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MOOSE

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Nick Jans

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STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
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LOCATION

GAME MANAGEMENT UNITS: Unit 1A (5,300 mi^2)
Unit 1B (3,000 mi^2)
Unit 2 (3,600 mi^2)
Unit 3 (3,000 mi^2)

GEOGRAPHIC DESCRIPTION: Southeast mainland and adjacent islands from Cape Fanshaw and Frederick Sound south to the Canadian border.

BACKGROUND

Most of the Unit 1A moose population is concentrated in the Unuk River drainage and seems stable. Good habitat is limited and moose numbers are low. The harvest is sporadic, ranging from zero to 8 moose each year. The Chickamin River supports a few moose as it did before a supplemental transplant in the early 1960s. A short-term increase followed the release, but moose populations have probably returned to pre-transplant levels. Three bulls have been taken from the Chickamin drainage in the past 15 years. Moose are occasionally reported from other parts of Unit 1A.

Moose inhabit several areas of Unit 1B, primarily near Thomas Bay and along the Stikine River. Suitable habitat has not been colonized adjacent to Bradfield Canal, but moose do live near Virginia Lake, Mill Creek, and Aaron Creek on the mainland. LeConte Bay and Glacier divide Unit 1B north and west of the Stikine River.

The moose population in Thomas Bay, north and east of LeConte Bay, is isolated by the Coast Mountains from populations in Canada. These moose occupy a heavily logged area. The Thomas Bay population may decline significantly as conifer regrowth in clearcut areas matures and reduces forage production. The average annual harvest of Thomas Bay moose during the decades of the 1950s, 1960s, 1970s, and 1980s was 5, 8, 10, and 18, respectively. The season was closed and no harvest occurred in 1982 and 1983.

Moose inhabiting the Alaska portion of the Stikine drainage represent the westernmost tip of a mainland population which extends into Canada. The Alaska portion of this population was estimated at 300 animals in 1983 (Craighead et al. 1984). Since 1983, winters have been mild and the population seemed to increase until 1989. Average annual harvest of Stikine River moose from the 1950s to the 1970s was about 27. From 1980 through 1989 the average annual harvest was 42.

The first reports of moose on Prince of Wales Island in Unit 2 were received by ADF&G in 1987 when the U.S. Forest Service reported a cow and calf near Snakey Lakes. Subsequent reports indicate that a moose population, size and composition unknown, inhabit the Snakey Lakes/Thorne River area on Prince of Wales Island. There is no open hunting season.

Moose inhabit the major islands of Unit 3. Increased sightings of moose during the 1980s and 1990s suggest these populations are growing. From 1960–67 the season was open from September 15–October 15 with a limit of 1 bull. The season was closed and reopened on

Wrangell Island in 1990 and Mitkof Island was opened in 1991. All of Unit 3 was opened in 1993.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following moose management objectives for Units 1A and 1B and Units 2 and 3 are based on biological data and input from the public.

Unit 1A

Unuk/Chickamin

	Objective	1994
Posthunt numbers	35	N/A
Annual hunter kill	3	6
Number of hunters	20	47
Hunter-days of effort	90	216
Hunter success	15%	13%

Unit 1B

Stikine River

	Objective	1993[a]
Posthunt numbers	450	N/A
Annual hunter kill	40	14
Number of hunters	300	141
Hunter-days of effort	2,100	795
Hunter success	13%	10%

[a] 1994 season closed by emergency order.

Thomas Bay:

	Objective	1994
Posthunt numbers	200	N/A
Annual hunter kill	20	11
Number of hunters	160	128
Hunter-days of effort	675	775
Hunter success	12%	9%

Unit 2

No objectives have been developed.

Unit 3

No objectives have been developed. When the moose plan was formulated in the late 1980s, we were unaware that within the next decade moose would be established and a hunt would ensue. We have no estimate of habitat carrying capacity or the population size. The Unit 3 moose harvest is often opportunistic, and future habitat management will probably have more effect on moose numbers and hunting opportunity than will other factors. We cannot estimate how long Unit 3 habitat will support a viable moose population. The issue of enhancing the Sitka black-tailed deer population that collapsed in the early 1970s on the Unit 3 islands compounds the complexity of establishing moose management goals. Moose numbers now seem high enough to support a hunting season in Unit 3, and we intend to continue the hunt as long as hunting does not affect the integrity of the population. We plan to establish goals for Unit 3 moose before the next management report is completed.

METHODS

We flew late winter surveys along the Stikine River valley. Hunters and harvested moose were checked in the field on the Stikine River and Thomas Bay hunts. We used field data to reconcile written hunter reports. Moose management was discussed in public meetings in Wrangell and Petersburg.

On their registration permit, Thomas Bay hunters reported the total number of moose (bulls, cows, and calves), wolves, and bears they saw during the hunting season.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Data are insufficient for us to quantitate population trends during the past 5 years. Moose populations appeared stable in Unit 1A (low density) and Thomas Bay in northern Unit 1B (moderate density). The Stikine River population in Unit 1B (moderate to low density) appeared to be decreasing. Increasing reports of moose in Unit 2 may indicate more moose or be a function of increased human access into once remote areas. The number of moose in Unit 3 (low to moderate density) seemed to be increasing.

The Stikine River population was estimated at 300 moose and increasing in 1983 (Craighead et al. 1984). Post-1983 harvest levels indicated the Stikine population slowly increased and then began to decrease in 1988. The percentage of calves surviving to late winter declined from 1980 to 1989 and remains at less than 10%. During 2 spring surveys in 1995 only 1 calf was seen (Table 1). Hunters took 57 bulls in 1988 and the kill has decreased each succeeding year.

The Thomas Bay population, based on recent harvest, is probably larger than the late 1970s estimate of 180 moose (ADF&G files, Petersburg).

No population data are available for Units 2 or 3.

Population Composition

Table 1 shows the results of all surveys made in the Stikine River valley since 1988/89. Tall conifers and inclement weather make adequate surveys difficult. We made no attempt to differentiate between bulls and cows but noted adults and calves during late winter aerial surveys.

Distribution and Movements

Moose have been seen crossing Dry Straits between Farm Island on the Stikine River delta and Mitkof Island. At low tide this strait can be crossed easily, and moose are reported to cross the strait in both directions. Radio telemetry of Stikine moose found no evidence of extensive seasonal migration (Craighead et al. 1984). Moose are well distributed in the Alaska portion of the Stikine River valley, Thomas and Farragut bays, and on the islands of Mitkof, Wrangell, and Kupreanof. Moose have been reported on Etolin, Zarembo, and Kuiu islands but may be absent from the Bradfield Canal area where several river valleys have suitable habitat.

MORTALITY

Harvest

Season and Bag Limit

Subunit 1A and 1B south of LeConte Glacier (Stikine)	Sept. 15–Oct. 15	1 bull by registration permit only.
Subunit 1B north of LeConte Glacier (Thomas Bay)	Oct. 1–Oct. 15	1 bull with spike/fork-50"/3 brow tine antlers, by registration permit only.
Unit 2	No open season	
Unit 3	Oct. 1–Oct. 15	1 bull with spike/fork-50"/3 brow tine antlers, by registration permit only.

<u>Board of Game Actions and Emergency Orders</u>. The Board of Game opened all of Unit 3 in 1993 to spike/fork or 50" or 3 brow tine antler restrictions by registration permit. The 1994 moose season was closed by emergency order in Unit 1B south of LeConte Bay and Glacier. This closure was due to a lack of mature breeding bulls in the herd.

<u>Hunter Harvest</u>. In Unit 1A the Unuk and Chickamin River moose populations are relatively small, isolated, difficult to hunt, and attract only a few hunters. The Unuk River population has supported a mean annual harvest of 3 bulls. Hunters killed 3 bulls in 1993 and 6 in 1994 (Table 2). One of the moose harvested in 1994 was killed at Wolf Creek on the Cleveland Peninsula. This is the first report of a moose being harvested on the Cleveland Peninsula. Harvest reports indicate 45 hunters participated in 1993 and 47 participated in 1994.

The moose harvest continued to decline in the Stikine portion of Unit 1B. Hunters killed 14 bulls in 1993 and the entire state season was closed by emergency order in 1994 (Table 3). Three moose were harvested under the federal season in 1994.

In 1993, 27 moose were harvested in Thomas Bay and 11 were harvested in 1994 (Table 4). The Unit 3 kill was 13 and 19 for 1993 and 1994, respectively (Table 5).

Hunter Residency and Success. Unit 1A moose hunters continue to be primarily Ketchikan and Metlakatla residents. Many of the hunters own cabins on the Unuk River. The hunter success rate for this subunit was 6% in 1993–1994, increasing to 13% in 1994–1995.

In the Stikine hunt area the number of hunters in the field and the success rate have decreased annually since 1989 (Table 6). Petersburg and Wrangell residents continue to take most of the moose.

Petersburg residents continued to dominate the Thomas Bay hunt (Table 7). The success rate was 20% in 1993 and 9% in 1994, meeting harvest and success rate objectives in 1993 but not in 1994.

Harvest Chronology. Harvest chronology for Units 1A, 1B, and Unit 3 remains fairly consistent. Most bulls are killed in the first half of the season, and the rate of kill decreases throughout the season (Table 8). Most hunters are in the field early in the season, then effort decreases except on weekends. Inclement weather does not seem to slow hunting effort early in the season.

Transport Methods. There were no apparent changes in transportation used by hunters in Units 1A and 1B. Most hunters used boats and 1 to 4 hunters used airplanes (Table 9). Hunters in Unit 3 relied on highway vehicles and the extensive road system to reach the field. Motorized land vehicles are prohibited for moose hunting in the Thomas Bay hunt and the Stikine Wilderness. In Thomas Bay vehicles may be used for purposes other than the actual hunting of moose.

Other Mortality

Wolves, black bears, and brown bears are moose calf predators, and wolves and brown bears take adult moose. The extent of predation on these moose herds is unknown, but few calves are being recruited into the Stikine herd.

HABITAT

Thomas Bay moose have used young age clearcuts since logging began in the 1950s. Conifer regrowth in the clearcuts is progressively reducing moose habitat, and canopy closure is reducing moose habitat value. The U.S. Forest Service cleared a 100-acre plot along the Patterson River to investigate the feasibility of improving moose habitat. Regrowth has been browsed heavily during summer, weakening winter habitat. Stikine moose range lies mostly within the Stikine/LeConte Wilderness area and is generally within the Stikine River drainage. Moose habitat in this area, identified by Craighead (1984), is designated wilderness and cannot be manipulated mechanically for habitat improvement.

CONCLUSIONS AND RECOMMENDATIONS

The small Unuk and Chickamin River moose populations attract very few hunters. The change to a registration permit has provided for more accurate reporting.

Unit 1B Stikine herd objectives were not met. The Federal Subsistence Board adopted an antler restriction for the 1993 season and restricted hunting on federal lands to federally eligible hunters only. Hunters needed to consult 2 separate and conflicting sets of regulations, 1 federal land and the other for nonfederal land. Hunters also needed federal and state permits to hunt legally.

In Thomas Bay the harvest and success rate were met in 1993 but not in 1994.

We recommend that Unit 2 remain closed to the taking of moose. We have no recommendations for Unit 3. We plan to establish management goals for this area soon.

The results of the antler restriction hunt in Thomas Bay demonstrate the effectiveness of this management method. I recommend that all of Unit 1B and Unit 3 be unified with a 31-day season by state registration permit only, beginning September 15 with a bag limit of 1 bull with spike/fork or 50" antlers or with at least 3 brow tines on 1 antler.

LITERATURE CITED

CRAIGHEAD, F. L., E. L. YOUNG, AND R. BOERTJE. 1984. Stikine River moose study, wildlife evaluation of Stikine-Iskut dams. Final Report. Alaska Dep of Fish and Game. Juneau. 72pp.

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Table 1 Unit 1B moose aerial surveys, Stikine area, 1988–94

Regulatory Year Month/Day	Nr Adults	Nr Calves	% Calves	Unidentified	Total Moose	Moose per/hr
1988/89						
02/13	42	5	(10)	3	50	31
04/10	27	3	(10)	0	30	27
1989/90						
07/27	45	14	(23)	2	61	31
03/02	27	2	(7)	0	29	16
03/08	61	5	(8)	0	66	36
1990/91						
07/20	23	3	(11)	2	28	22
07/25	10	1	(9)	0	11	10
07/27	30	0	(0)	0	30	12
08/11	8	3	(23)	2	13	6
08/18	26	3	(10)	0	29	12
12/15[a]	70	12	(15)	0	82	50
02/20[a]	38	6	(14)	0	44	34
03/05[a]	89	5	(5)	0	94	32
05/19[b]	0	0	(0)	2	2	2
1991/92						
03/03[c]	6	0	(0)	0	6	18
1992/93						
12/19[a]	59	12	(16)	2	73	21
03/25[a]	73	7	(9)	0	80	34
1993/94						
02/10[a,d]	46	4	(8)	0	50	39
1994/95						
03/02	34	0	(0)	0	34	
04/08	30	1	(3)	0	31	

[a] Helicopter survey
[b] River stage high, full leaf out in lower river, moose not visible
[c] Helicopter survey aborted due to weather
[d] Farm Island to 15 Mile Island only, then abandoned due to weather

Table 2 Unit 1A moose harvest, 1986–94

Regulatory Year	Reported Hunter Harvest Nr Males	% Males	Nr Females	% Females	Unk	Total
1986/87	0	(0)	0	(0)	0	0
1987/88	2	(100)	0	(0)	0	2
1988/89	6	(100)	0	(0)	0	6
1989/90	1	(100)	0	(0)	0	1
1990/91	5	(100)	0	(0)	0	5
1991/92	3	(75)	1	(25)	0	4
1992/93	5	(100)	0	(0)	0	5
1993/94	3	(100)	0	(0)	0	3
1994/95	6	(100)	0	(0)	0	6

Table 3 Unit 1B moose harvest, Stikine area, 1986–94

Regulatory Year	Reported Hunter Harvest Nr Males	% Males	Nr Females	% Females	Unk	Total
1986/87	51	100	0	0	0	51
1987/88	47	100	0	0	0	47
1988/89	57	100	0	0	0	57
1989/90	38	100	0	0	0	38
1990/91	36	97	1	3	0	37
1991/92	24	96	1	4	0	25
1992/93	18	95	1	5	0	17
1993/94	14	100	0	0	0	14
1994/95	closed by emergency order					

Table 4 Unit 1B moose harvest, Thomas Bay, 1986–94

Regulatory Year	Reported Hunter Harvest Nr Males	% Males	Nr Females	% Females	Unk	Total
1986/87	15	(100)	0	(0)	0	15
1987/88	22	(100)	0	(0)	0	22
1988/89	27	(100)	0	(0)	0	27
1989/90	20	(100)	0	(0)	0	20
1990/91	25	(100)	0	(0)	0	25
1991/92	15	(100)	0	(0)	0	15
1992/93[a]	27	(96)	1	(4)	0	28
1993/94	27	(100)	0	(0)	0	27
1994/95	11	(100)	0	(0)	0	11

[a] Includes illegal kill

Table 5 Unit 3 moose harvest, 1990–94

Regulatory Year	Reported Hunter Harvest Nr Males	% Males	Nr Females	% Females	Unk	Total	Illegal	Total
1990/91[a]	3	(100)	0	(0)	0	3	0	3
1991/92[b]	10	(100)	0	(0)	0	10	0	10
1992/93	17	(100)	0	(0)	0	17	0	17
1993/94	13	(100)	0	(0)	0	13	0	13
1994/95	19	(100)	0	(0)	0	19	0	19

[a] Wrangell Island only
[b] Wrangell and Mitkof Islands

Table 6 Unit 1B moose hunter residency and success, Stikine area, 1986–94

	Successful						Unsuccessful						
Regulatory Year	Local[a] Resident	Nonlocal Resident	Nonresident	Unk	Total Success	%	Local[a] Resident	Nonlocal Resident	Nonresident	Unk	Total	%	Total Hunters
1986/87	28	9	1	3	41	17	150	46	2	1	198	83	240
1987/88	37	7	1	2	47	21	127	49	0	5	181	79	228
1988/89[b]	41	16	0	0	57	19	167	74	4	3	248	81	305
1989/90[b]	23	15	0	0	38	13	170	106	7	0	283	87	321
1990/91[b]	36	0	1	0	37	12	215	27	1	0	243	88	280
1991/92[b]	23	1	1	0	25	12	146	34	5	5	190	88	215
1992/93	16	2	0	1	19	8	183	24	3	1	211	92	229
1993/94	14	0	0	0	14	10	121	6	0	0	127	90	141
1994/95	Closed by Emergency Order												

[a] Residents of Petersburg and Wrangell
[b] Unsuccessful hunter data expanded to correct for nonreporting hunters

Table 7 Unit 1B moose hunter residency and success, Thomas Bay area, 1986–94

	Successful					Unsuccessful					
Regulatory Year	Local[a] Resident	Nonlocal Resident	Nonresident	Total.	%	Local[a] Resident	Nonlocal Resident	Nonresident	Total	%	Total Hunters
1986/87	13	2	0	15	10	116	22	1	139	89	154
1987/88	21	0	1	22	20	79	7	2	88	80	110
1988/89	27	0	0	27	23	87	5	1	93	77	120
1989/90[b]	18	2	0	20	14	119	7	0	126	86	146
1990/91[b]	23	2	0	25	15	126	10	1	137	85	162
1991/92[b]	14	1	0	15	12	96	12	0	108	88	123
1992/93[b]	25	2	1	28	25	77	6	0	83	75	111
1993/94[b]	26	1	0	27	20	103	4	1	108	80	135
1994/95	11	0	0	11	9	108	9	0	117	91	128

[a] Residents of Petersburg and Wrangell
[b] Includes illegal kill

Table 8 Unit 1B and Unit 3 Harvest chronology, 1990–94

Location	Year	15-21 Sep	22-28 Sep	29 Sept - 5 Oct	6-15 Oct
Thomas Bay	1993/94	Season	Closed	19	8
	1994/95	Season	Closed	9	2
Stikine	1993/94	5	1	4	4
	1994/95	Closed by EO			
Unit 3	1993/94	Season	Closed	7	6
	1994/95	Season	Closed	15	4

Table 9 Successful hunter transport methods by area, 1990–94

Area	Year	Airplane	Boat	Highway Vehicle	3- 4-Wheeler	Horse	Unknown	Total
Thomas Bay	1990/91	1	22	0	2	0	0	25
	1991/92	1	14	0	0	0	0	15
	1992/93	0	27	0	0	1	0	28
	1993/94	4	23	0	0	0	0	27
	1994/95	1	9	0	0	0	1	11
Stikine	1993/94	1	13	0	0	0	0	14
	1994/95	Closed by EO						
Unit 3	1993/94	1	0	12	0	0	0	13
	1994/95	0	3	16	0	0	0	19

LOCATION

GAME MANAGEMENT UNIT: 1C (7,600 mi^2)

GEOGRAPHIC DESCRIPTION: That portion of the Southeast Alaska mainland from Cape Fanshaw to the latitude of Eldred Rock

BACKGROUND

Moose were first documented in western Subunit 1C in 1962 on the Bartlett River. In 1963 moose were observed in the Chilkat Mountain range; these moose probably originated from the Chilkat Valley population near Haines. By 1965 moose were sighted in the Endicott River and St. James Bay areas. Moose had probably moved into the Adams Inlet area (Glacier Bay) by that time because sightings were recorded for nearby Gustavus by 1968.

Swarth (1922) states that a moose was killed at the mouth of the Stikine River "some years" prior to 1919. If moose appeared at the same time on the Taku River, then presumably they first occurred in the lower part of the river near the turn of the century. In 1960, ADF&G biologists observed 38 moose on the Taku, and 27 moose were harvested there. Moose also iinhabit the Whiting and Speel Rivers south of the Taku; these animals may have originated from the Taku herd, the Whiting itself, or from some other source. In recent years moose and moose sign have been seen regularly in the Port Houghton area. These moose probably moved across the Fanshaw Peninsula from the Farragaut Bay/Thomas Bay population.

Moose did not occur naturally in Berners Bay. Fifteen calves from the Anchorage area were released there in 1958. A supplemental release of 6 more calves was made in 1960. In June of 1960, 3 cows with a single calf each were observed, indicating cows had bred at about 16 months of age. The first limited open season was held in 1963, when 4 bulls were killed. Since that time, the annual harvest has ranged from 5–23 animals.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Taku Area

Maintain a posthunting population of 150 moose, an annual harvest of 20, and a hunter success rate of 20%.

Berners Bay

Maintain a posthunting population of 90 moose, an annual harvest of 8, and a hunter success rate of 80%.

Chilkat Range

Maintain a posthunting population of 150 moose, an annual harvest of ten, and a hunter success rate of 15%.

METHODS

Aerial surveys were not conducted throughout most of Unit 1C during the report period due to a combination of factors, including loss of staff positions, poor weather, and commitments to make telemetry flights at mining study sites near Juneau. We conducted survey flights at Berners Bay both years, recognizing the need to annually reauthorize the cow hunt (Table 1). No aerial surveys were conducted in the Chilkat Range or the Taku area during this reporting period.

We collected incisors from moose taken in Unit 1C from successful hunters who brought in jaws as a condition of their permit. Data collected from drawing and registration permits included the length of hunt, hunter residency, hunt location, use of commercial services, and means of transport (for all hunters), and date of kill (for successful hunters).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Moose inhabit the Berners Bay area near the estimated carrying capacity (i.e., 100–150 animals) and are being maintained with selective harvests to adjust the bull to cow ratio (Table 1). In the Taku area some evidence indicates that moose numbers may be decreasing, although the population may be supplemented by animals moving downriver from Canada. Population dynamics are not well understood for the Chilkat Range moose herd, but harvest levels and anecdotal comments from hunters in the field indicate that moose numbers have probably been stable or increasing. The effect of this harvest level to the population are unknown. It is believed that moose from the Adams Inlet area within Glacier Bay National Park may be supplementing the harvest in the Endicott River area. An influx of moose from the park is also supporting an increasing harvest on state land at Gustavus.

Population Size

In Berners Bay the number of moose observed in fall and winter surveys has increased since 1986 (Table 1). An estimated 100–150 moose inhabit Berners Bay.

Recent survey data are not available for the Chilkat Range, except a late winter survey of Adams Inlet within Glacier Bay National Park in 1992–93 in which we found 79 adults and 11 calves (Table 1). The Endicott River portion of the Chilkat Range may be supporting 50 moose, and the entire Chilkat Range (outside of national park lands) may be supporting 150 moose. Previously animals from this area migrated to Adams Inlet in Glacier Bay, where willow communities have pioneered following recent glacial retreat. Moose from Adams Inlet may now be moving back to the east, supplementing the herd along the west side of Lynn Canal.

The moose population between Taku River and Cape Fanshaw probably numbers 150 animals. Animals from upriver in Canada quite possibly supplement the Taku herd, but the harvest in Canada has increased in recent years. No surveys have been flown in the Taku area since 1988 (Table 1). Farther south on the mainland, a few moose have been harvested in the Port Houghton area. These moose are almost certainly an extension of the group using Thomas and Farraugut bays on the south side of the Fanshaw Peninsula and are separate from other Unit 1C moose populations. Most, if not all, effort directed at Port Houghton moose comes from Petersburg in Unit 1B.

