reported, however confidence intervals will no longer be calculated for these metrics.

Distribution List:

Steve Machida, ADF&G- Anchorage
Peter Bente, ADF&G- Nome
Jim Dau, ADF&G- Kotzebue
Brandon Saito, ADF&G- Kotzebue
Letty Hughes, ADF&G- Nome
Tony Gorn, ADF&G- Nome
Adam Craig, ADF&G- Anchorage
Ryan Klimstra, ADF&G- Barrow
Phil Perry, ADF&G- Bethel
Patrick Jones, ADF&G- Bethel
Beth Lenart, ADF&G- Fairbanks
Jim Lawler, NPS- Fairbanks
Jeanette Koelsch, NPS- Nome
Ken Adkisson, NPS- Nome
Josh Schmidt, NPS- Fairbanks
Marci Johnson, NPS-Kotzebue
Susan Georgette, USFWS- Kotzebue
Brad Scotton, USFWS- Galena
Bruce Seppi, BLM- Anchorage
Tom Sparks, BLM- Nome

Table 1. Range wide composition estimates 2002-2015

Population	Year	# Grps	# Muskox	MB:100C	SY:100C	$\hat{p}_{SY}$	$\hat{p}_{MB}$
Sew Pen	2002	76	1345	44	44	18%(17%-19% 95% CI)	18%(17%-19% 95% CI)
Sew Pen	2012	89	1449	29	23	12%(11%-13% 95% CI)	15%(14%-16% 95% CI)
Sew Pen	2015	76	1062	39	17	8%(7%-9% 95% CI)	20%(18%-22% 95% CI)

Table 2. Subunit composition estimates 2002-2015

Population	Year	# Grps	# Muskox	MB:100C	SY:100C	$\hat{p}_{SY}$	$\hat{p}_{MB}$
22A	2012	9	104	69	69	23%(15%-31% 95% CI)	23%(15%-31% 95% CI)
22A	2015	18	164	64	21	8%(6%-10% 95% CI)	24%(21%-27% 95% CI)
22B	2002	16	178	58	48	18%(17%-19% 95% CI)	22%(20%-24% 95% CI)
22B	2004	15	236	39	39	18%(13%-23% 95% CI)	18%(13%-23% 95% CI)
22B	2007	22	317	48	35	15%(14%-16% 95% CI)	21%(20%-22% 95% CI)
22B	2009	11	196	38	26	11%(6%-16% 95% CI)	17%(12%-22% 95% CI)
22B	2010	14	215	30	25	14%(11%-17% 95% CI)	17%(13%-21% 95% CI)
22B	2012	15	278	28	19	10%(8%-12% 95% CI)	16%(13%-19% 95% CI)
22B	2015	20	218	44	12	6%(4%-8% 95% CI)	22%(18%-26% 95% CI)
22C	2002	15	209	70	57	19%(17%-21% 95% CI)	23%(20%-26% 95% CI)
22C	2004	16	217	86	26	10%(6%-14% 95% CI)	32%(26%-38% 95% CI)
22C	2007	29	412	57	37	16%(15%-17% 95% CI)	25%(24%-26% 95% CI)
22C	2008	18	283	31	33	16%(12%-20% 95% CI)	15%(11%-19% 95% CI)
22C	2009	20	352	35	19	9%(6%-12% 95% CI)	16%(12%-20% 95% CI)
22C	2011	19	319	21	32	17%(13%-21% 95% CI)	11%(8%-14% 95% CI)
22C	2012	13	243	26	22	12%(10%-14% 95% CI)	14%(12%-16% 95% CI)
22C	2015	8	155	45	7	4%(2%-6% 95% CI)	26%(21%-31% 95% CI)
22D	2002	21	455	33	41	19%(17%-21% 95% CI)	15%(13%-17% 95% CI)
22D	2006	31	516	42	36	16%(13%-19% 95% CI)	19%(16%-22% 95%CI)
22D	2010	18	259	54	18	9%(6%-12% 95% CI)	26%(21%-31% 95% CI)
22D	2011	27	467	29	24	13%(10%-16% 95% CI)	15%(12%-18% 95% CI)
22D	2012	15	259	22	13	8%(5%-11% 95% CI)	13%(10%-16% 95% CI)
22D	2015	17	287	26	19	11%(9%-13% 95% CI)	15%(12%-18% 95% CI)
22E	2002	14	341	49	49	17%(14%-20% 95% CI)	17%(14%-20% 95% CI)
22E	2005	38	517	35	32	15%(13%-17% 95% CI)	16%(14%-18% 95% CI)
22E	2010	28	363	51	32	15%(12%-18% 95% CI)	23%(20%-26% 95% CI)
22E	2011	25	375	53	59	21%(17%-25% 95% CI)	19%(15%-23% 95% CI)
22E	2012	15	219	33	28	13%(10%-16% 95% CI)	15%(12%-18% 95% CI)
22E	2015	7	142	39	21	10%(6%-14% 95% CI)	18%(13%-23% 95% CI)
23SW	2002	10	162	33	31	14%(12%-16% 95% CI)	15%(13%-17% 95% CI)
23SW	2010	11	157	19	18	11%(9%-13% 95% CI)	11%(9%-13% 95% CI)
23SW	2011	8	127	22	10	6%(2%-10% 95% CI)	13%(7%-19% 95% CI)
23SW	2012	12	239	24	22	11%(7%-15% 95% CI)	12(8%-16% 95% CI)
23SW	2015	6	96	32	26	14%(9%-19% 95% CI)	17%(12%-22% 95% CI)
23SE	2012	8	81	27	16	9%(4%-14% 95% CI)	15%(9%-21% 95% CI)

