Moose
Management Report
of Survey-Inventory Activities
1 July 2001–30 June 2003

Cathy Brown, Editor
Alaska Department of Fish and Game
Division of Wildlife Conservation
December 2004

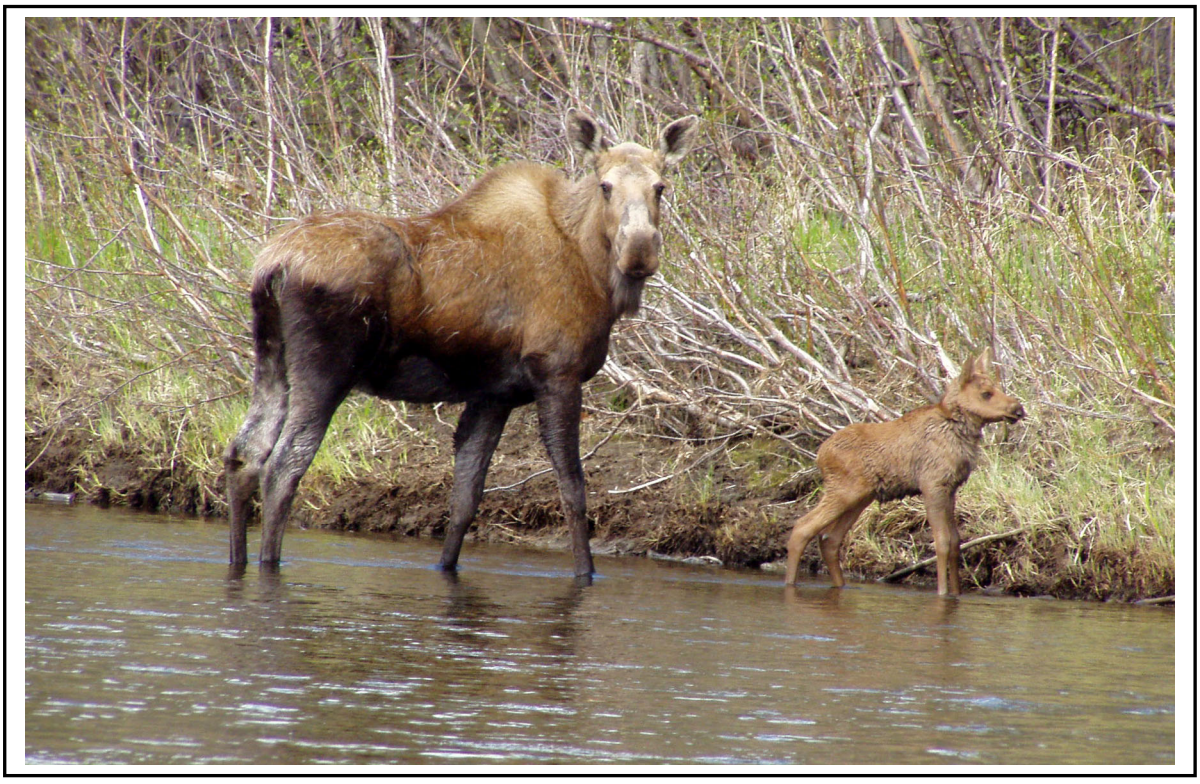

Photo by Randy Rogers, ADF&G

Please note that population and harvest data in this report are estimates and may be refined at a later date.

If this report is used in its entirety, please reference as: Alaska Department of Fish and Game. 2004. Moose Management Report of Survey-Inventory Activities 1 July 2001–30 June 2003. C. Brown, editor. Juneau, Alaska. If used in part, the reference would include the author's name, unit number, and page numbers. Authors' names can be found at the end of each unit section.

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Publications Specialist
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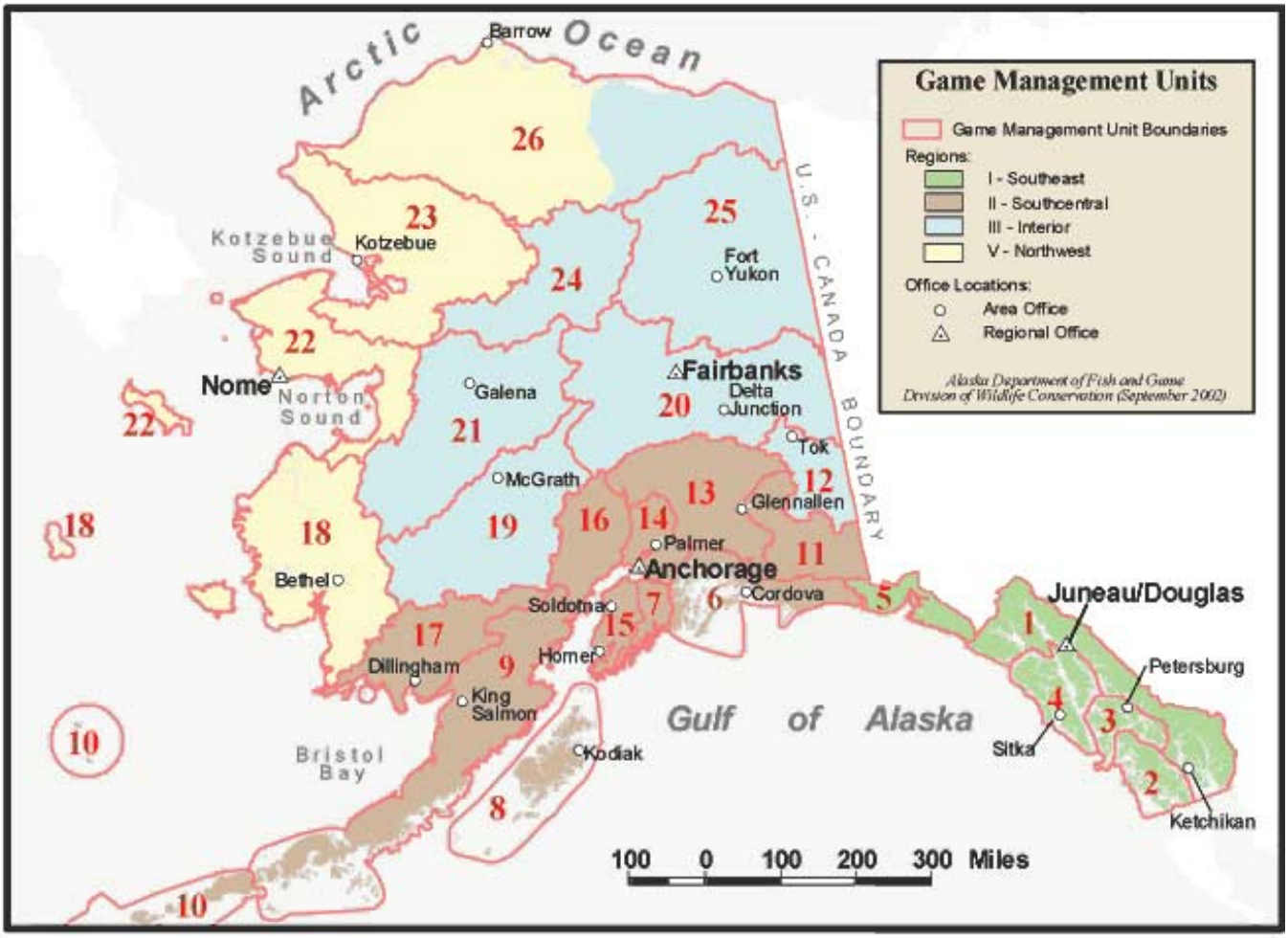
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Division of Wildlife Conservation
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JUNEAU, AK 99802-5526

MOOSE MANAGEMENT REPORT

From: 1 July 2001
To: 30 June 2003

LOCATION

GAME MANAGEMENT UNIT: 18 (42,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Yukon-Kuskokwim Delta

BACKGROUND

Moose are thought to have begun migrating to the Yukon-Kuskokwim Delta during the mid to late 1940s. Local elders from the Yukon River have confirmed this timing. The Yukon population occupies most of the available riparian habitat and the population is growing. The Kuskokwim population is small and is still in the process of colonizing the available riparian habitat. Most of the Yukon-Kuskokwim Delta is lowland treeless tundra, which is not suitable as winter habitat for moose.

Moose densities are moderate and growing in the Yukon River drainage, but very low throughout the entire lower Kuskokwim River drainage. Although moose are now more common than in the past, overall densities in Unit 18 are low relative to habitat availability.

Heavy hunting pressure from communities along the Kuskokwim River has effectively limited moose population growth along that riparian corridor. While moose population growth along the Yukon River had been slowed for similar reasons, compliance with hunting regulations has improved and moose populations there have responded. Extensive habitat is available for moose colonization and range expansion along most of the lower Kuskokwim River and its larger tributaries. Moose densities in adjacent Units 17, 19 and 21E remain higher than moose densities in Unit 18.

The boundaries of Unit 18 and those of the Yukon Delta National Wildlife Refuge (YDNWR) nearly coincide. The southern tip of Unit 18 is within the Togiak National Wildlife Refuge (TNWR). ADF&G shares common interests with the refuges and we regularly cooperate during surveys, field projects, and public meetings.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Allow the Unit 18 moose populations to increase to the levels the habitat can support.
- Maintain healthy age and sex structures for moose populations within the Yukon and Kuskokwim River drainages.

- Determine population size, trend, and composition of Unit 18 moose populations.
- Achieve a continual harvest of bulls without hindering population growth.
- Improve harvest reporting and compliance with hunting regulations.
- Minimize conflicts among user groups interested in moose within and adjacent to Unit 18.

MANAGEMENT OBJECTIVES

- Allow the lower Yukon River moose population to increase above its estimated size of 2500–3500 moose. Allow the lower Kuskokwim River moose population to increase above its estimated size of 75–250 moose to at least 2000 moose.
- Maintain the current age and sex structure for both populations, with a minimum of 30 bulls: 100 cows.
- Conduct seasonal sex and age composition surveys as weather allows.
- Conduct winter censuses and recruitment surveys in the established survey areas on a rotating basis.
- Conduct fall and/or winter trend counts to determine population trends.
- Conduct hunts consistent with population goals.
- Improve knowledge of, and compliance with, harvest reporting requirements and hunting regulations through education and incentives.
- Address user conflicts through education and hunter contacts.

METHODS

We monitor moose harvests and hunting activity in Unit 18 using harvest tickets/reports and by contacting hunters in the field. In September 2001 we operated a hunter check station at Paimiut Slough along the Yukon River near the border of Units 18 and 21E. In 2002 we contacted Unit 18 hunters within the Kuskokwim River drainage by boat. Whenever possible, we collect incisors and take antler measurements. Hunter participation is voluntary.

We've conducted an incentive program to encourage hunters to turn in their harvest reports annually since 1998. The department purchased prizes that were randomly distributed to hunters selected from a list of those who returned harvest reports. In recent years, hooded sweatshirts emblazoned with a logo depicting the potential reproduction from one cow moose were awarded as prizes. We held the drawing in August just prior to the upcoming hunting season.

In March 2002 we conducted moose censuses using spatial census (geostatistical) methods developed by Ver Hoef (2001). The survey area boundaries are shown in Figure 1 and are delineated within Unit 18 as follows:

- Paimiut Area: The Yukon River from old Paimiut Village downstream to Pilot Village.
- Andreafsky Area: The Yukon River from Pilot Village downstream to Mountain Village.
- Lowest Yukon Area: The Yukon River downstream from Mountain Village.
- Lower Kuskokwim Area: The Kuskokwim River riparian corridor between Kalskag and Kwethluk.
- Nyac Area: The uplands of the eastern tributaries of the lower Kuskokwim River and the riparian corridor along the Kisaralik River. This census area has been delineated, but has not yet been surveyed.

We altered the size of our survey areas to achieve cost savings, safety, and other efficiencies and to allow us to conduct a census in more than one area per year. Table 1 lists the size of the areas surveyed during each census and Figure 1 depicts the larger survey areas. We plan to census all of the Yukon River drainage survey areas in one year and alternate with the Kuskokwim River drainage survey areas the following year.

We conducted composition counts within the Yukon River survey areas in spring 2003 and in winter 2003. These surveys provided a measure of productivity and survival and provided an opportunity to observe body condition.

During August and September 2002, we conducted browse surveys along the mainstem of the Yukon and Kuskokwim Rivers using a boat and following methods developed by Seaton (2002).

We continued a cooperative strategy to establish a moose population along the Lower Kuskokwim River with the Lower Kuskokwim Fish and Game Advisory Committee (LKAC), the Association of Village Council Presidents (AVCP), interested individuals, and the U.S. Fish and Wildlife Service (FWS). As part of this effort, we conducted trend counts with observers from the Kuskokwim River villages to compare the Yukon River moose population to the number of moose on the Kuskokwim River.

We provided public information and education through public service announcements made available to the media, regular newspaper articles, and informal hunter contacts. We distributed coffee cups emblazoned with an educational logo depicting the potential production of one cow moose to hunters, advisory committee members, village leaders, Board of Game members, and others influential with hunters. This "moose circle coffee cup" has become a valuable focus for our educational efforts.

We provided enforcement information to the Department of Public Safety, Division of Fish and Wildlife Protection (now the Bureau of Wildlife Enforcement (ABWE) in Bethel and Aniak.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

In March 2002, we conducted moose population censuses in the Lowest Yukon, Andreafsky, Paimiut, and Lower Kuskokwim survey areas (Table 1). In general, the Yukon River moose population has continued to grow but a population along the Lower Kuskokwim has not yet become established.

Unless otherwise noted, the following results are reported at the 95% CI.

The moose population in the Lowest Yukon Area grew from a minimum count of 65 moose in 1994 to an estimated 674 ± 21.9% in 2002. Prior to 2002, this area was censused over a much larger area using a minimum count method because the extremely low moose numbers made Gasaway style (Gasaway et al. 1986) census methods impractical.

The moose population in the Andreafsky Area was estimated at 524 ± 29.8% moose in 1999 and at 418 ± 22.4% moose in 2002. However, the size of this count area was reduced in 2002 and the midpoint of the density estimate increased between these 2 surveys from 0.23 to 0.36 moose/mi^2; however, this difference was not significant. By eliminating the northern half of this survey area, we removed the most difficult and dangerous terrain and saved time and money, making it possible to complete surveys of all the Yukon River survey areas in one season.

The moose population in the Paimiut Area was estimated at 2024 ± 12.9% moose in 1999 using Gasaway style census methods. In 2002 this population was estimated at 2382 ± 16.1% moose using spatial methods. The midpoint of the density estimate increased from 1.30 to 1.52 moose/mi^2, but the difference was not significant.

In 2000 and 2002 we estimated the number of moose at 86 ± 26.4% and 117 ± 18.3% respectively in the Lower Kuskokwim Area using spatial techniques. The midpoint of the density estimate increased from 0.09 to 0.13 moose/mi^2 but the difference was not significant.

The moose density within the Lower Kuskokwim Area was 0.13 moose/mi^2 in 2002 but the moose habitat in this area is comparable to that in the Paimiut Area where the moose density in 2002 was 1.52 moose/mi^2. Clearly, the moose habitat in the Lower Kuskokwim Area is underutilized.

We planned to conduct population censuses in the Yukon River survey areas in 2001 and 2003, but they were canceled due to low snow accumulations and inadequate survey conditions. This is why our schedule of surveying each major river system every other year was not followed.

During January 2000, March 2001, and April 2002, we conducted moose trend counts to compare moose densities within the Kuskokwim River drainage to those along the Yukon River within the Paimiut Area (Table 2). We flew 4 passenger aircraft and flew at 80 mph, 700 feet indicated altitude or 500 feet above ground level and counted moose in the best moose habitat near the rivers. The observers included a pilot, a biologist, and 1 or 2 observers from Kuskokwim River villages per flight. An additional goal of these trend counts was to educate the village observers by giving them a perspective of the potential for larger moose populations within the Kuskokwim River drainage.

Population Composition

During the winter moose censuses in March 2002, we classified adults and calves in each of the survey areas (Table 3). No sex composition information is available from these surveys because they were conducted during the winter after antlers were shed. Moose calf survival was high, probably due to mild winter conditions during the current and previous winters, low to moderate predation, and good habitat.

We conducted composition counts during calving within the Lowest Yukon Area on 7 June 2001; 6 June 2002; and 9 June 2003 (Table 4). Although sample sizes are small, these data suggest high twinning rates, good survival, low predation rates, and a young age structure in this recently colonized area.

The Paimiut Area typically experiences green up a week to 10 days earlier than other parts of the unit and although we attempted a composition count within the Paimiut Area in spring 2003, we were unable to obtain useful data due to early leaf emergence.

In March 2003, we conducted a winter composition count in the Paimiut and Lowest Yukon survey areas and found 28 calves:100 adults in the Paimiut Area and 81 calves:100 adults in the Lowest Yukon Area. These data are consistent with the 2002 observations of a stable to growing population in the Paimiut Area and of a rapidly growing population in the Lowest Yukon Area.

Distribution and Movements

Moose are distributed throughout the Yukon River riparian corridor with highest concentrations occurring during the winter. Within this riparian corridor, the densities are greatest in the Paimiut Area followed by the Lowest Yukon and Andreafsky areas. Moose are usually found at low density near the villages but along the Yukon River that tendency is less pronounced now compared to previous reporting periods. Some moose are also found along the tributaries and distributaries of the Yukon and in the highlands north of the Yukon River.

The number of moose wintering in the Paimiut Area was judged to be lower in 2003 than during previous years. We attribute this change in winter density to low snow rather than a genuine decline in the moose population. Scattered reports of moose near Hooper Bay, Ingakslugwat Mountains, and in other areas not considered to contain winter range supports our contention that moose were not confined to their normal winter areas in 2003.

Moose can be found throughout the year along the riparian corridor of the Kuskokwim River from Lower Kalskag to Bethel. They exist at extremely low densities given the available habitat. Moose are seen in the downriver third of this corridor only sporadically.

The area drained by the tributaries of the Kuskokwim River and those rivers draining into Kuskokwim Bay supports small numbers of moose as colonizing animals from adjacent areas arrive. However, these moose have not survived to establish localized populations except perhaps in the Kwethluk River drainage where we received reports of moose wintering in 2001, 2002, and 2003. The latest report included 18 moose.

We have some radiotelemetry data, which show that moose are entering Unit 18 from adjacent Unit 17. During this reporting period, 5 of 35 moose radiocollared in adjacent Unit 17A were located at least once in Unit 18. These moose appear to be colonizing the southern drainages of Unit 18 including the Goodnews and Kanektok River drainages where Togiak NWR staff observed 5 moose in March 2002. We also have reports from local residents of increasing numbers of moose in this area. (Aderman and Woolington, 2001, and Aderman, personal communication).

During the summer, moose are found in low numbers throughout the unit. Moose have been reported along the Manokinak and Izaviknek rivers, near Chevak, and even swimming in the ocean beyond the mouth of the Yukon River. While these reports are unusual, they make the point that moose move about broadly throughout the Yukon-Kuskokwim Delta.

MORTALITY

Harvest

Season and Bag Limit. Seasons and bag limits for this reporting period can be found in Table 5. The bag limit throughout Unit 18 is one bull.

On federal public lands within Unit 18, federal regulations limit moose hunting to Alaska residents of Unit 18 and residents of Upper Kalskag. Within the Kuskokwim River drainage upriver from and including the Tuluksak River drainage, federal regulations also permit residents of Aniak and Chuathbaluk to hunt on federal public lands.

Federal seasons in Unit 18 were the same as the State of Alaska seasons with 2 exceptions. The federal season within the Kuskokwim River drainage was from 25 August to 25 September. Also, there is no federal season in Unit 18 south of and including the Kanektok River drainages.

2001–2002 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 18, that portion north and west of a line from Cape Romanzof to Kusilvak Mountain, and then to Mountain Village, and excluding all Yukon River drainages upriver from Mountain Village		
1 bull	5 Sep – 25 Sep	5 Sep – 25 Sep
Remainder of Unit 18		
1 bull per regulatory year; during the period 1 Dec–28 Feb, a 10-day season may be announced by emergency order (this EO did not include the Kuskokwim River drainage or the portion of Unit 18 south and east of the Kuskokwim River drainage)	1 Sep–30 Sep 27 Dec–5 Jan	1 Sep – 30 Sep

2002–2003 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 18, all Yukon River drainages north of the south banks of Kwikluak Pass and the Yukon River, including sloughs, downstream of Mountain Village		
1 bull	1 Sep–25 Sep	5 Sep–25 Sep
Unit 18, south of the south banks of Kwikluak Pass and		

2002–2003 Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
the Yukon River, and north and west of a line from Cape Romanzof to Kuzilvak Mt., and then to Mountain Village		
1 bull	1 Sep – 25 Sep	No open season
Unit 18, all Yukon River drainages north of the south bank of the Yukon River, including sloughs, upstream from Mountain Village		
1 bull per regulatory year; during the period 1 Dec–28 Feb, a 10-day season may be announced by emergency order	1 Sep – 30 Sep 17 Jan – 26 Jan	1 Sep – 30 Sep
Remainder of Unit 18 1 bull per regulatory year; during the period 1 Dec–28 Feb, a 10-day season may be announced by emergency order (this EO did not include the Kuskokwim River drainage or the portion of Unit 18 south and east of the Kuskokwim River drainage)	1 Sep–30 Sep 17 Jan – 26 Jan	No open season

Board of Game Actions and Emergency Orders. A 10-day winter resident season during the period from 1 December–28 February upriver from Mountain Village may be announced by emergency order when weather and travel conditions are safe. The season dates are selected after polling the affected villages. This season was opened from 27 December–5 January in 1996–1997, 1997–1998, 1998–1999, 1999–2000, and 2001–2002. Most villages prefer to have this season just after Christmas to allow time for travel conditions to improve and to avoid interference with the holiday. They also prefer to hunt prior to Slavic since feasting is an important part of the Russian Orthodox celebration. This explains the static nature of these emergency order openings.