Population Composition

Surveys of Berners Bay were flown in 1993 and 1994. The 1993 survey was conducted during late winter and sex and age ratios are not reliable. A total of 67 moose, of which 12 were calves, were counted. In 1994 we counted 75 moose (including 13 calves). The bull to cow ratio was 38:100. No other areas within Unit 1C were surveyed during the reporting period.

Mean age at harvest of Berners Bay moose was above 4 years for males and close to 6 years for females (Table 2). It is important to note that during 1994 2 moose of very old age (at least 15 years) were harvested. However, age distribution of harvested animals appears random throughout the harvest years.

Mean age at harvest of moose in the Chilkat Range for 1993 and 1994 (3.3 and 3.1 years, respectively) was considerably greater than that of moose harvested in the Taku River area (2.4 and 1.7 years). The same relationship was evident over the last 5 years (Table 3). Additionally, a greater number of age classes were represented in the Chilkat Range harvest (Table 3).

MORTALITY

Harvest

Season and Bag Limit

Unit 1C, Berners Bay drainages only	Sep 15–Oct. 15	1 moose by drawing permit. Up to 20 permits will be issued.
Unit 1C, except Berners Bay drainages	Sep 15–Oct. 15	1 bull by registration permit only.

Board of Game Actions and Emergency Orders. The Board of Game increased the number of permits that could be issued for the Berners Bay hunt at its spring meeting in 1993. We now issue 20 drawing permits for the area. No emergency orders were issued during the period.

Hunter Harvest. The Berners Bay drawing permit hunt was managed for a harvest of 10 moose each year during the previous reporting period (Table 4). The ratio of male to female moose established for the harvest has been based on aerial survey data. The harvest level was raised to 8 bulls and 7 cows, based on increases in the numbers of moose seen during surveys in 1993. Poaching in Berners Bay is probably minimal because of the proximity to Juneau.

The rest of Unit 1C is managed under a registration permit format with no hunt quota. The known Taku area harvest has ranged from 15–27 since 1986, and the take in the Chilkat Range has ranged from 6–30 (Table 5). Harvest outside of Berners Bay has increased. Hunters harvested 45 moose in 1993 and 43 in 1994 in the Chilkat Range and the Taku areas, the largest number since 1972 when 44 moose were taken near Berners Bay. There has been a dramatic increase in the number of moose taken at Gustavus, while harvest in the Taku area has remained at more historic levels. Coupled with the Berners Bay harvest, the total harvest in Unit 1C is at a 10-year (and historic) high.

In the Taku area, some portion of the moose harvest claimed by Alaskan hunters is probably taken in British Columbia. The magnitude of this take is unknown. Other illegal take (e.g., out-of-season, females, etc.), probably occurs on the Taku River within Alaska as well, as it undoubtedly does in the Endicott drainage and other sites in the Chilkat Range.

Permit Hunts. Between 247 and 1463 applications have been submitted for the Berners Bay moose drawing over the past 7 years. The proximity to Juneau and the high success rate explain the popularity of this hunt. In 1992, 1273 hunters applied for 8 bull and 7 cow permits, for a combined success rate of 1.2%. In 1994, 1463 hunters applied for 8 bull and 7 cow permits for a success rate of 1.0%.

Since the registration permit format was implemented for the portion of Unit 1C excluding Berners Bay, more than 200 permits have been issued annually (Table 4). A record high 352 were issued in 1993, with 346 permits being issued during 1994 (Table 4). Of these permittees, 241 and 227 actually hunted during 1993 and 1994, respectively, compared with 218 in 1991. Roughly 61% of the permittees who hunted reported hunting in the Chilkat Range; 49% reported hunting in the Taku area. Reporting compliance has continually remained high.

Hunter Residency and Success. Most moose harvested in Unit 1C continue to be taken by local residents (Table 6). In 1993 and 1994, subunit residents took 37 (80%) and 43 (82%), respectively, of moose harvested. Three reasons for this are 1) moose habitats are not readily accessible by highway vehicle, 2) nonlocal residents have better opportunities for moose hunting closer to home, and 3) nonresident hunters focus on areas with larger moose populations. In both 1993 and 1994 about 19% of all hunters in Unit 1C were successful, with hunters of the Chilkat Range being slightly more successful than Taku hunters each year (Table 5).

Harvest Chronology. The pattern of harvest first established in 1990 continued during the reporting period, with harvest weighted toward the beginning and end of the season. During the reporting period, 42% and 30% of harvested moose were killed in the first and last weeks of the season, respectively, with 28% being killed throughout the remainder of the season.

Transport Methods. Boats continue to be the most common form of transportation for moose hunters in Unit 1C (Table 7), used by 66% of successful hunters. Airplanes and highway vehicles were also used, with 12% and 13% of hunters using these means, respectively, during the reporting period. The predominant use of boats is not surprising, since most hunting areas are removed from highway access points, seasons are closed prior to the winter season, and aircraft landing sites are limited. However. hunters in Gustavus (Chilkat Range) primarily use highway vehicles.

Other Mortality

No natural mortality was documented during the report period. Deep snow during the early part of the winter of 1994–95 may have been a problem for calves, but weather conditions were mild, generally not affecting moose adversely in this subunit.

HABITAT

No habitat assessment or enhancement activities were carried out during the period.

CONCLUSIONS AND RECOMMENDATIONS

Management objectives were not met for Berners Bay. The population appears to be larger than the targeted 90 animals, hunter success was nearly 100% during the reporting period, and the harvest exceeded 8 animals each year. Management objectives for hunter success and animals harvested were not met for the Chilkat Range during the reporting period; the harvest objective (10 animals) roughly tripled during both years and 20% of hunters were successful. However, the status of the moose population in the Chilkat Range remains unknown because we have not conducted surveys. Management objectives for the Taku River area were not met during this reporting period. The status of the population is unknown, harvest was below 20 moose during both years, and hunter success was 18%.

Surveys of Berners Bay indicate the moose population is moderately dense but healthy. A 1992 survey of Adams Inlet indicated high numbers of moose wintering there. We believe that a continuation of the permit registration system should accommodate current population objectives in Unit 1C. Rising effort and harvest in the Chilkat Range increase the importance of acquiring survey data for moose in that portion of the unit. Decreasing effort in the Taku area indicates the population may be declining, increasing the importance of collecting survey data there as well.

Throughout the subunit jaws should be collected for age analysis of harvested moose. Areas supporting winter browse should be analyzed, even cursorily, to estimate the status of moose populations in relation to carrying capacity. Once population and carrying capacity estimates are made for the Taku and Chilkat Range populations, consideration can be given to revision of management objectives for those areas.

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Table 1 Aerial survey data in Unit1C, 1980–1994

Year	Total Bulls	Total Cows	Total Calves	Unknown Age/Sex	Total Moose	Count Time (hrs)	Total Bulls/ 100F	Calves per 100F	Calves % in herd	Moose per hour
					Berners Bay					
1980	8	26	5		40	1.8	31	19	13	22
1981	0	24	6		30	2.3	0	25	20	13
1982	4	82	19		105	3.4	5	23	18	31
1983	9	66	18		93	2.2	14	27	19	42
1984	22	60	19		101	2.2	37	32	19	46
1985	20	44	6		70	2.3	46	14	9	30
1986	15	46	7		68	1.6	33	15	10	41
1987					No Survey					
1988[1]	3	53	12		68	2.2	6	23	18	31
1989					No Survey					
1990	14	53	18		85	2.6	26	34	21	33
1991			11		61	1.2			18	50
1992	14	61	8		83	2.8	23	13	10	29
1993	---	---	12	45	67	2.8	---	---	18	24
1994	17	45	13		75	2.0	38	29	17	38
					Chilkat Range					
1968	1	2	1		4		50	50	25	
1975	0	3	2		5		0	67	40	
1986	3	10	6		19	1.5	30	60	32	
1987-91					No Survey					
1992[2]	---	---	11	79	97	1.3	---	---	13	75
1993-94					No Survey					
					Taku					
1978	3	30	15		49	3.4	10	50	31	14
1983	2	40	12		54	1.7	5	30	22	32
1986	2	42	1		45	1.8	5	2	2	25
1987					No Survey					
1988	2	16	4		22	1.6	13	25	18	14
1989-94					No Survey					

[1] Late winter survey; sex and age ratios unreliable.

[2] Late winter survey of Adams Inlet only; sex and age ratios unreliable.

Table 2 Age at harvest of Berners Bay moose in Unit 1C, 1978–1994

							Age	Class								Total	%	Mean
Year	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Kill	Aged	Age
									Males										
1978	0	1	2	1	2	2	0	1	1	0	0	0	0	0	0	0	11	91	4.6
1979	0	3	3	6	2	2	1	0	0	0	0	0	0	0	0	0	17	100	3.1
1980	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	5	80	4.8
1981	0	2	4	1	1	1	0	0	0	0	0	0	0	0	0	0	10	90	2.7
1982	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	5	100	2.3
1985	0	0	0	4	1	3	0	0	0	0	0	0	0	0	0	0	8	100	4.4
1986	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	5	80	3.8
1987	0	1	0	0	2	2	0	0	0	0	0	0	0	0	0	0	5	100	4.3
1988	0	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	4	100	4.0
1989	0	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	5	80	2.3
1990	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	0	5	100	3.5
1991	0	1	0	3	1	0	0	0	0	0	0	0	0	0	0	0	5	100	3.3
1992	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	5	20	3.5
1993	0	1	2	1	1	1	1	0	0	0	0	0	0	0	0	0	7	100	4.3
1994	0	2	1	2	0	1	0	0	0	0	0	0	0	0	0	1	8	88	4.7
									Females										
1983	0	0	1	1	2	1	1	2	1	1	1	1	0	0	0	1	5	100	1.8
1984	1	1	1	4	1	1	0	0	3	0	1	0	0	0	0	0	4	75	1.7
1985	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	7	100	5.6
1986–90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	---
1991	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	5	100	1.8
1992	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	4	75	1.7
1993	0	1	0	2	0	0	1	0	1	1	0	1	0	0	0	0	7	100	5.9
1994	1	1	1	0	0	0	1	1	0	0	0	0	0	0	0	1	7	71	6.6

Table 3 Moose age at harvest in Unit 1C, excluding Berners Bay, 1990–1994

							Age	Class								Total	%	Mean
Year	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Kill	Aged	Age
								Chilkat Range											
1990	0	7	3	3	1	1	1	0	0	0	0	0	0	0	0	0	24	67	2.9
1991	0	5	1	3	0	0	1	0	1	0	0	0	0	0	0	0	12	92	3.2
1992	0	2	4	2	2	1	0	1	0	0	0	0	0	0	0	0	20	60	3.3
1993	0	8	5	6	3	1	1	0	0	0	1	0	0	0	0	0	30	83	3.3
1994	0	10	4	2	1	3	0	2	1	0	1	0	0	0	0	0	27	89	3.1
								Taku											
1990	0	9	2	1	0	0	0	0	0	0	0	0	0	0	0	0	20	60	1.8
1991	0	5	4	1	0	0	0	1	0	0	0	0	0	0	0	0	14	78	2.6
1992	0	3	3	1	1	1	1	0	0	0	0	0	0	0	0	0	19	53	2.9
1993	0	3	4	1	3	1	0	0	0	0	0	0	0	0	0	0	15	73	2.4
1994	0	8	3	2	1	0	0	0	0	0	0	0	0	0	0	0	16	88	1.7

Table 4 Unit 1C hunter effort and success, 1984–1994

		Successful Hunters			Unsuccessful Hunters			Total Hunters		
Year	Permits Issued[1]	Nr Hunters	Total Nr Days	Avg Nr Days	Nr Hunters	Total Nr Days	Avg Nr Days	Nr Hunters	Total Nr Days	Avg Nr Days
					Berners Bay					
1984	---	13	31	2.2	1	6	6.0	15	37	2.5
1985	---	13	32	2.5	1	5	5.0	14	37	2.6
1986	---	5	7	1.4	2	9	4.5	7	16	2.3
1987	---	5	10	2.0	0	0	0.0	5	10	2.0
1988	5	4	8	2.0	1	8	8.0	5	16	3.2
1989	5	5	9	1.8	0	0	0.0	5	9	1.8
1990	5	5	14	2.8	0	0	0.0	5	14	2.8
1991	10	10	20	2.0	0	0	0.0	10	20	2.0
1992	10	9	23	2.6	0	0	0.0	9	23	2.6
1993	15	14	29	2.1	1	7	7.0	15	36	2.4
1994	15	14	38	2.7	0	0	---	14	38	2.7
					Chilkat Range					
1984	---	6	32	3.7	34	12	3.7	40	143	3.7
1985	---	7	19	2.1	65	16	2.5	72	180	2.5
1986	---	10	35	3.5	59	162	2.7	69	197	2.8
1987	---	6	21	3.5	57	134	2.4	63	155	2.5
1988	215	11	31	2.8	52	165	3.2	63	196	3.1
1989	305	10	26	2.6	77	250	3.2	87	276	3.2
1990	331	24	83	3.5	94	267	3.5	106	350	3.5
1991	316	12	38	3.2	70	321	4.6	82	359	4.4
1992	317	20	89	4.0	69	279	4.0	89	368	4.1
1993	352	30	128	4.3	118	526	4.5	148	654	4.5
1994	346	27	111	4.3	113	455	4.1	140	566	4.1
					Taku					
1984	---	18	75	4.2	75	280	3.7	83	355	4.3
1985	---	26	132	5.1	94	384	4.1	120	516	4.3
1986	---	15	84	5.6	84	395	4.7	99	479	4.8
1987	---	14	48	3.4	75	305	4.1	89	353	4.0

Table 4 Continued

Year	Permits Issued[1]	Successful Hunters Nr Hunters	Successful Hunters Total Nr Days	Successful Hunters Avg Nr Days	Unsuccessful Hunters Nr Hunters	Unsuccessful Hunters Total Nr Days	Unsuccessful Hunters Avg Nr Days	Total Hunters Nr Hunters	Total Hunters Total Nr Days	Total Hunters Avg Nr Days
1988	---	17	36	2.1	53	202	3.8	70	238	3.4
1989	---	27	106	3.9	77	271	3.5	104	377	3.6
1990	---	20	89	4.5	94	339	4.0	114	424	4.0
1991	---	14	52	3.7	88	358	4.1	102	410	4.0
1992	---	19	79	4.2	104	409	3.9	123	488	4.0
1993	---	16	40	2.7	77	318	4.4	93	358	4.1
1994	---	17	40	2.4	70	323	4.8	87	363	4.3

[1] Number given for the Chilkat Range from 1988 through 1994 is actually the number of permits issued for Unit 1C excluding Berner's Bay; only permittees who hunted may be categorized to either the Chilkat Range or Taku area.

Table 5 Historical harvests, number of hunters, and percent success in Unit 1C, 1984–1994

Year	Males	Females	Unknown	Total Kill	Hunters	% Success
			Berners Bay			
1984	0	13	0	13	15	93
1985	9	5	0	13	14	93
1986	5	0	0	5	7	71
1987	5	0	0	5	5	100
1988	4	0	0	4	5	80
1989	5	0	0	5	5	100
1990	5	0	0	5	5	100
1991	5	5	0	10	10	100
1992	5	4	0	9	9	100
1993	7	7	0	14	15	93
1994	8	6	0	14	14	100
			Chilkat Range			
1984	6	0	0	6	40	15
1985	7	0	0	7	72	10
1986	10	0	0	10	69	14
1987	6	0	0	6	63	10
1988	11	0	0	11	63	17
1989	10	0	0	10	87	11
1990	24	0	0	24	106[1]	23
1991	12	0	0	12	82	15
1992	20	0	0	20	89	22
1993	30	0	0	30	148	20
1994	27	0	0	27	140	19
			Taku			
1984	18	0	0	18	83	22
1985	26	0	0	26	120	22
1986	15	0	0	15	99	16
1987	14	0	0	14	89	16
1988	17	0	0	17	70	24
1989	27	0	0	27	104	26

Table 5 Continued

Year	Males	Females	Unknown	Total Kill	Hunters	% Success
1990	20	0	0	20	114[2]	18
1991	14	0	0	14	102	14
1992	19	0	0	19	123	15
1993	16	0	0	16	93	17
1994	17	0	0	17	87	18

[1] Twelve of the 106 hunters were assigned to the Chilkat Range (based on proportion hunting in each area) as they reported no specific area within Unit 1C.

[2] Twelve of the 114 hunters were assigned to the Taku (based on proportion hunting in each area) as they reported no specific area within Unit 1C.

Table 6 Unit 1C annual moose kill by residence, 1984–1994

Year	Total Kill	Gustavus	Juneau	Sitka	Wrangell	Petersburg	Haines	Other Alaska	Non-Resident
					Berners Bay				
1984	13	0	13	0	0	0	0	0	0
1985	13	0	13	0	0	0	0	0	0
1986	5	0	4	0	0	0	1	0	0
1987	5	0	5	0	0	0	0	0	0
1988	4	0	4	0	0	0	0	0	0
1989	5	0	5	0	0	0	0	0	0
1990	5	0	5	0	0	0	0	0	0
1991	10	0	9	0	0	0	1	0	0
1992	9	0	9	0	0	0	0	0	0
1993	14	0	13	0	0	0	1	0	0
1994	14	0	13	0	0	0	1	0	0
Total/(%)	97	---	(96)	---	---	---	(4)	---	---
					Chilkat Range				
1984	6	0	6	0	0	0	0	0	0
1985	7	0	5	0	0	0	1	0	1
1986	10	1	6	0	0	0	3	0	0
1987	6	0	6	0	0	0	0	0	0
1988	10	0	8	0	0	0	1	0	1
1989	10	1	6	0	0	0	2	0	1
1990	24	7	14	0	0	0	3	0	0
1991	12	6	6	0	0	0	0	0	0
1992	20	10	8	0	0	0	1	0	1
1993	30	11	13	0	0	0	5	1	0
1994	27	15	10	0	0	0	0	1	1
Total/(%)	162	(32)	(54)	---	---	---	(10)	(1)	(3)
					Taku				
1984	19	0	19	0	0	0	0	0	0
1985	26	0	24	1	0	0	0	1	0
1986	16	0	15	0	0	0	0	0	0
1987	14	0	12	0	0	0	0	0	2
1988	17	0	16	0	0	1	0	0	0

Table 6 Continued

Year	Total Kill	Gustavus	Juneau	Sitka	Wrangell	Petersburg	Haines	Other Alaska	Non-Resident
1989[1]	27	0	21	1	1	1	1	0	0
1990	20	0	18	1	0	1	0	0	0
1991	14	0	13	0	0	1	0	0	0
1992	19	0	15	0	0	2	0	1	1
1993	15	0	12	0	0	2	1	0	0
1994	17	0	10	0	0	2	0	2	0
Total/(%)	204	---	(87)	(2)	(1)	(5)	(1)	(2)	(2)

[1] Two hunters of unknown residency.

Table 7 Transport methods used by successful hunters in Unit 1C, 1993–1994

Year	Airplane Total	Airplane (%)	Boat Total	Boat (%)	3- or 4-Wheeler Total	3- or 4-Wheeler (%)	Hwy Vehicle Total	Hwy Vehicle (%)	Foot Total	Foot (%)
					Berners					
1993	0	---	14	(100)	0	---	0	---	0	---
1994	0	---	14	(100)	0	---	0	---	0	---
					Chilkat Range					
1993	6	(20)	16	(53)	1	(3)	4	(13)	3	(10)
1994	1	(4)	10	(37)	0	---	11	(41)	5	(19)
					Taku River					
1993	4	(25)	11	(69)	0	---	0	---	1	(6)
1994	3	(18)	14	(82)	0	---	0	---	0	---
					Unit 1C					
1993-94 Total/(%)	14	(12)	79	(66)	1	(1)	15	(13)	9	(8)
1988-91 Total/(%)	33	(21)	110	(69)	0	---	16	(10)	0	---

Table 8 Commercial services used by hunters in Unit1C, 1991-1994

Year	Unit Residents No	Unit Residents Yes	Other AK Residents No	Other AK Residents Yes	Non-Residents No	Non-Residents Yes	Total Use No	Total Use Yes	Transport	Non-Guided Services	Other Services
Berners Bay											
1991	6	2	0	0	0	0	6	2	0	0	2
1992	9	1	0	0	0	0	9	1	0	0	1
1993	13	0	1	0	0	0	14	0	0	0	0
1994	11	0	1	0	0	0	12	0	0	0	0
Chilkat Range											
1992	96	6	12	4	0	1	108	11	10	1	0
1993	92	6	23	7	0	0	115	14	9	3	2
1994	107	6	19	0	1	0	127	6	0	0	0
Taku Area											
1992	56	8	8	2	0	0	64	10	7	0	3
1993	61	7	71	7	0	0	132	14	12	2	0
1994	50	4	23	3	0	0	73	7	7	0	0
1991-92[1] %	91%	9%	77%	23%	---	100%	89%	11%	71%	4%	25%
Reporting Period %	94%	6%	89%	11%	100%	---	92%	8%	80%	14%	6%

[1] The use of commercial services was not collected during 1991 for hunters in the Chilkat Range or the Taku area.

LOCATION

GAME MANAGEMENT UNIT: 1D (2,700 mi^2)

GEOGRAPHIC DESCRIPTION: That portion of the Southeast Alaska mainland lying north of the latitude of Eldred Rock, excluding Sullivan island and the drainages of Berners Bay

BACKGROUND

In Subunit 1D most moose inhabit the Chilkat River watershed and the Chilkat Peninsula. Within this area there is an estimated 200–250 mi^2 of summer range, 110–120 mi^2 of winter range, and 80 mi^2 of preferred winter range. Small areas of moose habitat are also located in the Chilkoot, Katzehin, and Warm Pass valleys, and along the western shore of Lynn Canal.

Moose immigrated to the Chilkat River valley from drainages in Canada around 1930. Moose populations peaked in the Chilkat Valley in the mid-1960s with a population of 700 animals. By the early 1970s the moose population had sharply declined to 400–500 animals, possibly because of range overuse and overharvest. Survey data collected during the mid-1980s indicated the herd had declined further, with approximately 400 moose remaining in the Chilkat drainage.Today the moose population includes 300–400 moose.

Residents of Unit 1D have expressed concern over the decrease in moose numbers, the subsequent decline in hunting opportunity, and the "stampede" quality of registration permit hunts with low harvest quotas. Harvest objectives have been formulated based on survey data and harvest trends. Efforts were made to introduce measures (e.g., a spike-fork requirement) to slow the pace of the hunt, but these were pre-empted when a Tier II subsistence hunt was implemented for the area by the Board of Game in the 1990/1991 regulatory year. Widespread dissatisfaction with the allocation of 20 Tier II permits and concern over the status of the herd contributed to local opposition to holding a hunt in 1991, and no permits were issued that year. In 1992 the season was closed by emergency order before Tier II permits were issued.

In March of 1993 the Board of Game authorized a Tier II antler restriction hunt for Unit 1D. This hunt allowed more hunters the opportunity to hunt for a legal moose while affording protection to several age classes. Our objective is to spare a large proportion of the young and middle-aged bulls from harvest to strengthen the breeding age segment of the population, while still allowing many local hunters the chance to hunt moose.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following objectives have been formulated based on existing biological data and input from the public. They are presented in the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990–94 (ADF&G 1991). Management objectives for moose in the Chilkat River valley by 1994 include a posthunt population of 450 and a posthunt bull to cow ratio of 26:100, 250 hunters expending 500 hunter days, and a harvest of 30 moose for a hunter success rate of 12%.