Table 3. Distribution of muskox in minimum count and composition survey among different group size classes (S=small, 1–16 muskox; M=medium, 17–33 muskox; and L=large, ≥34 muskox).

Mgmt Area	Min Count #Ind	Min Count #Grps	Comp Surv #Ind	Comp Surv #Grps	Min Count % S	Min Count % M	Min Count % L	Comp Surv % S	Comp Surv % M	Comp Surv % L
22A, 21D Nulato Hills*	212	23	143*	18	83%	17%	0%	62%	38%	0%
22B East*	114	10	79*	8	80%	20%	0%	75%	25%	0%
22B West	182	12	138	12	58%	42%	0%	57%	43%	0%
22C	374	17	155	8	35%	41%	24%	28%	50%	22%
22D Rem	254	14	162	10	57%	29%	14%	31%	36%	33%
22D Kuz	54	5	33	2	80%	20%	0%	42%	58%	0%
22D SW	93	5	92	5	60%	20%	20%	37%	20%	43%
22E	171	11	142	7	64%	27%	9%	19%	27%	54%
23 SW	151	8	96	6	50%	38%	13%	40%	26%	34%
23, Other 24	39	2	0	0	0%	100%	0%	0%	0%	0%

*not including calves observed

Figure 1. 2015 Seward Peninsula Population Management Areas

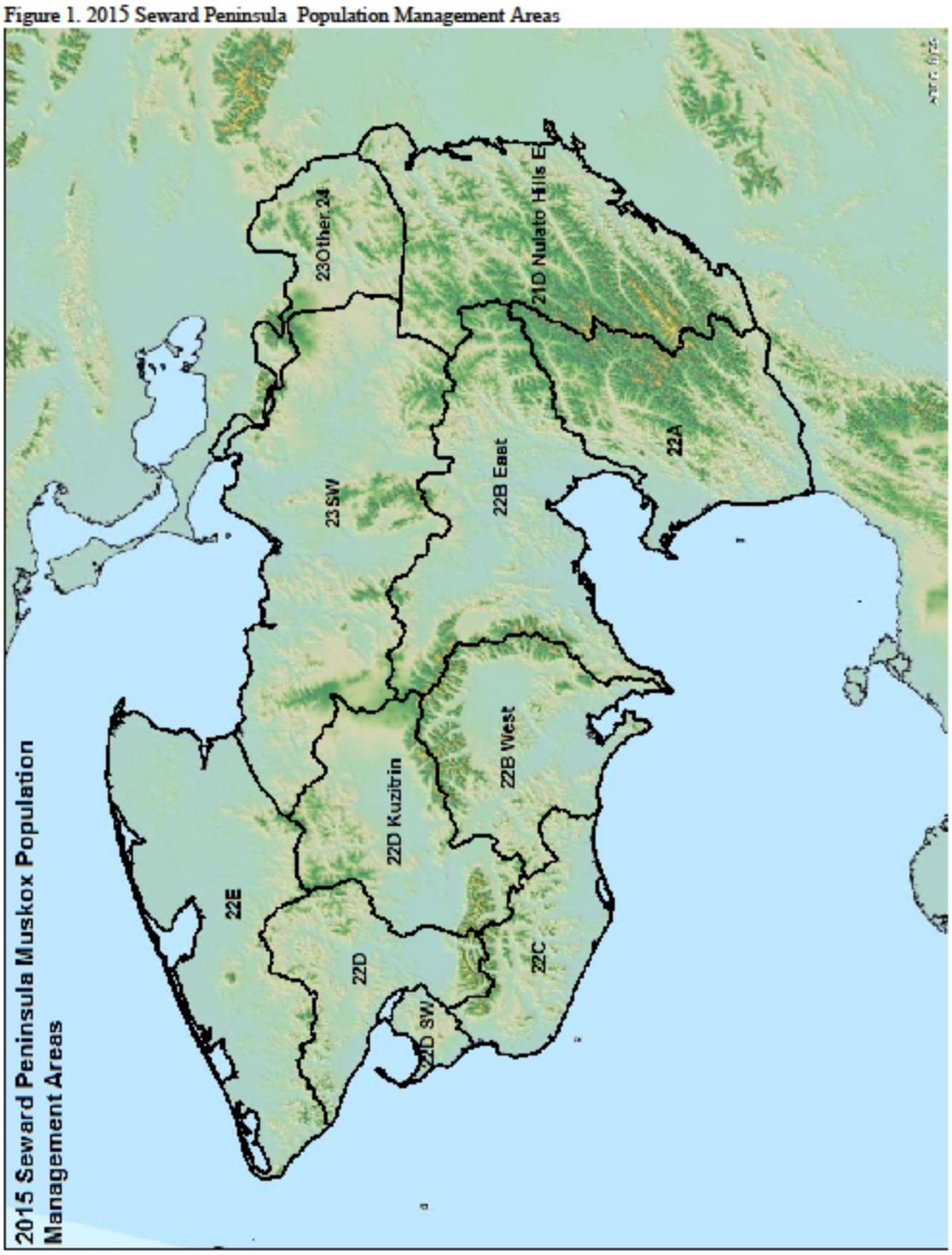

Figure 2. Seward Peninsula Muskox Population Composition, 2002-2015.

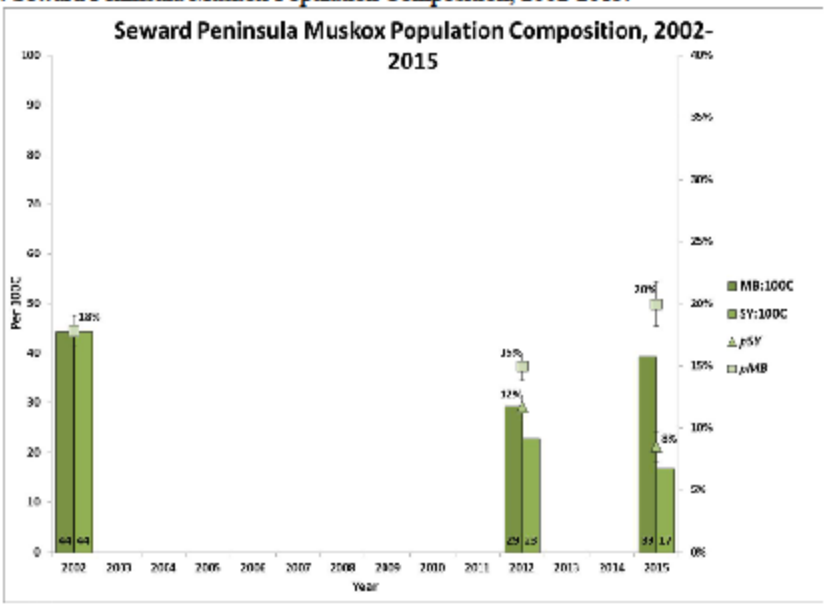

Figure 3. Subunit 22A Composition, 2012-2015.