During 2002–2003 the winter season was opened along the Yukon River upriver from Mountain Village from 17 to 16 January. It was not opened earlier due to poor travel conditions.

The winter moose season was not opened within, and south and east of the Kuskokwim River drainage. For the third year in 2002–2003 the winter season remained closed in this portion of Unit 18, following a request by the LKAC to leave it closed for at least 5 years. However, the LKAC has recently prepared a proposal to close the moose season entirely for 5 years within the Kuskokwim River portion of Unit 18 as part of an overall strategy to improve moose numbers. If the proposal passes, the time period to leave this winter season closed will be superseded.

The Board of Game closed nonresident moose hunting south of the Yukon River during the fall 2001 meeting in response to concerns that arose with the initiation of a nonresident caribou hunt south of the Yukon River. The board determined that nonresident caribou hunters in the Kilbuck Mountains would put an undesirable amount of pressure on the low moose population if nonresident hunts for both species were permitted. This change divided Unit 18 into 4 areas with different moose seasons beginning in 2002–2003.

As in 2000–2001, the fall 2002–2003 resident moose season in the hunt area downriver from Mountain Village was opened on 1 September rather than 5 September by emergency regulation to provide additional opportunity to harvest moose in response to poor salmon returns. This was the third time in 5 years that this season was extended.

Human-Induced Harvest. During the 2001–2002 open season, 427 hunters reported a harvest of 162 moose**.** For the 2002–2003 season, 589 hunters reported a harvest of 223 moose. This continues the general trend of increasing reported moose harvest in Unit 18 that began in the early 1990s (Table 6).

Local demand for moose is high in Unit 18. The annual combined reported and unreported harvest is estimated at 7–12% of the population on the Yukon River. Harvest exceeds annual recruitment on the Kuskokwim River and moose only survive there due to continual migration from adjacent areas. Estimated unreported harvest probably exceeds the reported harvest in the Kuskokwim drainage. We estimate the unitwide unreported harvest is approximately 100–200 moose annually.

The reported harvest of moose in Unit 18 does not reflect the actual harvest, but only shows the harvest by people who operate within the regulatory system. In recent years we have seen an increase, but the percentage of local residents hunting during established seasons with valid hunting licenses and harvest tickets is increasing, particularly during the fall. On the Yukon River, we believe that harvest reporting has improved largely because of the presence of the Paimiut hunter check station, the acceptance of harvest tickets/reports, the willingness of most hunters to harvest only bulls, our harvest reporting incentive program, and the successful cooperative effort that resulted in a huntable moose population below Mountain Village and greater public confidence in the regulatory system. However, there are hunters

who do not report, so moose harvest data from Unit 18 should be regarded as minimum estimates.

The majority of the reported Unit 18 moose harvest comes from the Yukon River drainage (Table 7) accounting for approximately 78% (127 moose) of the reported harvest in 2001–2002 and 83% (185 moose) in 2002–2003.

A moose hunting moratorium downriver from Mountain Village ended when a season was reopened in 1994–1995. Since then, 232 bull moose have been reported harvested in that hunt area. This includes 34 bulls harvested in 2001–2002 and 69 bulls harvested in 2002–2003. This is particularly interesting since as recently as 1988, no moose were observed during an intensive survey of this area.

During September 2001 we operated the Paimiut moose hunter check station for the 16th consecutive year at the junction of Twelve-Mile Slough and Paimiut Slough on the Yukon River approximately 4 miles east of Unit 18. Only 97 hunters stopped at the check station and we examined 18 moose. This is lower than during previous years when more than 200 hunters visited the check station and upwards of 60 moose were examined. The decreasing trend is likely to continue as the Yukon River moose population in Unit 18 continues to grow, making long, expensive moose hunting trips upriver unnecessary; as income from commercial fishing remains unstable; and as a greater understanding of land ownership and access restrictions by upriver regional and village corporations makes hunting trips into Unit 21E less appealing. Because of these, we decided that 2001 would be the final year we would operate the check station at Paimiut.

We operated a floating check station within the Unit 18 portion of the Kuskokwim River drainage during the 2002–2003 hunting season and contacted approximately 50 hunters, mostly during the last week of the season as Unit 18 hunters took advantage of the longer Unit 18 moose season compared to Unit 19 where they began their hunts. We provided information regarding the importance and benefits of not killing cow moose and distributed coffee mugs emblazoned with the moose circle logo. We did not encounter any successful Unit 18 moose hunters within the Kuskokwim drainage.

In Unit 18, there is growing use of state regulation 5 AAC 92.019, which allows moose to be taken outside established seasons for customary and traditional Alaska Native funerary or mortuary religious ceremonies. Typically, Unit 18 hunters contact the department prior to hunting under this statute, and we provide them with a letter outlining the regulation, informing them which animals are legal, and describing how to accomplish harvest reporting. We also provide the hunters with a copy of the administrative code (regulation) and contact the Alaska Bureau of Wildlife Enforcement to inform them of the arrangement.

This regulation requires the department to publicize a list of big game populations and areas, if any, for which the taking of a big game animal would be inconsistent with sustained yield principles. A big game animal from a population on this list would not be available for harvest for funerary or mortuary purposes under this statute. The list for Unit 18 includes all cow moose and all moose within and south and east of the Kuskokwim River drainage.

During 2001–2002, one hunter contacted the department regarding mortuary moose and reported an unsuccessful hunt. During 2002–2003, 4 hunters contacted the department and 2 moose were taken, 1 hunter reported that he was unsuccessful, and 1 hunter did not report (unsuccessful hunters are not required to report). All of these hunts took place along the Yukon River in Unit 18.

Permit Hunts. There were no permit hunts for moose in Unit 18 during the reporting period.

Hunter Residency and Success. As reported in past years, Alaska residents accounted for most of the moose hunting activity in Unit 18 with the vast majority being Unit 18 residents. Of 428 hunters who reported hunting during the 2001–2002 season, 7 were nonresidents. Of 589 hunters who reported hunting during the 2000–2001 season, 2 were nonresidents. Low moose densities within the Kuskokwim drainage, high cost, and federal restrictions generally make Unit 18 an unattractive destination for nonresident moose hunters.

The moose hunter success rates based on harvest reports were 38% for both the 2001–2002 and 2002–2003 seasons. Successful hunters spent an average of 7.8 days hunting in 2001–2002 and 7.0 days in 2002–2003. Unsuccessful hunters spent an average of 9.3 days hunting in 2001–2002 and 9.8 days in 2002–2003.

Many Unit 18 hunters are aware that hunting opportunities are better in adjacent Units 19 and 21E. On the Kuskokwim River many of the residents hunting moose between Kalskag and McGrath (in Unit 19) are from Unit 18. Similarly, on the Yukon River Unit 18 residents regularly hunt in Unit 21E, and even though the number of hunters making these upriver trips is declining, about 100 hunters from Unit 18 still visited the check station at Paimiut in 2001–2002. As a consequence, harvest allocation has been controversial among residents of Unit 18 and residents of Units 19 and 21E.

Harvest Chronology. The majority of reported moose harvest occurs during September when the general season is open. Only small numbers of moose have been reported harvested in the winter season (Table 6).

As the Yukon River moose population grows and becomes more accessible to Yukon River villagers, extended camping trips to hunt moose are being replaced by day trips from home. Harvest chronology is being driven by these day hunts and is influenced more by weather and the work week than by moose movements. Furthermore, hunters prefer to take moose early in the season citing better meat quality. As a consequence, only about 5% of the fall harvest takes place during the last 5 days of September.

Transport Methods. During the reporting period, boats were by far the most frequently used mode of transportation by moose hunters in Unit 18. Other minor reported modes of transportation were snowmachines and aircraft. There has been virtually no change in the method of access reported by moose hunters in Unit 18 since moose harvest reporting began.

Other Mortality

Black and grizzly bears occur along the major river corridors and large tributaries in Unit 18. We regularly see black and grizzly bears during moose calving surveys, and local residents

have complained of heavy predation on calves by bears. However, little direct information is available regarding this type of predation in Unit 18. Certainly, some predation occurs, but the effect bears have on moose numbers, particularly through predation on calves, is unknown.

Reports indicate that wolf numbers have increased considerably during this and the previous 3 reporting periods. This is expected because caribou have become more available, moose numbers have increased, and trapping pressure has declined. We estimate that 250–300 wolves in 25–30 packs live in Unit 18. Throughout most of Unit 18 the distribution and density of wolves reflects the distribution and density of moose, especially in the Yukon River drainage. In the lower Kuskokwim River drainage, caribou are the main prey for wolves and wolf distribution is not as closely linked to moose.

HABITAT

Assessment

We estimate a minimum of 8000 mi^2 of moose habitat exists in Unit 18. Approximately 4500 mi^2 of this habitat occurs along the riparian zone of the Yukon River and the remaining 3500 mi^2 is found along the Kuskokwim River and its tributaries. The islands and adjacent sloughs along the Yukon River corridor from Paimiut to Mountain Village represent the most productive moose habitat in Unit 18. The Yukon Delta has many distributaries fringed by willows and cottonwoods and even though the moose population has grown in this area, it still has fewer moose than could be supported by the available forage.

The riparian corridor along the Kuskokwim River in Unit 18 downstream of Kalskag is excellent moose habitat. Between Lower Kalskag and Akiachak, the forest and brush along the Kuskokwim provide some escape cover for moose. Downstream of Akiachak toward the mouth of the Kuskokwim, the riparian corridor narrows and escape cover is lacking. Along the Kanektok, Goodnews, and Arolik Rivers, moose are rarely found in the riparian corridor because cover and browse are very sparse.

Tributaries of the Kuskokwim bordered by spruce and cottonwood, interspersed with willow and alder, extend onto the tundra along the Gweek and Johnson Rivers to the west, and along the Tuluksak, Fog, Kisaralik, Kasigluk, Akulikutak, Eek, and Kwethluk Rivers, and smaller unnamed rivers to the east. In each of these drainages, the habitat could support more moose. Lack of escape cover from illegal hunters is the limiting factor affecting moose numbers in these low-density areas.

During late August and early September 2001, we conducted an assessment of moose browse along the Yukon and Kuskokwim rivers following methods developed by Seaton (2002). Our goal was to categorize the effect of recent moose browsing on the predominant shrubs used by moose in winter, with an objective of categorizing shrub architecture to estimate what proportion of shrubs in each moose survey area exhibit a "broomed" growth form caused by repeated heavy browsing.

We selected sample sites within each of the moose survey areas based on boat accessibility, moose distribution during winter, and safe boating access during inclement weather. Within

these sites feltleaf willow (*Salix alaxensis*) was the predominant species generated by primary succession following floods or ice scouring along sloughs. A few sites were in meadows off the mainstem of the river where diamondleaf willow (*S. pulchra*) was often the most prevalent species. A single linear transect was conducted at each site and these were defined by a start location using a GPS system and a compass bearing. Shrub architecture was characterized for the nearest stem to the boot toe on every fifth step and about 30 characterizations were made per transect.

We assigned shrub or sapling architecture between 0.5 and 3.0 m to one of 3 categories based on the visible browsing history over the life of the plant. *Unbrowsed* plants had no evidence of moose or snowshoe hare browsing, past or present. *Browsed* plants had fewer than half of current annual growth (CAG) twigs arising from lateral stems that were a product of browsing. *Broomed* plants could have sapling forms (main apical stem broken by moose) or bushy forms (more than half of the CAG leaders arising from lateral stems that were produced as a result of browsing). Broomed plants are essentially those in which moose or hares have significantly affected the growth form but not necessarily browse production or availability. A high proportion of broomed plants in a stand suggests that most of the plants used by herbivores have been intensely browsed in the past. We also noted if plants were *mature*, whereby >50% of CAG is >3.0 m.

Data and observations were summarized for each of the survey areas. The survey areas differ in moose density, vegetation, possibly predator abundance, patterns of snow accumulation, and spring phenology (up to 10 days later downriver on the Yukon).

LOWEST YUKON

We made 7 stops along Tunurokpak and Patsys Sloughs downriver from Mountain Village. Hare browsing was observed to 2 m, which provides a rough idea of snow drifting height by late winter. Hares had begun declining in abundance from their peak 2 winters ago and seemed to be influencing the growth form of shrubs more than moose (Table 8). Moose use of browse in this survey area was the lowest among the 4 we sampled, even though mean density of wintering moose was substantially higher on the Lowest Yukon survey area than on the Lower Kuskokwim. This area also had the highest proportion of mature shrubs, an indication that neither browsing nor ice scouring has kept willows from achieving free-to-grow status in the active floodplain.

ANDREAFSKY

We made 5 stops between St. Mary's and the site named Pilot Village on the U.S. Geological Survey topographical maps and observed a moderate amount of browsing and brooming (more by hares than moose), although sample sizes were small (Table 8).

PAIMIUT

We visited 15 sites between Pilot Station and the hunter check station on Paimiut Slough. The highest proportion of browsing and brooming by moose occurred in this survey area (Table 8), which corresponds to the highest moose density among the 4 survey areas (Table 1). The brooming index for Paimiut (28.2) was similar to that observed on the Yukon Flats in an area

noted for its low moose density. Moose had more of an effect on shrub architecture than hares (Table 8).

LOWER KUSKOKWIM

We collected data at 8 sites between Lower Kalskag and Church Slough, just upriver from Bethel. The highest proportion of unbrowsed shrubs occurred in this count area, with neither moose nor hares having much effect on shrub growth form (Table 8).

The information in Table 8 conveys our visual impression that a substantial amount of available browse in the active floodplain is not used by moose, particularly in the downriver areas. Many shrubs categorized as "browsed" had only 1 or 2 stems eaten and often needed close inspection to detect use. Diamondleaf willow occurred mostly in the meadows adjacent to the floodplain and had the highest proportion of broomed architecture caused by moose. Diamondleaf was often much older with relatively little CAG biomass compared to feltleaf willow in the floodplain. Redstem willow (*S. arbusculoides*), which grows both in floodplain and meadow sites, was also heavily broomed (Table 9).

We observed lateral growth of CAG leaders from the trunks of feltleaf shrubs up to 20 cm diameter at breast height and >10 m tall on terraces 1–2 m above the active floodplain. When the older shrubs assume a mature tree form (>50% CAG >3.0 m), these low lateral leaders can provide substantial forage to moose despite the decadent appearance of older stands. In the areas we sampled, browsing on *mature* feltleaf willows composed 1.5% of foraging events for moose. This tree-like growth form and similar forage use in feltleaf willow has also been observed along Three Day Slough on the Koyukuk River which supports one of the highest winter densities of moose in Interior Alaska.

We did a rough count of 60 stems/m^2 in a 3-year-old feltleaf willow cohort roughly 1.5 m tall on primary succession at the lower mouth of Tucker Slough (upstream from Russian Mission). This density extrapolates to 600,000/ha (242,817/ac), which is 1–2 orders of magnitude higher than in meadows or higher terraces with older, taller willows spaced more widely. Although self-thinning mortality from competition will be severe over the next few years, feltleaf biomass per hectare in the younger cohorts is high. Widespread feltleaf cohorts of the same age are evidence of major flood events on sections of both rivers 5–6 years ago, indicating ample fluvial disturbance in much of Unit 18 in recent years.

Enhancement

There were no habitat enhancement activities in Unit 18 during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

The most important management need is to improve moose numbers within the Kuskokwim River drainage. We have continued discussions with the LKAC, the YDNWR, village and tribal leaders, and other interested parties to develop a strategy to increase moose numbers that is acceptable to local residents and managers alike and we have agreed upon a strategy centered around a 5-year moose hunting moratorium (Appendix 1). The LKAC voted unanimously to submit a proposal to the Board of Game to initiate the moratorium beginning

in the fall of 2004. Local support is not universal but it is widespread as exemplified by the signed resolutions and other expressions of support we received from 11 of the 13 affected villages. We believe this support is essential for this strategy to succeed.

An issue that had greater importance during previous reporting periods is the allocation of hunting effort and harvest by local residents of Units 18, 19 and 21E. This is a "downriver resident" versus "upriver resident" issue along the Yukon and Kuskokwim Rivers. This issue has not been resolved but has lessened along the Yukon River as more moose have become available within Unit 18, and as understanding of upriver land ownership has grown. We hope to address this issue along the Kuskokwim through the Kuskokwim River moose strategy described above.

CONCLUSIONS AND RECOMMENDATIONS

Within living memory, moose have colonized the Yukon-Kuskokwim Delta in moderate densities along the Yukon River from Paimiut to the mouths of the Yukon, but remain at low to very low densities throughout the remainder of the unit. Although much of Unit 18 is lowland tundra unsuitable as moose winter habitat, moose could be present in higher numbers because areas of riparian habitat remain unoccupied and in all areas where moose are present, their numbers are lower than the habitat could support. Calf production and yearling recruitment are high, but hunting pressure from the relatively dense human population in the unit has slowed moose population growth and prevented a Kuskokwim River moose population from becoming established.

The illegal harvest, particularly of cows and particularly within the Kuskokwim River drainage, remains the most serious moose management problem in Unit 18. Although compliance is improving, a poorly developed cash economy, declining commercial fishing opportunities, and a high and growing density of people along the major rivers complicate moose management considerably. More than 20,000 rural residents live in 42 communities throughout Unit 18 and we need continued effort to curb illegal harvest of moose.

Differing state and federal seasons and bag limits for moose had previously hampered our ability to effectively manage moose and enforce hunting regulations. Recently however, there has been very good cooperation among federal and state wildlife managers to work toward common solutions for moose management. In general, throughout Unit 18 state and federal seasons now coincide.

Recent actions by user groups to shoulder some responsibility for the growth of local moose populations are welcome signs of increasing participation with existing management systems. Continued efforts to work with local user groups are vital for effective management and we are encouraged by the efforts of the LKAC to adopt a strategy to improve moose numbers within the Kuskokwim drainage.

We recommend that monitoring and taking inventory of the moose population remain a priority in Unit 18, especially the continuation of the population censuses along the Yukon and Kuskokwim Rivers. We should also continue to conduct composition counts and trend counts. The census results, in conjunction with composition surveys, will provide the

department with baseline demographic and recruitment information to properly manage the moose population.

The poor harvest reporting rates in Unit 18 are being addressed through an incentive that uses harvest reports as entry forms for a prize drawing. This raffle was initiated during the 1998–1999 hunting season and it has been well received by area hunters. Table 10 shows a trend of increasing use of harvest tickets/reports that began prior to the initiation of this program and has continued. The credit this program deserves for this continued increase is unknown; however, there are educational components associated with this program that provide additional value. We recommend that this program be continued.

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PREPARED BY:

Roger J. Seavoy
Wildlife Biologist III

SUBMITTED BY:

Peter J. Bente
Survey-Inventory Coordinator

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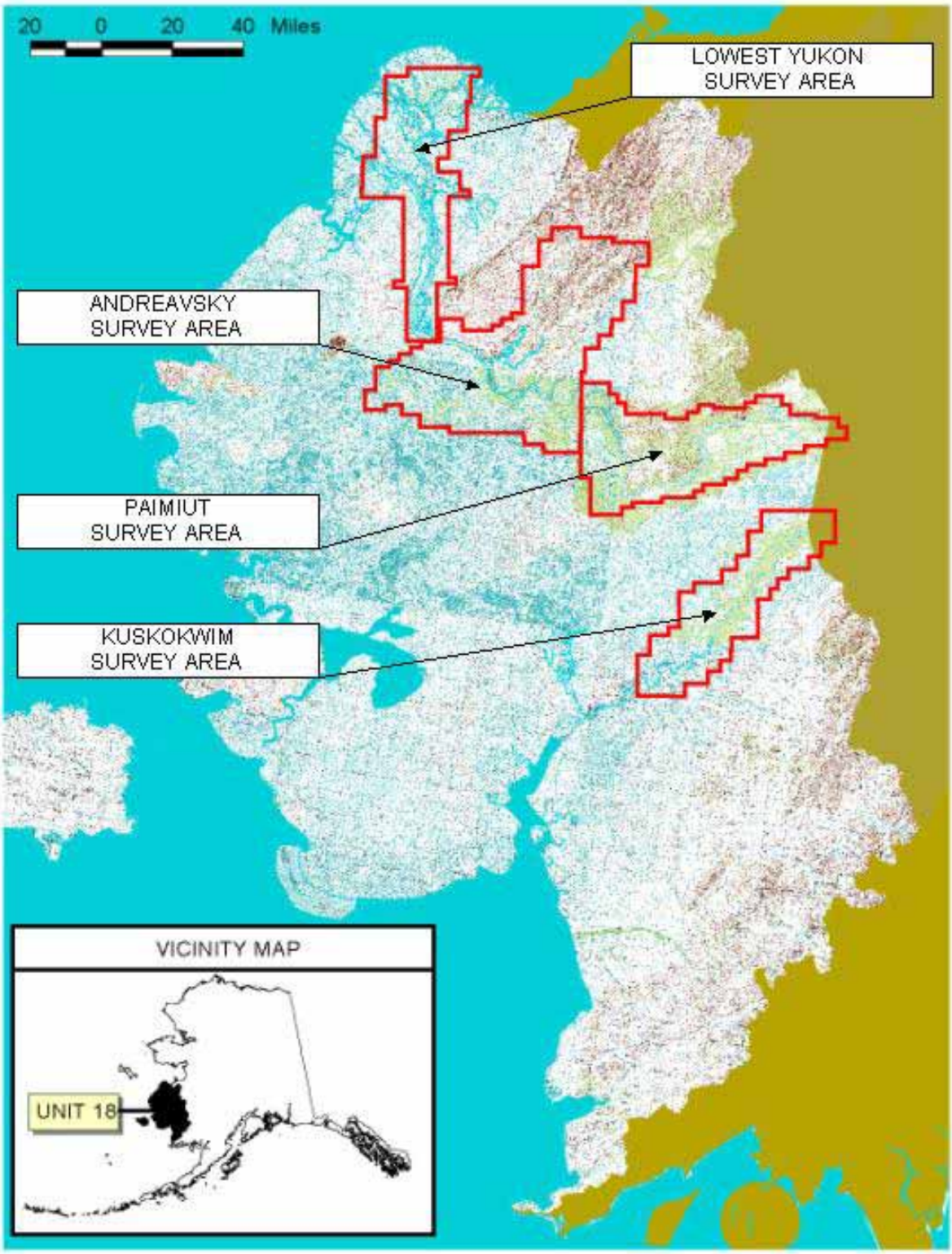

Figure 1 Unit 18 showing geostatistical population survey areas (Ver Hoef style survey areas). The larger area is shown for survey areas where boundaries were adjusted.