METHODS

We conducted aerial surveys of the Chilkat River valley in January and November of 1994 (Table 1). Areas covered included the Chilkat River valley from Murphy Flats to the vicinity of Turtle Rock, and the Klehini, Tahkin, and Kelsall river valleys.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Winter surveys flown in good viewing conditions in regulatory years 1993 and 1994 (Table 1) indicate the Chilkat valley moose population is about 350 animals. These survey results are similar to the last complete surveys (1991/92) and support previous conclusions regarding a population decline since the late 1980s.

Population Composition

Sex and age ratios from the January 1993 survey are unreliable due to antler drop; however, the November 1994 survey produced a bull to cow ratio of 53:100, the highest of any survey flown in the area (Table 1). Calves were estimated to compose 11% of the herd in 1993 (35 per 100 females) and 18% in 1994. The number of calves observed in 1994 is the highest since 1984. It is important to note that the 1994 survey was conducted earlier in the winter than in prior years, so a higher number of calves is to be expected and may not reflect any real improvement in survival. It appears that poor calf survival because of snow, predators, or other factors may be effectively eliminating recruitment in some years.

Mean age at harvest has increased from historic levels (Table 2). While the mean age was less than 4 years for all seasons from 1983 to 1989, the mean age was greater than 5 years during this reporting period. Moreover, the age distribution of animals harvested in 1993 and 1994 appears skewed toward older animals, as compared to prior harvest years in which younger animals composed most of the harvest. This is most likely a result of the spike-fork/50inch/3 brown tine regulations implemented since 1993, and the fact that no season was held during 1991 and 1992.

MORTALITY

Harvest

<u>Season and Bag Limit</u>

Oct 1–Oct 15	1 bull by Tier II permit only; 200 permits may be issued.

In 1991 a decision was made to cancel the Unit 1D moose season, based on lack of recruitment and a failure to complete surveys the preceding years. The 1992 season was canceled by emergency order before the Tier II permit application process, based on results of the December 1991 aerial survey. Tier II antler restriction seasons were held in 1993 and 1994.

Board of Game Actions and Emergency Orders. The Board of Game approved a Tier II antler restriction hunt just before the 1993 season. Emergency orders were used to close the 1993 and 1994 seasons, in part as a response to the number of illegally harvested animals. The closures were also implemented to limit harvest to a level the population could sustain. Despite the theoretical "self-limiting" aspect of spike-fork/50 inch/3 brow tine hunts, we wanted to kill no more than 30 bulls per year, targeting the harvest at 24 bulls. Emergency orders were issued to close the season after 3 days in 1993 and after 2½ days in 1994.

Hunter Harvest. Harvest levels remained at about 20 animals between 1985 and the early 1990s. In both 1993 and 1994, we managed the season for a harvest of 25 bulls. A total of 24 legal bulls were taken in 1993 and 17 in 1994. Three illegal bulls and 1 cow were killed in 1993; 3 illegal bulls were taken in 1994.

Permit Hunts. All moose hunting within the subunit is conducted under a Tier II subsistence permit system. We issued 176 permits in 1993 and 200 in 1994 (Table 3).

Hunter Residency and Success. During the reporting period, the moose hunt in Unit 1D was limited largely to residents of the subunit. Most permits were issued to residents of the subunit. Residents of Haines took all but 2 of the moose harvested in 1993 and all moose harvested in 1994 (Table 4). Hunter success was 22% and 12% during 1993 and 1994, respectively (Table 5). Successful hunters spent an average of 1.9 and 1.2 days in the field during 1993 and 1994, respectively (Table 3). Hunter days totaled 227 days in 1993 and 304 days in 1994.

Harvest Chronology. With the season opening on the first day of October, bulls were quite active and therefore vulnerable to hunters. Despite the format change to an antler restriction hunt, the moose season continued to be short, not exceeding 3 days in either year of the reporting period.

Transport Methods. Most hunters have previously used either boats or highway vehicles to hunt moose in Unit 1D (Table 6). This held true during 1993 and 1994, with only 1 hunter using a different means of transport during the reporting period. While boats and highway vehicles were used at nearly the same rate in 1993, boats were used predominantly in 1994.

Commercial Services. Commercial services were used by only 3 hunters during the reporting period (Table 7). This is not surprising since almost all hunters reside within, or very near, the subunit.

Other Mortality

Discussions with area residents suggest the brown bear population has increased in recent years and that predation may be partly responsible for the poor recruitment rates. Data in support of this claim is not available. Between 1992 and 1993 wolves were more active (or more noticeable) than usual, and we received several reports of wolves killing moose, along with demands that ADF&G "do something." Deep snow conditions during winters of the 1992–1993 reporting period probably contributed to calf mortality and undoubtedly contributed to predator success. During this reporting period wolf predation did not seem to pose a serious threat to the moose population. Deteriorating range conditions (Hundertmark et al. 1983) may also affect calf production and survival.

Highway vehicles kill between 3 and 5 moose in the subunit each winter. Poaching occurs, but the number of moose lost to this activity is unknown. No Fish and Wildlife Protection staff were stationed in Haines during 1993, although staff was stationed there in 1994.

Habitat

Nearly all of the moose habitat in this subunit lies within the Haines State Forest, managed under the multiple-use guidelines of the Haines State Forest Management Plan of 1986. The plan's goals include an annual harvest of 8.8 million board feet of timber (approximately 300 to 580 acres). Timber harvests occurred during the reporting period in the Chilkat River valley above Wells Bridge in areas that do not contain critical moose winter range. A logging operation adjacent to important early winter habitat probably affected the availability of late-winter/deep snow habitat by removing the forest canopy. While some increased browse production may occur in logged areas, we have not determined the extent and value of deciduous reproduction in these areas. The long-term usefulness of cut-over areas to moose will be reduced if a) timber harvest occurs in high value wintering areas, and b) cut-over areas are managed to produce second growth coniferous stands rather than deciduous browse species.

Habitat changes within nonforested portions of the area are also of concern. Research in the early 1980s showed a low proportion of young willow plants in shrub stands in the Chilkat River valley, and it is suspected that postglacial land uplift is causing permanent habitat change. Removal of decadent alder and cottonwood overstories in order to release willow, red-osier dogwood, and other browse species may counteract long-term changes. There is some degree of local interest in mechanically changing vegetation in areas close to Haines.

CONCLUSIONS AND RECOMMENDATIONS

The harvest objectives contained in the Strategic Plan for Management of Moose in Region I, Southeast Alaska 1990–94 (ADF&G 1991) were not met during the reporting period. Although the posthunt bull to cow ratio of 26:100 seems to have been met in 1994, the number of moose has not rebounded to the management objective of 450 animals; this objective will only be met if calf survival increases. The hunter success objective was met in both years, although the number of days expended was much lower than the targeted 500.

Implementation of an antler restriction hunt increased the age of harvested moose which, assuming that calf survival is adequate, allows more young bulls to reach breeding age. We hope this will lead to maximum calf production and allow the Unit 1D moose herd to stabilize near the carrying capacity of the habitat. The new hunt format has also had the important effect of allowing more people to hunt for moose while reducing the impact of the hunt upon the herd. While the difficulties of judging a legal bull causes complaints, the local community is supportive of the hunt because more people have an opportunity to hunt without endangering the safety of the herd. In the future, we will try to slow the pace of the hunt to reduce the number of animals taken illegally.

The effect of predation upon moose calf survival in this area is unknown. The healthy brown bear population (as well as the less prominent black bear population) probably accounts for substantial summer mortality. Winter wolf predation does not appear to be a serious problem, except when moose movements are restricted by extremely deep snow. We should continue to seek methods to determine the extent of predation.

McCarthy (ADF&G 1990) called for investigation into the relationship between timber harvest and moose habitat in the Chilkat River valley. Other means of converting decadent hardwood stands to encourage growth of browse species should be pursued and tried as pilot projects. Volunteer efforts may be able to accomplish enough so we could monitor browse growth and moose use before engaging in extensive habitat enhancement. We should also investigate the possibility of using prescribed fire to accomplish favorable habitat changes.

Recent surveys indicate moose numbers in Unit 1D are no longer declining and the present hunting scheme is working. However, predation, deep snows, and mediocre habitat point to the need for regular surveys to better understand the status and trend of the moose population.

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Table 1 Unit 1D aerial survey data, 1982–1994

Regulatory Year	Total Males	Total Females	Total Calves	Unknown	Total Moose	Count Time (hrs)	Bulls Per 100F	Calves per 100F	Calves % in herd	Moose per hour
1982	34	115	51	---	200	4.8	30	44	36	42
1983	16	148	47	---	211	5.8	11	32	22	36
1984	15	135	37	---	187	5.2	11	27	20	36
1985	23	155	29	---	207	5.5	15	19	14	38
1986	33	93	13	---	139	3.5	36	14	14	40
1987[1]			29	174	203				14	53
1988[2]			31	206	252	4.4			12	57
1989	18	45	10	---	73	1.5	40	22	14	48
1990[3]	18	67	6	---	91	3.5	30	9	7	26
1991	23	138	22	---	183	7.8	17	17	13	23
1992	27	98	21	---	149	2.9	28	21	14	52
1993			19	157	176	5.8			11	31
1994	41	77	27	---	149	4.3	53	35	18	35

[1] Late winter survey, sex and age ratios unreliable. In a second late winter survey a total of 215 moose (29 calves) were counted at a rate of 57 moose per hour.

[2] Late winter survey, sex and age ratios unreliable.

[3] Numbers are for survey flown on 12/14/1990. A second survey, flown only in the Chilkat Valley on 3/22/1991, resulted in a total count of 28 moose in 2.93 hours.

Table 2 Age structure of moose harvests in Unit 1D, 1983–1994

Regulatory Year	0.5	1.5	2.5	3.5	4.5	5.5	6.5	Age Class 7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Total Kill	% Aged	Mean Age
1983	1	3	7	10	6	0	1	2	0	1	0	0	0	0	0	0	62	50	3.8
1984	2	15	12	2	2	1	0	0	0	0	0	0	0.	0	0	0	36	94	2.3
1985	0	7	4	1	0	1	0	0	0	0	0	0	0	0	0	0	14	93	2.3
1986									Season Closed										
1987	0	3	6	7	3	1	0	0	0	0	0	0	0	0	0	0	22	91	3.2
1988	0	6	5	3	1	1	1	0	0	0	0	0	0	0	0	0	18	94	2.9
1989	0	10	5	2	2	0	0	0	0	0	0	0	0	0	0	0	18	100	2.3
1990																	19	0	0.0
1991									Season Closed										
1992									Season Closed										
1993	0	2	3	3	4	2	3	1	4	0	1	0	1	0	0	0	24	100	5.1
1994[1]	0	0	0	1	1	8	2	2	0	0	0	0	1	0	0	0	17	94	5.7

[1] Does not include an illegally harvested bull of age 3.

Table 3 Hunter effort and success in Unit 1D, 1983–1994

		Successful Hunters			Unsuccessful Hunters			Total Hunters		
Year	Permits Issued	Hunters	Total Days	Avg Days	Hunters	Total Days	Avg Days	Hunters	Total Days	Avg Days
1983	—	62			292			354		
1984	—	35	149	4.3	314	1540	4.9	349	1689	4.8
1985	—	14	43	3.1	29	109	3.8	43	152	3.5
1986					Season Closed					
1987	294	22	22	1.0	208	208	1.0	230	230	1.0
1988	259	18	18	1.0	188	188	1.0	206	206	1.0
1989	272	18	18	1.0	208	208	1.0	226	226	1.0
1990	20	19	48	2.5	1	7	7.0	20	55	28
1991					Season Closed					
1992					Season Closed					
1993	176	24	45	1.9	83	182	2.3	107	227	2.2
1994	200	17	20	1.2	130	284	2.2	147	304	2.1

Table 4 Unit 1D Annual moose kill by residence, 1984–1994

Regulatory Year	Total Kill	Haines	Skagway	Juneau	Sitka	Other Alaska	Non-Resident
1984[1]	35	23	1	7	2	1	0
1985	14	14	0	0	0	0	0
1986			Season Closed				
1987	22	22	0	0	0	0	0
1988	18	18	0	0	0	0	0
1989[2]	18	18	0	0	0	0	0
1990	19	19	0	0	0	0	0
1991			Season Closed				
1992			Season Closed				
1993	24	22	0	2	0	0	0
1994	17	17	0	0	0	0	0
Total	167						---
(%)		(92)	(1)	(5)	(1)	(1)	

[1] One hunter of unknown residency.
[2] Does not include an illegally harvested cow killed by a Haines resident.

Table 5 Historical harvests, number of hunters, and percent success in Unit 1D, 1980–1994

Regulatory Year	Males	Females	Unknown	Total Kill	Hunters	% Success
1980	48	0	0	48	342	14
1981	36	2	0	38	315	11
1982	24	1	0	25	267	9
1983	62	0	0	62	354	17
1984	35	1	0	36	349	10
1985	14	0	0	14	43	33
1986			Season Closed			
1987	22	0	0	22	230	10
1988	18	0	0	18	206	9
1989	18	1	0	19	226	8
1990	19	0	0	19	20	95
1991			Season Closed			
1992			Season Closed			
1993	24	0	0	24	107	22
1994	17[1]	0	0	17	147	12

[1] Does not include 1 illegal kill.

Table 6 Transport methods used by successful hunters in Unit 1D, 1987–1994

	Airplane		Boat		ORV		Highway Vehicle		Other	
Year	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
1987	3	(14)	12	(12)	1	(5)	6	(27)	0	---
1988	0	---	16	(88)	1	(6)	1	(6)	0	---
1989[1]	2	(11)	10	(55)	2	(11)	4	(22)	1	(1)
1990	0	---	10	(58)	0	---	7	(37)	2	(8)
1991-2					Season Closed					
1993	0	---	13	(54)	0	---	10	(45)	1	(4)
1994	0	---	13	(81)	0	---	3	(19)	0	---
Total	5	(5)	48	(53)	4	(4)	31	(34)	4	(4)

[1] Does not include an illegally harvested cow.

Table 7 Commercial services[1] used by hunters in Unit 1D, 1993–1994

	Unit Residents		Other AK Residents		Total Use		Other
Year	No	Yes	No	Yes	No	Yes	Services
1993	60	1	3	1	73	2	2
1994	104	1	3	0	107	1	1
Reporting Period (%)	(99)	(1)	(99)	(1)	(99)	(1)	(100)

[1] The use of commercial services was not collected for individual hunters prior to 1993.

LOCATION

GAME MANAGEMENT UNIT: 5 (5,800 mi^2)

GEOGRAPHIC DESCRIPTION: Cape Fairweather to Icy Bay, eastern Gulf of Alaska coast.

BACKGROUND

Moose were first documented along the lower Alsek River in eastern Unit 5 in the late 1920s or early 1930s. Range expansion to the west followed, with animals documented on the Malaspina Forelands west of Yakutat Bay by the 1950s. Westward movement of this moose population was probably curtailed by the glaciers and waters of Icy Bay.

The moose population in Unit 5 grew rapidly and peaked in the early 1960s, with population estimates exceeding 2000 animals. The population declined to a sustainable carrying capacity in the mid-1960s. The severe winters of 1971–72 and 1972–73 and poor reproductive success depressed moose numbers enough that Unit 5A hunting seasons were closed between 1974 and 1977. Since 1978 moose hunting in Unit 5 has been managed under a registration permit system.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The following objectives have been identified by staff based on existing biological data and input from the public and are contained in the Strategic Plan for Management of Moose in region I, Southeast Alaska (ADF&G 1991). They are compared to estimates of current population and use levels.

	CURRENT (1994)	PLAN OBJECTIVE
UNIT 5A YAKUTAT FORELANDS		
Posthunt moose numbers	~800	1,000
Annual hunter kill	60	70
Number of hunters	221	250
Hunter-days of effort	901	1,025
Hunter success	27%	28%
Subunit 5A Nunatak Bench		
Posthunt moose numbers	~30	50
Annual hunter kill	0	5
Number of hunters	0	10
Hunter-days of effort	0	60
Hunter success	--	50%

UNIT 5B MALASPINA FORELANDS	Current (1994)	PLAN OBJECTIVE
Posthunt moose numbers	Unknown	250
Annual hunter kill	7	25
Number of hunters	26	50
Hunter-days of effort	83	200
Hunter success	27%	50%

METHODS

Fall aerial surveys were conducted in Unit 5A in early December 1994. Ages of harvested moose were determined from incisors submitted by hunters under the terms of the registration permit. Other data collected included the number of days hunted, hunter residency, kill date and location, and transport type.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Since the hunting closures in the mid-1970s, the Unit 5A moose population slowly increased toward the habitat's carrying capacity. The Nunatak Bench moose herd reestablished following the retreat of the Hubbard Glacier and the ebb of the waters of Russell Fiord in 1986. Based on 1994 surveys the Board of Game reopened a hunt in this area. The Unit 5B moose population appears healthy at moderate densities.

Population Size

We conducted aerial surveys in the Yakutat Forelands and Nunatak Bench but not in the Malaspina Forelands this reporting period. Because moose use forested areas in the Yakutat area, especially east of the Dangerous River, we asssume the animals enumerated in surveys compose roughly one-half of the moose present.

A total of 397 moose were counted during the 1994 survey of the Yakutat Forelands (Table 1). Total survey time was lower than previous years, while the sighting rate was greater than most historical surveys. Based on this survey, we estimate the Yakutat Forelands population is between 600 and 800 animals.

We counted 25 moose during an aerial survey of Nunatak Bench, an increase from the survey conducted in 1990 (Table 1) and consistent with surveys from 1982 through 1984. Prior to 1986, when the blockage of Russell Fiord by the Hubbard Glacier caused flooding of much of this herd's winter range, we estimated 50 animals inhabited this area. Because brushy vegetation has invaded the shoreline since saltwater levels have receded, moose have begun to reoccupy Nunatak Bench. Based on this survey, we estimate that 50 moose inhabit the area.

Moose population dynamics in Subunit 5B are not as well understood as those in Subunit 5A. Only a portion of the subunit has been surveyed since 1982, and the two most recent efforts have been at a time of year when sex was not determinable. The population is estimated to be approximately 250 moose. No survey was completed in the reporting period (Table 1).

Population Composition

Composition was estimated for both the Yakutat Forelands and Nunatak Bench; however, since portions of the Yakutat Forelands surveys were flown from a C-185 aircraft, the sex ratio (Table 1) does not reflect all counts. In the Yakutat Forelands, the bull to cow ratio seems to be about 1:5, with calves representing 21% of the count. The bull to cow ratio of the Nunatak Bench herd is 4:3, with calves representing 16% of the count.

Age at harvest of Unit 5A moose is changing (Table 2). Mean age at harvest decreased from 6.0 to 3.0 by 1987 and has remained at this level. Whereas most animals taken prior to 1985 were at least 3.5, most animals taken since 1987 have been less than 3.5; 23 of 60 moose taken in 1994 were age 1.5. In contrast, the mean age of moose harvested from the Malaspina Forelands has remained above 3.0 for all years except 1993. The mean age of harvested animals was 4.9 in 1994; the distribution of ages of harvested animals appears random.

MORTALITY

Harvest

Season and Bag Limit

Subunit 5A, Except Nunatak Bench	Oct. 15-Nov. 15	1 bull by registration permit; 60 bulls may be taken. Season will close west of Dangerous River when 30 bulls have been taken in that area.
Subunit 5A, Nunatak Bench	No open season	
Subunit 5B	Sept. 1-Dec. 15	1 bull by registration permit; 25 bulls may be taken.

Board of Game Actions and Emergency Orders. In 1993 moose hunting continued throughout the Yakutat Forelands until November 15. It is unusual for the entire area to remain open for the complete season due to hunting pressure on the west side of the Dangerous River. The following year was also unusual, with emergency orders used to close the season in both segments of the hunt. That portion of Unit 5A west of the Dangerous River was closed on October 20, 1994, when the harvest target of 30 bulls was achieved, and the portion of the subunit east of the Dangerous River was closed on November 7, 1994, when the quota of 60 bulls for the subunit was reached. The Board of Game, in response to favorable survey information, reopened Nunatak Bench to a registration hunt with a 5 moose quota. The first season in which moose may be taken will be 1995.

Hunter Harvest. In 1990 the hunt quota for the Yakutat Forelands was increased to 60 bulls and the area has been managed for that number ever since. The Malaspina Forelands hunt has been managed for a quota of 25 bull moose since 1978. Harvest has remained relatively constant since 1988, with a total of 57 to 71 moose being taken each year from 1988 to 1994. Hunters harvested 65 legal bulls in Unit 5 during 1993 and 67 legal animals in 1994 (Table 1).

Permit Hunts. During this period regulations provided for 2 registration permit hunts within Unit 5: Hunt RM061 in Subunit 5A (Yakutat Forelands) and Hunt RM062 in Subunit 5B (Malaspina Forelands). The Nunatak Bench area in Subunit 5A, which remained closed during this reporting period, will reopen during 1995 (hunt number RM059).

Federal regulations limit hunting on federal lands to local residents during the first week of the state moose hunting season on the Yakutat Forelands. Despite the fact that there is a block of nonfederal land around Yakutat where nonlocals can legally hunt during that week, effort is such that local residents harvest most moose taken before October 22 (and most moose taken west of the Dangerous River during the entire season) (Table 4). The number of RM061 permits issued has continued to increase (Table 5). Fifty bull moose were taken in 1993 and 60 were killed in 1994.

Fifty four permits and 42 permits were issued for Hunt RM062 in Unit 5B during 1993 and 1994, respectively (Table 5), both below the 1988–1992 mean of 59. Fifteen bulls were taken in Unit 5B in 1993 and 7 bulls were harvested in 1994, lower than all previous years except 1992.

The Nunatak Bench area has not been open for moose hunting since 1986.

Staff from the Division of Fish and Wildlife Protection and both fisheries divisions of the Department of Fish and Game continued to assist with permit issuance and monitoring of these permit hunts. Enforcement personnel from the US Forest Service also helped monitor the hunt in Unit 5A during the reporting period. Although reminder cards and certified letters were used to increase compliance with permit reporting requirements, a few permittees were cited for failing to report their hunts. In 1993 1 bull was found dead east of the airport. A field necropsy revealed it was a wounding loss. One cow was found dead near the Situk River bridge and was salvaged for charity. In 1994 1 permittee was convicted of killing a female moose and reporting it as a bull. Another cow was killed east of the Yakutat airport; a third female was found dead, gutted, and abandoned just west of the airport. Both of the latter were salvaged by ADF&G, FWP, and USFS personnel and distributed to charities.

Hunter Residency and Success. Local residents hunt primarily in Unit 5A on the Yakutat Forelands (Table 4). Starting in 1987, local residents have been able to hunt for the first week of the season on federal lands before it opened to nonlocal hunters. This first week traditionally accounts for most of the Unit 5A harvest, and because most easily accessible land is contained within federal land boundaries, harvest by Yakutat residents dominates the hunt. Local hunters took approximately 62% of the moose harvested in Unit 5A during 1993 and 1994. Most moose taken by local hunters was taken during the first week of the season. Later in the season, nonlocal hunter use increases in areas accessible only by air. Nonlocal Alaskans hunting in Unit 5A took 17 moose (34%) in 1993 and 20 (33%) in 1994. Nonresidents took 2 moose in Unit 5A during 1993 and 1994.

Since 1986 overall success (Table 3) of hunters in Unit 5A has ranged from 19 to 32percent. During this reporting period, hunter success was 25% and 29% in this area. The average number of days expended by hunters on the Yakutat Forelands reached all time highs in 1993 (Table 5), but returned to historic levels in 1994.