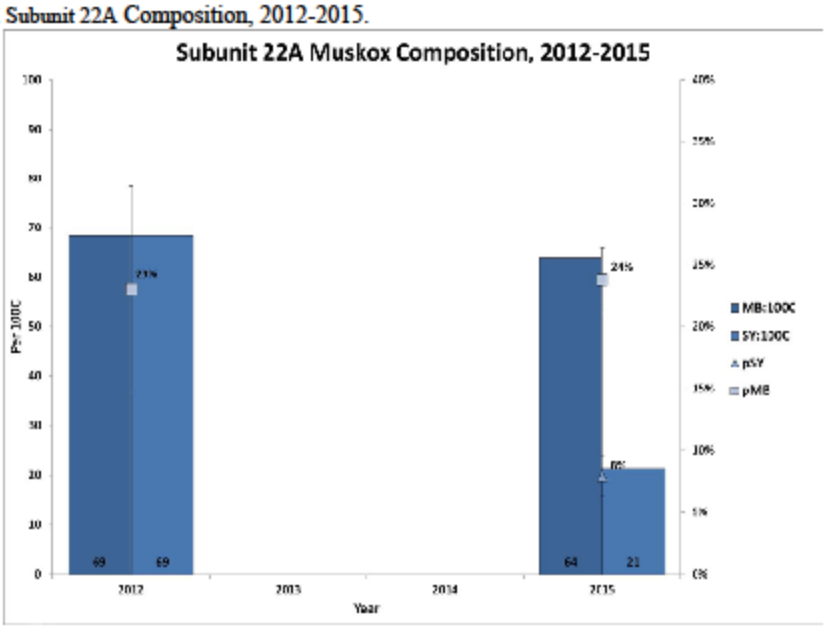

Figure 4. Subunit 22B Composition, 2002-2015.

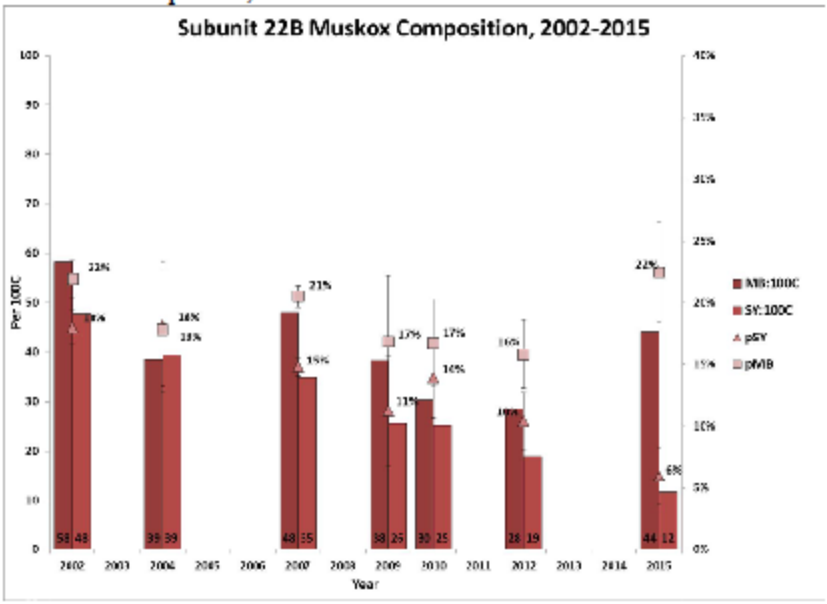

Figure 5. Subunit 22C Composition, 2002-2015.