Table 1 Unit 18 moose population census history

Survey Area	Year	Area (mi^2)	Estimate at 95%CI	Density (moose/mi^2)	Census Technique
Lowest Yukon	1988	1703	0	NA	Minimum count
	1992	1703	28	0.02	Minimum count
	1994	1703	65	0.04	Minimum count
	2002	1151	674 ± 21.9%	0.59	Spatial method
Andreafsky	1995	1393	52 ± 74.0%	0.04	Gasaway method
	1999	2279	524 ± 29.8%	0.23	Spatial method
	2002	1150	418 ± 22.4%	0.36	Spatial method
Paimiut	1992	1558	994 ± 19.7%	0.64	Gasaway method
	1998	1558	2024 ± 12.9%	1.30	Gasaway method
	2002	1571	2382 ± 16.1%	1.52	Spatial method
Lower Kuskokwim	1993	648	216 ± 44.6%	0.33	Gasaway method
	2000	907	86 ± 26.4%	0.09	Spatial method
	2002	907	117 ± 18.3%	0.13	Spatial method
Lower Kuskokwim Unit 18 only	2002	869	94 ± 23.0%	0.11	Spatial method

Table 2 Comparison of moose seen per hour on the Kuskokwim in Unit 18 vs. similar habitat in the Paimiut survey area.

Location	Date	time searching	moose observed	moose per hour
Kuskokwim	Jan 2000	4:45	47	10
Kuskokwim	March 2001	1:25	8	6
Kuskokwim	April 2002	1:00	2	2
Yukon River	Jan 2000	1:56	445	229
Yukon River	March 2001	1:10	311	266
Yukon River	April 2002	0:59	90	90

Table 3 March 2002 estimate of calves:100 adults within Unit 18 survey areas

Survey Area	Calves:100 Adults
Paimiut	50.6
Andreafsky	21.8
Lowest Yukon	29.5
Lower Kuskokwim	40.3

Table 4 Spring composition counts in the Lowest Yukon Area

Year	Total	Bulls	Cows > 2	Cows = 2	Yearlings	Calves	Twins
2001	55	12	5	11	19		8
2002	25	5	7	2	3	4	4
2003	88	12	13	15	24	2	22

Table 5 Summary of moose hunting regulations and harvest in Unit 18, 2001–2003

Regulatory year	Resident or Nonresident hunt	Season dates	Bag limit and area affected
2001–2002	Residents and Nonresidents	5 Sep–25 Sep	1 bull; Yukon River Delta[a]
	Residents and Nonresidents	1 Sep–30 Sep	1 bull; remainder of Unit 18
	Residents	27 Dec–5 Jan[b]	1 bull; remainder of Unit 18 excluding the Kuskokwim River drainage[c]
2002–2003	Residents	1 Sep–25 Sep[d]	1 bull; Yukon River Delta north[e]
	Nonresidents	5 Sep – 25 Sep	1 bull; Yukon River Delta north[e]
	Residents	1 Sep–25 Sep[d]	1 bull; Yukon River Delta south[f]
	Nonresidents	no open season	Yukon River Delta south[f]
	Residents and Nonresidents	1 Sep–30 Sep	1 bull; Above Mountain Village north[g]
	Residents	1 Sep–30 Sep	1 bull; Above Mountain Village south[h]
	Nonresidents	no open season	Above Mountain Village south[h]
	Residents	17 Jan–26 Jan[b]	1 bull; excluding Yukon River Delta[a] and the Kuskokwim River drainage[c]

[a] That portion of Unit 18 north & west of a line from Cape Romanzof to Kusilvak Mountain, to Mountain Village, and excluding all Yukon River drainages upriver from Mountain Village.

[b] A 10-day winter season is announced by emergency order between 1 Dec and 28 Feb.

[c] The Kuskokwim River drainage includes the Kuskokwim River drainage proper and that poriton of Unit 18 south and east of the Kuskokwim River drainage.

[d] This resident season was changed by emergency regulation to address an economic emergency caused by poor salmon returns.

[e] That portion of Unit 18 including all Yukon River drainages north of the south bank of Kwikluak Pass and the Yukon River, including sloughs, downstream of Mountain Village.

[f] That portion of Unit 18 south of the south banks of Kwikluak Pass and the Yukon River, including sloughs, downstream of Mountain Village and north and west of a line from Cape Romanzof to Kusilvak Mountain, to Mountain Village.

[g] That portion of Unit 18 including all Yukon River drainages north of the south bank of the Yukon River, including sloughs, upstream of Mountain Village.

[h] That portion of Unit 18 south and east of a line from Cape Romanzof to Kusilvak Mountain, to Mountain Village and south of the south bank of the Yukon River, including sloughs, upstream of Mountain Village (or remainder of Unit 18).

Table 6 Fall and winter moose harvests for Unit 18, 1978–2003

Regulatory	Fall harvest		Winter harvest		Unknown harvest		Total
Year	(N)	(%)	(N)	(%)	(N)	(%)	Harvest (N)
1978–1979	42	88	6	12	0	0	48
1979–1980	11	92	1	8	0	0	12
1980–1981	45	94	3	6	0	0	48
1981–1982	72	90	8	10	0	0	80
1982–1983	54	93	4	7	0	0	58
1983–1984	61	97	2	3	0	0	63
1984–1985	63	87	7	10	2	3	72
1985–1986	43	83	8	15	1	2	52
1986–1987	54	90	6	10	0	0	60
1987–1988	40	83	8	17	0	0	48
1988–1989	67	98	0	2	0	0	68
1989–1990	31	94	1	3	1	3	33
1990–1991	55	90	6	10	0	0	61
1991–1992	63	94	4	6	0	0	67
1992–1993	64	83	13	17	0	0	77
1993–1994	93	97	3	3	0	0	96
1994–1995	76	87	11	13	0	0	87
1995–1996	71	96	3	4	0	0	74
1996–1997	97	100	0	0	0	0	97
1997–1998	95	100	0	0	0	0	95
1998–1999	124	99	1	1	0	0	125
1999–2000	136	95	7	5	0	0	143
2000–2001	166	95	5	3	4	2	175
2001–2002	140	86	9	6	13	8	162
2002–2003	202	91	10	4	11	5	223

Table 7 Reported moose harvest in the Yukon River, Kuskokwim River and Johnson River drainages, Unit 18, 1981–2003

	Moose harvest (%)		
Regulatory year	Yukon River	Kuskokwim River	Johnson River
1981–1982	57	32	11
1982–1983	58	36	6
1983–1984	63	33	4
1984–1985	62	32	6
1985–1986	67	17	16
1986–1987	66	34	0
1987–1988	52	42	6
1988–1989	81	19	0
1989–1990	55	39	6
1990–1991	80	15	5
1991–1992	75	24	1
1992–1993	64	33	3
1993–1994	77	24	2
1994–1995	86	14	0
1995–1996	85	15	0
1996–1997	72	28	0
1997–1998	75	24	1
1998–1999	78	12	6
1999–2000	80	18	2
2000–2001	82	14	3
2001–2002	127	29	2
2002–2003	185	32	4
Average	79	26	4

Table 8 Categorization of browse architecture on winter range of moose in GMU 18, western Alaska, August–September 2002. Feltleaf willow (*Salix alaxensis*) composed 77% of 1,134 shrubs sampled, followed by balsam poplar (*Populus balsamifera*, 7%), redstem willow (*S. arbusculoides*, 5%), diamondleaf willow (*S. pulchra*, 4%), and other shrub species.

						Moose		Snowshoe hares	
Count area (transects)	n[a]	% unbrowsed	% mature	% browsed	Brm index[b]	% browsed	Brm index[b]	% browsed	Brm index[b]
Lowest Yukon (7)	262	46.9	14.5	36.3	5.9	6.9	0 (18)	29.4	7.2 (83)
Andreafsky (5)	171	45.0	1.2	45.0	16.3	17.0	9.4 (32)	28.1	20.0 (60)
Paimiut (14)	460	37.0	1.7	41.5	28.2	37.4	29.2 (243)	4.1	17.4 (23)
Lower Kuskokwim (8)	240	77.5	6.3	16.3	0	10.0	0 (24)	6.3	0 (15)

[a] Number of shrubs categorized along linear transect, across all transects in survey area.

[b] Index is proportion of shrubs receiving any browsing that were broomed ((broomed / [browsed + broomed])* 100), by respective herbivore. Sample size for index ratio (in parentheses for moose and hares individually) is number broomed + number browsed. In 16 instances where both hares and moose had browsed an individual shrub, the event was recorded for both herbivores (1.4% of all observations).

Table 9 Categorization of browse architecture on winter range of moose in GMU 18, western Alaska, August–September 2002.

Species[a]	Trans[b]	n[c]	% unbrowsed	% mature	% browsed	Brm index [d]	Moose		Snowshoe hares	
							% browsed	Brm index [d]	% browsed	Brm index [d]
S. alaxensis	35	877	50.1	6.7	35.0	16.1	22.6	29.7 (244)	12.4	10.7 (122)
P. balsamifera	15	76	60.5	0	32.9	16.7	26.3	16.7 (24)	6.6	16.7 (6)
S. arbusculoides	14	51	35.3	2.0	37.3	34.5	5.9	76.9 (13)	31.4	0 (16)
S. pulchra	7	46	47.8	4.3	21.7	54.5	4.3	85.7 (14)	17.4	0 (8)
S. lasiandra	7	30	30.0	0	46.7	33.3	23.3	0 (7)	23.3	50.0 (14)
S. spp.[e]	8	25	20.0	0	76.0	5.0	20.0	0 (5)	56.0	6.7 (15)
C. stolonifera	1	15	46.7	0	40.0	25.0	40.0	25.0 (8)	0	0 (0)
A. spp.	3	13	76.9	7.9	15.4	0	15.4	0 (2)	0	0 (0)
R. hudsonianum	1	1	0	0	0	0	100	0 (1)	0	0 (0)

[a]*Salix alaxensis* (feltleaf willow), *Populus balsamifera* (balsam poplar), *S. arbusculoides* (redstem willow), *S. pulchra* (diamondleaf willow), *Cornus stolonifera* (red osier dogwood), *Alnus* spp. (alder), *Ribes hudsonianum* (northern black currant).

[b]Number of transects where represented (35 total among the 4 moose count areas).

[c]Number of shrubs categorized along linear transect, across all transects and moose count areas.

[d]Index is proportion of shrubs receiving any browsing that were broomed ((broomed / [browsed + broomed])* 100), by respective herbivore. Sample size for index ratio (in parentheses for moose and hares individually) is number broomed + number browsed. In 16 instances where both hares and moose had browsed an individual shrub, the event was recorded for both herbivores (1.4% of all observations).

[e]Positive identification not obtained; believed to be primarily *S. richardsonii* (Richardson willow) and *S. bebbiana* (Bebb willow).

Table 10 Number of hunters and reported harvest since the 1993–1994 regulatory year. A harvest reporting incentive program was initiated in 1998–1999.

Regulatory year	Number of hunters	Reported Harvest
1993–1994	249	96
1994–1995	247	87
1995–1996	301	74
1996–1997	350	97
1997–1998	363	95
1998–1999	383	125
1999–2000	436	143
2000–2001	421	175
2001–2002	428	162
2002–2003	589	223

APPENDIX 1.

Lower Kuskokwim Moose Strategy

1) The people of the Lower Kuskokwim River communities desire a larger moose population so a greater harvest can be sustained. This document is an agreement among the signatories on our strategy to achieve our goal.

2) This strategy applies to the Unit 18 portion of the Kuskokwim River drainage, including the Eek River drainage.

3) The moose season in this area will remain closed for 5 years beginning in the year 2004.

4) The fall season will be reopened for bulls only after 5 years of no hunting or there is a minimum moose population in the Lower Kuskokwim moose count area of 1000.

5) We recognize the importance of cow moose to future moose populations. We understand that there will be no cow hunts unless habitat degradation occurs from excessive moose browsing. We understand that most moose in a population are cows and that 20–30 bulls per 100 cows is normal in hunted populations.

6) We anticipate that the moose population will grow to at least 2000 moose in the Lower Kuskokwim count area after adherence to a 5-year moratorium on hunting and continued adherence to a harvest of bulls only.

7) We understand that a larger moose population will better, but not completely, serve the subsistence needs of the residents of this area. We fully expect, however, that the number of moose harvested locally will greatly increase.

8) Enforcement has a role in this strategy that needs to be developed in a cooperative fashion.

9) The reward this strategy promises is substantial, and we are committed to achieving our goal of at least 2000 moose in the Lower Kuskokwim moose count area.

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO BOX 25526
JUNEAU, AK 99802-5526

MOOSE MANAGEMENT REPORT

From: 1 July 2001
To: 30 June 2003[a]

LOCATION

GAME MANAGEMENT UNIT: 22 (25,230 mi^2)

GEOGRAPHIC DESCRIPTION: Seward Peninsula and the adjacent mainland drained by all streams flowing into Norton Sound

BACKGROUND

Before 1930 very few moose were observed on the Seward Peninsula. However, by the late 1960s much of the suitable habitat in Unit 22 contained moose. Moose populations grew rapidly in the 1960s through the early 1980s and peaked in the mid 1980s in most parts of the unit. Severe winters in 1989, 1990 and 1992 caused declines in moose densities because winter browse was insufficient to maintain such large populations in Units 22B and 22D (Nelson 1995). Populations in these areas never recovered and recent data indicates these populations and others in the unit are currently declining. Habitat is no longer believed to be a major limiting factor at current population levels; rather, brown bear predation on calves is thought to be a significant factor suppressing Unit 22 moose populations.

Although moose have been present in Unit 22 for a relatively short time, they rapidly became an extremely important food source for many Seward Peninsula residents, and demand for moose by subsistence and sport hunters is high throughout the unit. Gravel roads, trails, navigable rivers and snowmachines provide hunters with easy access to suitable moose habitat (Machida 1997). Annual harvests reported from 1969 through 2002 ranged from a low of 44 moose in 1972 to a high of 408 moose in 1986 (Table 1). However, in recent years declining moose populations prompted the Board of Game to implement restrictions intended to reduce harvest in many parts of Unit 22. Unit residents account for the majority of the annual reported harvest.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

The following population objectives and bull:cow ratios presented to the Board of Game are the management goals for Unit 22:

[a] This unit report also includes data collected after the reporting period at the discretion of the reporting biologist.

- Unit 22 unitwide: Maintain a combined population of 5100–6800 moose.
  - Unit 22A: Maintain a population of 600–800 moose.
  - Unit 22B West: Increase and stabilize the population at 1000–1200 moose.
  - Unit 22B East: Insufficient data exists to develop a specific management goal; however, increased recruitment rates and population growth are desired.
  - Unit 22C: Slightly reduce and maintain a population of 450–475 moose.
  - Unit 22D: Increase and stabilize the population at 2000–2500 moose.
  - Unit 22E: Increase and stabilize the population at 200–250 moose.
- Maintain a minimum bull:cow ratio of 30:100 in Units 22A, 22B, 22D, and 22E.
- Maintain a minimum bull:cow ratio of 20:100 in Unit 22C.

The Unit 22 population objective (5100–6800 moose) recommended by the department was adopted by the Board of Game in November 2001. This objective was revised downward slightly from our previous management goal of 5700–7300 moose, which may be slightly larger than the habitat can support. In Units 22A, 22B, 22D and 22E our goal is to increase and stabilize the population from a period of steady decline in moose numbers. In Unit 22C, the goal is to slightly reduce numbers and maintain a population within winter browse carrying capacity. We attempt to maintain a minimum bull:cow ratio of 30:100 in all units except Unit 22C where a minimum bull:cow ratio of 20:100 is acceptable.

MANAGEMENT OBJECTIVES

The management objectives for survey and inventory activities in Unit 22 are:

- In selected areas of the unit make annual estimates of moose abundance, sex and age composition, and yearling recruitment and determine trends in population size and composition.
  - Complete censuses in the 5 subunits of Unit 22 on a 3-year rotational basis to estimate moose abundance.
  - Complete late fall and/or early spring aerial surveys in selected portions of the unit to provide an index of moose population status and trends, sex and age composition, and yearling recruitment.
- Monitor human and natural mortality factors affecting the population.
  - Evaluate hunting mortality by analyzing all moose harvest data.

- Improve harvest reporting through public education, vendor support and improved communication, and by conducting community-based harvest assessment surveys in selected villages.

- Evaluate hunting regulations and recommend changes if necessary for conservation purposes.

- Improve public understanding of hunting regulations and the reasons they are necessary.

METHODS

We conducted aerial surveys in the spring and fall to estimate sex and age composition and short yearling recruitment in portions of Unit 22 during the report period. In March of 2002, a moose census of Unit 22D was completed using the geostatistical population estimator technique (J. VerHoef, ADF&G, personal communication). In March of 2003 the same technique was used to census moose in the Unalakleet River drainage in Unit 22A and in Unit 22E. We summarized harvest reports returned by hunters and harvest data collected during big game harvest surveys in Golovin, Unalakleet and Stebbins. The department implemented registration moose hunts in the most heavily hunted areas along the Nome road system in Units 22B and 22D. Public meetings were held in Unit 22A to discuss declining moose populations and to form recommendations to the Board of Game for changes to hunting regulations.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

In Unit 22A, a census of the Unalakleet River drainage, completed during 6–10 March 2003, estimated 75 moose (90% ± 38.6%), showing a significant decline in moose numbers since previous censuses in 1989 and 1994 (Table 2). Spring 2000 and 2003 recruitment surveys found very low recruitment rates in other Unit 22A drainages north of the Golsovia River drainage. In the portion of the unit southwest of the Golsovia River drainage recruitment rates were higher, but overall numbers of moose were low. These data indicate the population is well below our management goal of 600–800 moose for the unit. Historically moose densities have been lower in Unit 22A than in many other parts of the unit, possibly due to higher predator densities and/or less suitable habitat. Currently, however, there appears to be considerable unused habitat. Comparison of low moose numbers found in winter censuses and surveys to relatively high numbers observed during fall composition surveys substantiates reports from longtime local residents that some moose migrate from summer and fall range in the Unalakleet River drainage to wintering areas in the Anvik and Yukon River drainages in Unit 21.

Moose densities in Units 22B and 22D have declined since the dramatic increases observed in the 1980s. The winters of 1989, 1990, and 1992 were particularly severe on moose, and winter mortality was reported to be higher than normal during those years. Census data from western Unit 22B show a 50% decline between 1987 and 1999 with continued low recruitment (Table 2). The 1999 population estimate for western Unit 22B was 797 moose (90% C.I. ±19%). Although we have no density estimates for eastern Unit 22B, recruitment estimates in 1999 and 2000 in the Koyuk drainage were similar to those in the western portion of the unit. Based on this

information and comments by local residents, we suspect poor calf survival may also be affecting moose densities in eastern Unit 22B.

A 2002 moose census in Unit 22D estimated 1594 moose (90% C.I. +/-12.2%), indicating a 45% population decline since the area was first censused in 1988 (Table 2). The 2002 census documented an 18% decline since 1997 in the Kuzitrin River drainage portion of Unit 22D, while the population in the American/Agiapuk portion of the census area remained relatively stable between 1997 and 2002.

The Unit 22C moose population grew steadily throughout the 1990s and in spring 2001 was estimated at 557 moose. This estimate exceeds our management goal by 18% and adds to concern that the population may exceed the carrying capacity of the winter range. Yearling recruitment is highest in Unit 22C and generally exceeds 20%. However, the bull:cow ratio is low, varying between 10–20 bulls:100 cows.