In Unit 5B the hunt is less dominated by local use, although the Malaspina Forelands hunt is an important alternative for Yakutat hunters who fail to take a moose during the Unit 5A hunt. Local residents took 3 of 15 moose harvested (20%) in 1993 and 3 of 7 moose (57%) in 1994. Nonlocal state residents killed 3 moose in 1993 and 1994, while nonresidents took 9 moose in 1993 and 1 in 1994. Effort by successful hunters of the Malaspina Forelands was extremely high in 1994 (15.6 days/hunter). Anecdotal information indicated that moose were located further than usual from the coast, where access was feasible. The reasons for this apparent change in distribution are unknown.

Harvest Chronology. The early season moose harvest in Unit 5 is relatively low, due in part to the fact that only Unit 5B is open from September 1 through October 14 (Table 4). Most of the Unit 5 harvest takes place during the first week of the Unit 5A season when habitat adjacent to Yakutat is first open, easily accessible by boat or highway vehicle. The pace of the 1993 hunt was relatively slow, with hunt quotas not being reached during the entire season. However, in 1994, 20 of 60 moose (33%) killed in Unit 5A were taken on opening day, and 43 (72%) by the time the first week was over. The quota of 25 bulls for the Malaspina Forelands area within Unit 5B has not been reached since 1981. Although the season is longer than it is in Unit 5A, the area is more difficult to access.

The moose hunting season has been closed in the Nunatak Bench area since 1986.

Transport Methods. Transport methods used during the reporting period were similar to recent years (Table 6). Aircraft continue to be the most popular single means of transportation among successful hunters, with 50% of all successful Unit 5 hunters using aircraft to access the field. Boat access is the second most important transport method for Unit 5 hunters, averaging about one quarter of all successful hunters. Use of 3- and 4-wheelers for Unit 5 hunts is important and probably underrepresented. Also, many unsuccessful hunters use these machines for access. Habitat impacts, wounding losses, animal harassment, and fair chase ethics are all concerns involving the use of 3- and 4-wheelers. Virtually every fish camp has one or more of these machines. Although these off-road vehicles have been used in Yakutat for many years, more hunters seem to be using them as a primary method of access. These machines are commonly used to drag whole moose from a kill site to the nearest road. Rutted meadows from wheeled vehicles are now a common sight in Unit 5A.

It is important to note that despite the importance of aircraft for hunter transportation, few Yakutat resident hunters use aircraft. Combined, highway vehicles, boats, 3- and 4-wheelers, and hunts conducted on foot surpass the number of successful hunts supported by airplane access; these transport modes characterize the local hunt. The use of aircraft increases later in the season as nonlocal hunters begin hunting in remote areas.

Commercial Services. Commercial services were used by 22% of the Unit 5 hunters during the reporting period (Table 7). Nonlocal hunters were more likely to use commercial services, primarily for transport to the field. Commercial services were used more by Unit 5B hunters than by those in Unit 5A. This undoubtedly reflects the fact the Malaspina Forelands are much more difficult to access.

Other Mortality

Reports of natural mortality during the reporting period seemed similar to most recent years. Anecdotal information and apparent increases in wolf populations indicate that mortality from wolf predation may have increased. However, there is no evidence that a higher percentage of moose are being taken by predators at this time.

HABITAT

No habitat assessment or enhancement procedures were undertaken by ADF&G staff during the period.

CONCLUSIONS AND RECOMMENDATIONS

Complete fall sex and age composition counts should be conducted for all Unit 5 moose herds. Age data on harvested moose should continue to be collected and carefully scrutinized. The skewed harvest (toward young animals) may indicate a problem in the management strategy.

Most management goals for hunts in Unit 5 were not met during this reporting period. The Nunatak Bench remained closed in 1994, so we did not meet the harvest management objective. Management goals regarding hunter success were attained, or nearly attained, for RM061 (Yakutat Forelands) in 1993 and 1994 and for RM062 (Malaspina Forelands) in 1993 (Table 3). However, hunter success for RM062 was only 27% in 1994, roughly half the management goal. Hunter effort was below the management objective for all hunts except RM061 in 1993. Harvest objectives set for 1994 were not reached. In the Malaspina Forelands, harvest objectives were not reached primarily because of hunter effort. In contrast, the moose population in the Yakutat Forelands has not increased enough to support a harvest of 70 animals.

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Table 1 Unit 5 aerial survey data, 1974–1994

Year	Total M	Total F	Total Calves	Unk	Total Moose	Count Time (hrs)	Tot M Per 100F	Calves per 100F	Calves % in herd	Moose per hour
					5A Yakutat Forelands					
1974	21	81	29		131	5.2	26	36	22	25
1975	43	183	32		288	10.9	23	17	11	26
1977	82	198	44		334	11.1	41	22	13	30
1978	50	134	32		229	7.4	37	24	14	31
1981	93	243	65		402	15.7	38	27	16	26
1984	90	229	60		379	12.1	39	26	16	31
1985	50	168	41		259	11.0	30	24	16	24
1986	34	166	60		260	11.3	20	36	23	23
1987	---	---	83		322	11.2	---	---	26	29
1988	91	339	85		515	10.3	27	25	17	50
1989					No Survey					
1990	43	309	93		445	6.8	14	30	21	66
1991[1]					204	8.0	---	---	---	26
1992			37		196	5.9	---	---	19	33
1993[2]					219	6.3	---	---	---	35
1994[3]	51	124	51	158	397	9.3	20	32	21	41
					5A Nunatak Bench					
1982	8	14	0		22	0.6	57	0	0	37
1983	5	10	10		25	0.8	50	100	40	31
1984	10	13	4		27	0.5	77	31	15	54
1985					No Survey					
1986	5	4	1		10	0.5	125	25	10	20
1987-93					No Survey					
1994	3	18	---		25	0.3	16	22	16	75
					5B Malaspina Forelands					
1981[4]	21	88	25		134	3.1	24	28	19	43
1982	26	103	16		145	8.4	25	16	11	17
1983	---	---	21		66	1.8	---	---	32	37
1984-86					No Survey					
1987[5]	---	---	14		69	2.8	---	---	20	25
1988-94					No Survey					

Table 1 Continued

[1] Natl. Park Service survey using a PA-18 done from 3/1 to 3/5, 1991, between Glacier Bay Preserve and the Dangerous River.

[2] USFS survey using a C-185 done from 2/14 to 2/17, 1994, between Yakutat and Dry Bay.

[3] Age and Sex ratios reflect flights made in a PA-18 (5.5 hrs. from 12/2 to 12/3, 1994) whereas total numbers include flights in both the PA-18 and C-185 (3.62 hrs. from 12/6 to 12/7 1994). Seven unclassified bulls included under Total M.

[4] Bancas Point to Sitagi Bluffs only.

[5] Early winter survey, sex and age ratios unreliable.

Table 2 Age structure of moose harvests in Unit 5, 1981–1994

Year	0.5	1.5	2.5	3.5	4.5	5.5	6.5	Age Class 7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5	Total Kill	% Aged	Mean Age
									Yakutat Forelands										
1981	0	0	4	6	5	4	1	1	1	1	0	0	1	0	0	0	27	89	6.0
1982	0	2	10	13	8	5	6	1	2	0	0	0	0	0	0	0	49	96	4.3
1983	0	0	9	8	10	6	4	2	2	0	1	0	0	0	1	0	47	91	4.9
1984	2	13	11	6	7	3	2	3	0	0	0	0	0	0	0	0	49	96	3.2
1985	1	15	10	10	2	1	3	1	0	1	1	1	0	0	0	0	46	100	3.4
1986	3	10	13	8	4	9	3	1	0	2	0	0	0	0	0	0	54	98	3.6
1987	1	14	7	3	7	2	1	0	1	0	0	0	0	0	0	0	38	95	3.0
1988	0	17	16	5	2	3	1	0	1	0	1	0	0	0	0	0	47	98	2.9
1989	0	10	16	7	5	4	0	1	0	0	0	0	0	0	0	0	45	96	3.1
1990	0	16	18	14	4	3	2	0	0	0	0	0	0	0	0	0	57	100	2.9
1991	0	20	18	7	4	1	0	1	1	0	0	0	0	0	0	0	52	100	2.7
1992	0	13	5	5	3	1	2	1	0	0	0	0	0	0	0	0	50	60	3.0
1993	0	12	7	14	3	2	1	2	1	0	0	0	0	0	0	0	50	84	2.8
1994	0	23	8	6	5	4	0	3	2	1	0	1	0	0	0	0	60	90	2.9
									5A Nunatak Bench (No Data)										
									5B Malaspina Forelands										
1990	0	5	2	3	2	1	0	1	0	0	0	0	0	0	0	0	14	100	3.2
1991	0	3	3	1	2	2	1	0	3	0	0	0	0	0	0	0	17	88	4.5
1992	0	0	5	0	0	0	0	1	0	0	0	0	0	0	0	0	7	86	3.3
1993	0	2	4	3	3	0	1	0	0	0	0	0	0	0	0	0	15	87	2.8
1994	0	0	0	1	3	1	1	0	1	0	0	0	0	0	0	0	7	100	4.9

Table 3 Historical harvests, number of hunters, and hunter success in Unit 5, 1978–1994

Year	Males	Females	Unk	Total Kill	Hunters	% Success
			5A Yakutat Forelands			
1978	28	0	0	28	123	23
1979	20	0	0	20	167	12
1980	28	0	0	28	175	16
1981	27	0	0	27	180	15
1982	49	0	0	49	199	25
1983	47	0	0	47	235	20
1984	49	0	0	49	230	21
1985	46	0	0	46	129	36
1986	54	0	0	54	198	27
1987	38	0	0	38	199	19
1988	47	0	0	47	153	31
1989	45	0	0	45	163	28
1990	57	0	0	57	178	32
1991	52	0	0	52	175	30
1992	50	0	0	50	199	25
1993	50	1[1]	0	51	204	25
1994	60	1[1]	0	61	208	29
			5A Nunatak Bench			
1980	1	0	0	1	7	14
1981	4	0	0	4	12	33
1982	3	6	0	9	14	64
1983	2	0	0	2	9	22
1984	3	3[1]	0	6	14	43
1985	2	0	0	2	3	67
1986-94			Season Closed			
			5B Malaspina Forelands			
1980	18	0	0	18	66	27
1981	26	1[1]	0	27	86	32
1982	18	0	0	18	53	34
1983	11	0	0	11	55	20
1984	15	0	0	15	50	30
1985	13	0	0	13	62	21
1986	9	0	0	9	34	26

Table 3 Continued

1987	8	0	0	8	34	24
1988	11	0	0	11	40	28
1989	12	0	0	12	44	27
1990	14	0	0	14	49	40
1991	17	0	0	17	39	44
1992	7	0	0	7	25	28
1993	15	0	0	15	31	48
1994	7	0	0	7	26	27

[1] Illegal kill; this kill not included in the calculation of hunter success.

Table 4 Annual moose kill by community of residence in Unit 5, 1982–1994

Year	Total Kill	Yakutat	Juneau	Ketchikan	Sitka	Pelican	Hoonah	Petersburg	Haines	Wrangell	Other Alaska	Non-Resident
						5A Yakutat Forelands						
1982	49	23	13	1	5	0	1	0	2	0	2	2
1983	47	23	17	2	0	0	0	0	0	0	3	2
1984	49	18	16	2	6	0	2	1	0	1	1	2
1985	44	28	13	0	3	0	0	0	0	0	0	0
1986	54	22	16	1	4	1	3	0	4	0	2	1
1987	38	27	7	0	1	0	0	0	0	0	2	1
1988	47	38	6	0	0	0	1	0	0	0	1	1
1989	45	40	2	0	1	0	0	0	0	0	2	0
1990	50	45	11	1	0	0	0	0	1	0	3	2
1991	52	28	15	0	2	0	0	0	1	0	5	2
1992	50	32	7	0	0	3	0	0	3	0	2	3
1993	50	31	11	0	3	1	0	0	0	0	2	2
1994	60[1]	38	14	1	0	2	0	0	0	0	3	2
						5B Malaspina Forelands						
1980[2]	18	7	2	3	0	0	0	0	0	0	0	3
1981	27	14	7	2	0	0	0	0	0	0	0	4
1982	18	8	3	2	1	0	0	0	0	0	0	4
1983	11	8	2	1	0	0	0	0	0	0	0	0
1984	15	5	1	6	0	0	0	0	0	0	0	3
1985	13	8	2	1	0	0	1	0	0	0	1	0
1986	9	3	2	0	0	0	0	0	0	0	0	4
1987	8	5	1	0	0	0	0	0	0	0	0	2
1988	11	5	3	1	1	0	0	0	0	0	1	0
1989	12	7	2	1	0	0	0	0	0	0	1	1
1990	14	9	3	0	0	0	0	0	0	0	1	1
1991[3]	17	7	4	1	0	0	0	0	0	0	3	1
1992	7	4	3	0	0	0	0	0	0	0	0	0
1993	15	3	2	1	0	0	0	0	0	0	0	9
1994	7	3	2	0	0	0	0	0	0	0	1	1

[1] Does not include the single known illegal kill.
[2] Includes three kills by hunters of unknown residency.
[3] Includes one kill by hunter of unknown residency.

Table 5 Hunter effort and success in Unit 5, 1982–1994

Year	Permits Issued	Successful Hunters: Hunters	Successful Hunters: Total Days	Successful Hunters: Avg Days	Unsuccessful Hunters: Hunters	Unsuccessful Hunters: Total Days	Unsuccessful Hunters: Avg Days	Total Hunters: Hunters	Total Hunters: Total Days	Total Hunters: Avg Days
5A Yakutat Forelands										
1982	—	49	137	2.8	150	697	4.6	199	834	4.2
1983	—	47	136	2.8	188	921	4.9	235	1057	4.6
1984	—	49	132	2.7	181	978	5.4	230	1110	4.8
1985	—	44	117	2.7	84	457	5.4	128	574	4.6
1986	—	54	171	2.7	143	696	4.9	197	867	3.6
1987	—	38	109	2.9	161	948	5.9	199	1057	5.6
1988	206	47	95	2.0	106	281	2.7	153	376	2.4
1989	213	45	107	2.4	118	620	5.3	163	727	4.3
1990	213	57	110	1.9	122	497	4.2	178	607	3.5
1991	236	52	162	3.1	123	425	3.4	175	587	3.6
1992	238	50	130	2.6	149	771	6.0	199	901	4.5
1993	239	50	204	4.1	154	979	6.5	204	1183	5.9
1994	268	60	167	2.9	148	712	4.8	208	879	4.4
5A Nunatak Bench										
1980	—	1	5	5.0	6	35	5.8	7	40	5.7
1981	—	4	13	3.0	8	28	3.5	12	41	3.4
1982	—	9	95	10.6	5	13	2.6	14	108	7.7
1983	—	2	21	10.5	7	84	12.0	9	105	11.7
1984	—	6	27	4.5	8	24	3.0	14	51	3.6
1985	—	2	44	22.0	1	10	10.0	3	32	10.7
1986-94					Season Closed					
5B Malaspina Forelands										
1980	—	15	49	3.3	66	273	4.1	81	322	4.0
1981	—	27	90	3.3	59	228	3.9	86	318	3.7
1982	—	18	54	3.0	35	171	4.6	53	215	4.1
1983	—	11	27	2.4	44	178	4.0	55	205	3.7
1984	—	15	40	2.7	40	191	4.8	55	231	4.2
1985	—	13	34	2.6	49	226	4.6	62	260	4.2
1986	—	9	40	4.4	27	139	5.1	36	179	5.0
1987	—	8	56	2.8	16	83	5.2	24	139	5.8
1988	58	11	39	3.5	29	120	4.1	40	159	4.0
1989	65	12	47	3.9	32	143	4.7	44	190	4.3
1990	60	14	53	3.8	35	80	2.4	49	133	2.8
1991	60	17	51	3.0	22	90	4.5	39	141	3.8
1992	52	7	22	3.1	18	61	3.4	25	83	3.3
1993	54	15	30	2.0	16	91	5.7	31	121	3.9
1994	42	7	109	15.6	19	26	1.9	26	135	6.4

Table 6 Transport methods used by successful hunters in Unit 5, 1998–1994

	Airplane		Boat		3- or 4-Wheeler		ORV		Highway Vehicle		Foot	
Year	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)	Total	(%)
					5A Yakutat Forelands							
1990	29	(51)	10	(18)	7	(12)	0	---	11	(19)	0	---
1991	29	(56)	6	(12)	7	(13)	0	---	10	(19)	0	---
1992	22	(44)	8	(16)	9	(18)	0	---	11	(22)	0	---
1993	25	(50)	12	(24)	6	(12)	0	---	5	(10)	2	(4)
1994	24	(41)	15	(25)	9	(15)	0	---	9	(15)	2	(3)
					5B Malaspina Forelands							
1990	9	(69)	4	(31)	0	---	0	---	0	---	0	---
1991	14	(82)	2	(12)	0	---	1	(6)	0	---	0	---
1992	5	(100)	0	---	0	---	0	---	0	---	0	---
1993	12	(80)	0	---	3	(20)	0	---	0	---	0	---
1994	5	(71)	2	(29)	0	---	0	---	0	---	0	---
					Unit 5							
1990/91 Total/(%)	108	(56)	30	(15)	23	(12)	1	(1)	32	(16)	0	---
1993/94 Total/(%)	66	(50)	29	(22)	18	(14)	0	---	14	(11)	4	(3)

Table 7 Commercial services used by hunters in Unit 5, 1992–1994

Year	Unit Residents No	Unit Residents Yes	Other AK Residents No	Other AK Residents Yes	Nonresidents No	Nonresidents Yes	Total Use No	Total Use Yes	Transport	Registered Guide	Other Services
					5A Yakutat Forelands						
1991[1]	11	7	0	13	0	3	11	23	19	2	2
1992	123	8	40	17	5	1	168	26	22	0	4
1993	122	11	26	18	3	2	151	31	28	2	1
1994	131	9	26	24	0	0	157	33	32	1	0
					5B Malaspina Forelands						
1991	1	4	0	9	0	0	1	13	9	0	4
1992	2	3	3	5	0	4	5	12	5	7	0
1993	1	5	6	7	0	7	7	19	13	6	0
1994	6	0	0	8	1	1	7	9	8	1	0
1991/92[1] (%)	89	11	65	35	50	50	80	20	70	14	16
Reporting Period (%)	91	9	50	50	29	71	78	22	88	11	1

[1] Use of commercial services was not collected for each individual hunter, particularly local residents, and was not included in percentage calculations.

LOCATION

Game Management Unit: 6 (10,140 mi^2)

Geographic Description: Prince William Sound and North Gulf Coast

BACKGROUND

Moose populations in most of Unit 6 originated from transplants. During 1949 through 1958, 24 calves were released on the western Copper River Delta in Unit 6C (Burris and McKnight 1973). This small population rapidly spread eastward, first occupying Unit 6B and then advancing by the late-1960s into Bering River in Unit 6A. Moose may also have reached Unit 6A moving westward from the Malaspina Glacier forelands in Unit 5A. The introduced population may have reached a record high of approximately 1600 in 1988 (Griese 1990). The only moose endemic to Unit 6 are small populations in Unit 6D near Valdez and at the head of Kings Bay. These populations never extended their ranges and probably number about 40 animals today.

Data collection for management of the Unit 6 population included aerial surveys, censuses and harvest monitoring. Surveys and censuses allowed us to estimate moose/mi^2, total number, and population composition. However, annual collection of sex and age ratios was hampered by poor survey conditions during November and early December when we collected most sex and age data. Harvest was monitored by field checks of hunters, permit reports, and harvest ticket reports.

Harvest of the introduced population began with 25 bulls killed in 1960. Total reported take through regulatory year 1994/95 was 3450 moose. Total harvest of the endemic moose population in Unit 6D during the same period was approximately 34 moose.

Population density objectives were relatively conservative in the 1970s and early 1980s because we were concerned about mortality during severe winters. The objectives were established at 0.9–1.2 moose/mi^2 after a severe winter in 1971–72 and remained conservative under management plans formulated in 1976 (Rausch 1977). In 1987 the department increased the density objectives to 1.8–2.0 moose/mi^2. We revised objectives during this reporting period to incorporate new habitat information (MacCracken 1992) and to use refined estimates of population size obtained during the past 4 years.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

Our primary and secondary management goals for Unit 6A (East) are to take large moose and to provide for optimum harvest. Primary and secondary goals for the remainder of the unit are to provide for optimum harvest and to provide for the greatest opportunity to participate in hunting.

Posthunt Management Objectives

Our management objective for Unit 6A (East) is to maintain a population of 300–350 moose and a minimum bull:cow ratio of 30:100. Our objective for Units 6A (West) and 6B is to maintain a population of 300–350 moose and a minimum bull:cow ratio of 15:100 in each Unit. In Unit 6C our objective is to increase the population to 400 moose by the year 2006 and to maintain a minimum bull:cow ratio of 15:100.

METHODS

We conducted modified Gasaway et al. (1986) censuses to estimate number of moose and composition. Density stratifications were based upon prior knowledge of moose distribution from radio telemetry data (MacCracken 1992) and from stratification flights in a Cessna 185 aircraft (Nowlin 1994). Piper Supercub (PA-18) and Bellanca Scout aircraft were used for searches of sample units. Sex and age ratio estimates were obtained only from censuses conducted before mid-December. Population estimates were not corrected for sightability. Corrections calculated during previous censuses indicated we observed >89% of the moose that were present. U.S. Forest Service (USFS), Cordova Ranger District, assisted during all censuses by providing observers.

The area censused included only important moose habitat. This habitat was found below 500 ft elevation in the river valleys and deltas of the coastal plain. Viereck et al. (1986) described the habitat types present, and MacCracken (1992) identified which types were most important for moose. Important habitats included open tall-willow (*Salix* spp.), closed tall alder-willow, (*Alnus sinuata-Salix* spp.), low sweetgale-willow (*Myrica gale-Salix* spp.), woodland spruce (*Picea sitchensis*) and aquatic (wet forb-hebaceous).

We completed surveys, rather than censuses, during 1990-91. These were nonsystematic searches of moose habitat at 1.4–2.2 minutes/mi^2. Estimates of total numbers were based on densities observed, on percentage of wintering habitat surveyed, and on quality of survey conditions.

Hunters participating in drawing or registration permit hunts were required to report and were sent no more than 2 reminder letters. Hunters participating in general moose hunts were sent 1 reminder letter if they failed to return their original hunt report.

We summarized data by unit, except for Unit 6A that was divided into eastern and western portions. The eastern portion included all drainages into the Gulf of Alaska between Cape Suckling and the head of Icy Bay. The western portion included all drainages into the Gulf between Cape Suckling and Palm Point.

I modeled the population in Unit 6C to provide a basis for planning an increase in numbers and harvest. J. MacCracken (pers. commun.) suggested increasing the population. He estimated an ecological carrying capacity of 380 (253 females and 127 males) moose during a severe winter. I chose 400 (305 females and 95 males) as a conservative objective. I then used a deterministic population model (Schwartz 1993) to estimate the time required to reach the objective if 5 cows were harvested annually and if no cow were harvested. Annual bull harvest was 20–25 while the population increased. I also used the model to estimate sustainable harvest when the population objective was achieved. Input for the model (Table 1) was determined using results of surveys (Griese 1990), censuses (Nowlin 1994) and radio telemetry (MacCraken 1992, T. Stephenson, pers. commun.).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

No censuses were completed during 1993–94 because of poor sightability due to lack of snow cover. We completed censuses during 1994–95 in Units 6B (16 November 1994) and 6C (7–8 December 1994). We obtained estimates of bull:cow ratios during each census because most bulls had not shed antlers. We also estimated total number during 1994–95 in other units where censuses were not completed. Those estimates were based upon previous censuses, productivity and survival, and/or anecdotal observations.