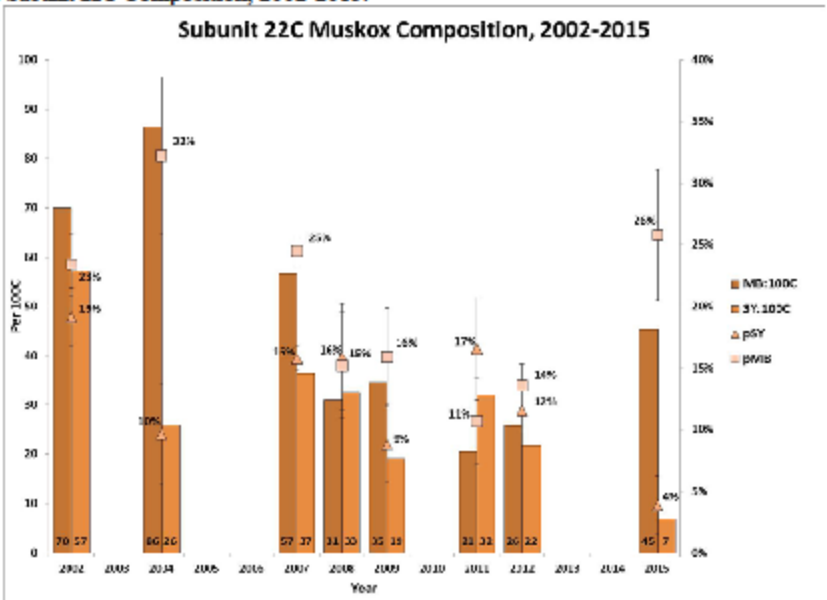

Figure 6. Subunit 22D Composition, 2002-2015.

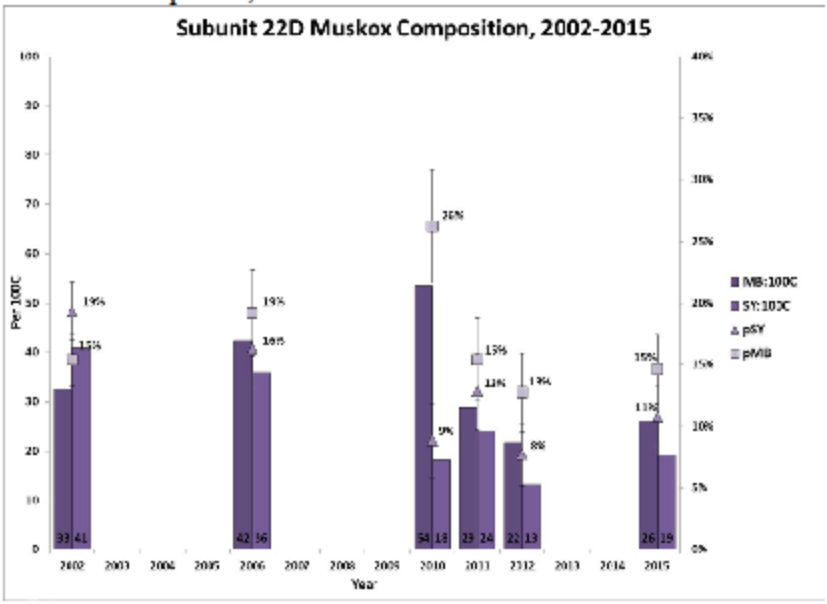

Figure 7. Subunit 22E Composition. 2002-2015 (Excludes fall Surveys).

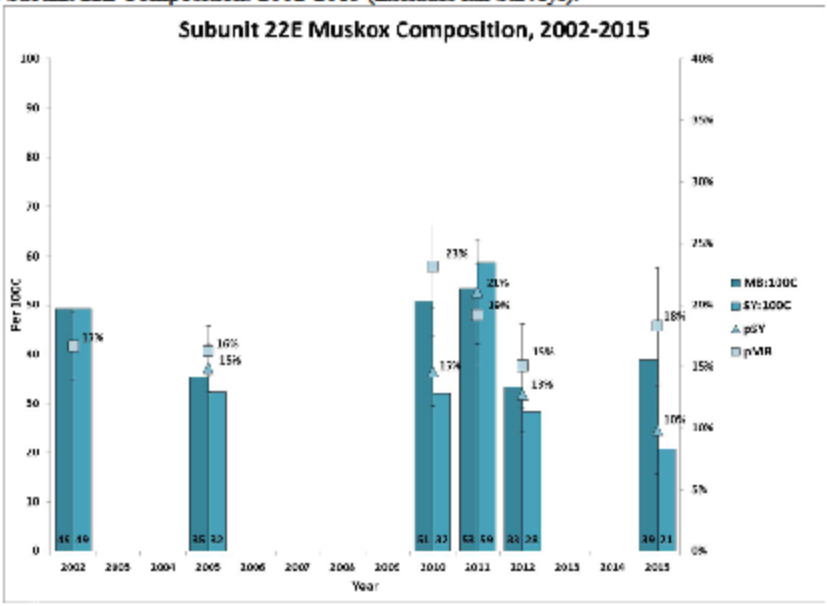

Figure 8. Subunit 23 SW Composition, 2002-2015 (Excludes fall Surveys).