The first stratified census of Unit 22E was completed in March 2003, yielding an estimate of 504 moose (90% C.I. ±10%). This estimate is higher than all previous estimates and well above our management goal of 200–250 moose (Table 2). Past radiocollar studies have shown considerable seasonal migration between Units 22E and 22D, and the increase observed is probably due to unusually sparse snow cover enabling moose that normally winter in Unit 22D drainages to remain on their summer range in Unit 22E. It is unlikely that there has been a significant overall increase in moose numbers in this area. In the future we will attempt to account for yearly differences in distribution of moose by censusing both Units 22D and 22E in the same year.

Population Size

A 5–12 March 2002 census of Unit 22D was completed using the geostatistical population method developed by Jay VerHoef. The estimate for the entire 2500 mi^2 census area was 1594 moose (90% C.I. 1399–1790 ±12 %). This estimate indicates population size declined by 45% since the area was first censused in 1988, and a 13% decline was indicated between the previous census in 1997 and 2002 (Table 2). The calf:adult ratio was 14 calves:100 adults (90% C.I. ±21).

Separate estimates were generated for the Kuzitrin River drainage and the Agiapuk River drainage portions of the census area. The estimate for the Kuzitrin River drainage was 1028 moose (90% C.I. ±14%), indicating a 47% decline in population size since the 1988 census and an 18% decline since 1997. The calf:adult ratio was 12 calves:100 adults (90% C.I. ±25%). The recruitment rate was 11%.

The estimate for the Agiapuk River drainage was 567 moose (90% C.I. ±21%), indicating a 40% decline since 1988 and a relatively stable population since 1997 (point estimate showed a 2% decline, which is not statistically significant). The calf:adult ratio was 17 calves:100 adults (90% C.I. ±31%). The recruitment rate was 14%. The census results showing a continued decline in the Kuzitrin drainage and a fairly stable population in the Agiapuk drainage were consistent with expectations based on data from recruitment and composition surveys in recent years and with impressions of many local residents.

In 2003 a geostatistical population census of the approximately 2000 mi^2 Unalakleet River drainage in Unit 22A was completed 6–10 March. We obtained an estimate of 75 moose (90% C.I. 46–103 ±39%). The calf:adult ratio was 15 calves:100 adults (90% C.I. ±75%). We do not have previous estimates for the entire drainage; however, when compared to the 1989 census estimate of 325 moose in a 1124 mi^2 portion of the drainage, more than a 3-fold decline is indicated. These results are consistent with results of spring surveys showing very low recruitment rates and with concerns of many local residents.

During 9–11 March 2003 we conducted the first geostatistical population census in Unit 22E. Previous estimates were minimum direct counts obtained during moose surveys of riparian habitat. The 2003 estimate was 504 moose (90% C.I. 456–551 ±10%), and 23 calves:100 adults. The recruitment rate was 19%. This estimate is above our management goal of 200–250 moose and higher than all previous Unit 22E estimates. It would suggest a reversal in the decade-long trend of declining moose numbers and low recruitment rates in Unit 22E; however, we believe the estimate reflects an unusual abundance of moose wintering in the unit instead of an actual increase in the overall population in Unit 22E. Collaring studies in the mid 1980s showed considerable seasonal movement of moose between Unit 22E and the American/Agiapuk River drainages in Unit 22D, and many moose that typically wintered in Unit 22D moved to Unit 22E during summer months. During the winter of 2002–2003 snow cover was very sparse and shallow. We found many moose in coastal areas where they have not been found during previous winter surveys. Snow depth was likely insufficient to drive many moose to their typical wintering areas in the river bottoms in Unit 22E and to the American and Agiapuk River drainages in Unit 22D. However, the 19% recruitment rate was higher than in previous years (8% in 2000) and the March 2003 recruitment rate in the American/Agiapuk River drainages in Unit 22D was also higher (23% short yearlings) than in recent years, indicating a widespread improvement in calf survival.

Population Composition

In November 2001, fall composition surveys were conducted in portions of Units 22B, 22C and 22D. Results from those surveys were reported in the previous management report. In November 2002, we surveyed the Snake and Stewart River drainages in Unit 22C, and in November 2003 composition surveys were flown in Kuzitrin and Agiapuk River drainages in Unit 22D. These surveys were done using a Robertson R44 helicopter, which greatly improves our ability to find moose when snow cover is minimal. In October 2003 we flew composition surveys in Unit 22A in the Unalakleet and Golsovia River drainages using a Cessna-185. Results of all composition surveys are found in Table 3. In spring 2003, recruitment surveys were flown in Units 22A, 22B, and 22D (Table 4).

Unit 22A In March 2003 spring recruitment surveys were flown in the Unalakleet, Golsovia and Pikmiktalik River drainages of Unit 22A. We surveyed the main stem of the Unalakleet River immediately after the census to address Unalakleet residents' skepticism about our low count. We found 19 moose with 16% short-yearlings, which was consistent with census results. In the Golsovia River drainage 29 moose were counted with 21% short-yearlings. In the lower Pikmiktalik River drainage, we found 17 moose and 35% short-yearlings.

In early October 2003 (after the reporting period) department and BLM staff flew composition surveys in the Unalakleet and Golsovia drainages of Unit 22A for the first time. Sightablility in

the trees was poor without snow cover, but we were able to ascertain some important information. In the Unalakleet drainage where our observations were limited to a small portion of total moose habitat, we classified 68 moose, which is close to the March 2003 census estimate of 46–103 moose for the entire drainage. This supports local claims that more moose are present in the drainage in the fall than in winter months. We found 69 bulls:100 cows and 20 calves:100 cows. Our survey occurred close to the peak of rut and bulls were more visible than cows, thus our bull:cow ratio is likely skewed upward. However, rutting groups were small with few cows per bull, indicating a fairly high bull:cow ratio. It is unlikely that depletion of bulls by excessive hunting pressure is responsible for the dramatic decline in moose numbers. Also of note were the overall low density of moose and the vast amount of unused habitat.

In the Golsovia River drainage we found 26 moose, 50 bulls:100 cows and 67 calves:100 cows. Here, too, moose density appears very low with much vacant habitat; however, the fall calf:cow ratio and the calf:adult ratios seen in previous winter surveys are higher than those documented in most parts of Unit 22.

Unit 22B. In spring 2003 we flew a Niukluk River recruitment survey, finding 65 total moose, and 6 short-yearlings. The recruitment rate was 9%. In 2003, in other parts of Unit 22 where we surveyed, we documented higher recruitment rates than we have seen in recent years, but this was not the case in western Unit 22B, where the recruitment rate has remained at 10% or lower since 1991.

Unit 22C. In November 2002 we surveyed the Snake River drainage in Unit 22C and classified 95 moose, finding 18 bulls:100 cows and 52 calves:100 cows. In the Stewart River drainage we found 30 moose, 42 bulls:100 cows and 16 calves:100 cows. Combining these adjacent drainages we classified 125 moose, finding 24 bulls:100 cows and 43 calves:100 cows. This is the highest calf:cow ratio we have documented in Unit 22C. The bull:cow ratio in the Stewart River drainage is considerably higher than that documented in the more accessible adjoining drainages and helps alleviate concerns about excessive bull harvest in Unit 22C.

Unit 22D. In March of 2003 we flew Kuzitrin River drainage recruitment surveys along the main stems of the lower Kougarok River drainage, the Noxapaga/Kuzitrin River drainages above the Taylor Highway bridge and the main stem of the Kuzitrin River below the bridge. Results were similar in all three areas (Table 4). We recorded 19 short-yearlings:100 adults and a 16% recruitment rate (n=644). A higher portion of yearlings were found in this area than in the previous recruitment survey in 2000 or in the 2002 Unit 22D census. We also surveyed the Agiapuk River survey area and there too found a higher than usual proportion of short-yearlings with 30 short-yearlings:100 adults and a 23% recruitment rate (n=320).

In November 2003 (after the reporting period) we flew composition surveys in portions of the Kuzitrin River drainage in Unit 22D, finding 26 bulls:100 cows (n=232). This represents a substantial increase since 2000 and 2001 when 15–16 bulls:100 cows were observed. Most of the bulls seen were yearling or 2-year-old bulls, with very few large bulls. However, the overall increase in bull numbers is a positive indication that the harvest quota for this area, imposed in 2002, is having the desired effect of increasing the bull:cow ratio. We found 15 calves:100 cows, which is similar to calf:cow ratios documented in this area since 2000.

A November 2003 (after the reporting period) survey of the American and Agiapuk River drainages documented 24 bulls:100 cows (n=223) which is below ratios documented previously in that area. However, fog prevented observations in the upper Agiapuk portion of the survey area where we have consistently found the highest concentration of bulls. It is likely that the lack of observations from that area reduced the observed bull:cow ratio and unlikely that there was a sudden large reduction in bull numbers. We found 27 calves:100 cows, which is the highest calf:cow ratio we have documented in this survey area.

Distribution and Movements

No studies were undertaken during this reporting period to evaluate distribution or movements of moose in Unit 22.

MORTALITY

Harvest

Season and Bag Limit. The 2001–2002 seasons and bag limits were unchanged from the previous reporting period. In 2002–2003, changes were implemented in Units 22B, 22D, and 22E.

2001–2002 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A		
Residents: 1 bull	1 Aug–30 Sep 1 Dec–31 Jan	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least 1 side		1 Aug–30 Sep
Unit 22B, that portion east of the Darby Mountains, including the drainages of the Koyuk and Inglutalik Rivers		
Residents: 1 bull	1 Aug–30 Sep 1 Nov–31 Dec	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least 1 side		1 Nov–31 Dec
Remainder of Unit 22B		
Residents: 1 bull	1 Aug–30 Sep 1 Dec–31 Jan	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least 1 side		1 Sep–30 Sep

2001–2002 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22C Residents: 1 bull Or one antlerless moose by registration permit	1 Sep–14 Sep 15 Sep–30 Sep	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side		1 Sep–14 Sep
Unit 22D, that portion within the Kougarok, Kuzitrin and Pilgrim River drainages Residents: 1 antlered bull	1 Aug–31 Jan	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side		1 Sep–30 Sep
Remainder of Unit 22D Residents: 1 antlered bull or 1 moose	1 Aug–31 Jan 1 Dec–31 Dec	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side; however, antlerless moose may be taken only from 1 Dec–31 Dec.		1 Aug–31 Jan
Unit 22E Residents: 1 moose; however, no person may take a cow accompanied by a calf	1 Aug–31 Mar	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side		1 Aug–31 Mar

2002–2003 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22A Residents: 1 bull	1 Aug–30 Sep 1 Dec–31 Jan	

2002–2003 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least 1 side		1 Aug–30 Sep
Unit 22B, that portion east of the Darby Mountains, including the drainages of the Koyuk and Inglutalik Rivers		
Residents: 1 bull	1 Aug–30 Sep 1 Nov–31 Dec	
Nonresidents: 1 bull with 50-inch antlers or with 4 or more brow tines on at least 1 side		1 Nov–31 Dec
Remainder of Unit 22B		
Residents: 1 antlered bull by registration permit only; or	10 Aug–23 Sep	
1 bull by registration permit only	1 Jan–31 Jan (Season may be announced by emergency order)	
Nonresidents:		No open season
Unit 22C		
Residents: 1 bull; or	1 Sep–14 Sep	
1 antlerless moose by registration permit	15 Sep–30 Sep	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side		1 Sep–14 Sep
Unit 22D, that portion within the Kougarok, Kuzitrin and Pilgrim River drainages		
Residents: 1 antlered bull by registration permit only; or	20 Aug–14 Sep	
1 bull by registration permit only	1 Jan–31 Jan (Season may be announced by emergency order)	
Nonresidents:		No open season

2002–2003 Units and Bag Limits	Resident/Subsistence Hunters	Nonresident Hunters
Unit 22D Southwest, that portion west of the Tisuk River drainage, west of the west bank of the unnamed creek originating at the unit boundary opposite the headwaters of McAdam's Creek to its confluence with Tuksuk Channel		
Residents: 1 antlered bull by registration permit only; or	20 Aug–14 Sep	
1 bull by registration permit only	1 Jan–31 Jan (Season may be announced by emergency order)	
Nonresidents:		No open season
Remainder of Unit 22D		
Residents: 1 antlered bull or 1 moose; however, antlerless moose may be taken only from 1 Dec through 31 Dec. A person may not take a cow accompanied by a calf	10 Aug–14 Sep 1 Oct–31 Jan	
Nonresidents: 1 bull with 50–inch antlers or with 4 or more brow tines on at least 1 side		1 Sep–14 Sep
Unit 22E		
Residents: 1 antlered bull	1 Aug–31 Dec	
Nonresidents:		No open season

Board of Game Actions and Emergency Orders. In November 2001 the Board of Game addressed concerns about declining moose populations in parts of Unit 22 by making a number of changes to moose seasons and bag limits in Units 22B, 22D and 22E that went into effect in regulatory year 2002–2003. In Unit 22B west of the Darby Mountains (remainder of Unit 22B), fall and winter resident registration permit hunts with harvest quotas were established from 10 August to 23 September for any antlered bull and from 1 January to 31 January for any bull. The nonresident moose season in western Unit 22B was closed.

In the portion of Unit 22D that includes the Kuzitrin drainage and the area west of the Tisuk River drainage a resident registration hunt for bull moose was established with a separate quota for each area. The season is 20 August–14 September for any antlered bull. If the quotas for these areas are not reached, a winter season from 1 January to 31 January may be announced.

The nonresident moose season in these portions of Unit 22D was closed. In the remainder of Unit 22D the resident season was shortened to 10 August–14 September and 1 October–31 January. The nonresident season is 1 September–14 September.

In Unit 22E the resident moose season was shortened by 3 months to 1 August–31 December, and the bag limit was changed from 1 moose to 1 antlered bull. The nonresident season was closed.

In July 2001, prior to the board actions described above, we issued an emergency order shortening the 2001 resident and nonresident moose seasons in the most heavily hunted parts of Units 22B and 22D. In western Unit 22B, Unit 22D in the Kuzitrin River drainage and in southwestern Unit 22D, the resident season was shortened to 20 August–14 September. The nonresident season was reduced to 1–14 September. In Unit 22E the shortened season for all hunters was 1 August–31 December and the bag limit was changed from 1 moose to 1 antlered bull.

In December 2002 an emergency order was issued announcing 1–31 January seasons for bull moose by registration permit in western Unit 22B and southwestern Unit 22D. Quotas of 10 bulls in western Unit 22B and 3 bulls in 22D southwest were announced, but neither was filled so the seasons ran to the published closure date.

In November 2003 (after the reporting period) the board made additional changes in moose regulations in Units 22A, 22B, 22C, and 22D, effective in regulatory year 2004–2005. In Unit 22A seasons were shortened and 3 hunt areas with differing seasons and bag limits were established to take into account the different hunting patterns in different parts of Unit 22A. In Unit 22A north of and including the Shaktoolik and Tagoomenik River drainages, the resident season was shortened to 1 August–30 September, and the nonresident season was shortened to 1–14 September. In Unit 22A in the Unalakleet drainage and all drainages flowing into Norton Sound north of the Golsovia drainage and south of the Tagoomenik and Shaktoolik drainage, the resident season was shortened to 15 August–25 September, and the nonresident season was closed. In the remainder of Unit 22A the resident season was shortened to 1 August–30 September and 1–31 December, and the bag limit was changed to 1 antlered bull. The nonresident season was reduced to 1–30 September.

In western Unit 22B the winter registration moose hunt from 1–31 January was put into permanent regulation, so emergency order openings will no longer be necessary. The bag limit was changed from 1 bull to 1 antlered bull to prevent accidental harvest of cows.

A registration hunt for bull moose was established in Unit 22C to simplify permit requirements in the Nome area. People hunting in all areas along the Nome road system will need only 1 registration permit, which will be valid in 4 hunt areas: Unit 22C, western Unit 22B, the Kuzitrin drainage in Unit 22D, and Unit 22D southwest. No changes were made to seasons or bag limits in Unit 22C.

In Unit 22D remainder, where hunting pressure has recently increased, a nonresident registration hunt was established with a limit of up to 10 permits.

In November 2003, following the board meeting, we issued an emergency order that closed the winter moose season in Unit 22A north of the Golsovia River drainage and shortened the winter season by 1 month to the month of December in the remainder of Unit 22A and changed the bag limit to 1 antlered bull. Data showing steep declines in the Unit 22A moose population prompted us to put the board's actions into effect immediately rather than waiting for the 2004 regulatory year. The Federal Subsistence Board mirrored this action with a "Special Action." The November emergency order also announced the opening of a 1–31 January season in western Unit 22B and 22D southwest with a quota of 10 bulls in Unit 22B and 3 bulls in 22D southwest.

Hunter Harvest. During the 2001–2002 season, harvest ticket data shows that 421 hunters harvested 127 moose (119 males and 8 females). A harvest of 172 moose (160 males and 12 females) was reported taken by 563 hunters during the 2002–2003 season (Table 1).

In 2001 and 2002, moose harvests and success rates were the lowest reported in Unit 22 since the mid 1970s. Declining numbers of moose; fewer hunters in the field in 2001; an emergency order in 2001 shortening seasons in western Unit 22B, Unit 22D in the Kuzitrin River drainage, southwestern Unit 22D and Unit 22E; and permanent regulation changes shortening seasons and restricting harvest in the same areas in 2002 contributed to reduced hunter effort and harvest. In 2002 more people reported hunting in Unit 22 than in recent years, but the increase is attributed to the strictly enforced reporting requirements in the new registration hunts, rather than an actual increase in the number of hunters in the field.

Compliance with license and harvest reporting requirements by Nome residents is believed to be high, but harvest reporting by village residents has always been incomplete. During this reporting period, the department and Kawerak Inc. continued a community-based harvest assessment program begun in April 1999 to obtain more accurate big game harvest data from Unit 22 villages. In April 2002 household surveys were conducted in Golovin, and no moose harvest was reported. In May 2003 we surveyed Unalakleet and Stebbins. Unalakleet residents reported harvesting 29 moose, and 31% of the households that reported hunting moose were successful. Only 41% (12 moose) of the moose taken by Unalakleet residents were reported by harvest ticket. Stebbins households reported a harvest of 20 moose. The success rate in Stebbins was 46%. Twenty percent of the Stebbins harvest (4 moose) was reported by harvest ticket. (Georgette 2004).

In 2001–2002, 7% (8 cows) of the reported harvest was cows and in 2002–2003 the cow harvest was 8% (12 cows) of the total (Table 1). Ninety-five percent of these cows were harvested in the antlerless moose registration hunts in Unit 22C. Although no cow harvest was reported during village harvest surveys in this reporting period, harvest surveys in previous years have shown that more cows are harvested than are reported by harvest ticket. However, now that antlerless seasons have been closed in most parts of Unit 22, we believe that cow harvest is minimal.

Permit Hunts. Two registration permit hunts for antlerless moose are administered in Unit 22C. Hunt RM850 occurs in the portion of Unit 22C in the Nome and Snake River drainages with up to 5 available permits. RM852 is in the remainder of Unit 22C and up to 15 permits may be available. In 2001 only 10 permits were issued (3 in RM850 and 7 in RM852) due to concern about higher than normal winter mortality in spring 2001. In RM850, 3 cows were harvested and

5 cows were harvested in RM852. In 2002 all 20 permits were issued, and 3 cows were taken in RM850 and 8 cows were harvested in RM852 (Table 5).

In 2002 registration hunts with harvest quotas were implemented for bull moose in the heavily hunted portions of Units 22B and 22D along the Nome road system (Table 5). In Unit 22B west of the Darby Mountains, 204 people reported hunting in fall registration hunt (RM846) and 38 bulls were taken from a 42 bull quota. The western Unit 22B winter hunt (RM848) had a harvest quota of 10 bulls (6 bulls reserved for the winter hunt plus 4 from the unfilled portion of the fall quota). Nine people reported hunting, and 2 bulls and 1 cow (accidental harvest) were taken.

In Unit 22D the fall registration hunt (RM856) contained 2 separate hunt areas with separate quotas, one encompassing the entire Kuzitrin River drainage and the other in southwestern Unit 22D along the Nome-Teller highway. A combined total of 209 people reported hunting in RM856, and 30 bulls were taken out of a 33 bull quota in the Kuzitrin drainage and 1 bull out of an 8 bull quota was taken from Unit 22D southwest. A Unit 22D winter registration hunt (RM858) was opened only in Unit 22D southwest and no one reported hunting or taking a moose.

The registration hunts with harvest quotas require reporting within 3 days of harvesting a moose, and hunters must turn in the lower jaw for aging and tooth analysis. The public has been impressively compliant with these new requirements. Reporting by people who hunt but fail to harvest a moose has typically been lax in the past, but increased emphasis on the need to report has increased the reporting rate in the registration hunts.

Hunter Residency and Success. During 2001–2002 Unit 22 residents accounted for 68% of the harvest and in 2002–2003, 80% of the harvest (Table 6). For 10 years prior to this reporting period the proportion of the harvest attributable to local residents remained remarkably constant ranging from 69%–74%. In 2002 the regulatory changes that closed nonresident seasons in large parts of the unit and harvest quotas that tend to discourage nonlocal hunters from flying to Unit 22 were probably responsible for the decrease in nonlocal harvest. Nonresidents accounted for 15% of the harvest in 2001 and 10% in 2002, compared to 11–13% during the previous reporting period.