Population Size

The Unit 6 moose population was probably 1227 during winter 1994–95. The largest concentration was 325 animals in Unit 6A (East), followed by 300 in Unit 6A (West), 296 in Unit 6B (Table 2), 281 in Unit 6C, and 40 in Unit 6D.

The population probably declined by 336 moose over the past 5 years. In 1990–91 we estimated 1563 moose (Nowlin 1990). Most of the reduction was in Units 6A (West) and 6A (East), where we increased harvest and where calf survival declined. We planned this reduction because moose numbers were probably higher than could be supported by the winter food supply. Numbers also declined slightly in Units 6B and 6C because of lower calf survival in both units and overharvest of bulls in 6B.

We achieved our planned population reduction in Unit 6A (West) in 1992–93. The following year, we stabilized the population by implementing permit hunts that reduced the harvest by 50%–60%. We achieved our planned reduction in Unit 6A (East) in 1994–95. We then developed a joint proposal with the Copper River–Prince William Sound Fish and Game Advisory Committee (CRAC) to stabilize the population by reducing harvest. A bag limit of 1 bull, with a minimum antler size of 50 inches or 3 brow tines, and a 1 September–31 October season was proposed. The proposal included a bag limit of 1 antlerless moose, with a 1 November–31 December season. The Board of Game adopted it for implementation in 1995–96.

Population Composition

Bull:cow ratios and percent calves were 22:100 and 10%, respectively, in Unit 6B. In Unit 6C, they were 27:100 and 14%, respectively. Compared to previous years, the bull:cow ratio declined in Unit 6B and was unchanged in Unit 6C. The decline in Unit 6B was probably due to overharvest of bulls during the past 4 years. Percent calves were lower in both units.

Population Modeling

Unit 6C models indicated that we would reach the population objective of 400 within 11 years, with continuing harvest of 5 cows and 20–25 bulls annually (Figure 1). The bull:cow ratio would change from 27:100 to 19:100. When the objective is achieved, 30–35 bulls and 15–20 cows would be harvested annually to stabilize the population (Figure 2). Under the scenario allowing no cow harvest, the population objective could be achieved in 7 years, and the resulting bull:cow ratio and sustainable harvest would be the same as under the cow harvest scenario.

I presented modeling results to CRAC and to the general public in Cordova. Both supported increasing the population over an 11-year period. There was a clear desire to continue taking a few cows to ensure that authority to harvest females would not be jeopardized. There was also concern about potential starvation during a severe winter if our estimates of ecological carrying capacity were too high.

MORTALITY

Harvest

Season and Bag Limit. The season during 1993–94 for resident and nonresident hunters in Unit 6A (East) was 1 September–31 December, with a bag limit of 1 moose. During 1994–95, the Board shortened the season for antlerless moose to 15 November–31 December. In Unit 6A (West) the season for resident and nonresident hunters was 1 September–5 October, with a bag limit of 1 moose. Take of no more than 30 bulls was authorized by registration permit, and harvest of 30 antlerless moose was authorized by drawing permit. The season in Unit 6B was open for resident hunters only during 27 August–30 September, with a bag limit of 1 moose. Take of 30 bull moose was authorized by registration permit, and harvest of 30 antlerless moose was authorized by drawing permit. No motorized vehicles were allowed for transportation from 27 August–31 August. In Unit 6C the season was open for resident hunters only and was 1 September–30 September, with a bag limit of 1 moose. Issuance of 40 drawing permits, 20 for bull and 20 for antlerless moose, was authorized. The season in Unit 6D for resident and nonresident hunters was 1–30 September, and the bag limit was 1 bull.

Board of Game Actions and Emergency Orders. The Board of Game changed the season in Unit 6A (East) from 20 August–31 December to 1 September–31 December in 1993–94. We requested the change to achieve better alignment of season openings in Unit 6. In 1994–95 the Board shortened the antlerless season in Unit 6A (East) to 15 November–31 December in 1994–95. We proposed the shortened season to reduce cow harvest because the population was declining faster than planned. In 1993–94, the Board also changed the season in Unit 6A (West) from 20 August–31 December to 1 September–5 October, and changed the bag limit from 1 moose by harvest ticket to 1 moose by permit. We requested the change to reduce harvest and stabilize the population after a planned reduction in numbers.

We issued emergency orders each year to close the registration permit hunts for bull moose in Units 6A (West) (11 September 1993 and 8 September 1994) and 6B (4 September 1993 and

1 September 1994). The purpose was to limit harvest to $\leq$30 animals, as authorized in regulation for each hunt.

Hunter Harvest. Reported moose harvest for Unit 6 was 163 in 1993–94 and 149 in 1994–95 (Table 3). The 1993–94 take was lower than the previous 2 years but unchanged from 1990–91. However, the harvest in 1994–95 was the lowest in 5 years. Most of the decrease was in Unit 6A (West), where we reduced harvest by 50–60% to stabilize the population after a planned reduction in numbers.

Composition of the kill was 67% males and 33% females during 1993–94 and 72% males and 28% females during 1994–95, similar to previous years.

Permit Hunts. During this reporting period, Units 6A (West) and 6B each had 1 registration and 1 drawing hunt, and Unit 6C had 2 drawing permit hunts (Table 4). Success was high in all hunts (40%–100%), except for the registration hunt in Unit 6B. Lower success in this hunt was due to the type of hunt (i.e., unlimited hunter participation). Also, the season closed by emergency order after 9 days of hunting in 1993–94 and after 6 days in 1994–95.

Harvest by permit hunts was as expected and administration presented no unusual problems, except for the registration hunt for antlered/bull moose in Unit 6B. We could not adequately control harvest in this hunt. Number of hunters did not change significantly. However, use of airboats for transportation greatly increased hunter efficiency, resulting in higher harvests during increasingly shorter periods of time. Over the past 4 years, 69% of bulls harvested were taken by hunters using airboats for transportation. Desired bull harvest was exceeded during each year by 35%–60%, in spite of issuing emergency orders closing the hunt before the end of the season. Exceeding the harvest target probably caused a decline in the bull:cow ratio from about 31:100 in 1990–91 to 22:100 in 1994–95 and contributed to a population decline of approximately 50 animals. Number of days of hunting without special restrictions on motorized vehicles declined from 19 in 1991–92 to 1 in 1994–95.

I briefed CRAC concerning the harvest control problem in Unit 6B and requested they develop solutions that would have community support. They proposed continuing the registration permit hunt and prohibiting taking moose until 3:00 a.m. following the day on which an airboat is used for transportation. The committee felt the airboat restriction would slow the rate of harvest sufficiently to reestablish control, thereby avoiding a more restrictive drawing permit hunt. In addition, they proposed requiring all airboats used in the hunt to have a department identification number to aid enforcement. We supported the committee's proposal. The Board of Game adopted it for implementation in 1995–96.

Hunter Residency and Success. Local residents were 63% and 68%, respectively, of all hunters in Unit 6 who reported residency during 1993–94 and 1994–95 (Table 5). Alaska residents from other parts of the state were 19% of hunters during each year, while nonresidents were 17% and 15% of the total, respectively. Hunter success during 1993–94 and 1994–95 was 42% and 47%, respectively. These proportions were similar to previous years.

Harvest Chronology. Most of the Unit 6 harvest during the past 2 years occurred during September (Table 6). During 1993–94, 72% of the moose were taken during this period, and 78% were harvested during this time in 1994–95. Most hunting opportunity was during September. Hunts in Unit 6A (East) extended to the end of December; however, poor weather conditions often limited hunter access late in the season. The harvest pattern has not changed over the past 5 years.

Transport Methods. The transport methods used by Unit 6 hunters changed little over the last 5 years (Table 7). Boat users, primarily airboaters, were dominant, followed by aircraft and highway vehicle users.

CONCLUSIONS AND RECOMMENDATIONS

Our objectives for population size were achieved in Units 6A (East) and 6A (West). We used harvest to reduce numbers in Unit 6A (East) from 490 in 1988–89 (Nowlin 1994) to 325 in 1994–95. We then implemented a minimum antler size for the bull harvest and a shortened season for both bull and antlerless moose hunts in 1995–96. This change should reduce the take and stabilize the population at 300–350. We also used harvest to reduce the population in Unit 6A (West) from 460 in 1988–89 (Nowlin 1994) to 295 in 1992–93. We achieved stabilization by implementing permit hunts to reduce the take.

Progress meeting bull:cow ratio objectives in Unit 6A was not evaluated because sex ratio data were not collected. Collecting this data should be a high priority if adequate conditions for a census occur while most bulls still have antlers.

We achieved our sex ratio objective, but were slightly below our desired population size in Unit 6B. Numbers decreased because of low calf survival and overharvest of bulls. Efficiency of hunters using airboats for transportation made it impossible to control the kill of bulls using the registration permit system that was in place during this reporting period. The harvest control problem should abate with new regulations for 1995–96 that prohibit hunting the same day airboats are used for transportation and that require identification numbers on airboats. Close monitoring of this hunt should continue until control is clearly reestablished.

The number of antlerless permits in Unit 6C should be reduced to 5. This should allow the population to increase toward our objective of 400 moose. Annual censuses should be completed to monitor progress, verify our models, and ensure we continue to meet our sex ratio objective.

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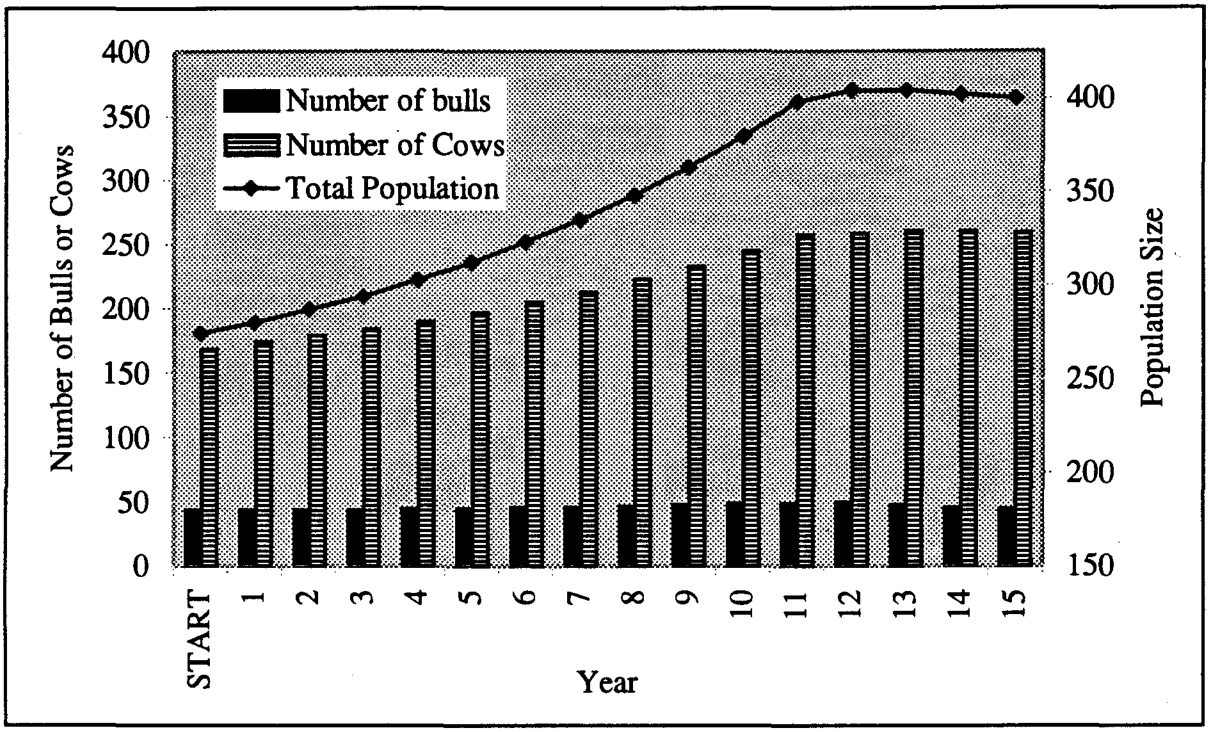

Figure 1. Subunit 6C projected moose population growth if 5 cows and 20-25 bulls were harvested annually for the first 11 years.

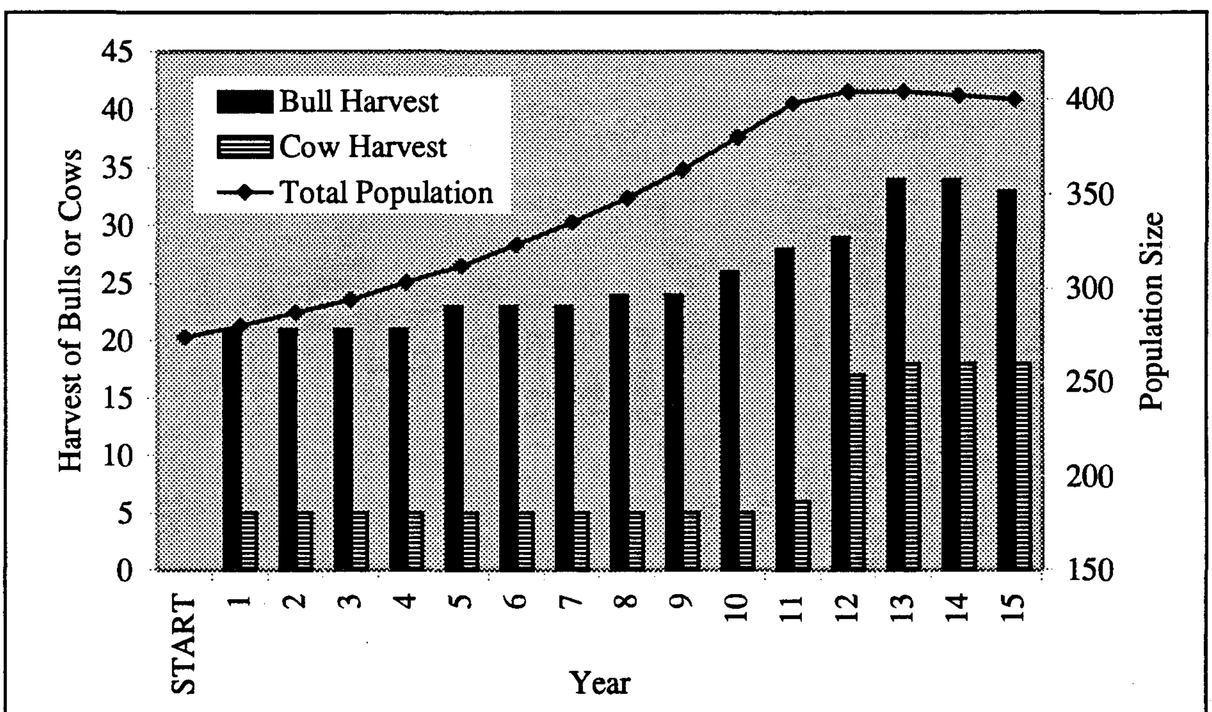

Figure 2. Subunit 6C projected moose population growth and harvest if 5 cows and 20-25 bulls were harvested annually for the first 11 years.

Table 1 Unit 6C moose population model input

Parameter	Value
Starting Population Size	45 (Bulls) 180 (Cows) 60 (Calves) 285 (Total)
Starting Calves (%):	21
Starting Bulls:100 Cows:	26
Twinning Rate (%):	41
Calf Survival (%):	28 (Summer) 99 (Hunt) 70 (Winter)
Male Yearling Survival (%):	100 (Summer) 50 (Hunt) 96 (Winter)
Female Yearling Survival (%):	95 (Summer) 76 (Hunt) 97 (Winter)

Table 2 Unit 6 fall/winter moose counts and estimated population size, 1990-95

Subunit	Regulatory year	Count type	Bulls: 100 cows	Calves(%)	Adults [a]	Estimated population size	Estimated population 90% C.I.	Total moose observed
6A (East)	1990/91	None	-	-	-	-	-	-
	1991/92	None	-	-	-	-	-	-
	1992/93	Census	-	8	384	416	373-459	378
	1993/94	None	-	-	-	-	-	-
	1994/95	None	-	-	-	-	-	-
6A (West)	1990/91	Survey	-	17	236	370	-	286
	1991/92	None	-	-	-	-	-	-
	1992/93	Census	23	12	259	295	255-334	273
	1993/94	None	-	-	-	-	-	-
	1994/95	None	-	-	-	-	-	-
6B	1990/91	Survey	31	18	249	350	-	304
	1991/92	Census	-	16	260	311	279-343	224
	1992/93	Census	19	17	271	328	268-387	203
	1993/94	None	-	-	-	-	-	-
	1994/95	Census	22	10	266	296	244-347	182

Table 2 Continued

Subunit	Regulatory year	Count type	Bulls: 100 cows	Calves(%)	Adults [a]	Estimated population size	Estimated population 90% C.I.	Total moose observed
6C	1990/91	Survey	28	15	156	350	-	183
	1991/92	Census	-	21	184	233	206-260	199
	1992/93	Census	26	25	225	299	263-335	204
	1993/94	None	-	-	-	-	-	-
	1994/95	Census	27	14	242	281	205-358	236

[a] Adults observed in surveys or estimated in census.

Table 3 Unit 6 moose harvest and accidental death, 1990-95

		Hunter harvest									
	Regulatory	Reported					Estimated			Accidental	
Subunit	year	M	(%)	F	(%)	Total [a]	Unreported	Illegal	Total	death	Total
6A (East)	1990/91	21	(84)	4	(16)	25	5	2	7	0	32
	1991/92	25	(76)	8	(24)	33	6	1	7	0	40
	1992/93	35	(69)	16	(31)	52	4	2	6	0	58
	1993/94	44	(66)	23	(34)	67	3	1	4	0	71
	1994/95	29	(76)	9	(24)	39	2	1	3	0	42
6A (West)	1990/91	36	(67)	18	(33)	55	4	2	6	0	61
	1991/92	51	(59)	36	(41)	89	5	3	8	0	97
	1992/93	50	(61)	32	(39)	82	4	1	5	0	87
	1993/94	21	(84)	4	(16)	25	0	2	2	0	27
	1994/95	25	(83)	5	(17)	30	0	2	2	0	32
6A TOTAL	1990/91	57	(72)	22	(28)	80	9	4	13	0	93
	1991/92	76	(63)	44	(37)	122	11	4	15	0	137
	1992/93	85	(64)	48	(36)	134	8	3	11	0	145
	1993/94	65	(71)	27	(29)	92	3	3	6	0	98
	1994/95	54	(79)	14	(21)	69	2	3	5	0	74

Table 3 Continued

		Hunter harvest									
	Regulatory	Reported					Estimated			Accidental	
Subunit	Year	M	(%)	F	(%)	Total [a]	Unreported	Illegal	Total	death	Total
6B	1990/91	30	(64)	17	(36)	47	0	1	1	0	48
	1991/92	36	(75)	12	(25)	48	0	2	2	0	50
	1992/93	29	(71)	12	(29)	41	0	1	1	0	42
	1993/94	27	(63)	16	(37)	43	0	0	0	0	43
	1994/95	32	(73)	12	(27)	44	0	1	1	1	46
6C	1990/91	18	(58)	13	(42)	31	0	2	2	0	33
	1991/92	15	(54)	13	(46)	28	1	5	6	0	34
	1992/93	19	(59)	13	(41)	32	1	3	4	1	37
	1993/94	18	(64)	10	(36)	28	0	4	4	0	32
	1994/95	20	(57)	15	(43)	35	0	2	2	2	39
6D	1990/91	0	(0)	0	(0)	0	0	0	0	0	0
	1991/92	1	(100)	0	(0)	1	0	0	0	0	1
	1992/93	2	(100)	0	(0)	2	0	0	0	0	2
	1993/94	0	(0)	0	(0)	0	0	0	0	0	0
	1994/95	1	(100)	0	(0)	1	0	0	0	0	1

Table 3 Continued

		Hunter harvest									
	Regulatory	Reported					Estimated			Accidental	
Subunit	Year	M	(%)	F	(%)	Total[a]	Unreported	Illegal	Total	death	Total
Unit 6	1990/91	105	(67)	52	(33)	158	9	7	16	0	174
TOTAL	1991/92	128	(65)	70	(35)	200	12	11	23	0	223
	1992/93	135	(65)	73	(35)	209	9	7	16	1	226
	1993/94	110	(67)	53	(33)	163	3	7	10	0	173
	1994/95	107	(72)	41	(28)	149	2	6	8	3	160

[a] Totals may include moose of unknown sex and subunit.

Table 4 Unit 6 moose harvest data by permit hunt, 1990-95

Subunit/ hunt no.	Regulatory year	Legal moose	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	(%)	Cows	(%)	Total reported harvest
6A/RM160[a]	1993/94	Bull	101	60	48	53	21	(100)	0	(0)	21
	1994/95	Bull	86	43	49	51	25	(100)	0	(0)	25
6A/DM162[b]	1993/94	Antlerless	15	33	40	40	0	(0)	4	(100)	4
	1994/95	Antlerless	20	55	44	56	0	(0)	5	(100)	5
6B/R964	1990/91	Bull	179	25	78	22	30	(100)	0	(0)	30
	1991/92	Antlered	245	24	80	19	35	(100)	0	(0)	35
	1992/93	Antlered	186	40	75	25	28	(100)	0	(0)	28
6B/RM164	1993/94	Bull	229	34	82	18	27	(100)	0	(0)	27
	1994/95	Bull	164	34	70	30	32	(100)	0	(0)	32
6B/D966	1990/91	Antlerless	30	3	41	59	0	(0)	17	(100)	17
	1991/92	Antlerless	30	17	48	52	1	(8)	12	(92)	13
	1992/93	Antlerless	20	15	24	76	1	(8)	12	(92)	13

Table 4 Continued

Subunit/ hunt no.	Regulatory year	Legal moose	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	(%)	Cows	(%)	Total reported harvest
6B/DM166	1993/94	Antlerless	20	15	6	94	0	(0)	16	(100)	16
	1994/95	Antlerless	20	10	28	67	0	(0)	12	(100)	12
6C/D967	1990/91	Antlered	20	10	0	100	18	(100)	0	(0)	18
	1991/92	Antlered	20	5	21	79	15	(100)	0	(0)	15
	1992/93	Antlered	20	0	5	95	19	(100)	0	(0)	19
6C/DM167	1993/94	Bull	20	5	5	95	18	(100)	0	(0)	18
	1994/95	Bull	20	0	0	100	20	(100)	0	(0)	20
6C/D968	1990/91	Antlerless	20	10	28	72	0	(0)	13	(100)	13
	1991/92	Antlerless	20	10	28	72	0	(0)	13	(100)	13
	1992/93	Antlerless	15	0	13	87	0	(0)	13	(100)	13
6C/DM168	1993/94	Antlerless	10	0	0	100	0	(0)	10	(100)	10
	1994/95	Antlerless	15	0	0	100	0	(0)	15	(100)	15

[a] Registration permit hunt.

[b] Drawing permit hunt.