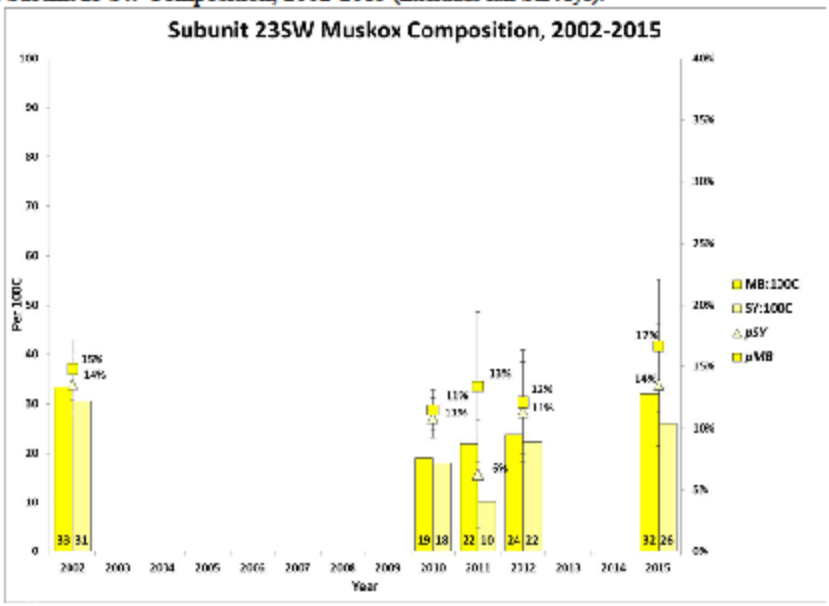

Figure 9. Subunit 23 SE Composition, 2012

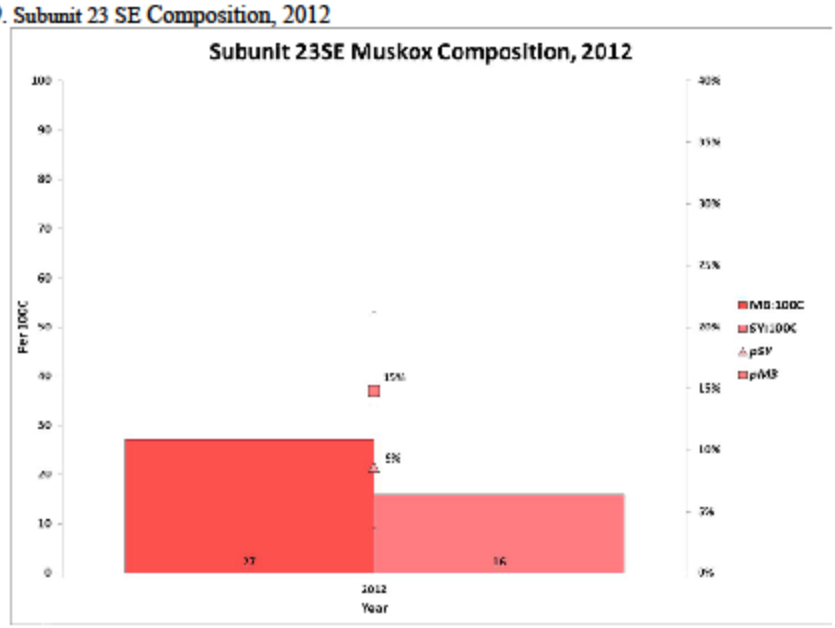

Figure 10. Seward Peninsula reported muskox harvest, regulatory years 1995-2014