Harvest Chronology. Shortened season lengths have consolidated much of the harvest into the months of August and September in most parts of the unit (Table 7). Previously, long seasons that ran from August through January in many parts of the unit and through March in Unit 22E allowed harvest to occur over a period of up to 8 months. During this reporting period, most of the hunter effort and reported harvest occurred during September (72%) and August (13%). In October moose season was only open in remote portions of Unit 22D and in Unit 22E. In November eastern Unit 22B was the only place in Unit 22 with an open season. Some hunting activity also occurred in December and January during open seasons in Unit 22A and remote parts of Unit 22D and in December in Unit 22E. In Unit 22E, where there are no roads, and river access to moose habitat is limited, most of the harvest prior to 2001 occurred during January, February and March when hunting is possible by snowmachine.

Data from community-based harvest assessment in Koyuk, Shaktoolik, Elim and White Mountain indicate August is the favored month for moose harvest in those villages. Most of the

remaining harvest there occurs in September or December (Georgette 1999 and 2000). Surveys of Teller, Brevig, Shishmaref and Wales found different harvest timing in the western villages. In Teller, October was the favored month for moose harvest, followed by September and August. In Brevig the highest harvest was in September, followed by December and October. In Shishmaref and Wales harvests were highest in March, but March moose harvest was no longer legal during this reporting period (Georgette 2001). Survey data show September is the preferred month for moose harvest in Unalakleet, and in Stebbins most of the harvest occurs in December (Georgette 2004).

Transport Methods. During this reporting period 33% of successful moose hunters used boats, 32% used 4-wheelers, 15% used highway vehicles and 9% used snowmachines (Table 8). Only 5% of the harvest was by hunters using airplanes. The number of moose harvested by hunters using only highway vehicles for transportation has declined steadily over the last decade. Moose densities are now very low along the road corridor and hunters often must travel to areas far from the road system for successful hunts. Four-wheel-drive 4-wheelers provide access to remote areas, particularly areas characterized by open terrain, such as Unit 22D.

Other Mortality

No surveys were attempted to determine natural mortality rates of Seward Peninsula moose. We believe that bear density in Unit 22 has increased over the last decade and that predation by bears on calf and adult moose is a significant factor suppressing moose populations in many parts of the unit. Recruitment rates are generally very low in most parts of the unit. A 1996–1998 radiocollar study of cow moose in western Unit 22B found that up to 75% of the moose calves observed died within 3 months of birth and 71% of calf mortality occurred within a month of birth. Although calf viability may be a factor, such high mortality shortly after birth suggests predation (Persons 1998). During years when deep, soft snow persists well into May, bear predation on adult moose may be significant; however, during this reporting period winter conditions in most parts of the unit appeared to be fairly easy on moose. Wolves are becoming more numerous on the Seward Peninsula, especially in areas occupied by wintering caribou from the Western Arctic herd. Predation by wolves was not previously believed to be a significant factor in moose mortality, but that may be changing as wolves become more abundant.

HABITAT

Assessment

A browse survey of the Snake River drainage in Unit 22C was organized for April 2003, but early breakup prevented the work from occurring. The project is rescheduled for March 2004. The growing moose population in Unit 22C and the increasingly heavy use of winter habitat there raises concerns that the carrying capacity may be exceeded. In the past during winters of heavy snow accumulation, winter ranges have been heavily browsed, but at current population levels in most parts of the unit we do not believe that habitat limitations are suppressing moose populations.

Enhancement

There were no habitat enhancement activities conducted in Unit 22 during the reporting period.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

In Units 22B and 22D the Federal Subsistence Board adopted regulations or special actions that differ from state moose regulations. While this has not resulted in biological problems, it has increased the complexity of the regulations and created public confusion. State and federal managers need to work cooperatively to produce and distribute maps and simplified explanations on which regulations apply where.

In January 2002 Unit 22 staff began collaborating with Fairbanks researchers Dr. Julie Maier (University of Alaska) and Dr. Raphaela Stimmelmayr (Tanana Chiefs Conference) to investigate the causes of cracked and broken teeth frequently observed in the jaws of moose harvested on the Seward Peninsula. Such breakage is not known to occur in other Alaska moose populations. Previous investigations initiated by former Unit 22 Area Biologist Bob Nelson in the late 1980s were inconclusive.

The 55 jaws examined in 2002 indicate oral bone loss and periodontal disease are common in Seward Peninsula moose (74% of jaws were affected). Fluorosis was initially suspected, but results from bone mineral analysis corroborate previous analyses and do not support that hypothesis. However, in our study high lead and zinc levels were highly correlated to severity of tooth breakage and are known to cause anomalies in enamel formation in laboratory rodents. Other possible explanations for elevated bone loss include cadmium exposure, inbreeding and a founder effect. Investigations of these and other possibilities will continue. It is possible that poor tooth condition may be associated with lowered productivity and reproductive potential of affected animals.

CONCLUSIONS AND RECOMMENDATIONS

The moose population on the Seward Peninsula grew steadily from the 1960s through the early 1980s and began to decline during the late 1980s and early 1990s. We estimate the population reached a maximum size of 7000–10,000 moose on the Seward Peninsula during the mid to late 1980s. Subsequent declines likely caused by a combination of winter mortality, reduced productivity, low recruitment and increased predation reduced the population size to between 4500 and 6500 animals. Survey and inventory projects during this reporting period show continuing population declines and low recruitment rates in much of Unit 22A, 22B, and the Kuzitrin drainage in Unit 22D, indicating a widespread problem with calf survival in the unit. In a large portion of Unit 22 it is likely that harvest and natural mortality are exceeding recruitment and that populations are declining. Census and survey results were more optimistic in the Agiapuk River drainage in Unit 22D where the 2002 census showed the population to be stable. In this area healthy recruitment rates were found in March 2002 and 2003, and a high proportion of calves was found in November 2003. In Unit 22E 2003 census results also showed a much improved recruitment rate.

Results from a research study in western Unit 22B in the late 1990s indicate several factors are contributing to low recruitment in that portion of the unit. Predators, especially bears, are abundant in the area, and bear predation on calves is probably the most significant factor in calf mortality. However, the factors of a population dominated by older cows, frequent severe winter snow conditions, poor winter range quality, periodontal disease and factors responsible for it may be acting in combination to lower productivity and produce calves that are less vigorous at

birth and have subsequent lowered survival (Persons 1998). Some or all of these factors may influence recruitment in other parts of the unit.

In November 2001 concern about declining moose numbers in the most accessible parts of Units 22B, 22D and 22E led the Board of Game to adopt significant changes to hunting regulations in the most heavily hunted portions of these units. The nonresident seasons were closed, resident seasons were shortened, registration hunts with quotas were established in Units 22B and 22D, and in Unit 22E the antlerless season was closed. Additionally, brown bear hunting regulations were liberalized in Unit 22. In November 2003 (after this reporting period) the board dealt with declining moose populations in Unit 22A by shortening seasons and adopting an antlered bull bag limit. In Unit 22D remainder where harvest pressure has increased as a result of restrictions elsewhere, the board made a preemptive move and limited nonresident harvest by establishing a registration hunt with a limited number of permits. The public is well aware of declining moose numbers and played an active role in developing all regulations adopted by the board.

Unit 22C is the only portion of Unit 22 where consistently high recruitment rates have allowed the population to exceed our management goal. An antlerless moose hunt in Unit 22C was initiated in 2000 to help stabilize the population and prevent overuse of the limited winter habitat. A Unit 22C census and browse survey planned for March 2004 will help us determine if further reduction of numbers is advisable. Although we believe that at current population levels, habitat is not a significant limiting factor for moose in other parts of the unit, we hope to apply the habitat assessment techniques learned from habitat specialist Tom Paragi (ADF&G, Fairbanks) in Unit 22C to other parts of the unit with chronic low recruitment rates and long term population declines such as western Unit 22B and the Kuzitrin drainage in Unit 22D.

During this reporting period we implemented a change to moose survey and inventory procedures by increasing the frequency of moose censuses in each of the units to once every 3 years rather than once every 5 years. Declining population trends and the importance of moose to local users necessitated more frequent population estimates so we can identify and respond more promptly to downward trends. Although this required a reduction in time and money devoted to muskox and reduced funds for fall and spring moose composition surveys, obtaining frequent moose population estimates is our best method for monitoring this important resource.

Compliance with regulations and harvest reporting is thought to be reasonably high in the Nome area and has improved as a result of education efforts associated with the new registration hunts. However, in the remainder of the unit some residents do not acquire licenses and/or harvest tickets prior to hunting and much of the harvest is unreported. Public education programs and a visible enforcement effort improve compliance with regulations, but we have found the community-based harvest assessment programs started in 1999 to be the most effective way to collect accurate harvest data from village residents. This data has been essential in providing the board with a realistic picture of moose harvest and timing in Unit 22 and has greatly influenced the board in its regulatory decisions. This program should be continued and expanded to provide ongoing estimates of moose harvest and subsistence use of moose by village residents.

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PREPARED BY:

Kate Persons
Wildlife Biologist III

SUBMITTED BY:

Peter Bente
Management Coordinator

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Table 1 Unit 22 historical moose harvest by sex, hunter effort, and success rate for regulatory years 1969–2002

Regulatory year	Males	Females	Unknown sex	Total harvest	Total hunters[a]	Percent success
1969–1970	69	1	2	72	182	40
1970–1971	70	0	1	71	139	51
1971–1972	59	0	1	60	168	36
1972–1973	44	0	0	44	99	44
1973–1974	103	32	1	136	317	43
1974–1975	149	72	1	222	479	46
1975–1976	136	0	2	138	389	25
1976–1977	186	51	3	240	611	39
1977–1978	151	88	5	244	457	53
1978–1979	198	97	2	297	596	50
1979–1980	193	75	2	270	760	36
1980–1981	156	71	1	228	492	46
1981–1982	225	72	1	298	696	43
1982–1983	244	100	0	344	904	38
1983–1984	291	68	46	405	1292	31
1984–1985	298	91	6	395	1086	36
1985–1986	279	92	3	374	876	43
1986–1987	306	101	1	408	892	46
1987–1988	286	20	4	310	775	40
1988–1989	332	36	7	375	748	50
1989–1990	208	82	0	290	713	41
1990–1991	280	70	0	350	700	50
1991–1992	207	95	0	302	656	46
1992–1993	217	72	0	289	645	45
1993–1994	225	21	1	247	553	45
1994–1995	201	10	0	211	486	43
1995–1996	169	13	3	185	469	39
1996–1997	176	20	2	198	456	43
1997–1998	197	6	0	203	423	48
1998–1999	195	13	3	211	510	41
1999–2000	244	5	3	252	581	43
2000–2001	194	27	0	221	536	41
2001–2002	119	8	0	127	421	30
2002–2003	160	12	0	172	563	31

[a]Minimum known number of hunters.

Table 2 Summary of Unit 22 spring moose censuses, 1987–2003

Area	Year	Size (mi^2)	Census estimate (Nr.)			Density (Nr./mi^2)		Calves per 100 Adults	Percent calves	Methods
			Adults	Calves	Total	Adult	Total			
Unit 22A Unalakleet Drainage	1989	1124	273	52	325	0.24	0.29	19	16	Gasaway
Unit 22A Unalakleet Drainage	2003	2000	64	11	75	0.04	0.04	15	15	Geostatistical
Unit 22B West	1987	2105	1676	218	1894	0.80	0.90	13	11.5	Gasaway
Unit 22B West Reduced area	1992	859	603	95	698	0.70	0.81	16	14	Modified Gasaway
Unit 22B West	1999	2105	749	49	797	0.36	0.38	7	6	Geostatistical
Unit 22B West Reduced area	1999	859	448	28	476	0.52	0.58	6	6	Geostatistical
Unit 22C	1990	1368	322	85	407	0.24	0.30	26	21	Gasaway
Unit 22C	1995	1368	394	85	479	0.29	0.35	22	18	Modified Gasaway
Unit 22C	2001	1368	413	139	557	0.30	0.41	34	25	Geostatistical
Unit 22D Kuzitrin Drainage	1988	1456	1673	278	1951	1.14	1.34	17	14	Gasaway
Unit 22D Kuzitrin Drainage Reduced Area	1993	856	943	153	1096	1.10	1.28	16	14	Modified Gasaway
Unit 22D Kuzitrin Drainage	1997	1456	1019	232	1251	0.70	0.86	23	19	Modified Gasaway

Table 2 Summary of Unit 22 spring moose censuses, 1987–2003 (continued)

Area	Year	Size (mi^2)	Census estimate (Nr.)			Density (Nr./mi^2)		Calves per 100 Adults	Percent calves	Methods
			Adults	Calves	Total	Adult	Total			
Unit 22D Kuzitrin Drainage	2002	1456	915	113	1028	0.63	0.71	12	11	Geostatistical
Unit 22D Agiapuk Drainage	1988	1041	782	159	941	0.75	0.90	20	17	Gasaway
Unit 22D Agiapuk Drainage Reduced Area	1993	723	406	77	483	0.56	0.66	19	16	Modified Gasaway
Unit 22D Agiapuk Drainage	1997	1041	451	127	578	0.43	0.56	28	22	Modified Gasaway
Unit 22D Agiapuk Drainage	2002	1041	485	82	567	0.47	0.54	17	14	Geostatistical
Unit 22E	1991	NA	208	18	226	NA	NA	9	8	Riparian Survey
Unit 22E	1996	NA	164	32	196	NA	NA	20	16	Riparian Survey
Unit 22E	2001	NA	157	12	169	NA	NA	8	7	Riparian Survey
Unit 22E	2003	4500	408	96	504	0.09	0.11	23	19	Geostatistical

Table 3 Unit 22 aerial moose composition surveys, fall of 1992, 1994, and 2000–2003

Survey area	Year	Bulls per 100 cows	Calves per 100 cows	Total calves	Percent calves	Total adults	Total moose
Unit 22A							
Unalakleet River	2003	69	20	7	10	59	66
Golsovia River	2003	50	67	8	31	18	26
Unit 22B							
American Creek	1992	58	10	4	10	38	42
	1994	28	28	8	18	37	45
Niukluk River	2000	27	8	7	6	108	115
	2001	30	14	8	10	73	81
Unit 22C							
Snake River	1992	11	30	11	21	41	52
	1994	14	32	12	22	42	54
	2000	10	25	16	20	69	85
	2001	17	24	17	17	83	100
	2002	18	52	29	31	66	95
Stewart River	2001	39	17	7	11	57	64
	2002	42	16	3	10	27	30

Table 3 Unit 22 aerial moose composition surveys, fall of 1992, 1994, and 2000–2003 (continued)

Survey area	Year	Bulls per 100 cows	Calves per 100 cows	Total calves	Percent calves	Total adults	Total moose
Unit 22D							
Henry/Washington Ck.	1994	40	23	22	14	133	155
Kougarok/Noxapaga	2000	16	11	19	9	197	216
	2001	15	19	16	14	98	114
	2003	26	15	24	10	208	232
Agiapuk	2000	44	23	43	14	275	318
	2001	30	6	5	4	107	112
	2003	24	27	40	18	183	223

Table 4 Unit 22 short yearling recruitment surveys, spring 1991–2003

Survey area and survey year	Nr. calves	Nr. adults	Total	Percent Calves
Unalakleet, main stem (Unit 22A)				
2000	7	77	84	8
2003	3	16	19	16
Shaktoolik, main stem (Unit 22A)				
2000	5	40	45	11
2003	2	11	13	15
Ungalik, main stem (Unit 22A)				
2000	1	28	29	3
2003	0	1	1	0
Golsovia drainage (Unit 22A)				
2000	4	11	15	27
2003	6	23	29	21
Pikmiktalik main stem (Unit 22A)				
2000	2	4	6	33
2003	6	11	17	35
Fish River (Unit 22B)				
1991	12	202	214	6
1993	11	227	238	5
1994	15	255	270	6
1995	16	384	400	4
Niukluk River (Unit 22B)				
1991	30	319	349	9
1995	13	133	146	9
1997	6	77	83	7
2000	9	81	90	10
2003	6	59	65	9
Koyuk River (Unit 22B)				
1999	21	208	229	9
2000	19	223	242	8
Snake River (Unit 22C)				
1993	15	63	78	19
1994	18	39	57	32
1999	33	92	125	26
2000	21	98	119	18
2001	20	76	96	21

Table 4 Unit 22 short yearling recruitment surveys, spring 1991–2003 (continued)

Survey area and survey year	Nr. calves	Nr. adults	Total	Percent calves
Lower Kougarok River (Unit 22D)				
1991	14	103	117	12
1994	33	153	186	18
1995	42	227	269	16
2000	16	168	184	9
2003	32	180	212	15
Kuzitrin/Noxapaga River (Unit 22D)				
1991	23	191	214	11
1994	16	71	87	18
2000	14	203	217	6
2003	52	276	328	16
Kuzitrin Below Bridge (Unit 22D)				
2000	17	271	288	6
2003	16	87	103	15
American River (Unit 22D)				
1995	51	248	299	17
Agiapuk/American (Unit 22D)				
2003	74	246	320	23

Table 5 Unit 22 Registration moose hunt statistics for regulatory years 2001–2002

Year	Hunt	Total permits	Reported	Males killed	Females killed	Unknown killed	Hunted	Did Not Hunt
2001	RM850	3	3	0	3	0	3	0
2001	RM852	8	8	0	5	0	8	0
2002	RM850	5	5	0	3	0	5	0
2002	RM852	15	15	0	8	0	14	1
2002	RM846	399	391	38	0	0	204	187
2002	RM848	15	15	2	1	0	9	6
2002	RM856	416	406	31	0	0	209	197
2002	RM858	3	2	0	0	0	0	2

Table 6 Residency and success of moose hunters in Unit 22, regulatory years 2001–2002 and 2002–2003

Regulatory	Residency of successful hunters					Residency of unsuccessful hunters				
Year/Unit	Unit[a]	State[b]	Nonresident	Unknown	Total	Unit[a]	State[b]	Nonresident	Unknown	Total
2001–2002										
22A	13	1	5	1	20	25	7	1	0	33
22B	14	7	8	0	29	41	27	6	1	75
22C	32	5	0	0	37	71	9	3	0	83
22D	20	5	6	0	31	62	18	9	0	89
22E	7	3	0	0	10	5	0	0	0	5
22 unknown	0	0	0	0	0	7	1	1	0	9
Total	86	21	19	1	127	211	62	20	1	294
2002–2003										
22A	20	1	4	0	25	16	4	5	0	25
22B	37	6	7	0	50	176	13	2	0	191
22C	37	4	1	0	42	131	17	3	0	151
22D	36	6	6	0	48	166	19	5	0	190
22E	7	0	0	0	7	6	1	0	0	7
22 unknown	0	0	0	0	0	3	0	0	0	3
Total	137	17	18	0	172	498	54	15	0	567

[a] Resident of Unit 22

[b] Other Alaska resident

Table 7 Chronology of Unit 22 moose harvest, regulatory years 2001–2002 and 2002–2003

Regulatory year/ Unit	Month of harvest									
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Unknown	Total
2001–2002										
22A	1	15	1	0	2	1	0	0	0	20
22B	3	20	0	6	0	0	0	0	0	29
22C	0	37	0	0	0	0	0	0	0	37
22D	3	24	0	0	2	1	0	0	1	31
22E	0	4	2	0	4	0	0	0	0	10
Total	7	100	3	6	8	2	0	0	1	127
2002–2003										
22A	3	16	0	0	4	2	0	0	0	25
22B	8	32	0	8	0	2	0	0	0	50
22C	0	42	0	0	0	0	0	0	0	42
22D	20	20	5	0	0	2	0	0	1	48
22E	1	4	1	0	1	0	0	0	0	7
Total	32	114	6	8	5	6	0	0	1	172

Table 8 Means of transportation reported by successful Unit 22 moose hunters, regulatory years 1999–2002

Regulatory Year/Unit	Aircraft	Horse	Boat	3 or 4 Wheeler	Snowmobile	Off-road vehicle	Highway vehicle	Air boat	Unknown	Total
1999–2000										
22A	1	0	23	11	5	0	1	0	0	41
22B	6	0	25	24	5	1	5	0	1	67
22C	1	0	10	10	0	2	14	0	1	38
22D	3	0	17	42	4	0	22	0	4	92
22E	0	0	2	0	12	0	0	0	0	14
Total	11	0	77	87	26	3	42	0	6	252
2000–2001										
22A	0	0	12	3	0	0	0	0	0	15
22B	4	0	18	18	10	0	3	0	1	54
22C	0	1	10	13	0	5	23	0	1	53
22D	1	0	15	30	7	7	16	0	0	76
22E	0	0	4	2	15	1	0	0	0	22
Unknown	0	0	0	1	0	0	0	0	0	1
Total	5	1	59	67	32	13	42	0	2	221
2001–2002										
22A	1	0	8	9	2	0	0	0	0	20
22B	0	0	9	11	6	2	1	0	0	29
22C	0	0	7	15	0	3	12	0	0	37
22D	3	0	8	10	3	4	1	1	1	31
22E	0	0	2	4	4	0	0	0	0	10
Total	4	0	34	49	15	9	14	1	1	127
2002–2003										
22A	0	0	14	4	6	1	0	0	0	25
22B	7	0	17	16	3	0	6	0	1	50
22C	0	0	2	19	0	2	19	0	0	42
22D	2	0	25	9	2	5	5	0	0	48
22E	1	0	5	0	1	0	0	0	0	7
Total	10	0	63	48	12	8	30	0	1	172

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO BOX 25526
JUNEAU, AK 99802-5526

MOOSE MANAGEMENT REPORT

From: 1 July 2001
To: 30 June 2003

LOCATION

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

GEOGRAPHICAL DESCRIPTION: Western Brooks Range and Kotzebue Sound

BACKGROUND

Moose began to recolonize the eastern portion of Unit 23 during the 1920s (J. Magdanz, personal communication) and expanded their range to the Chukchi Sea coast by the mid to late 1940s (W. Uhl and L. Davis, personal communication). Moose currently rank second to caribou as a source of terrestrial meat for most residents of the unit. Moose are also avidly sought primarily for recreation by resident and nonresident hunters who live outside Kotzebue Sound. Commercial services associated with moose hunting provide substantial income to guides, outfitters and transporters who operate in Unit 23. The wide distribution and accessibility of moose throughout the unit makes them important to nonconsumptive users, e.g., viewers and photographers.