Table 5 Unit 6 moose hunter residency and success, 1990-95

		Successful					Unsuccessful					
Subunit	Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Total	(%)[b]	Local resident	Nonlocal Resident	Nonresident	Total	(%)[b]	Total hunters
6A (East)	1990/91	1	5	19	25	(61)	3	11	2	16	(39)	41
	1991/92	3	10	20	33	(56)	3	14	9	26	(44)	59
	1992/93	7	18	27	52	(69)	5	10	8	23	(31)	75
	1993/94	12	28	26	67	(52)	12	24	23	61	(48)	128
	1994/95	9	7	21	39	(53)	12	12	11	35	(47)	74
6A (West)	1990/91	31	11	13	55	(65)	13	10	7	30	(35)	85
	1991/92	54	16	16	89	(68)	17	17	6	41	(32)	130
	1992/93	64	12	6	82	(65)	22	15	7	45	(35)	127
	1993/94	15	2	8	25	(50)	15	2	8	25	(50)	50
	1994/95	18	3	9	30	(52)	15	8	5	28	(48)	58
6A TOTAL	1990/91	32	16	32	80	(63)	16	21	9	46	(37)	126
	1991/92	57	26	36	122	(65)	20	31	15	67	(35)	189
	1992/93	71	30	33	134	(66)	27	25	15	68	(34)	202
	1993/94	27	30	34	92	(52)	27	26	31	86	(48)	178
	1994/95	27	10	30	69	(52)	27	20	16	63	(48)	132

Table 5 Continued

Subunit	Regulatory year	Successful					Unsuccessful					Total hunters
		Local resident[a]	Nonlocal resident	Nonresident	Total	(%)[b]	Local resident	Nonlocal Resident	Nonresident	Total	(%)[b]	
6B	1990/91	42	5	-[c]	47	(29)	102	15	-[c]	117	(71)	164
	1991/92	43	5	-[c]	48	(23)	144	17	-[c]	161	(77)	209
	1992/93	38	3	-[c]	41	(32)	78	10	-[c]	88	(68)	129
	1993/94	43	0	-[c]	43	(25)	113	13	-[c]	126	(75)	169
	1994/95	41	3	-[c]	44	(35)	68	13	-[c]	81	(65)	125
6C	1990/91	30	1	-[c]	31	(86)	4	1	-[c]	5	(14)	36
	1991/92	28	0	-[c]	28	(76)	8	1	-[c]	9	(24)	37
	1992/93	28	4	-[c]	32	(91)	2	1	-[c]	3	(9)	35
	1993/94	25	3	-[c]	28	(97)	1	0	-[c]	1	(3)	29
	1994/95	27	8	-[c]	35	(100)	0	0	-[c]	0	(0)	35
6D	1990/91	0	0	0	0	(0)	7	1	0	16	(100)	16
	1991/92	0	1	0	1	(5)	9	8	1	18	(95)	19
	1992/93	2	0	0	2	(17)	8	2	0	10	(83)	12
	1993/94	0	0	0	0	(0)	11	4	0	15	(100)	15
	1994/95	1	0	0	1	(4)	14	7	2	23	(96)	24

Table 5 Continued

		Successful					Unsuccessful					
Subunit	Regulatory year	Local[a] resident	Nonlocal resident	Nonresident	Total	(%)[b]	Local resident	Nonlocal Resident	Nonresident	Total	(%)[b]	Total hunters
Unit 6 TOTAL	1990/91	104	22	32	158	(46)	129	38	11	186	(54)	344
	1991/92	128	32	37	200	(44)	181	59	16	257	(56)	457
	1992/93	139	37	33	209	(55)	115	38	15	169	(45)	378
	1993/94	95	33	34	163	(42)	152	43	31	228	(58)	391
	1994/95	96	21	30	149	(47)	109	40	18	167	(53)	316

[a] Resident of Unit 6.
[b] Totals may include harvest by hunters of unknown residency and may include harvest from unknown subunits.
[c] Nonresidents ineligible to receive permits.

Table 6 Unit 6 moose harvest percent by time period, 1990-95

		Harvest periods							
Subunit	Regulatory year	8/20-8/31	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31	11/1-11/30	12/1-12/31	n
6A (East)	1990/91	0	16	40	16	20	8	0	25
	1991/92	13	13	28	19	13	13	3	32
	1992/93	0	23	25	23	21	2	6	52
	1993/94	0	18	18	34	7	13	9	67
	1994/95	0	8	26	18	15	26	8	39
6A (West)	1990/91	0	33	29	25	6	4	4	52
	1991/92	13	13	24	34	8	5	3	87
	1992/93	4	10	64	10	5	3	4	77
	1993/94	0	92	0	8	0	0	0	25
	1994/95	0	93	3	3	0	0	0	30
6A TOTAL	1990/91	0	27	32	22	10	5	3	77
	1991/92	13	13	25	30	9	7	3	119
	1992/93	2	16	48	16	12	2	5	129
	1993/94	0	38	13	27	5	10	7	92
	1994/95	0	45	16	12	9	14	4	69

Table 6 Continued

Subunit	Regulatory year	Harvest periods 8/20-8/31	9/1-9/15	9/16-9/30	10/1-10/15	10/16-10/31	11/1-11/30	12/1-12/31	n
6B	1990/91	0	77	23	0	0	0	0	47
	1991/92	0	66	34	0	0	0	0	47
	1992/93	0	80	20	0	0	0	0	41
	1993/94	2	77	21	0	0	0	0	43
	1994/95	11	68	20	0	0	0	0	44
6C	1990/91	0	52	48	0	0	0	0	31
	1991/92	0	43	57	0	0	0	0	28
	1992/93	0	69	31	0	0	0	0	32
	1993/94	0	64	36	0	0	0	0	28
	1994/95	0	46	54	0	0	0	0	35
6D	1990/91	0	0	0	0	0	0	0	0
	1991/92	0	0	100	0	0	0	0	1
	1992/93	0	50	50	0	0	0	0	2
	1993/94	0	0	0	0	0	0	0	0
	1994/95	0	100	0	0	0	0	0	1
Unit 6 TOTAL	1990/91	0	47	33	11	5	3	1	155
	1991/92	8	30	32	18	6	4	2	195
	1992/93	1	37	40	10	7	1	3	204
	1993/94	1	53	19	15	3	6	4	163
	1994/95	3	52	26	5	4	7	2	149

Table 7 Unit 6 moose harvest percent by transport method, 1990-95

Subunit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway Vehicle	n
6A (East)	1990/91	92	0	8	0	0	24
	1991/92	64	18	18	0	0	28
	1992/93	78	8	12	0	2	51
	1993/94	77	17	2	2	3	66
	1994/95	74	11	6	3	6	70
6A (West)	1990/91	55	45	0	0	0	53
	1991/92	53	47	0	0	0	88
	1992/93	32	67	0	1	0	81
	1993/94	20	80	0	0	0	25
	1994/95	40	60	0	0	0	30
6A TOTAL	1990/91	66	31	3	0	0	77
	1991/92	56	40	4	0	0	116
	1992/93	50	44	5	1	1	132
	1993/94	62	34	1	1	2	91
	1994/95	64	26	4	2	4	100

Table 7 Continued

Subunit	Regulatory year	Airplane	Boat	3- or 4-wheeler	ORV	Highway Vehicle	n
6B	1990/91	11	76	0	0	13	45
	1991/92	11	74	0	0	15	47
	1992/93	20	70	0	8	3	40
	1993/94	7	77	0	2	14	43
	1994/95	7	79	0	2	12	42
6C	1990/91	0	39	0	3	58	31
	1991/92	0	38	4	0	58	26
	1992/93	0	28	0	0	72	32
	1993/94	0	50	0	0	50	28
	1994/95	0	32	0	3	65	34
6D	1990/91	0	0	0	0	0	0
	1991/92	0	100	0	0	0	1
	1992/93	0	0	0	0	100	2
	1993/94	0	0	0	0	0	0
	1994/95	100	0	0	0	0	1
Unit 6 TOTAL	1990/91	37	46	1	1	16	153
	1991/92	37	48	3	0	12	190
	1992/93	36	46	3	2	13	206
	1993/94	36	48	1	1	14	162
	1994/95	38	40	2	2	18	177

LOCATION

GAME MANAGEMENT UNIT: 7 (3,520 mi^2)

GEOGRAPHIC DESCRIPTION: Eastern Kenai Peninsula

BACKGROUND

The Unit 7 moose population irrupted most recently during the 1960s after wildfires in adjacent Unit 15A created large areas of early seral vegetation. Wolf numbers were simultaneously reduced to low levels. A rapid population decline followed in the early 1970s after 3 severe winters in 4 years. The population has fluctuated at low levels since then as predator densities stabilized and habitat quality remained in climax stages.

Since 1980, spruce bark beetles (*Dendroctonus rufipennis*) have established in many old growth spruce stands in Unit 7. In 1993 an aerial survey showed 26,000 acres of land were infested with spruce bark beetles and much of the mature overstory had died (Jim Peterson ADNR, pers. commun.). Several prescriptive logging cuts have been initiated in response. Almost 5,500 acres of forested land in Unit 7 are planned for harvest in 1996 (Steve Albert ADF&G pers. commun.). Reduction of old-growth forests may be beneficial to the moose population by enhancing nutritional quality and availability of winter food plants.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

To Maintain a healthy population of moose with a minimum bull to cow ratio of 15:100.

METHODS

Aerial sex and age composition surveys were conducted in November and December of both years in selected trend count areas. We collected annual moose harvest data through the statewide harvest reporting system.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Terrain features and extensive mature spruce forest prevented application of the moose census technique described by Gasaway et al. (1986). Results from aerial surveys and harvest reports indicate that the moose population has remained stable since the mid-1980s. The 1994–95 winter was considered moderately severe in most of the region. Documented winter mortality was predominantly calves of the year. We believe the moose population has remained stable at approximately 1000 animals.

Population Composition

Four of 32 count areas, excluding Portage and Placer River drainages, were surveyed during 1994 fall sex and age composition surveys. We surveyed 453 moose with ratios of 31 calves:100 cows and 34 bulls:100 cows. Yearling bulls:100 cows were 11, reflecting poor overwinter survival in 1994. The winter of 1994–95 was considered severe with deep and persistent snow. Overwinter survival was also expected to be low (Table 1).

MORTALITY

Harvest

Season and Bag Limit. A moose hunting season occurred in the Placer River drainage and that portion of Placer Creek drainage (Bear Valley) outside the Portage Glacier Closed Area and that portion of Unit 14C within the 20-Mile River drainage. The bag limit was 1 moose by drawing permit only with 40 permits for antlered moose and 60 permits for antlerless moose. The season was 20 August–30 September for hunt DM210 (Bulls only) and 20 August–10 October for hunt DM211 (antlerless). The remainder of Unit 7 moose season was from 20 August–20 September in 1993 and 1994 for 1 bull with spike-fork or 50-inch antlers.

Board of Game Action and Emergency Orders. During the Spring 1993 Board of Game Meeting, the Board extended the general moose season by 11 days, creating a new season opening of 20 August. In addition, the Board made it illegal for the public to feed moose.

Hunter Harvest. In 1993, 62 moose were harvested by 413 hunters during the general season (Table 2). Twenty-two (35%) hunters reported taking spike/fork bulls (less than 35 in) compared to 35 (56%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Five reports (8%) indicated either unknown size or illegal classification.

In 1994, 56 moose were harvested by 425 hunters during the general season (Table 2). Twenty-two (39%) hunters reported taking spike/fork bulls (less than 35 in) compared to 31 (55%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Three reports (5%) indicated either unknown size or illegal classification. Successful hunters averaged 5.5 and 5.4 days hunting in 1993 and 1994, respectively. Two moose were reported with antler spreads exceeding 65 inches.

Permit Hunts. Permit hunt results for Unit 7 (hunts DM210 and DM211) were included in the management report for Unit 14C.

Hunter Residency and Success. Hunter success in 1993 was 15.0%. Nineteen (31%) successful hunters were unit residents, 28 (45%) were nonunit residents and 14 (23%) were nonresidents (Table 3). One successful hunter did not specify residency. Residency reported for unsuccessful hunters was as follows: unit residents 156, nonunit residents 185, nonresidents 5, and unspecified residency 5.

Hunter success in 1994 was 13.2%. Twenty-two (39%) successful hunters were unit residents, 27 (48%) were nonunit residents and 4 (7%) were nonresidents (Table 3). Three successful hunters (5%) did not specify residency. Reported residency for unsuccessful hunters was as follows: unit residents 141, nonunit residents 203, nonresidents 13, and unspecified residency 12.

Harvest Chronology. Beginning in 1993 the general open season for Unit 7 was 20 August–20 September (32 days). Reported chronology of harvest indicates the highest percentage of harvest occurred during the last 10 days of the season in 1993. In 1994, 10 moose were harvested on opening day. Hunters harvested from zero to 4 moose daily for the rest of the 1994 (Table 4) season.

Transport Methods. In 1993, 40% of successful hunters reported highway vehicles as their means of transportation (Table 5). Horses were the second most common transportation means (19%) for successful hunters. Hunters using boats, aircraft, or ATVs, accounted for 18%, 15%, or 3%, respectively, of the reported harvest.

In 1994, 45% of successful hunters reported highway vehicles as their means of transportation (Table 5). The second most common transportation means for successful hunters was horse (20%). Hunters using boats, aircraft, or ATVs accounted for 16%, 9%, or 4%, respectively, of the reported harvest.

Other Mortality. In addition to reported harvest in Unit 7, 34 moose were killed by trains (4) or motor vehicles (30) during the 1993–94 winter. There were 18 reported train kills for the 1994–95 winter. At least 34 moose were killed in Unit 7 by motor vehicles in 1994 (Table 2). Approximately 75% of these animals were salvaged for human use. The "Give Moose a Brake" program (Del Frate and Spraker, 1991) continued its awareness activities throughout the peninsula. Crippling loss by hunters is unknown but probably is less than 10% of the reported harvest.

Effect of predation by wolves and bears is unknown. The unit supports an estimated 50 wolves, a ratio of 1 wolf per 20 moose. Black bears are abundant throughout the unit, and brown bears are common in all drainages supporting salmon. Predation alone should prevent the moose population from increasing.

HABITAT

Assessment

Reduction of some old-growth forest in response to spruce bark beetle infestations through logging and prescribed burning by the US Forest Service was a priority in Unit 7. Logging prescriptions and reforestation techniques that encourage hardwood production were recommended. If hardwood production increases in these affected areas, moose will probably benefit from the higher quality habitat. However, if site preparation is not adequate, grass (*Calamagrostis* spp.) will compete with both spruce and hardwood seedlings.

CONCLUSIONS AND RECOMMENDATIONS

The 1993–94 winter was considered normal with little documented mortality. Winter conditions in Unit 7 during 1994–95 were moderately severe, and many calves were lost throughout the region, lowering harvest rates in 1995. Human-caused moose mortality, including road or train kills and harvest, represented approximately 10% of the estimated moose population of 1000.

The harvest of moose under spike-fork/50 inch regulations fluctuated in response to previous winter severity. Spike-forks are almost always yearlings and the proportion of young animals in the harvest should provide a "barometer" of the health of that particular cohort. By properly evaluating the severity of a particular winter, we can also forecast the upcoming harvest. Schwartz et al. (1992) reported a thorough review of the selective harvest system.

The bull to cow ratios have been higher than the recommended objectives of a minimum of 15 bulls per 100 cows since the selective harvest program began. Adequate bull to cow ratios are desired to minimize the length of the rut and ensure that most cows conceive during their first estrous cycle (Schwartz et al. 1994). Given the low moose density (<40 moose per mi^2) and rugged terrain of Unit 7, a higher bull to cow ratio may be necessary to maintain a healthy population.

Under the current selective harvest system and current harvest patterns, I recommend no changes in regulations. If bull to cow ratios continue above objective levels, specific drainages may be designated for late season permit hunts. However, to avoid shifts in hunting pressure, Unit 7 and 15 general open season lengths and bag limits should be kept consistent.

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Table 1 Unit 7 fall aerial moose composition counts and estimated population size, 1990–1995

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1990/91	39	13	22	14	305	355	35	1000
1991/92	27	18	26	17	94	115	43	1000
1992/93	34	7	18	12	218	248	24	1000
1993/94[a]	–	–	–	–	–	–	–	–
1994/95	34	18	31	19	367	453	40	1000

[a] No surveys completed.

Table 2 Unit 7 moose harvest[a] and accidental death, 1990–95

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1990/91	69	0	0	69			20	8	7	15	104
1991/92	60	0	0	60			20	29	7	36	116
1992/93	54	0	0	54			20	31	0	31	105
1993/94	62	0	0	62			20	30	4	34	96
1994/95	56	0	0	56			20	34	18	52	108

[a]Excludes permit hunt harvest.
[b]Prior to 1991 accidental deaths were estimated.

Table 3 Unit 7 moose hunter[a] residency and success, 1990–95

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total(%)	Total Hunters
1990/91	23	40	6	69 (15)	175	194	8	385 (85)	454
1991/92	24	32	4	60 (13)	186	222	5	416 (87)	476
1992/93	24	26	4	54 (12)	166	205	6	379 (88)	433
1993/94	19	28	14	62[c] (15)	156	185	5	351[d] (85)	413
1994/95	22	27	4	56[e] (13)	141	203	13	369[f] (87)	425

[a] Excludes hunters in permit hunts.

[b] Local = residents of Unit 7.

[c] One successful hunter did not specify residency.

[d] Five unsuccessful hunters did not specify residency.

[e] Three successful hunters did not specify residency.

[f] Twelve unsuccessful hunters did not specify residency.

Table 4 Unit 7 moose harvest[a] chronology percent by time period, 1990–95

Regulatory year	Harvest periods: 8/20-25	8/26-8/31	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	n
1990/91[b]	--	--	33	13	29	19	6	69
1991/92[b]	--	--	40	12	22	25	2	60
1992/93[b]	--	--	26	11	26	30	7	54
1993/94[c]	15	3	11	6	32	27	5	62
1994/95[c]	25	13	18	11	7	21	5	56

[a] Excludes permit hunt harvest.
[b] General open season Sep 1–Sept. 20;
[c] General open season Aug. 20–Sep 20.

Table 5 Unit 7 moose harvest[a] percent by transport method, 1990–95

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1990/91	19	23	9	4	0	0	41	4	69
1991/92	13	21	7	5	0	2	48	5	61
1992/93	16	13	13	4	0	0	51	4	55
1993/94	15	19	18	0	0	3	40	5	62
1994/95	9	20	16	4	0	0	45	7	56

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 9 (33,600 mi^2)

GEOGRAPHIC DESCRIPTION: Alaska Peninsula

BACKGROUND

Moose were scarce on the Alaska Peninsula before the mid-1900s, but they increased dramatically and spread southwestward during the 1950s and 1960s. Unsuitable habitat south of Port Moller limited movement into Unit 9D. Even during the 1960s when the population was growing, calf:cow ratios were relatively low, and as the population reached its peak, the ratios declined. Evidence of range damage from overbrowsing was noted. Poor calf survival was believed to be caused by nutritional stress. Liberal hunting regulations were in effect from 1964 to 1973, first to slow population growth and subsequently (during the early 1970s) to reduce the population so that willow stands could recover from heavy browsing. Even though a series of hunting restrictions began after 1973, the population continued to decline, especially in Subunit 9E. By the early 1980s moose densities in Unit 9E were 60% below peak levels and calf:cow ratios were extremely low, despite evidence that range conditions had improved (ADF&G files). Brown bear predation on neonatal moose was the primary limiting factor of moose in Unit 9.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Population objectives for moose in Unit 9 are to: 1) maintain existing densities in areas with moderate (0.5–1.5 moose/mi^2) or high (1.5–2.5 moose/mi^2) densities; 2) increase low-density populations (where habitat conditions are not limiting) to 0.5 moose/mi^2 by 1995; 3) maintain sex ratios of at least 25 bulls:100 cows in medium-to-high density populations and at least 40 bulls:100 cows in low-density areas.

METHODS

We scheduled fall sex and age composition aerial surveys throughout Units 9B, 9C, and 9E during November through early December when adequate snow cover was available. We collected harvest data from harvest tickets. We monitored harvests and checked hunters primarily within the Naknek River drainage.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Results of fall sex and age composition surveys in Units 9B, 9C, and the central portion of 9E indicated that populations in most of Unit 9 have stabilized over the past 10 years. Very low moose densities and unreliable snow conditions in Unit 9A and the southern portion of 9E precluded efficient surveys for monitoring trends in population size or composition. Although no recent surveys have been specifically directed toward moose in Unit 9D, incidental observations south of Port Moller showed no noticeable expansion of moose in that area.

Population Size

A 1983 census in the central portion of Unit 9E resulted in an estimate of 1148 moose (90% CI = $\pm$16%) in the 1314-mi^2 study area. Extrapolation of this census to the remainder of Unit 9E provided a rough estimate of approximately 2500 moose. The area of Unit 9C outside of Katmai National Park had approximately 500–600 moose. Approximately 2000 moose were within Unit 9B. Units 9A and 9D probably contained less than 300 and 50 moose, respectively.

Population Composition

Unfavorable snow and flying conditions have hampered trend survey efforts for the past several years, resulting in only occasional surveys outside Unit 9C. Table 1 provides a summary of sex and age composition data in Unit 9C since 1990. Annual differences in the number of moose counted, and to some extent differences in ratios, reflect which of the 3 trend areas were surveyed.

In 1993 the Dog Salmon and Cinder River count areas were surveyed with the help of the National Park Service. In total, we classified 191 moose, with ratios of 47.5 bulls and 11.7 calves:100 cows. In 1994 we surveyed the Blue Mountain, Dog Salmon, Mother Goose, and Pacific trend areas with help from the National Park Service and Fish and Wildlife Service. We counted 365 moose, with ratios of 38 bulls and 21 calves:100 cows. Two trend areas in Unit 9B (Nakeen and Big Mountain) were also surveyed in 1994. The ratios were 34 bulls and 25 calves:100 cows (n = 99 moose).

Survey data from Unit 9C and the limited data from other subunits show that bull:cow ratios have stabilized at acceptable levels. Calf:cow ratios remained low.

MORTALITY

Harvest

Seasons and Bag Limit. No changes to state or federal moose hunting regulations occurred during 1993–94. In Unit 9A, resident hunters could hunt from 1–15 September, and the open season for nonresidents was 5–15 September. The bag limit was 1 bull for all hunters. In Unit 9B nonresidents could hunt from 5–15 September and the bag limit was 1 bull with 50-inch antlers, and resident hunters could hunt from 1–15 September and 1–31 December, with a bag limit of 1 bull. The season dates in Unit 9C were the same as for Unit 9B; however, within the southern portion of the Naknek drainage, federal lands were open in December only to local rural residents and a subsistence registraton permit was required to take antlerless moose. The state season within the Naknek drainage was open to any resident in December, and the bag limit was 1 bull. In the remainder of Unit 9C, residents could take any moose during the December season. Unit 9D had no open season. The state season for resident hunters in Unit 9E was 10–20 September and 1–31 December; the season for resident and nonresident hunters was 10–20 September. The bag limit in Unit 9E was 1 bull; however, moose taken from 10–20 September must have an antler spread of at least 50 inches or at least 3 brow tines on at least 1 antler. The federal subsistence seasons in Unit 9E were 1–20 September and 1–31 December with a bag limit of 1 antlered bull.

Game Board Actions and Emergency Orders. No regulatory actions were implemented during 1993–94.

Hunter Harvest. During 1993 hunters reported killing 224 moose, including 222 bulls and 2 cows. In 1994 the reported harvest was 234 moose, including 227 bulls and 7 cows (1 of which was taken under the federal subsistence permit hunt) (Table 2). Harvests from 1988 to 1994 averaged 228. The Unit 9 harvest over the past 12 years has also averaged 228 (range = 173–300) and steadily increased through 1987, followed by a decline.

Permit Hunts. The state registration hunt No. 972 was restricted by emergency order to antlered moose only in 1991. The registration permit hunt was discontinued in 1992, and a general bull-only season was implemented for December 1992.

In 1992 a federal subsistence registration hunt was established during December on all federal land within the Naknek drainage. Only bulls were legal on federal land north of the river. The permit requirement for the federal lands north of the Naknek River was dropped in 1994. South of the Naknek River, nonlocal state residents were excluded from hunting on federal lands. Subsistence hunters could kill 1 moose, and a quota of 5 antlerless moose was set. The Becharof National Wildlife Refuge office issued 3 permits in 1992 and 1 antlerless bull was reported. In 1993 we issued 2 permits and no moose were taken. In 1994, 5 permits were issued and 1 cow was taken.

Hunter Residency and Success. The number of moose hunters using Unit 9 increased during 1981–87 and peaked at 645. Since then the number has leveled off at a mean of 579 for the period 1990–94 (Table 3). While there have been fluctuations in the proportion of the 3 residency categories, there is no clear trend. Most subsistence hunters did not get moose harvest tickets and consequently were not represented in the local resident category. Since 1988 the success rates have been stable, with nonresidents having higher success (49%, range = 43–59%) than either residents of Unit 9 (35%, range = 28–50%) or other Alaska residents (30%, range = 19–34%). Nonresidents had a higher success rate because virtually all of them flew out to hunt, and many of them employed guides.

Harvest Chronology. Since 1990 approximately 85% of the moose harvest has occurred during September (Table 4). Harvest levels in December have remained low, but vary (range = 9–21% of total), depending on weather and travel conditions.

Transportation Methods. Aircraft continued as the most common method of transportation in Unit 9, followed by boats (Table 5). No major change in transportation type occurred in the past 5 years.

Other Mortality

Given the continued low calf production, bear predation of neonatal moose remained the apparent primary cause of natural mortality. Bear:moose ratios in Unit 9 ranged from >1:1–1:10, and they were much higher than anywhere else within the indigenous range of moose. Winter conditions during 1993–94 were relatively mild and winter mortality was insignificant. The 1994–95 winter started with significant deep snow in northern 9B but dissipated by late winter and did not result in a major die-off.

CONCLUSIONS AND RECOMMENDATIONS

Hunting regulations have been restricted in all subunits, except the Branch River Drainage in Unit 9C, to eliminate antlerless moose hunting because of low calf:cow ratios. Additionally, fall seasons have recently been shortened and moved to the first half of September in the northern 3 subunits to maintain bull:cow ratios at prescribed levels. Harvests have remained relatively stable for 12 years, despite major changes to moose regulations in other parts of southcentral Alaska (e.g., the spite/fork-50" regulation). The recent average harvest of 228 moose per year seems within sustainable levels, and no regulatory changes are needed.

Brown bear predation on neonatal moose was the major limiting factor preventing the increase in moose densities in Unit 9. However, very high bear:moose ratios would require substantial reduction in bear densities to achieve a measurable improvement in moose calf survival. ADF&G has placed a priority on managing bears in Unit 9, and any extreme reduction in bear numbers would probably be opposed by a large segment of the public.

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Table 1 Subunit 9C aerial moose composition counts and estimated population size, 1990–94

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1990/91	37	5	25	17	232	274	39	1000
1991/92	48	9	16	18	118	131	27	1000
1992/93	38	7	26	21	550	635	40	1000
1993/94	43	8	21	13	568	650	52	1000
1994/95	51	8	23	13	466	535	45	1000

Table 2 Unit 9 moose harvest[a] and accidental death, 1990–94

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			Grand
year	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	total
1990/91	248	6	0	254	--	--	100	--	--	--	354
1991/92	214	6	2	222	--	--	100	--	--	--	322
1992/93	205	1	1	207	--	--	100	--	--	--	307
1993/94	222	2	0	224	--	--	100	--	--	--	324
1994/95	227	7[b]	0	234	--	--	100	--	--	--	334

[a] Includes permit hunt harvest.
[b] Includes 1 taken under federal subsistence permit.

Table 3 Unit 9 moose hunter[a] residency and success, 1990–94

Regulatory year	Successful				Unsuccessful				
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	Total hunters
1990/91	45	57	125	242 (42)	70	113	128	338 (58)	580
1991/92	62	41	114	222 (37)	115	172	78	378 (63)	600
1992/93	45	59	97	207 (37)	114	115	111	352 (63)	559
1993/94	38	59	118	224 (39)	99	115	120	347 (61)	571
1994/95	62	51	108	233 (40)	63	142	142	354 (60)	587

[a]Excludes hunters in permit hunts.
[b]Resident of Unit 9.

Table 4 Unit 9 moose harvest[a] chronology percent by time period, 1990–94

Regulatory year	Harvest periods							*n*
	9/1-9/4	9/5-9/9	9/10-9/14	9/15-9/20	9/21-9/25	12/1-12/15	12/16-12/31	
1990/91	6	28	39	10	0	11	7	254
1991/92	9	15	42	18	0	6	10	222
1992/93	7	20	47	16	<1	5	4	207
1993/94	8	16	40	19	<1	6	6	224
1994/95	4	19	31	20	0	10	11	233

[a]Excludes permit hunt harvest.

Table 5 Unit 9 moose harvest[a] percent by transport method, 1990–1994

Regulatory year	Percent of harvest: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	*n*
1990/91	65	--	19	5	7	2	3	254
1991/92	56	--	20	8	11	1	3	236
1992/93	62	--	25	5	4	1	1	206
1993/94	58	--	22	6	7	1	3	224
1994/95	57	--	19	4	17	1	2	227

[a]Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 11 (13,300 mi^2)

GEOGRAPHIC DESCRIPTION: Chitina Valley and the eastern half of the Copper River Basin

BACKGROUND

Moose abundance in Unit 11 was generally considered low from the early 1900s until the 1940s, increased during the 1950s, and reached a peak population in the early 1960s. When moose were most abundant, we observed between 85 and 120 moose per hour during fall composition counts. The moose population declined from the late 1960s until 1979, when the population was considered to have reached its lowest level. In 1979 we observed only 12 moose per hour during fall counts. Moose numbers stabilized, then increased in Unit 11 during the early to mid-1980s, and were probably the highest in 1987 when 55 moose per hour were observed.

Moose harvests in Unit 11 averaged 164 (123–242) per year from 1963 until 1974. Either-sex bag limits were in effect until 1974, and 40% of the harvest were cows. During this period, hunting seasons were long and were split to provide for fall and winter hunting. The moose harvest peaked, as did the total number of hunters and hunter success rate, in the early 1970s. In response to declining moose numbers, the 1974 fall moose season was shortened, the winter season was closed, and the harvesting of cows prohibited. Between 1975 and 1989, fall seasons remained 1–20 Sep. In 1990 the moose season was shortened in response to deep snow conditions and to align with the season in Unit 13.

Most of Unit 11 was included in Wrangell–Saint Elias National Monument in December 1978. In 1980 monument status was changed to park/preserve with passage of the Alaska National Interest Lands Conservation Act.

MANAGEMENT DIRECTION

POPULATION OBJECTIVE

To allow the population to fluctuate as dictated by available habitat and predation rates; to maintain a population with a posthunt minimum of 30 bulls:100 cows with 10–15 adult bulls:100 cows.

HUMAN USE OBJECTIVE

To allow human harvest of bulls when hunting them does not conflict with unit management goals or herd population objectives.

METHODS

An aerial survey was conducted during the late fall in 1994 and 1995 to determine sex and age composition and population trends on a count area located along the western slopes of Mount

Drum. Harvests and hunting pressures were monitored through a harvest ticket reporting system; we also monitored the average reported antler length in the harvest. Predation and overwinter mortalities were monitored in the field whenever possible and by reports from hunters and trappers.

Large portions of Unit 11 are classified as limited suppression zones, where wildfire would be allowed to burn. Several lightning strikes that occurred in limited suppression areas were allowed to burn without suppression. However, burn conditions were unfavorable and little habitat was affected by wildlife during this reporting period.

We further addressed moose habitat issues by attending meetings on a proposed logging operation and commenting on reforestation alternatives should logging occur. Again, the focus was to improve moose habitat after logging trees infected with spruce beetles.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

The number of moose observed during fall sex and age composition counts in Count Area (CA) 11 (the western slopes of Mount Drum) decreased between 1990 and 1992, as reflected by the 75% decline in the number of moose counted per hour. Since 1992 the number of moose observed during fall counts in this count area have increased (Table 1). Low moose numbers observed during the 1992 count probably reflect count conditions or movement rather than an actual decline in moose numbers. The similar count results in 1991 and 1994 probably more clearly reflect moose numbers in CA-11 during the period from 1991 to 1994.

Population Size

An accurate population estimate is not available for all of Unit 11 because a complete census has never been conducted. Moose numbers observed during the 1995 fall composition counts in CA 11 resulted in a density estimate of 0.5 moose per mi^2. Density estimates from 0.1 to 0.4 moose/mi^2 were calculated in 1986 during late winter stratification surveys when 20% of the estimated 5,200 mi^2 of moose habitat in the unit was surveyed. Based on these density estimates, we obtained an extrapolated population estimate of 2500. During the fall of 1993, NPS biologists conducted a Gasaway census in portions of Unit 11. The density estimate was 0.58 moose/mi^2 and the extrapolated population estimate from this survey was 3000 moose (Route, pers. commun.).

Population Composition

A bull:cow ratio of 92:100 was obtained in CA 11 in 1995, similar to the ratio of 91 bulls:100 cows in 1991 and 1994. These bull:cow ratios have been among the highest ever observed in CA-11. This adult bull:cow ratio greatly exceeds the current management goal of maintaining no less than 15 adult bulls:100 cows. There was also an increase in yearling bulls since 1992 and the current yearling bull ratio is the highest in 10 years. Higher calf production in 1994 resulted in additional overwinter survival and recruitment into the yearling cohort.

The calculated calf:cow ratio in CA-11 was 21:100 in 1995, down 16 percent from the 1994 figure of 25:100. Calf production in CA-11 during the last 2 years is the highest observed in 10 years. The last time calf production/survival exceeded 20 calves:100 cows was in 1983.

Distribution and Movement

Data from past fall composition and winter stratification surveys, field observations, and reports from the public indicated the highest moose numbers in the unit are along the slopes of Mts. Sanford, Drum and Wrangell. Portions of Unit 11 south of the Chitina River have the lowest density of moose in the unit.

Fall rutting and postrutting concentrations normally occur in upland habitats as high as elevations of 4,000 feet. Migrations to lower elevations are initiated by snowfall, but usually do not occur until late November–early December after fall counts. By late winter, moose numbers in riparian habitats along the Copper and Chitina rivers are at their highest levels for the year. Some moose from the western slopes of Unit 11 move to lower elevations in a westerly direction across the Copper River to winter in eastern Unit 13.

MORTALITY

Harvest

Seasons and Bag Limit

20 Aug–20 Sep

State — 1 S/F 50" Bull or 3 brow tines

Federal Subsistence — 1 bull

Board of Game Actions and Emergency Orders. The hunting regulations for moose in Unit 11 remained unchanged between 1975 and 1989. In 1990 a separate federal subsistence season was established because the state subsistence law with a rural preference was determined to be illegal by the State Supreme Court. The bag limit for the federal subsistence hunt is any bull moose. During the spring 1993 BOG meeting, the Unit 11 season was set at 20 Aug–20 Sep, and the bag limit was changed to 1 bull with spike-fork antlers or antlers with a minimum 50-inch width or 3 brow tines. These changes were effective in the 1993 season. This action aligns the moose season and bag limit in all units on the road system in southcentral Alaska. The federal subsistence season was also established to coincide with the state's season.

Hunter Harvest. Hunters reported killing 36 bull moose in 1994 and the harvest has slowly been increasing since bottoming out in 1992 (Table 2). Although the current harvest is the highest in 3 years, it is still below the average annual harvest of 51 reported during the last half of the 1980s. Hunting pressure the last 2 years is the lowest ever reported in Unit 11. During the last 10 years, 150–200 hunters usually reported hunting in the unit.

The mean antler spread reported for bulls harvested during 1993 and 1994 was 46.6 and 49.6 inches, respectively. Both figures exceeded the 5-year mean of 44 inches obtained between

1985 and 1989 under the 36-inch regulation and before federal subsistence harvests of any bull. An increase in the average antler size was expected since the minimum legal spread increased from 36 to 50 inches. Such a large average antler size indicates that hunting pressure in Unit 11 has not been heavy enough to crop bulls before they reach maturity and that there were enough mature bulls available for breeding.

Illegal and unreported harvests of both bulls and cows have been documented in Unit 11 and, in some years, may be as much as 20% of the reported harvest. Poaching activity is assumed to be greatest along the Nabesna and McCarthy Roads where vehicle access allows for hunting and transporting illegally taken moose without being observed.

Hunter Residency and Success. Local residents accounted for 56% ($n = 20$) of the moose harvest in 1994, nonlocal Alaskan residents took 30% ($n = 11$), while nonresidents took only 14% ($n = 5$) (Table 3). Since establishing a federal subsistence moose hunt in 1990, local residents have had the highest success ratio every year except 1992. One reason for higher success rates for local subsistence hunters is that between 1990 and 1992, the federal subsistence hunting season was longer than the general state hunt. Since 1992 state and federal hunts have had similar dates. Another reason for local higher success rates is that NPS regulations allow only local rural residents to hunt in those portions of the unit designated as Park. Because nonlocal residents and nonresidents can hunt only on preserve lands, they are excluded from much of the unit. Also, local residents can take any size bull under federal subsistence laws, while nonlocals must take a spike-fork or 50" bull.

The hunter success rate in 1994 was 29%, the highest since 1989 and more than double the 14% success rate reported in 1992 when severe weather restricted hunting effort. Successful hunters spent an average of 5.2 days to kill a moose in 1994, while unsuccessful hunters averaged 8.1 days in the field. From 1989 through 1993, successful hunters averaged 6.0 days hunting and unsuccessful hunters 6.8 days. Hunting effort for successful hunters fluctuates between years with no trend evident. However, during the last 4 years unsuccessful hunters have been spending more time in the field than previously reported.

Harvest Chronology. Chronology data indicate more moose are taken during the later portion of the season in Unit 11 (Table 4). The exception to this occurred in 1990 when the state hunting season was only 5 days long, making chronology comparisons that year meaningless. Bull moose are more vulnerable in the latter part of the season because their movements increase as the onset of the rut approaches. Also, moose are more visible to hunters because leaf fall usually occurs by mid-September.

Transportation Methods. Transportation methods used by successful hunters are listed in Table 5. Aircraft, 3- or 4-wheelers, and highway vehicles are the common transportation modes for Unit 11 moose hunters. Transportation methods that may be used by hunters in Unit 11 are limited by NPS regulations. Aircraft cannot be used in portions of the unit designated as park, and all vehicle use is restricted to existing trails, except by permit. The effect of these rules is to limit hunting opportunity in the more remote portions of the unit.

Preliminary 1995 Harvest. Preliminary moose harvest figures were obtained for the 1995 hunting season by hand tabulating harvest report forms and only represents a minimum estimate of the kill. To date, 37 bulls have been reported from Unit 11. This is only a very slight increase from the 1994 take of 36.

Other Mortality

Predator–prey studies have not been conducted in Unit 11. Wolves and brown bears are abundant, but predation rates are unknown. Field observations of wolf kills during winter, coupled with additional reports by hunters and trappers of suspected wolf predation, suggested that wolves are important predators of moose in the unit. Brown bear predation was less apparent because it does not occur during winter when it would be easier to detect. The low calf:cow ratios observed during fall counts indicate early calf mortality similar to that observed in areas with high brown bear predation on neonatal moose calves. Because this unit has a very low-density moose population, predation could limit recruitment and maintain moose at current low densities. Moose populations can be suppressed at very low densities for long periods of time by predation, especially when alternative prey such as caribou and sheep are available, as they are in Unit 11 (Gasaway et al. 1983).

HABITAT

Assessment

Fires occurred throughout much of Unit 11 prior to the mid-1940s, when fire suppression activities were instituted by the Bureau of Land Management (BLM). The beneficial effects of those fires in creating moose habitat have long since passed. Only 1 fire, the Wilson Camp Fire, has burned enough acreage in the past 30 years to produce a substantial amount of moose browse. That fire occurred in 1981 and covered 13,000 acres. Recent fire starts have either received initial fire suppression activities, or if not put out, have not had favorable burning conditions or fuel supplies. Currently, vast areas within the unit support stands of mature spruce, which are of limited value as moose habitat. Habitat types currently most used by moose in the unit are climax upland and riparian willow communities. Recent observations of light-browse utilization on range transects suggest moose are not limited by the amount of browse available.

Enhancement

Habitat manipulation to benefit moose is not currently an option because most of the unit is included in Wrangell–Saint Elias National Park and Preserve. Although NPS regulations prohibit habitat manipulation, Unit 11 is included in the Copper River Fire Management Plan with most remote areas under the limited suppression category.

CONCLUSIONS AND RECOMMENDATIONS

Moose numbers in Unit 11 declined between 1990 and 1993. Before this, moose numbers in the late 1980s were probably stable. During the last 2 years, an increase in moose per hour and yearling bull:cow and calf:cow ratios observed during fall sex and age composition counts indicate moose numbers have increased. However, the moose per hour figure is still below that obtained during the mid to late 1980s. The Unit 11 moose population along the western slopes of the Wrangells is still lower than before the recent series of bad winters beginning in the late 1980s. Calf production and/or survival to fall the last 2 years are the highest in 10 years. The increase in yearling bulls also indicates overwinter calf survival was higher last year. The winter of 1994–95 was severe, although not as bad as the previous 4 winters.

The Board of Game lengthened the moose season and changed the antler size requirement for bull moose starting in the 1993 season. These changes only affected sport hunters on preserve lands. Subsistence hunters on both park and preserve lands were still regulated by federal subsistence guidelines.

The moose harvest has increased over the last 2 years after bottoming out in 1992. The harvest in 1992 was especially low because of an early winter with deep snow and record cold temperatures during moose season. Most hunters, in fact, could not travel during the last 2 weeks of the season.

The 1993 and 1994 harvests, however, are still below the bull harvest level reached in the mid and late 1980s. Hunting pressure declined over this reporting period. Currently, the number of hunters that reported hunting moose in Unit 11 is the lowest in almost 30 years.

I recommend a research program be established to investigate factors limiting growth of the moose population. Unit 11 habitat has the potential to support more moose. The population objective of maintaining moose at existing densities (i.e., 0.1 and 0.7 moose/mi^2) needs to be reconsidered and perhaps increased. We also need to explore options available to managers to enhance the moose population consistent with NPS regulations.

LITERATURE CITED

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Table 1 Moose composition counts in Count Area 11 of Unit 11, 1991–1995

Year	Males: 100 females	Yearling males: 100 females	Calves: 100 females	Calf %	Adults	Total moose	Moose /hour	Density moose/mi^2
1991	`91	5	18	9	105	115	29	0.4
1992	64	0	4	2	41	42	13	0.1
1993[a]	--	--	--	--	--	--	--	--
1994	91	8	25	11	101	114	24	0.4
1995	92	10	21	10	136	151	34	0.5

[a]No data, fall count not completed.

Table 2 Annual moose harvest in Unit 11, 1990–1994

	Reported			Estimated			
Year	M	F	Total[a]	Unreported	Illegal	Total	Total
1990	31	0	32	5	5	10	42
1991	42	0	42	5	5	10	52
1992	23	0	23	5	5	10	33
1993	30	0	30	5	5	10	40
1994	36	0	36	5	5	10	46

[a] Includes unknown sex.

Table 3. Moose hunter residency and success in Unit 11, 1990-94.

	Successful				Unsuccessful			
Year	Local resident	Nonlocal resident	Non resident	Total[a]	Local resident	Nonlocal resident	Non resident	Total[a]
1990	16	12	2	32	63	47	4	115
1991	24	14	3	42	81	58	4	145
1992	9	11	3	23	59	73	4	139
1993	15	9	4	30	31	52	8	91
1994	20	11	5	36	45	38	6	89

[a] Includes unspecified residency.

Table 4 Moose harvest chronology percent by time period in Unit 11, 1990–94

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th
1990	5–9 Sep[a] 1–20 Sep[b]	7	48	16	29	0
1991	1–15 Sep[a] 1–20 Sep[b]	17	19	43	21	0
1992	1–15 Sep[a] Aug 25–Sep 20[b]	5	30	45	20	0
1993	20 Aug–20 Sep	0	13	10	53	23
1994	20 Aug–20 Sep	2	2	25	11	53

[a] State hunt
[b] Federal subsistence hunt

Table 5 Successful moose hunter transport methods by percent in Unit 11, 1990–94

Year	Airplane	Horse	boat	3- or 4-wheeler	Snow-machine	ORV	Highway vehicle	Unk
1990	28	0	3	22	0	13	28	6
1991	36	0	2	31	0	5	19	7
1992	35	4	9	22	0	0	30	0
1993	40	0	7	20	0	7	23	3
1994	42	8	8	28	0	6	8	0

LOCATION

GAME MANAGEMENT UNIT: 12 (10,000 mi^2)

GEOGRAPHIC DESCRIPTION: Upper Tanana and White River drainages

BACKGROUND

Moose were 2 to 3 times more numerous in Unit 12 in the mid-1960s than they are today. The Unit 12 moose population declined rapidly from 1966 through 1976, as they did in surrounding areas. Several severe winters, high predation by wolves and grizzly bears, and high cow moose local harvests all contributed to the population decline. Cow moose hunts were stopped after 1974, and the Nabesna Road moose season was closed entirely from 1974 through 1981. Between 1986 and 1991, the Little Tok River drainage was closed to moose hunting because of low rates of yearling recruitment and a deteriorating bull:cow ratio.

In response to declining area moose populations, wolf control programs were conducted in adjacent Units 20D (1980), 20E (1981–1983), and in extreme northern Unit 12 (1981-1983). We attempted to reduce the grizzly bear population in 1982 by liberalizing harvest regulations, and by conducting moose habitat enhancement programs during the late 1980s. Between 1982 and 1989 the moose population in Unit 12 increased due to these management programs and also because favorable climatic conditions prevailed during this period. However, the population remained at a low density (0.4–0.6 moose/mi^2).

Unit 12 has been an important moose hunting area for local residents, hunters from southcentral Alaska, and guided nonresidents and an important wildlife viewing area for tourists driving the Alaska Highway. During the 1960s when the Unit 12 moose population was high, hunting seasons and bag limits were liberal and hunter participation and success were high. Moose were commonly viewed while traveling the area's highways. During that period, needs of consumptive and nonconsumptive users were met. Since the unit's moose population declined to a low level, the hunting season and bag limit have become very restrictive and the total harvest declined by over 40%. Also, the Upper Tanana Valley is the first area in Alaska visited by thousands of travelers driving the Alaska Highway. Most of these travelers are here to view Alaska's wildlife. Since the mid-1970s, few tourists have observed moose in Unit 12.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population in concert with other components of the ecosystem.

- Continued sustained opportunities for subsistence use of moose.