From the time moose reappeared in Unit 23 through the late 1980s, public comments, trend count surveys and observations by department staff suggested moose populations increased throughout the region. Severe winters and extensive spring flooding occurred during 1988–1991. These factors, combined with high populations of grizzlies and wolves, probably caused moose populations to stabilize or decline throughout the Kotzebue Basin.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Maintain healthy age and sex structures of moose populations within Unit 23.
- Determine size, trend and composition of Unit 23 moose populations.

MANAGEMENT OBJECTIVES

- Monitor the size and sex/age composition of moose populations in the Noatak, Squirrel, Kobuk and Selawik/Tagagawik Rivers and Northern Seward Peninsula drainages through aerial censuses.
- Maintain a minimum November ratio of 40 bulls:100 cows and a minimum density of 0.5 moose/mi^2 in each major drainage within Unit 23.

METHODS

Population trend and sex/age composition data were obtained from aerial moose censuses. No fall moose censuses were conducted during this reporting period because of poor survey conditions. The department (ADF&G) censused moose in that portion of Unit 23 west of and including the Buckland River drainage during April–May 2002. ADF&G and National Park Service (NPS) censused moose in that portion of the Kobuk drainage east of and including the Shungnak and Pick River drainages during March 2003. All spring censuses used the geostatisical (spatial) population census technique (Ver Hoef, unpublished) where: 1) sample units were stratified as "high" or "low" density; 2) "desktop" stratification with aerial confirmation of questionable sample units (SUs) was employed; and 3) sightability was not estimated.

Harvest information was derived from statewide moose harvest ticket reports for nonlocal hunters. Community-based harvest assessments were used to estimate moose harvests by unit residents. The term "nonlocal hunter" refers to all hunters who reside outside Unit 23 and "local hunter" refers to residents of Unit 23.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Spring census results indicate Unit 23 moose densities are currently 0.1–0.3 moose/mi^2 in large portions of Unit 23 (Table 1). Maximum moose density is probably <1 moose/mi^2 throughout the unit. This is lower than many other portions of Alaska (Hicks 1998).

Interpreting moose census data from Unit 23 is difficult (Tables 1 and 2). Although we began conducting rigorous Gasaway-type censuses in Unit 23 in 1992 (Gasaway, et al. 1986), most areas have been censused only once or twice since that time. Therefore, results for individual census areas reveal little about population trends. In the middle and lower Noatak drainage where we have multiple years of census data (Tables 1 and 2), density estimates have been confounded by repeated modification of the census area (Dau 2002). Perhaps most important, spring census results from the middle and lower Noatak drainage suggest census areas of <2000 mi^2 may be affected as much by snow-induced movements of moose as by changes in population size. Finally, relatively small census areas (i.e., <2000 mi^2) containing a high proportion of high quality habitat, as we originally delineated in various portions of Unit 23, are probably relatively insensitive to changes in moose population size. By disproportionately selecting these areas, moose maintain high local densities even as overall population levels decline and they disappear from marginal habitat.

To counter these problems, in 2001 the department substantially increased the size of spring moose census areas in the Noatak drainage (including the upper portion of the Squirrel drainage), the upper Kobuk drainage and on the northern Seward Peninsula (Table 1). Expanding these areas should minimize the effects of moose movements on census results and preclude the need to repeatedly modify census areas to include newly discovered high-use

areas. Additionally, these expansions will include a greater proportion of marginal and even poor moose habitat than the original census areas.

Because moose census data for Unit 23 are difficult to interpret, we rely heavily on reports from the public and on opportunistic observations by agency staff. These sources of information are consistent with recent spring census data that suggest moose populations have substantially declined in large portions of Unit 23. Similarly, moose density has declined almost 50% in large portions of Unit 22 since about 1990 (K. Persons, personal communication). Moose may be stable in the Selawik drainage (Selawik National Wildlife Refuge, unpublished information); however, my observations of fewer moose and fewer shed antlers in marginal habitat compared to the early 1990s suggests they have slowly declined in this area, too. Moose have reportedly declined in the upper Kobuk drainage since the early 1990s (G. Bamford, personal communication; Tables 1 and 2).

Population Composition

Although census data are of limited value for monitoring moose density in Unit 23, estimates of population composition (i.e., bull:cow, calf:cow and calf:adult ratios) are probably reasonably accurate. With one exception (1997 Tagagawik drainage census), spring censuses have consistently indicated low calf recruitment for Unit 23 (Table 1). This is consistent with my opportunistic observations and reports from many local residents and some long-term commercial operators. Parturition rates appear to be high (B. Shults, personal communication), and I have observed more twins since 1998 than prior to that time. My opportunistic observations and reports from many local hunters and some commercial operators suggest bear predation on neonates is substantially reducing recruitment of moose.

Recruitment during spring 2003 in at least the western portion of Unit 23 was probably higher than suggested by the upper Kobuk moose census in that year (Table 1). For example, on 9 April 2003, department staff surveyed most of the main stem of the Kobuk River between the mouth of Melvin Channel and the mouth of the Shungnak River. At that time moose were highly concentrated along the main stem of the Kobuk River; we observed almost no moose or tracks >1–2 mi from the river. Although we merely "high graded" the riparian corridor to maximize the sample size, we still saw 1150 moose (968 adults and 182 calves) with 19 calves:100 adults and 10 sets of twins. Although not comparable to a rigorous census, it suggests recruitment was probably better following the winter of 2002–2003 than during the previous 6–8 years. This is consistent with many reports from residents of Unit 23 and from some commercial operators.

We have no recent fall composition data to evaluate bull:cow ratios. There is no indication that bull:cow ratios are currently a management concern.

Distribution and Movements

As densities have generally declined throughout Unit 23, moose have essentially disappeared from some localized areas. Examples of this are Aklumayak Creek and the Kaluktavik River, both small tributaries of the middle Noatak River that held many moose in the late 1980s and early 1990s. In contrast, moose density in some localized areas appears to be similar to that before the decline. Examples are the Mulgrave Hills and the northeast portion of the Selawik

Hills. This contraction of moose distribution is probably influenced by habitat quality and possibly by behavior of moose as well (e.g., movement to traditional rutting areas during fall).

Reports from elder Inupiaq hunters in the upper Kobuk villages (e.g. Wesley Woods and Neal Sheldon) and old time pilots (e.g. Nelson Walker) indicate moose were never abundant in the Noatak drainage above the Cutler and Aniuk Rivers. Currently, almost no moose reside year-round in this area. In April 2001, while on a snowmachine trip from Kotzebue to the headwaters of the Noatak River, I saw a total of 2 moose (both bulls) and no other tracks east of the Cutler River. On a similar trip in April 2003, I saw 1 cow with a calf in the Imelyak River and tracks of perhaps 4–5 other individuals. Although large riparian willow thickets occur in this portion of the unit, the absence of spruce probably renders this marginal moose habitat. Additionally, both wolves and brown bears have appeared abundant in the upper Noatak drainage during recent years.

MORTALITY

Harvest

Seasons and Bag Limits.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
2001–2002		
Unit 23 north of and including the Singoalik River drainage		
One moose; cows with calves may not be taken	1 Jul–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep
Noatak drainage		
One moose; however, antlerless moose may be taken only from 1 Nov–31 Mar.; cows with calves may not be taken	1 Aug–15 Sep 1 Oct–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–15 Sep
Remainder of Unit 23		

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
One moose, cows with calves may not be taken	1 Aug–31 Mar	
One antlered moose with spike-fork or 50 inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep
2002–2003		
Unit 23 north of and including the Singoalik River drainage One moose; calves and cows with calves may not be taken	1 Jul–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep
Noatak drainage One moose; however, antlerless moose may be taken only from 1 Nov–31 Mar. Calves and cows with calves may not be taken	1 Aug–15 Sep 1 Oct–31 Mar	
One antlered moose with spike-fork or 50-inch antlers or antlers with 4 or more brow tines on 1 side		6 Sep–15 Sep
Remainder of Unit 23 One moose; calves and cows with calves may not be taken	1 Aug–31 Mar	
One antlered moose with spike-fork or 50 inch antlers or antlers with 4 or more brow tines on 1 side		1 Sep–20 Sep

Board of Game Actions and Emergency Orders. The board reauthorized antlerless moose seasons for the 2001–2002 and 2002–2003 regulatory years. At the November and December 2003 meetings (after this reporting period) the board adopted several regulatory changes for moose regulations in Unit 23. The board:

1) lengthened the nonresident moose season in the Noatak drainage to 1–20 September beginning during the 2004–2005 regulatory year;

2) restricted the nonresident bag limit to 1 bull with 50-inch or 4+ brow tine antlers (i.e., eliminated nonresident take of spike-fork bulls) beginning during the 2004–2005 regulatory year;

3) established nonresident drawing permit hunts for moose; 7 permit hunts with boundaries corresponding to existing Guide-Outfitter Areas will go into effect beginning September 2005;

4) established a registration permit hunt for resident hunters beginning during the 2004–2005 regulatory year; season will be 1 August–31 December and the bag limit will be 1 moose, but antlerless moose can only be taken 1 November–31 December; permits will only be issued in person within Unit 23 during 1 June–15 July; and

5) restricted the general season and bag limit for resident hunters beginning during the 2004–2005 regulatory year; the season will be 1–20 September and the bag limit will be 1 bull with 50-inch or 4+ brow tine antlers.

These restrictions were imposed in response to low numbers of moose in large portions of Unit 23.

Hunter Harvest. Community-based harvest assessments indicate approximately 350 moose are harvested annually by unit residents (Table 3). This is substantially higher than the 28 and 40 moose that unit residents reported taking through the statewide harvest ticket system in 2001–2002 and 2002–2003, respectively. Although moose harvest ticket data appear to capture $\leq$10% of the actual harvest by unit residents, it probably reflects temporal trends in local harvests reasonably well. Harvest ticket data is probably reasonably accurate for nonlocal hunters based on reports from Department of Public Safety staff that most nonlocal hunters get a moose harvest ticket before hunting. Combining harvest ticket data and community harvest assessments indicates total annual harvest was ~500 moose in 2001–2002 and in 2002–2003.

All community-based estimates of unit resident moose harvest were determined when caribou were abundant and generally available at least sometime during the year. If caribou availability decreases through shifts in distribution or population decline, harvest of moose by local residents will almost certainly increase. Most unit residents explain the decline in local moose harvest during 1979–1994 (Fig 3) as a result of increased caribou availability during that time. Currently, the subsistence need for moose in Unit 23 is 325–400 moose annually.

Total reported harvest increased from 1979–1980 through 1988–1989. A general trend of slowly declining harvest began after that time (Table 4, Fig 1). In contrast, the total number of moose hunters has generally increased from 1979–1980 through this reporting period. As in the past, the reported harvest of female moose was small during 2001–2002 and 2002–2003 in terms of absolute numbers (9 and 10 females reported taken, respectively; Table 4), and in relation to total harvest (6% of the total harvest each year).

The decline in hunter numbers that occurred in the Noatak drainage from 1992–1993 through 1999–2000 may have stabilized or reversed (Fig 2). Hunter numbers continued to increase in the Kobuk and Selawik drainages and more hunters used each of these drainages than the Noatak drainage. The Selawik drainage is roughly half the size of the Kobuk or Noatak drainages, and much of the Selawik drainage is open tundra (i.e., poor moose habitat). Besides the social problems that stem from hunter crowding, the moose population in this drainage may be subject to overharvest if this trend in hunter numbers continues. Numbers of moose hunters remained low and stable in Wulik/Kivalina drainages and in northern Seward Peninsula drainages.

Permit Hunts. There were no permit hunts for moose in Unit 23 during the reporting period.

Hunter Residency and Success: Numbers of nonresident and nonlocal Alaska resident moose hunters continued to increase during this reporting period ($R^2 = 0.88$; Fig 3). The strength of this relationship is surprising given annual variability in hunting conditions (weather, onset of freeze-up, water levels, etc), regulatory changes, availability of commercial services, economic considerations (e.g., the cost of airline tickets) and other factors that affect hunting in Unit 23. Factors contributing to this trend include: 1) increasing commercial services in Unit 23; 2) increasingly restrictive hunting regulations for moose and other species outside of Unit 23, especially for nonresident hunters; 3) word of mouth advertisement of good hunting in Unit 23; and 4) the scarcity of trophy bulls in other units.

Harvest ticket data suggest numbers of unit resident moose hunters were low during this reporting period compared to levels reported during the late 1970s and early 1980s (Fig 3). These data also suggest the number of local moose hunters generally declined from 1979–1980 through 1994–1995. This is consistent with reports from unit residents that dependence on moose declined with the recovery of the Western Arctic Caribou Herd after the mid 1970s. This trend may have stabilized or reversed since that time. Of course, these trends should be viewed with caution given the historically low proportion of local hunters that participate in the harvest ticket system.

Success rates peaked in 1988 at 69% but have slowly declined since that time. Success rates have been <50% every regulatory year since 1992–1993 ($n = 10$ years). Prior to that time hunter success was <50% in only 2 of 14 years (1982 and 1983). During 1998–1999, 38% of all moose hunters were successful, and in 2000–2001 success was 42%. Trends in success rates have been similar among unit resident, nonlocal resident and nonresident hunters (Fig 4).

Recent widespread use of float-equipped airplanes by transporters, greater use of 4-wheelers by guides and an increasing numbers of village residents transporting nonlocal hunters via boat continued to reduce the number of refugia available to moose in Unit 23. Nonlocal

demand for transporter services continued to exceed availability despite growth of this industry within the unit. The large disparity between transporter supply and demand by nonlocal hunters means Unit 23 could experience rapid and substantial increases in numbers of nonlocal hunters if transporter services suddenly increased. This could further reduce the quality of hunting in Unit 23, intensify conflicts between local and nonlocal hunters and increase moose harvests.

Harvest Chronology. As in the past, during this reporting period the majority of moose were harvested in September despite an 8-month-long moose season in most of the unit. Virtually all sport hunting occurs during this time because weather is mild and conducive to airplane and boat access, it entirely encompasses the nonresident season, and bulls have completely developed antlers free of velvet. In 2001–2002, 85% of the reported harvest occurred during September, and in 2002–2003 this percentage was 81%. The percentage of total harvest taken during September has generally increased since the 1979–1980 regulatory year. This probably reflects increasing numbers of nonlocal hunters in Unit 23.

Transport Methods: Airplanes continued to be the primary mode of transportation for most hunters who reported hunting moose in Unit 23 (Table 5). Sixty-seven percent of all hunters reported using airplanes to access moose hunting areas in 2001–2002; in 2002–2003 this percentage was 66%. As in the past, boats were the next most commonly used means of transportation for hunting moose during this reporting period. Most unit residents hunt moose using boats or snowmachines, while most nonlocal hunters at least initially access hunting areas using airplanes.

Other Mortality

From 1992 to 1997 the mean annual adult cow mortality rate was 15% in the Noatak moose telemetry study. No collared cows were harvested by hunters during the study; therefore, this estimate represents natural mortality. The age structure of the collared sample of moose was older than the overall population because we did not collar cows <24 months old or collar moose annually. Even so, we think these limitations did not substantially bias our estimate of adult cow mortality.

HABITAT

Assessment

Moose habitat was not evaluated by ADF&G in Unit 23 during this reporting period. In 2000 the NPS began to monitor moose browse through range exclosures in portions of the Noatak National Preserve (B. Shults, personal communication).

Enhancement

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

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Conflicts among user groups, including local subsistence hunters, nonlocal hunters and commercial operators, continued to be the major nonregulatory management problem in Unit

23 during this reporting period. The nature and reasons behind these conflicts have been previously described (Dau 2002). Department of Public Safety staff report that waste of meat by trophy hunters during the fall hunting season declined as a result of the meat-on-bone regulation imposed during the 2002–2003 regulatory year.

CONCLUSIONS AND RECOMMENDATIONS

Declining moose and increasing hunter effort necessitate we improve our biological understanding of moose populations in Unit 23. I recommend we:

1. Census large areas (4000–10,000 mi^2) to minimize the effects of moose movements on density estimates and to include marginal habitat in addition to high quality habitat in census areas.

2. Census moose every 2–3 years in each census area. Potential census areas include 1) lower Noatak/upper Squirrel drainages, 2) Selawik drainage, 3) upper Kobuk drainage, and 4) northern Seward Peninsula.

3. Tighten confidence intervals around density and composition estimates through intensive sampling and by incorporating trend information into point estimates as soon as possible.

4. Conduct spring and fall censuses to prevent long gaps between density estimates. Supplement spring censuses with low-intensity fall surveys to monitor bull:cow ratios.

5. Resume the Unit 23 user issues planning process once a planner has been hired for Region V.

6. Continue community-based harvest assessments in villages throughout Unit 23 to monitor local harvests, and employ the statewide harvest ticket system to monitor nonlocal harvests.

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PREPARED BY:

Jim Dau
Wildlife Biologist III

SUBMITTED BY:

Peter Bente
Management Coordinator

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

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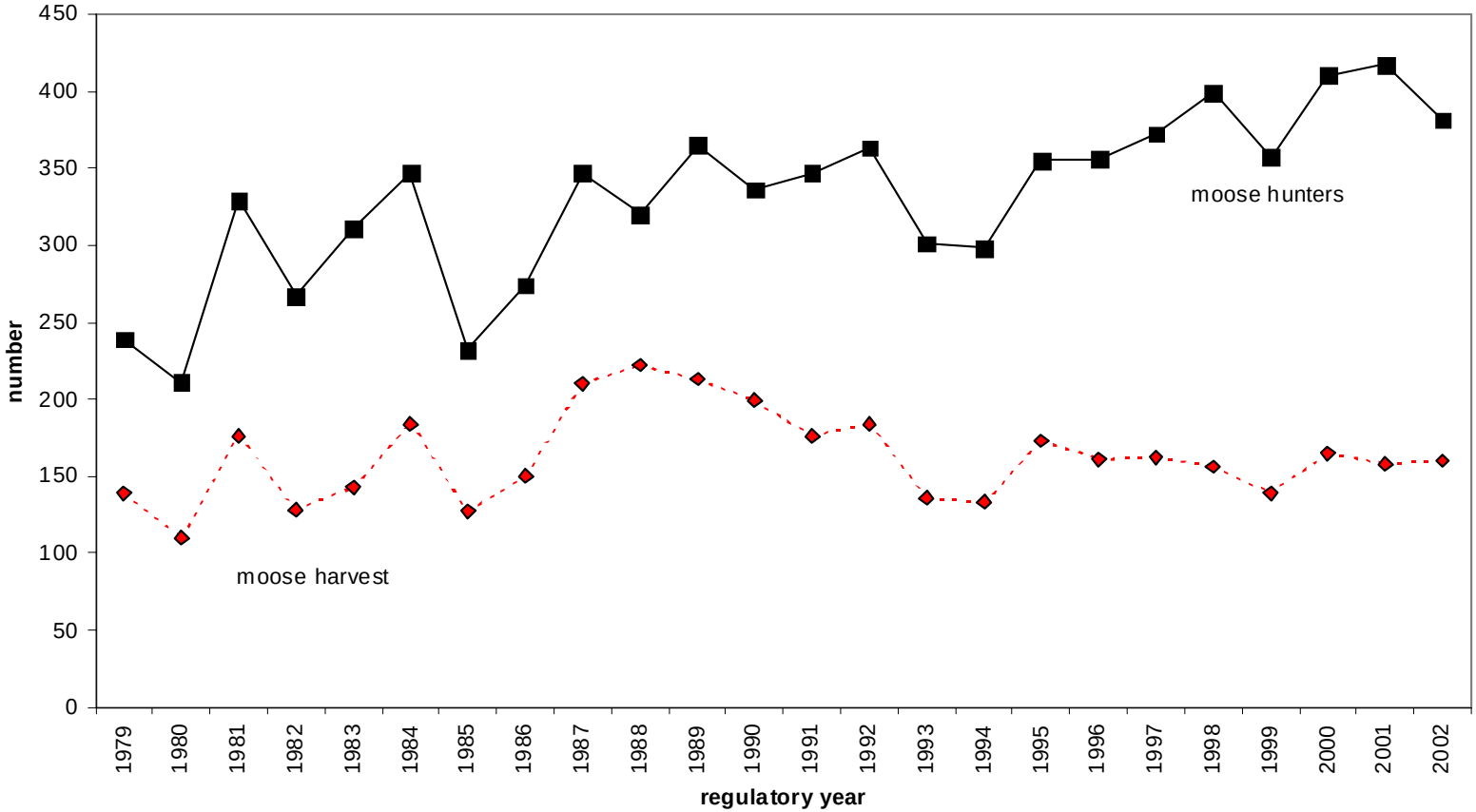

Figure 1 Unit 23 moose hunters and harvests reported through the statewide harvest ticket system, 1979–1980 through 2002–2003

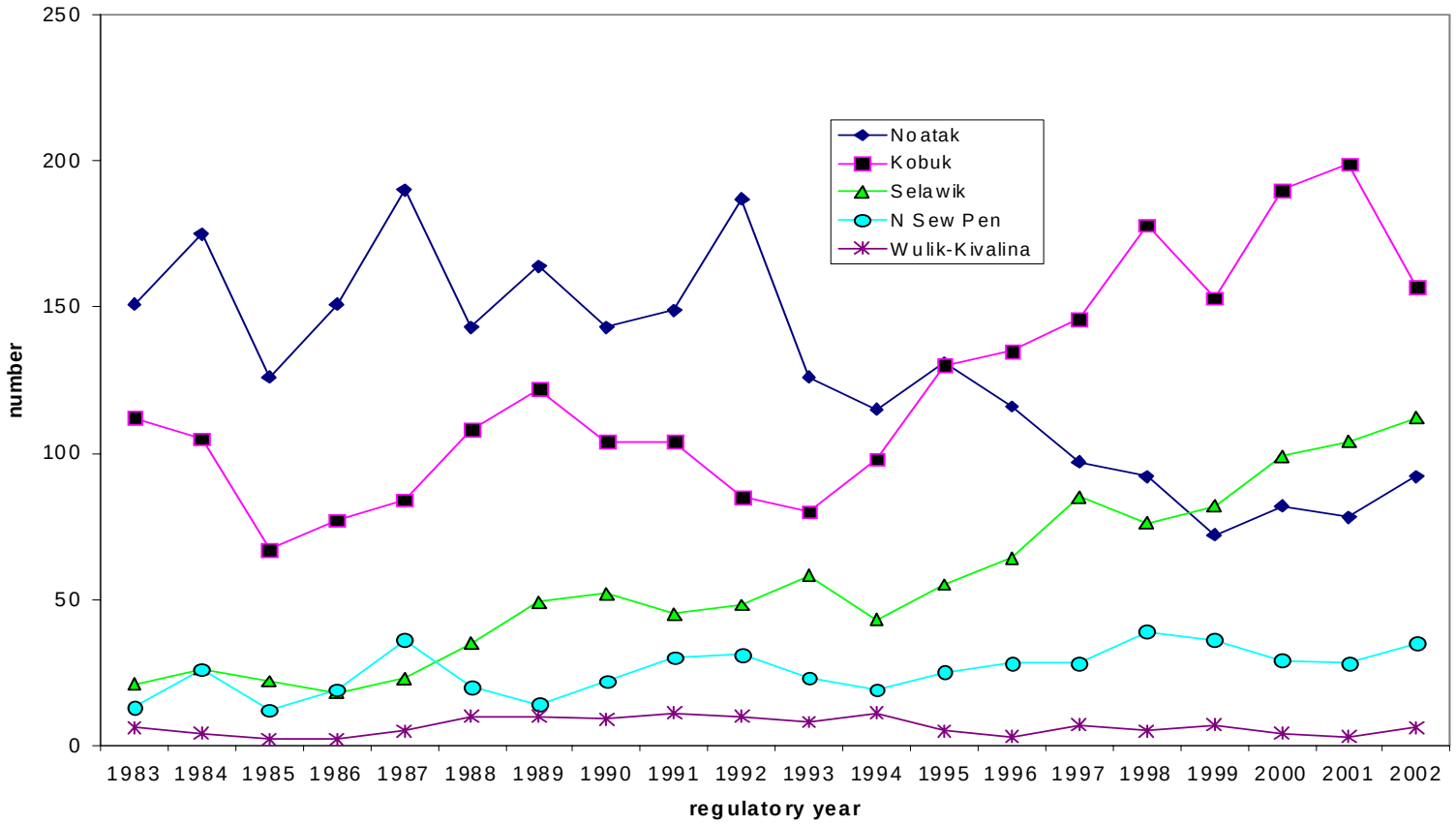

Figure 2 Unit 23 moose harvest by drainage (statewide harvest ticket data), 1983–1984 through 2002–2003

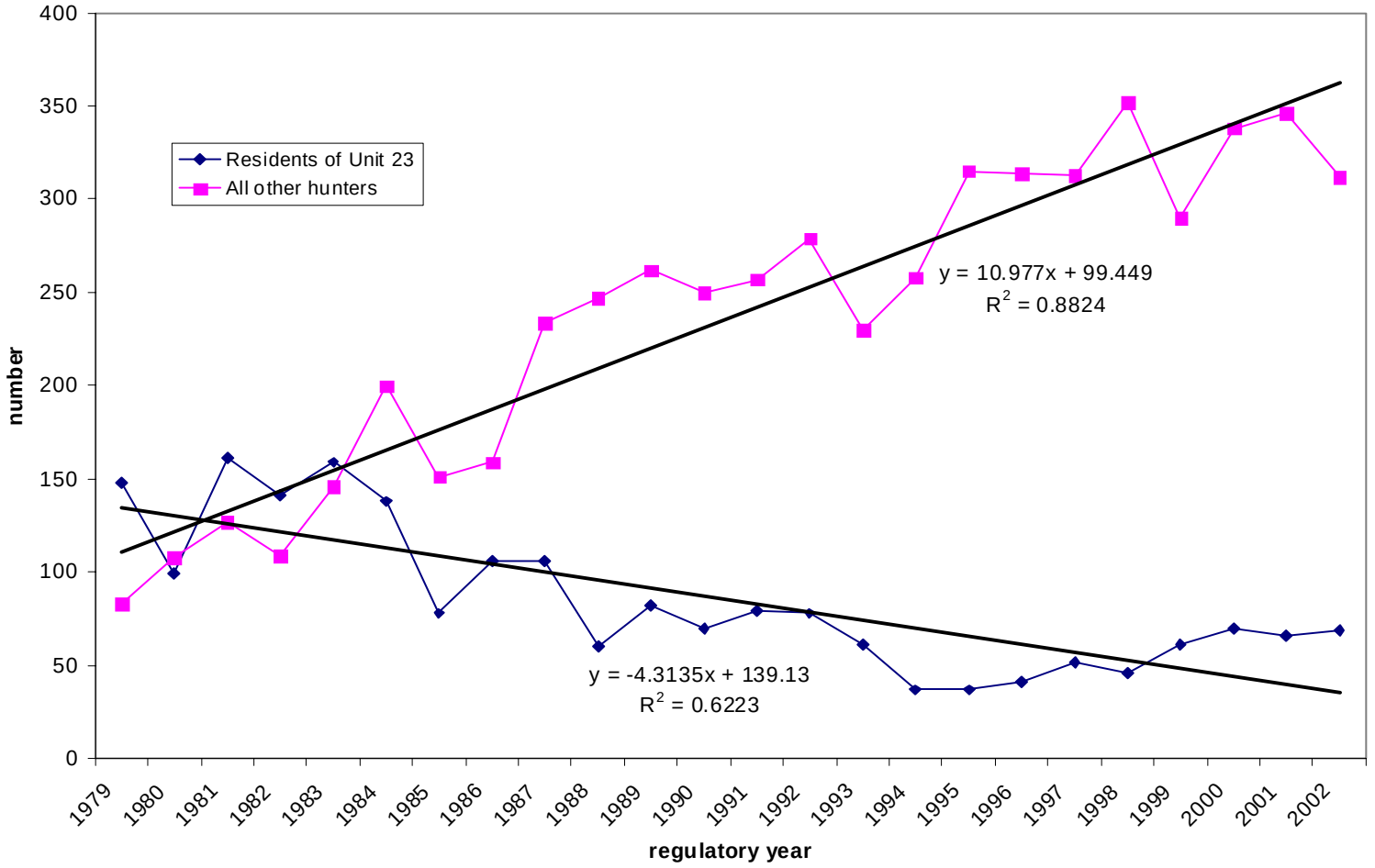

Figure 3 Numbers of Unit 23 moose hunters by residence (harvest ticket data), 1979–1980 through 2002–2003

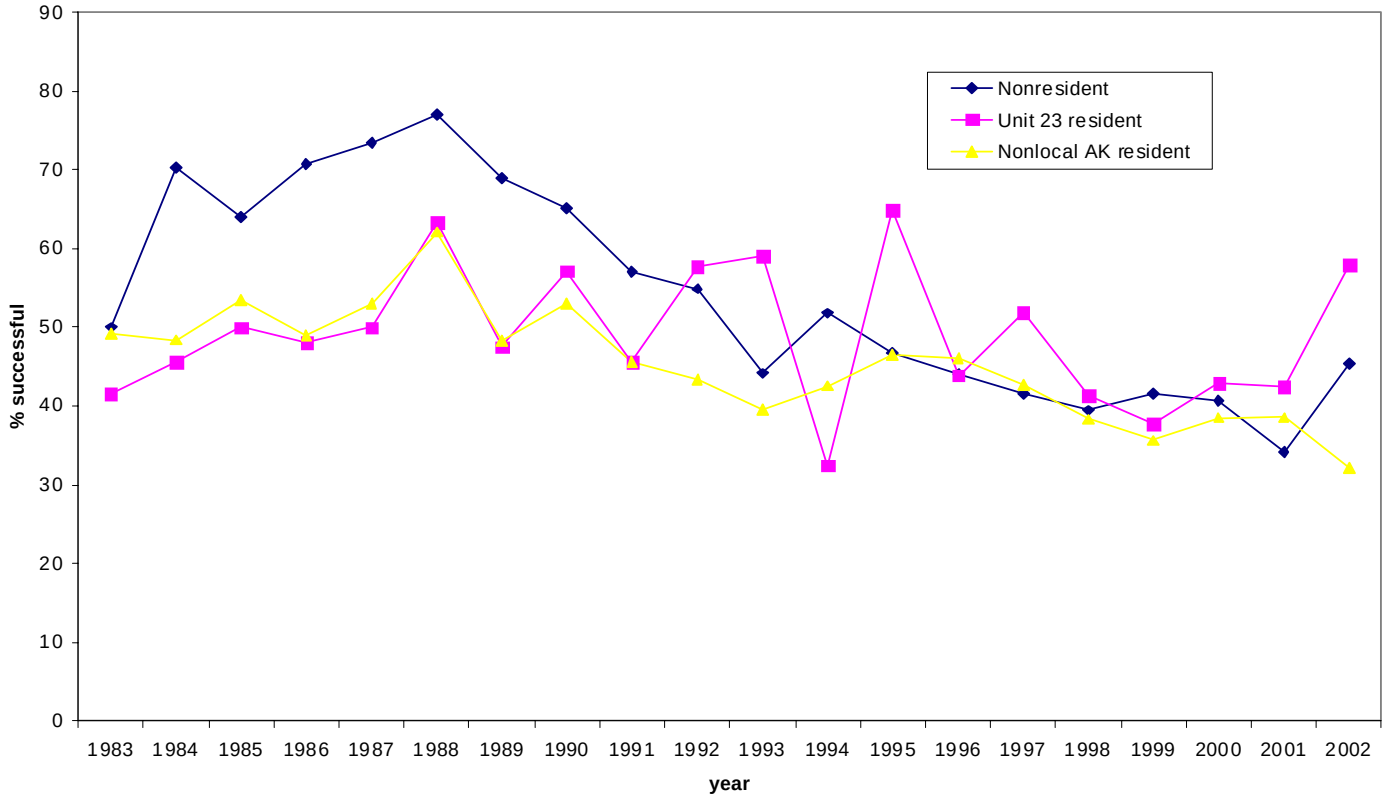

Figure 4 Unit 23 moose hunter success rate by residence (harvest ticket data), 1983–1984 through 2002–2003

Table 1 Unit 23 spring moose censuses, 1997–2003

Area	Year	Size (mi^2)	Census estimate (Nr.)			Density (Nr./mi^2)		Calves:100 Cows	Method
			Adults	Calves	Total	Adult	Total		
Tagagawik	1997	1000.9	952	191	1145	0.95	1.14	20	Standard Gasaway
Tagagawik	2001	1692.6	1259	115	1374	0.70	0.76	9	Standard Gasaway
Lower Noatak	1997	1627.9						8	Modified Gasaway
Lower Noatak	1998	1627.9						12	Modified Gasaway
Lower Noatak	1999	2111.2	1126	65	1191	0.53	0.56	6	Modified Geostatistical
Lower Noatak	2000	2111.2	710	59	779	0.34	0.37	8	Modified Geostatistical
Lower Noatak	2001	2111.2	1325	130	1453	0.63	0.69	10	Modified Geostatistical
Noatak/Squirrel	2001	5230.2	1580	151	1731	0.30	0.33	10	Modified Geostatistical
N. Seward Pen.	2002	5888.5	576	38	614	0.10	0.10	7	Modified Geostatistical
Upper Kobuk	2003	4001.5	765	91	856	0.19	0.21	12	Modified Geostatistical

Table 2 Unit 23 fall moose censuses, 1992–2003

Area	Year	Size (mi^2)	Est. Nr. adults	Est. Nr. calves	Total estimate	Adult density (nr. mi^2)	Total density (nr./mi^2)	Bulls:100 Cows	Calves: 100 Cows	Methods
Squirrel	1992	1440.9	1110	262	1372	0.77	0.95	37	33	Std. Gasaway
Squirrel	1998	1440.9	1304	233	1537	0.90	1.07	50	27	Geostatistical
Middle Noatak	1993	1627.9	956	169	1125	0.59	0.69	43	24	Std. Gasaway
Salmon	1995	891.4	594	186	780	0.67	0.87	78	56	Mod. Gasaway
Salmon	1997	891.4	895	129	1024	1.00	1.15	60	23	Std. Gasaway
Upper Kobuk	1995	1438.0	730	85	815	0.51	0.57	62	19	Linear Regression
Upper Selawik	1999	1045.9	569	80	648	0.54	0.62	68	23	Std. Gasaway

Table 3 Estimated moose harvest in Unit 23 villages from community harvest estimates (Subs. Div. unpub. data except as noted)

Village	Year of survey	Village pop. in survey year	Nr. moose reported harvested	Per capita moose harvest	Estimated village pop. in 2001–2003	Estimated annual moose harvest in 2001–2003
Kotzebue	1986	2681	65	0.024	3076	74
Noatak	1999	423	4	0.005		3
Noatak	2002	455	3	0.007	469	
Kivalina	1992	344	17	0.049	388	19
Point Hope[a]	1992	685	14	0.020	725	14
Noorvik[b]	1998	598	37	0.062		
Noorvik	2002	677	56	0.083	649	54
Kiana	1999	388	8	0.021	408	9
Ambler[c]				0.082	291	24
Shungnak	1998	257	21	0.082	264	22
Kobuk[c]				0.082	125	10
Selawik	1999	772	64	0.083	821	68
Buckland[d]				0.102	410	42
Deering	1994	148	15	0.102	131	13
Total					7757	352

[a] North Slope Borough, unpub. data
[b] Noorvik IRA, unpub. data
[c] estimated from Shungnak 1998 data
[d] estimated from Deering 1994 data

Table 4 Number of moose hunters by residency and success, and moose harvests by sex for Unit 23, 1979–1980 through 2000–2001

	Hunter residency					Hunter success			Sex of moose harvested		
Year	Unit 23 resident	Nonlocal resident	Non-resident	Unk	Total hunters	Succ.	Unsucc.	Succ. rate	Males	Females	Unk. Sex
1979–1980	148	51	32	8	239	139	100	58	129	10	0
1980–1981	99	61	47	4	211	110	101	52	97	6	7
1981–1982	161	80	47	41	329	176	153	53	160	15	1
1982–1983	141	81	28	17	267	128	139	48	119	8	1
1983–1984	159	116	30	6	311	143	168	46	131	12	0
1984–1985	138	126	74	9	347	184	163	53	162	17	5
1985–1986	78	101	50	3	232	127	105	55	112	12	3
1986–1987	106	94	65	9	274	150	124	55	142	8	3
1987–1988	106	102	132	7	347	210	137	61	194	15	1
1988–1989	60	116	131	15	320	222	98	69	207	15	6
1989–1990	82	120	142	21	365	213	152	58	200	11	2
1990–1991	70	115	135	16	336	199	137	59	185	14	1
1991–1992	79	136	121	11	347	176	171	51	143	33	0
1992–1993	78	157	122	6	363	184	179	51	159	25	0
1993–1994	61	144	86	10	301	136	165	45	118	17	1
1994–1995	37	148	110	3	298	133	165	45	127	6	0
1995–1996	37	189	126	3	355	173	182	49	164	8	1
1996–1997	41	178	136	1	356	161	195	45	145	15	1
1997–1998	52	171	142	7	372	162	210	44	154	8	0
1998–1999	46	167	185	1	399	156	243	39	146	8	2
1999–2000	61	129	161	6	357	139	218	39	127	11	1
2000–2001	70	166	172	2	410	165	245	40	154	11	0
2001–2002	66	153	193	5	417	158	259	38	148	9	1
2002–2003	69	162	150	0	381	160	221	42	168	10	1

Table 5 Number of moose hunters by transportation type in Unit 23, 1983–1984 through 2000–2001

Year	Airplane	Boat	Snow machine	Horse/dog team	3- or 4-wheeler	Off-road vehicle	Highway vehicle	Unknown	Total hunters
1984–1985	173	103	17	1	2	3	2	46	347
1985–1986	137	59	10	1	6	0	0	19	232
1986–1987	121	89	14	1	6	2	3	38	274
1987–1988	165	93	25	0	21	0	4	39	347
1988–1989	207	63	13	1	13	0	1	22	320
1989–1990	229	89	16	1	7	0	2	21	365
1990–1991	224	61	19	0	10	1	1	20	336
1991–1992	231	65	28	2	7	0	3	11	347
1992–1993	248	63	23	1	7	0	3	18	363
1993–1994	193	72	17	0	9	1	2	7	301
1994–1995	191	74	13	2	5	1	4	8	298
1995–1996	240	77	11	0	16	0	1	10	355
1996–1997	234	77	20	1	16	0	2	6	356
1997–1998	250	74	19	2	13	0	2	12	372
1998–1999	289	76	10	1	11	1	0	0	388
1999–2000	245	78	18	2	11	0	2	0	356
2000–2001	260	113	17	3	7	1	2	0	403
2001–2002	278	112	12	0	7	1	2	0	412
2002–2003	268	113	13	1	6	0	2	0	403

Alaska Department of Fish and Game
Division of Wildlife Conservation
(907) 465-4190 PO BOX 25526
JUNEAU, AK 99802-5526

MOOSE MANAGEMENT REPORT

From: 1 July 2001
To: 30 June 2003[a]

LOCATION

GAME MANAGEMENT UNIT : 26A (56,000 mi^2)

GEOGRAPHICAL DESCRIPTION: Western North Slope

BACKGROUND

Archaeological evidence indicates moose have been present on the North Slope either sporadically or at low densities for many years. Since about 1940, moose populations have increased in size and have become well established in Unit 26A. Nearly all moose are confined to riparian habitat along river corridors during winter. During summer, many moose move into small tributaries and hills surrounding riparian habitat, and some disperse as far as the foothills of the Brooks Range and across the coastal plain. The largest winter concentrations of moose are found in the inland portions of the Colville River drainage.

Since 1970, late-winter surveys have been conducted annually to assess population status and short yearling recruitment. Complete surveys of all major drainages in Unit 26A were completed in 1970, 1977, 1984, 1991, and 1995. The population increased steadily from a count of 1219 moose in 1970 to 1535 in 1991, then declined to 757 in 1995 (Trent, 1989; Carroll, 1998). Trend counts indicated that the population continued to decline until 1996 to about 25% of the 1991 population; then, numbers increased from 1997 through 2001 (Carroll 2002).

Census and trend counts indicated that the population declined by 75% between 1992 and 1996. Adult mortality was high and fall surveys indicated poor calf survival during 1993 (4% calves), 1994 (2% calves), and 1995 (0%). The decline appeared to be a combination of malnourishment, disease, mineral deficiency, predation, weather factors, and competition with snowshoe hares (Carroll, 1998). Samples were collected from hunter-killed moose and those that were found dead in 1995 and 1996. In addition, we captured, examined, sampled, and radiocollared 45 female and 5 male moose in 1996 and 1997. Analysis indicated that nearly all of the moose tested to be marginally deficient in copper. Several cows captured in 1996 and 1997 tested positive for antibodies to the bacteria *Brucella suis Biovar 4* (8 of 43) and *Leptospira interrogans serovar pomona* (6 of 30). Both diseases cause abortions and weak calves. Relatively high moose populations in the 1980s and early 1990s may have led to overbrowsing. Snowshoe hares moved into the area in the early 1990s and irrupted, placing further stress on the

[a] This unit report also includes data collected outside the reporting period at the discretion of the reporting biologist.

browse plants. Wolf and grizzly bear numbers were at relatively high levels during the time of the decline.

The population began to recover in 1996. Radiotracking surveys indicated that the adult and calf survival rates increased substantially. Short yearling counts indicated recruitment ranged from 17% to 26% between 1997 and 2001. The trend area count increased from 152 moose in 1996 to at least 333 moose in 2001 (Carroll, 2002) .

Hunters have used aircraft to hunt moose since the early 1970s (Trent 1989). Most local hunters travel by boat along the Colville River to hunt moose. The mean reported harvest from 1985 to 1993 was 59 moose per year, with a high of 67 in 1991. The harvest decreased to 40 during 1994–1995 and 14 in 1995–96 as the moose population declined and regulations became more restrictive. Hunters harvested from 0 to 5 moose per year between 1996 and 2001 (Carroll, 2002).

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Allow for the recovery of the Unit 26A moose population and maintain a population of over 1000 moose, with a bull: cow ratio of over 30:100.

- Maintain a moose population capable of satisfying subsistence and general hunt needs.

MANAGEMENT OBJECTIVES:

- Conduct a unitwide spring census every 5 years and yearly spring trend area counts to assess population trend and recruitment on subsequent years.

- Conduct a yearly fall aerial sex and age composition survey of the Colville River population.

- Conduct radiotelemetry surveys to examine calf production and survival, distribution, and mortality rates each summer, fall, and spring.

- Monitor predator populations and other mortality factors through field observations and public contacts.

- Examine dead moose to look for causes of death, disease, mineral deficiencies, and contaminants.

- Develop updated population objectives in cooperation with the public and other agencies.

METHODS

We used a Cessna 185, a Bellanca Scout, and a Piper PA–18 aircraft to conduct census, trend area, and fall composition counts. During the census we attempted to survey all available moose habitat in Unit 26A. The trend count area included the Colville River valley from the mouth of the Killik River to the mouth of the Anaktuvuk River; the Chandler River below Sivugak Bluff; and the Anaktuvuk River below Table Top Mountain. During fall composition counts, we

surveyed the trend count area, plus other selected areas, such as the lower Colville River and the Killik River. For all surveys we flew over suitable riparian habitat and attempted to locate all the moose in the survey areas. We determined short yearling recruitment and total number of moose during spring surveys and determined sex and age composition and estimated the antler size of bulls during the fall surveys.

Surveys to locate and observe radiocollared moose were flown in conjunction with the above-mentioned fall and spring surveys. In addition, we conducted calving success surveys each year during the first week of June. We obtained global positioning system locations for all moose observed during radiotracking surveys and noted whether females had 0, 1, or 2 calves.

We compiled harvest data from harvest reports submitted by hunters, from subsistence harvest surveys, and from talking to hunters.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size and Trend

Census results of 1219, 1258, 1447, and 1535 moose in 1970, 1977, 1984, and 1991, respectively, indicate the population was stable and slowly increasing for at least 20 years. A 1995 census indicated a 51% decline in the population between 1991 and 1995 (Carroll 2002). Censuses were conducted in 1999 when 326 moose were counted and 2002 when 576 were counted (Table 1). It was felt that we might have undercounted in 1999 due to early spring conditions and moose dispersing away from the river bottoms.

Trend area counts indicated that the population declined until 1996 to about 25% of the 1991 population and has steadily increased since then. Trend area count numbers increased from 152 in 1996 to 333 in 2001 (Carroll 2002). The trend area counts continued to increase in 2002 to 307 moose and in 2003 to 413 moose (Table 2). This would indicate an increase of about 15% per year between 1996 and 2003. The number of moose counted in the trend count area is increasing faster than in the upper part of the drainages.

The increase in population after 1996 resulted from low adult mortality and high calf survival, probably due to some combination of the following factors: recovery of vegetation after overbrowsing, reduction of bacterial diseases prevalent in the population, reduced predation, weather factors, and reduced hunting pressure.

We used radiocollared moose to determine how many moose were missed by observers during the spring count in 1999. We found that we had failed to see between 12% and 18% of the collared moose in the original count (Carroll, 2000). The number missed probably varies from year to year, depending on conditions.

Population Composition

The percentage of short yearlings counted in spring surveys was very low between 1994 and 1996 (3%, 2%, and <1%). However, it increased dramatically in 1997 when 23% were observed, and continued high from 1998 through 2001 when between 17% and 26% short yearlings were counted. During the reporting period 13% were observed in 2002 and 25% in 2003 (Table 2).

During fall 2001 composition surveys we observed 304 moose within the trend count area, including 105 bulls (69 bulls:100 cows), 153 cows, and 46 calves (30 calves:100 cows). During fall 2002 we observed 334 moose within the trend count area, including 87 bulls (52 bulls:100 cows), 166 cows, and 81 calves (49 calves:100 cows). In 2003 (after the reporting period) we observed 288 moose in the trend count area, including 93 bulls (75 bulls: 100 cows), 124 cows, and 71 calves (57 calves:100 cows). Fall bull:cow ratios can be quite variable because weather conditions influence how many bulls are in the survey area during fall counts. These counts continued the trend of increasing summer calf survival since 1996 compared to 1993–1995 (Table 3).

With improved calf survival, the percentage of bulls in the younger age groups gradually increased, and there is now good representation in all bull antler size groups as shown here:

Estimated bull antler widths in inches

Inches	<30	30–39	40–49	50–59	60+
1996	0%	0%	38%	45%	17%
1997	4%	8%	16%	48%	24%
1998	13%	22%	14%	31%	20%
1999	18%	16%	12%	28%	26%
2001	13%	18%	17%	32%	20%
2002	15%	12%	16%	25%	32%
2003	10%	18%	17%	29%	26%

Distribution and Movements

By late winter most moose can be found in the riparian corridors, primarily on the Colville River drainage. During late April, when snow cover begins to disappear in the foothills, moose begin to move away from the riparian corridors. During late May and early June most parturient cows move away from the river bottoms to calve. Bull moose disperse widely during the summer months, ranging from the northern foothills of the Brooks Range to the Arctic coast. Most cow moose move out of the river bottoms, but stay near riparian habitat during summer months, while some range onto the coastal plain. During the fall, as snow cover accumulates, moose move back into the riparian corridors of the large river systems.

During 1996 and 1997 we radiotracked the collared moose several times and obtained the following distribution information:

- 13 June 1996. 25 of 35 collared moose had moved away from the river bottoms into small tributaries or hills surrounding the major rivers. Eighteen of 20 cows seen with calves had moved away from the major rivers before calving. Most pregnant cows stayed on the major rivers until a few days before parturition and then moved away from the river bottoms to give birth. Three cows moved from the Anaktuvuk River to the Tuluga River to give birth. The mean distance that moose had moved away from the river

bottoms was 8 miles and ranged from less than a mile to 18 miles. Three of 5 bulls moved away from the river bottoms, with 12 miles being the maximum distance traveled.

- 28 July 1996. 16 of the collared cows were in the riparian corridors, and 18 had dispersed away from the river bottoms. Most of the cows were within 8 miles of the rivers, but one cow and calf were 107 miles north and another cow/calf pair was 36 miles north of the Colville River. One bull was located 2 miles from the riparian corridor and 2 were found in the foothills of the Brooks Range. Two bulls were not found, and we assumed they moved out of the survey area.

- 5–8 November 1996. 20 collared cow moose were sighted on the river bottoms and 14 were found on tributaries and hills around the rivers. Three bulls were found in the riparian corridor, 1 was adjacent to the corridor, and 1 was not found in the survey area.

- 1–2 April 1997. 28 cow moose were in the riparian habitat of the river bottoms and 4 moose in the areas adjacent to the rivers. Two bulls were dead, 2 were in the riparian corridor, and 1 was not found.

MORTALITY

Harvest

Season and Bag Limit.

2001–2002 Units and Bag Limits	Required Ticket or Permit Type	Open Season
Unit 26A: that portion in the Colville River drainage downstream from the Anaktuvuk River		
Residents: One bull**	Harvest	1 Aug–31 Aug
Nonresidents		No open season
Remainder of Unit 26A		
All hunters		No open season

**Hunters may not hunt moose during August using aircraft for transportation or for carrying meat.

Season and Bag Limit.

2002–2003 Units and Bag Limits	Required Ticket or Permit Type	Open Season
Unit 26A: that portion in the Colville River drainage downstream from and including the Chandler River		

2002–2003 Units and Bag Limits	Required Ticket or Permit Type	Open Season
Residents: One bull**	Harvest	1 Aug–14 Sep
Nonresidents:		No open season
Remainder of Unit 26A:		
Residents: One bull**	Harvest	1 Sep–14 Sep
Nonresidents:		No open season

**Hunters may not hunt moose during August or 1–14 September using aircraft for transportation or for carrying meat.

Board of Game Actions and Emergency Orders. During its November 2001 meeting the Board of Game increased the hunt area and length of the season. The hunt area was increased during August so that it included the Colville River drainage downstream from and including the Chandler River. In addition, the hunt area and season were increased so that all of Unit 26A was opened 1–14 September. The bag limit continued to be one bull moose. The board also modified the time period of the Unit 26A Controlled Use Area so that aircraft cannot be used for moose hunting, including transportation of hunters, their gear, and/or parts of moose during the open season from 1 August to 14 September.

Hunter Harvest. Hunter harvest reports indicate 4 bull moose were harvested during fall of 2001, and 10 in 2002 (Table 4). The increase in 2002 was a result of the season and hunt area being increased. Antler sizes in 2002 were: 1 from 30–39 inches, 5 from 40–49 inches, 3 from 50–59 inches, and 1 unknown (Table 5).

Permit Hunts. There were no permit hunts for moose in Unit 26A during the reporting period.

Hunter Residency and Success. During 2001 all successful hunters and most unsuccessful hunters were local residents. During 2002, 8 of 10 successful hunters were local residents and 11 of 19 total hunters were local residents. Hunters had a 53% success rate in 2002 (Table 6).

Harvest Chronology. During 2001 all reported hunting took place during August. During 2002 20% of reported moose were harvested in August and 80% in September (Table 7).

Transport Methods. All hunters used boats for transportation during 2001 and 2002 (Table 8).

Other Mortality

The Unit 26A moose population declined by approximately 75% between 1991 and 1996. A variety of factors contributed to the decline including: overpopulation, competition with snowshoe hares, copper deficiency, the bacterial diseases brucellosis and leptospirosis, weather, insect harassment, and predation from bears and wolves.

The mortality rate has been low for both adults and calves since 1996. Among the radiocollared moose the mortality rate was 5.7% for 1996–1997, 2.1% for 1997–1998, 0% for 1998–1999,

11.9% for 1999–2000, 7.25% for 2001–2002, and 13% for 2002–2003 for an average of about 6.7% mortality per year. Because no moose have been collared since 1997, the mortality rate of these collared moose is considered to be only a rough indicator for the entire population. Calf mortality has also decreased substantially since 1996. The percentage of short yearlings counted during spring surveys increased from an average of 2% from 1994 through 1996 to 22% from 1997 through 2003 (Table 2).

Mortality due to predation has probably decreased substantially during recent years. We conducted wolf surveys in the study area and found that wolf density declined from 4.1 wolves/1000 km^2 in 1994 to 1.6 wolves per 1000 km^2 in 1998. There is no indication that bear numbers have decreased, but is possible that some "specialist" bears that preyed on moose calves during the summer may have died or left the area.

The facts that we have not observed moose that appear to have died of starvation, and that most of the moose now appear to be in very good condition, indicate that the vegetation has recovered from the overbrowsing that probably took place when the population was at peak numbers during the late 1980s and early 1990s.

The mortality caused by brucellosis and leptospirosis may be greatly reduced due to the diseases having run their course. The moose that were exposed and were susceptible to the diseases died or did not produce calves that survived. The moose that were resistant to the diseases have survived and are reproducing.

CONCLUSIONS AND RECOMMENDATIONS

After several years of declining population numbers, the Unit 26A moose population began to increase in 1997. As a result of low adult mortality and high calf survival, the number counted in the trend count area has increased from 152 in the spring of 1996 to 413 in 2003, an increase of 15% per year. The recruitment rate for short yearlings has averaged 22%, and the adult mortality rate among moose that were collared in 1996 and 1997 has averaged about 6.7% for the last 7 years.

The population increase has been due to a combination of factors. Vegetation has recovered from being overbrowsed by moose when the population was at high numbers in the 1980s and early 1990s, allowing for better survival of adults and calves. The presence of bacterial diseases that were prevalent in the population is reduced. Some "specialist" bears that preyed on moose calves during the summer may have died or left the area. Wolf density in the area is much lower than it was during the decline, so there is less wolf predation. Weather factors have been more favorable during recent years. In addition, some moose may have migrated into Unit 26A from areas to the south or east.

In response to the severe population decline, we changed the management goal in 1996 from maintaining the population to rebuilding the population. The Board of Game passed regulations that eliminated hunting pressure for most of the area in 1996. While hunting was not the major cause of the decline, it was a contributing factor and one that could be changed to help rebuild the population. After the population increased consistently for 5 years, the board increased the hunt area and season for a bulls-only hunt in 2001 and continued restrictions on the use of aircraft for moose hunting. This regulation has provided more hunting opportunity but allows for

the continuing recovery of the population. If the population continues to grow, hunting restrictions may be further liberalized in the future.

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Prepared by:

Geoffry Carroll

Wildlife Biologist III

Submitted by:

Peter Bente

Management Coordinator

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Table 1 Number of adult and calf moose from Unit 26A censuses, 1970–2002

Year	Adults	Calves	Total	% Calves
1970	911	308	1219	25
1977	991	267	1258	21
1984	1145	302	1447	21
1991	1231	304	1535	20
1995	746	11	757	1
1999	274	52	326	16
2002	496	74	576	13

Table 2 Unit 26A moose trend counts: Anaktuvuk River from the mouth to Sivugak Bluff, Chandler River from the mouth to Table Top Mountain, and Colville River between the mouths of Anaktuvuk and Killik Rivers, 1970, 1974–1981, and 1983–2003

Year	Total moose	Adults	Short Yearlings	Short Yearling (%)
1970	750	523	227	30
1974	544	458	86	16
1975	556	386	170	31
1976	650	494	156	24
1977	802	632	170	21
1978	767	623	144	19
1979	644	536	108	17
1980	841	676	165	20
1981	639	594	45	7
1983[a]	315	268	47	15
1984	756	590	166	22
1985	757	613	144	19
1986	866	678	188	22
1987	700	627	73	10
1988	684	602	82	12
1989	699	630	69	11
1990	618	543	74	12
1991	647	516	176	21
1992	510	416	133	18
1993	504	424	85	15
1994	407	396	11	3
1995	307	302	5	2
1996	152	151	1	<1
1997	188	145	43	23
1998	206	153	53	26
1999	210	174	36	17
2000	325	245	80	25
2001	333	251	82	25
2002	307	267	40	13
2003	413	309	104	25

[a] Partial counts due to incomplete snow cover and wide dispersal of moose.

Table 3 Unit 26A fall aerial moose composition trend area counts 1983–2003

Year	Bulls:100 Cows	Calves:100 Cows	Calves (%)	Adults	Total moose
1983	54	38	20	150	188
1986	47	18	11	302	339
1987	39	21	13	101	104
1990	33	45	25	277	371
1991	40	39	22	254	325
1992	36	41	23	190	248
1993	36	6	4	381	397
1994	35	3	2	287	293
1995[a]	70	0	0	34	34
1996	60	44	22	126	161
1997	46	40	22	80	102
1998	64	35	18	131	159
1999	49	52	26	155	209
2001	69	30	15	258	304
2002	52	49	24	253	334
2003	75	57	25	217	288

[a] Partial counts due to incomplete snow cover and wide dispersal of moose.

Table 4 Unit 26A moose harvest, 1985–2002

	Reported hunter harvest		
Regulatory year	Male	Female	Total
1985–1986	50	15	65
1986–1987	46	6	52
1987–1988	49	13	62
1988–1989	51	6	57
1989–1990	41	3	44
1990–1991	60	4	64
1991–1992	59	8	67
1992–1993	52	8	60
1993–1994	53	8	61
1994–1995	36	4	40
1995–1996	14	0	14
1996–1997	0	0	0
1997–1998	2	0	2
1998–1999	5	0	5
1999–2000	2	0	2
2000–2001	0	0	0
2001–2002	4	0	4
2002-2003	10	0	10

Table 5 Percent antler width categories (inches) among moose harvested in Unit 26A, 1983–2002

Regulatory year	Unknown	<20	20–29	30–39	40–49	50–59	60+	*N*
1983–1984	0	0	4	35	15	35	12	26
1984–1985	0	3	5	18	33	30	13	40
1985–1986	0	0	7	11	18	47	19	45
1986–1987	0	0	7	18	29	42	4	45
1987–1988	0	0	0	20	24	47	9	45
1988–1989	0	2	2	0	27	55	14	49
1989–1990	0	0	3	14	14	51	18	39
1990–1991	0	0	4	15	10	59	12	57
1991–1992	16	0	3	3	13	49	16	56
1992–1993	13	0	2	5	7	48	25	52
1993–1994	15	3	2	5	11	49	15	53
1994–1995	10	1	2	8	9	62	8	40
1995–1996	7	0	7	14	7	50	15	14
1996–1997	0	0	0	0	0	0	0	0
1997–1998	0	1	0	0	1	0	0	2
1998–1999	0	1	1	1	1	0	1	5
1999–2000	0	1	0	1	0	0	0	2
2000–2001	0	0	0	0	0	0	0	0
2001–2002	3	1	0	0	0	0	0	4
2002-2003	1	0	0	1	5	3	0	10

Table 6 Moose hunter residency and success, Unit 26A, 1987–2002

	Successful hunters						Total hunters					
Regulatory year	Local res[a]	Non-local res[b]	Nonres[c]	Unk[d]	Total	(%)	Local res[a]	Non-local res[b]	Nonres[c]	Unk[d]	Total	
1985–1986	–	–	–	–	65	66	29	45	24	0	98	
1986–1987	–	–	–	–	52	65	29	33	18	0	80	
1987–1988	–	–	–	–	62	61	40	20	39	0	99	
1988–1989	–	–	–	–	57	69	12	30	37	5	84	
1989–1990	9	13	21	1	44	66	10	23	33	2	68	
1990–1991	8	19	35	2	64	65	13	40	43	3	99	
1991–1992	9	37	29	1	67	66	13	51	37	1	102	
1992–1993	12	16	29	3	60	57	25	35	41	4	105	
1993–1994	7	22	29	3	61	79	11	30	32	4	77	
1994–1995	8	7	24	1	40	74	11	14	29	0	54	
1995–1996	4	3	6	1	14	33	13	12	15	3	43	
1996–1997	0	0	0	0	0	0	4	2	0	0	6	
1997–1998	2	0	0	0	2	10	20	0	0	0	20	
1998–1999	5	0	0	0	5	25	18	2	0	0	20	
1999–2000	2	0	0	0	2	14	12	2	0	0	14	
2000–2001	0	0	0	0	0	0	UN[e]	UN	UN	UN	UN	
2001–2002	4	0	0	0	4	UN	UN	UN	UN	UN	UN	
2002-2003	8	2	0	0	10	53	11	8	0	0	19	

[a] Local resident hunters are residents of the North Slope Borough.
[b] Nonlocal resident hunters are residents of the State of Alaska, but not residing in the North Slope Borough.
[c] Nonresident hunters.
[d] Unknown residency.
[e] Unknown harvest.

Table 7 Percent chronology of moose harvest, Unit 26A, 1987–2002

Regulatory year	Harvest periods						
	Aug	1–7 Sep	8–14 Sep	15–21 Sep	22–31 Sep	Oct–Dec	*N*
1987–1988	9	36	35	6	4	10	62
1988–1989	9	45	34	6	3	0	57
1989–1990	17	48	18	16	0	2	44
1990–1991	4	44	39	6	5	2	64
1991–1992	10	55	22	10	0	3	67
1992–1993	9	58	20	3	8	2	60
1993–1994	7	62	23	3	3	2	61
1994–1995	3	50	19	18	5	5	40
1995–1996	29	7	50	7	0	7	14
1996–1997*	–	–	–	–	–	–	0
1997–1998*	100	–	–	–	–	–	2
1998–1999*	100	–	–	–	–	–	5
1999–2000*	100	–	–	–	–	–	2
2000–2001*	–	–	–	–	–	–	–
2001–2002*	100	–	–	–	–	–	–
2002–2003	20	80					

*Season only open in August

Table 8 Percent transport methods for moose harvest in Unit 26A, 1987–2002

	Percent method of transportation					
Regulatory year	Airplane	Boat	3 or 4 wheeler	Snowmachine	ORV	*N*
1987–1988	80	15	2	1	2	59
1988–1989	81	18	1	–	–	53
1989–1990	84	14	2	–	–	40
1990–1991	62	28	3	2	3	61
1991–1992	85	7	3	3	2	67
1992–1993	85	13	0	2	0	60
1993–1994	83	17	0	0	0	61
1994–1995	78	18	0	2	2	40
1995–1996	50	43	7	0	0	14
1996–1997	–	–	–	–	–	0
1997–1998	–	100	–	–	–	2
1998–1999	–	100	–	–	–	5
1999–2000	–	100	–	–	–	2
2000–2001	–	–	–	–	–	–
2001–2002	–	100	–	–	–	–
2002–2003		100				