- Maximum sustained opportunities to participate in hunting moose.
- Maximum opportunities for the nonconsumptive use of moose.

MANAGEMENT OBJECTIVES

- Maintain a minimum posthunting sex ratio of 40 bulls:100 cows east of the Nabesna River and a minimum ratio of 20 bulls:100 cows in the remainder of the unit.

METHODS

CENSUSES AND COMPOSITION SURVEYS

Moose population size was estimated in a 1120 mi^2 area in northwestern Unit 12 during November 1994. Methods followed standard census techniques (Gasaway et al. 1986) except that we stratified the area using historic count data collected during past contour counts or censuses. The area was divided into 34 high and 42 low/medium strata sample units. Of these, we flew 24 random sample units covering approximately 32% of the study area. Sixteen of the sample units were flown in the high stratum and 8 in the low-medium stratum. Standard search intensity was 4.25 min/mi^2. Portions of 12 units (8 highs, 4 lows) were resampled at a search intensity of 12 min/mi^2 to determine a sightability correction factor.

We conducted standard contour counts in October and November 1993–1995. During 1994 and 1995 we surveyed only traditional areas in southern Unit 12. All moose observed were classified as either large bulls (antlers >50 inches), medium bulls (antlers larger than yearlings but <50 inches), small bulls (spike, cerviform, or palmate-antlered yearling bulls), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose.

HARVEST

We estimated harvest using harvest report cards. Information obtained from the reports was used to determine total harvest, hunter residency and success, harvest chronology, and hunter transportation modes.

BROWSE

During May and June 1993, we estimated browse use by moose in at least 6 different areas in Unit 12. In each study area we sampled 50 to 100 points. Use of current growth was categorized as none (0%), low (1%–25%), medium (26%–75%), and high (76%–100%). Mean percentage of twigs browsed was then estimated following procedures outlined by Gasaway et al. (1992).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Based on data collected during annual moose contour surveys and 3 area-specific censuses (1989, 1990, and 1994), the moose population in Unit 12 increased slowly from 1982 until 1989 but then remained stable until 1993. Since 1993 calf production and survival have increased, causing the Unit 12 population to grow slightly. Most of the increase occurred in the northwest portion of the unit and primarily within the area affected by the Tok wildfire. This area supported 0.19 moose/mi^2 in 1989 but increased to 0.6 moose/mi^2 by 1994. Overall, moose densities ranged from 0.03/mi^2 (10/1000 km^2) in the Northway Flats to 2.3/mi^2 (888/1000 km^2) along the north side of the Nutzotin Mountains. The 1995 population estimate in Unit 12 was 3000–3500 moose. The estimated density was 0.5 to 0.6 moose/mi^2 (193–231/1000 km^2) of suitable moose browse.

Past research indicates that predation was the primary factor maintaining the Unit 12 moose population at low density. Because predator management is not an option in most of Unit 12, I expect the moose population to remain at a low density (<1.0 moose/mi^2) for an extended period of time.

Population Composition

Results of the moose composition surveys conducted in Unit 12 during 1993–1995 are presented in Table 1. Composition data since 1994 are not directly comparable with past years because sampling techniques have changed. Instead of annually counting all traditional count areas in Unit 12, we now census a much larger area, which includes many of the traditional count areas, on a 3-year rotation. Benefits of the new technique include confidence limits around composition estimates and, because more area and habitats are being sampled, less chance for weather anomalies to affect the count. The disadvantage is that a composition estimate for most of the area is not obtained annually. To protect against missing a catastrophic event to the area's moose population between censuses, at least 2 of the traditional count areas will be sampled annually.

Bull:cow ratios range from about 20:100 along the north side of the Alaska Range to over 80:100 along the Nutzotin Mountains. Primary factors affecting the ratio are hunter access and low yearling recruitment. The most heavily hunted area in Unit 12 is the northwestern portion. The 1994 bull:cow ratio in this area was 39:100, which exceeds the 5-year average of count areas within the census area (28:100). Most of the increase was due to an increased yearling bull population and to sampling a greater proportion of areas seldom hunted. Between 1990 and 1993, the yearling bull:cow ratio averaged 8.2:100 compared with 16.4:100 during 1994. During this report period the lowest bull:cow ratios existed within the Little Tok River drainage and along the front face of the Alaska Range. Both of these areas have experienced moderate to high harvest rates the past 3 years and poor yearling recruitment. In response to the declining bull population in the Little Tok River, a spike-fork or 50-inch regulation was enacted in 1993.

The 1995 bull:cow ratio in southcentral to southeastern Unit 12 was 81.5:100, slightly below the 5-year average of 92.3:100. Yearling bull recruitment has declined since 1991, averaging 10.8:100 compared to 20.8:100 between 1987 and 1991.

The 1994 calf:cow ratio (Table 1) in northwestern Unit 12 exceeded the 5-year mean of 28.5:100. This was the second consecutive year of high calf survival. Increased survival was probably due to the combination of moderate to high grizzly bear, black bear, and wolf harvests and favorable weather conditions. Calf survival was also high in adjacent Unit 13C (Bob Tobey, pers commun) and Unit 20E during this period.

During 1995 calf survival in southcentral and southeastern Unit 12 was comparable to 1994 and slightly above the 5-year average of 23.1:100, but below rates in northwestern Unit 12. Climatic conditions during 1994 and 1995 were comparable between the 2 areas. Greater predator abundance is the most plausible explanation for the lower survival rates in the southern portion of the unit. Grizzly bear harvest is low in this area and densities are believed higher compared to the remainder of Unit 12. Also, very little wolf trapping occurs in this area due to land ownership status and limited access. The largest packs and highest wolf density in Unit 12 are within the unit's southern portion.

Distribution and Movements

Moose are found throughout Unit 12 below an elevation of about 4000 feet. In total the amount of suitable habitat is about 6000 mi^2 (15,540 km^2). Most moose in Unit 12 migrate between seasonal ranges. The longest known movements are for moose that rut in the Tok River area, including Dry Tok Creek. Many cows migrate as far south as the Gakona River for calving, return to the Tok River for the rut, and then move north to the Tanana River during mid to late winter.

Moose distribution has changed in Unit 12 over the past 5 years. Very few resident moose now exist on the Northway Flats, near Tanacross, or north of Tok along the Tanana River. Year-round poaching of both sexes has contributed to the decline of resident moose in these lowland areas near human settlements. However, the number of moose using the Tok River Valley and the Tetlin Hills has increased substantially since 1989. Densities have increased from 0.19 moose/mi^2 to 0.6 moose/mi^2. Moose use this area throughout the year. Increased use of this area is probably a result of improved habitat due to the 1990 Tok River fire and moderate harvests of predators.

MORTALITY

Harvest

Season and Bag Limit. Seasons and bag limits in Unit 12 during regulatory year 1995 were as follows:

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 12, that portion lying east of the Nabesna River and south of the winter trail running southeast from Pickeral Lake to the Canadian border.	1 Sep–30 Sep	1 Sep–30 Sep
Remainder of Unit 12.		
Resident Hunters: 1 bull.	1 Sep–15 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers.		5 Sep–15 Sep

Board of Game Actions and Emergency Orders. In spring 1993 the Board of Game restricted the bag limit in the Little Tok River drainage to 1 bull with spike-fork antlers or 50-inch antlers with 4 or more brow tines on 1 side for both residents and nonresidents. In spring 1995 the board authorized a spike-fork season 20–28 August in Unit 12 for residents only.

Hunter Harvest. Total reported harvest in Unit 12 during fall 1994 was 88 moose (87 bulls and 1 unspecified). The 5-year average moose harvest in Unit 12 was 92 (Table 2). During 1994 most harvest occurred in the Tok River (28), Chisana River (18), and Tetlin River (14) drainages. Enacting an antler size restriction in the Little Tok River reduced harvest to 6 in 1993 and 2 in 1994, down from 10–20 bulls per year during 1991 and 1992. During 1995 the preliminary reported harvest was 100 bulls. Four spike-fork bulls were taken during the early season.

Reported harvest represented only 2.5–3.0% of the population and probably had little impact. However, in Unit 12, out-of-season poaching may be as high as 40 moose of either sex, and unreported harvest of moose for Native funeral potlatches is as high as 15–20 annually. Most of this harvest occurs near communities and along the road system. The total Unit 12 annual human-induced harvest is probably closer to 4–5% of the population, including concentrated high harvest of cow moose. At this harvest level the moose population around human settlements will continually be maintained at very low density.

Antler size was reported for 79 bulls resulting in a mean of 44.1 inches, similar to the 5-year average of 44.5. Thirteen bulls (16.5%) were judged to have been yearlings (antlers <30 inches), 26 (32.9%) were 2–4 years old (antler spread 30.0–49.9 inches), and 40 (50.6%) were mature bulls (antler spread >50 inches). Antler spreads were estimated for 87 bulls observed during the census in northwestern Unit 12. Of these, 39.1% were yearlings, 34.4% were 2 to 4 year olds, and 26.4% were mature bulls. Antler size was reported for 37 bulls ($\bar{x}$ = 41.8 inches) harvested within the census area, 9 (24.3%) were yearlings, 14 (37.8%) were 2–4 years old, and 14 (37.8%) were mature bulls. The higher than expected mature bull harvest is due to regulation, as 57.1% of these bulls were taken by nonresidents or in an area having a spike-fork or 50-inch restriction.

Hunter Residency and Success. In Unit 12 local residents, nonlocal residents, and nonresidents accounted for 61%, 32%, and 7% of the moose hunters, respectively. Local hunters harvested 43 (49%), nonlocals 28 (32%), and nonresidents 17 (19%) of the 88 bulls reported (Table 3).

During 1994, 462 hunters reported hunting moose in Unit 12, exceeding the 5-year average of 433. The increase in hunters was due to more local resident hunting in Unit 12. The higher number of local resident reports is probably due to 2 reasons: 1) improved reporting rate since 1992 and 2) recent large scale logging and road construction has increased the local population and many of the newcomers are participating in the area's hunts. The unit success rate was 19%, compared to the 5-year mean of 22%.

Harvest Chronology. In that portion of Unit 12 where the moose season ends on 15 September, the greatest moose harvest normally takes place during the second week of the season (Table 4) and on 14–15 September. During 1994, 13 moose were taken during these last 2 days. The harvest decline during the third week of the season since 1991 was due to the shortening of the season to 15 days in most of Unit 12. The number of hunters who utilized the longer season in southern Unit 12 and the total harvest remained comparable with past years. Most of these hunters are guided nonresidents or residents of Chisana.

Transport Methods. During the past 5 years in Unit 12, most hunters used highway vehicles (40%), boats (16%), 3- or 4-wheelers (14%), airplanes (9%), other ORVs (8%), and horses (6%). Method of transport was unknown for 7% of the hunters. Hunters using highway vehicles have the lowest average success rate (12.6%), but traditionally take the greatest number of moose annually (Table 5). Hunters using horses have the highest success rate (65.2%). Horses are primarily used by guides to transport nonresident hunters. Success rates of hunters using airplanes (30%), 4-wheelers (27.6%), or ORVs (29.4%) are comparable. Traditionally, boats (20.4%) have not been efficient means of transportation for hunting moose in Unit 12 because of crowded hunting conditions along major rivers. In Unit 12 hunters who traveled away from the highways, major trails, and rivers had a 32% success rate during 1994 compared with the unitwide success rate of 19%.

Other Mortality

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Unit 12 and has maintained the population at a low density (0.42-0.58 moose/mi^2) since the mid-1970s. In contrast to other areas that contain sympatric moose, wolf, and grizzly bear populations, wolves—not grizzly bears— were the primary predators on moose calves on the Northway-Tetlin Flats. Wolf predation also appeared to be the greatest source of adult mortality. However, in other areas of Unit 12, fall composition data indicate grizzly bear predation on moose calves to 5 months of age was high. In most of Unit 12 the grizzly bear population is stable at an estimated natural Interior grizzly bear density (16–20 bears/1000 km^2). Between 1989 and 1993, calf and yearling recruitment in Unit 12 were at levels that indicate the population was stable to slightly declining. Unfavorable weather and predators were primary limiting factors.

Wolf populations have been fluctuating in Unit 12 at least since 1989 when tens of thousands of Nelchina and Mentasta caribou started to winter in or migrated through Unit 12. An effect of this large seasonal food source was an increased number of wolves in the unit. Between 1989 and 1992, the fall Unit 12 wolf population increased 34–41%, and during 1992–1993, there were 230–243 wolves in a minimum of 28 packs. The grizzly bear population probably declined in portions of the unit since the mid-1980s due to increased harvest by hunters (Gardner, in press). During this period moose calf survival appeared to hold steady (calf:cow ratios ranged between 24 and 30:100) and yearling moose survival appeared to decline (average yearling bull:cow ratio ranged between 7 and 13).

In 1992 the wolf population began to decline in Unit 12 due to increased harvest by trappers. The estimated decline within the unit was about 25%, but most of the decline occurred within the western portion of the unit. Over 40% of the harvest occurred within this area, and the estimated wolf population decline was 30–40%. By 1994 grizzly bear densities within the Tok and Tetlin River drainages and along the Nabesna Road probably had declined by 30% due to harvest by hunters. Effects of reduction in wolves and grizzly bears on the moose population is unknown, but during the next few years, we will evaluate effects on the moose population trend. However, considering the status and trend of major moose predators in most of the unit, I expect the Unit 12 moose population to remain at low density for an extended period.

HABITAT

Assessment

Only about 6000 mi^2 in Unit 12 are considered to be moose habitat. However, excessive wildfire suppression for nearly 30 years has allowed vast areas of potentially good moose habitat to become cloaked in spruce forests that lack high-quality deciduous moose browse. In response, we have conducted habitat enhancement work in Unit 12 since 1982. Over 1600 acres of old-aged, decadent willows have been intentionally disturbed to stimulate crown-sprouting of new leaders. This work has produced an estimated 2 million pounds of additional browse each year for wintering moose. In eastern Unit 12 the US Fish and Wildlife Service has conducted prescribed fires to benefit moose on the Tetlin National Wildlife Refuge.

Browse studies have shown that use of preferred browse species is low in relation to their availability and that disturbed sites were being used far more heavily than adjacent undisturbed areas. Currently, habitat is not limiting the moose population in Unit 12.

From June to September 1990, a wildfire burned approximately 97,000 acres of primarily decadent black spruce muskeg in the Tetlin Hills and adjacent Tok River lowlands. Quality moose browse species have recolonized much of this area and, in response, the area's moose population is increasing rapidly (from 0.19 moose/mi^2 to 0.6 moose/mi^2 by 1994). Quality moose winter browse supplies are expected to continue for the next 15 to 20 years.

Nonregulatory Management Problems/Needs. Throughout most of Unit 12, moose densities are low and can support only limited harvest. However, there are methods that potentially can be used in areas of low moose density to increase hunter opportunity without negatively limiting the population's ability to grow. In Unit 12 we initiated an early spike-fork season. This age class represents 15% of the bulls but composes only 2% of the harvest. By offering an early season hunt dedicated to this age class and antler configuration, we will increase hunter opportunity and possibly save some older bulls or larger yearlings during the later season, and potentially reduce poaching losses. Many areas of the state support low densities of moose but are important hunting areas, and probably some of these areas could use this harvest practice. In Units 12 and 20E, most people appreciated the extra season. Violations were minimal.

In Units 12 and 20E, moose composition and population trend have been primarily estimated using contour trend counts. Moose populations in these units are low density but concentrated in relatively small areas. Trend count surveys work in most years but occasionally weather or some other factor causes a shift in distribution, producing results difficult to interpret. In an attempt to improve our monitoring of the area's moose population, we have subdivided Units 12 and 20E into 4 major management areas and will be trying a new method of surveying. Each year we plan to census using a Gasaway-like census in 1 of these areas. We will also conduct 1 to 2 trend counts in the management areas not being censused each year. The areas we will sample are 1200 mi^2 and have been censused at least once during the past 8 years. During census years, we will stratify the area using data collected during past censuses and trend count surveys unless there has been a major alteration in the habitat (wildfire) or moose utilization of a particular area fluctuates. These areas will be stratified from the air prior to the census. Under this approach, we hope to obtain an unbiased population and composition estimate for 1 to 2 management areas annually, keep abreast of anomalies in other portions of the management area, and actually spend less money on moose counts. We have now completed 2 of these censuses and have obtained population estimates with a precision of ± 16% in 1994 in northwestern Unit 12 and ± 28.5% in 1995 in the Mosquito Flats area in Unit 20E. The primary problem in 1995 was a significant change in moose distribution within 3 traditional count areas. Had we not stratified and counted the entire area, we would never have distinguished this shift from a real change in the moose population. We will try a third area in 1996 and then evaluate the technique to see if we have improved our monitoring program or if contour trend counts with periodic censuses are the best methods for the area.

CONCLUSIONS AND RECOMMENDATIONS

Moose are far less numerous in Unit 12 than they were in the 1960s. The population increased during the late 1980s, but since 1989 has stabilized or slightly declined. Moose numbers, especially near the road system, are very low. Presently, annual harvests and hunter success are only one-third to one-half of what they had been in the 1970s. Furthermore, every year hundreds of Alaska Highway travelers comment on the lack of wildlife in the Upper Tanana

Valley. Habitat is not limiting, but predation and possibly illegal hunting in certain areas are maintaining the moose population at low densities. Since 1991 the moose population has grown within the area affected by the Tok wildfire. Residents of Tetlin and Tok and a growing number of nonlocal residents are beginning to use this area. However, current moose population size and trend in most of the unit is not meeting the needs of consumptive and nonconsumptive users.

In more accessible areas of Unit 12 the bull:cow ratio has declined to 20–30:100 due to moderate harvest rates and low yearling recruitment. In the Little Tok River, an antler restriction regulation was adopted to protect the bull:cow ratio yet allow maximum hunter opportunity. Harvest may also need to be restricted in a similar manner in the Tok and Robertson River drainages if the bull:cow ratios continue to decline.

A spike-fork season was implemented in 1995. Survey data indicated this antler configuration represented about 15% of the bull population annually but composed only 2% of the harvest. By offering a season strictly for spike-forks, more hunting opportunity is offered without limiting the population's ability to grow. Public support of the hunt during its first year was high. The actual harvest during the first year was 4 spike-fork bulls. We will monitor harvest success for 2 more years and possibly, extend the season.

A new moose surveying technique being tried in Units 12 and 20E yielding precisions of 16% to 28.5% may improve our ability to monitor the area's moose population. We will try the technique in 1996, evaluate the results, and decide on the usefulness of the technique.

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Table 1 Unit 12 aerial moose composition counts, 1988-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/hr
1988-1989	64	18	33	189	17	943	1133	40
1989-1990[a]	50	13	30	223	17	1094	1317	44
1990-1991	47	12	25	185	15	1071	1256	40
1991-1992	49	12	24	200	14	1264	1472	44
1992-1993	45	10	26	165	15	906	1071	32
1993-1994[b]	26	7	36	187	22	662	850	57
1994-1995[c]	38	16	39	87	21	327	414	
1994-1995[d]	97	13	25	47	11	374	421	44
1995-1996[d]	82	12	26	65	12	461	526	51

[a] Tok and Dry Tok were not surveyed. These survey areas normally yield a sample of 400+ moose.
[b] Cheslina and the northern face of the Nutzotin Mountains were not surveyed. These survey areas normally have about 100 bulls:100 cows.
[c] Based on census results from northwestern Unit 12.
[d] Cheslina, Kalukna, Nabesna, and Chisana count areas were sampled using contour survey techniques.

Table 2 Unit 12 moose harvest and accidental death, 1990-1994

Regulatory year	Harvest by hunters: Reported M (%)	F (%)	Unk	Total	Harvest by hunters: Estimated Unreported	Illegal	Total	Accidental death: Road	Train	Total	Total
1990-1991	94 (96)	0 (0)	4	98	15-20	30-40	45-60	4-5		4-5	147-163
1991-1992	109 (99)	0 (0)	1	110	15-20	30-40	45-60	4-5		4-5	159-175
1992-1993	71 (100)	0 (0)	0	71	15-20	30-40	45-60	4-5		4-5	120-136
1993-1994	91 (100)	0 (0)	0	91	15-20	30-45	45-65	5-7		5-7	141-163
1994-1995	87 (100)	0 (0)	1	88	15-20	30-45	45-65	7		7	140-160

Table 3 Unit 12 moose hunter residency and success, 1990-1994

Regulatory year	Successful				Unsuccessful				
	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Total hunters
1990-1991	45	26	17	98 (23)	186	131	15	332 (77)	430
1991-1992	48	49	13	110 (27)	160	132	9	305 (73)	415
1992-1993	23	35	12	71 (15)	222	164	13	408 (85)	479
1993-1994	38	33	18	91 (24)	186	90	12	289 (76)	380
1994-1995	43	28	17	88 (19)	240	118	15	374 (81)	462

[a] Residents of Units 12 and Units 20E and eastern 20D are considered local residents. Major population centers are Eagle, Chicken, Boundary, Northway, Tetlin, Tok, Tanacross, Slana, and Dot Lake.

[b] Total may include hunters who did not specify whether or not they were residents.

Table 4 Unit 12 moose harvest chronology by time period, 1990-1994

Regulatory year	Harvest periods					Total[a]
	9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/28-10/5	
1990-1991	18	41	28	4	3	98
1991-1992	34	45	22	4	1	110
1992-1993	25	31	6	4	4	71
1993-1994	29	40	16	4	0	91
1994-1995	25	26	25	3	4	88

[a] Difference between total and summation of harvests by week represents moose taken on unknown dates.

Table 5 Unit 12 moose harvest percent by transport method, 1990-1994

Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990-1991	17	15	21	11		6	23	5	98
1991-1992	10	14	10	25		14	25	2	110
1992-1993	18	23	10	11		10	28	0	71
1993-1994	8	19	15	22	0	16	18	2	91
1994-1995	10	20	19	18	0	7	23	2	88

LOCATION

GAME MANAGEMENT UNIT: 13 (23,376 mi^2)

GEOGRAPHIC DESCRIPTION: Nelchina and Upper Susitna rivers

BACKGROUND

Moose densities in Unit 13 were low during the early 1900s, but started to increase by the 1940s. Moose were abundant throughout the 1950s, and the population peaked in the mid-1960s. After peaking, the moose population declined and probably reached a low in 1975 when 41 moose per hour and 15 bulls:100 cows were observed during fall surveys. Factors contributing to the decline were severe winters, increased predation, and large human harvests of both bulls and cows. The number of moose counted during fall surveys increased in 1978 and climbed at an average annual rate of 5% until 1987 when the population peaked again. Since then, the moose numbers have declined.

Historically Unit 13 has been an important area for moose hunting in Alaska. Annual harvests were large, averaging over 1200 bulls and 200 cows during the late 1960s and early 1970s. Hunting seasons were long, with both fall and winter hunts. As moose numbers began to decline, harvests were reduced by eliminating both the cow season and winter season in 1972 and reducing fall bull seasons to 20 days in 1975. Harvests in the late 1970s averaged 775 bulls per year, but bull:cow ratios in the population were low. Beginning in 1980 the bag limit was changed from any bull, to bulls with an antler spread of at least 36 inches or 3 brow tines on at least 1 antler. Under this management regime, the 1980 bull harvest dropped to 557, down 34% from the 1979 harvest of 848. From 1981 through 1988 the harvest increased, peaking in 1988 with a harvest of 1259 moose. In 1985 the regulation for Unit 13A West was changed to allow the taking of only those bulls with spiked or forked antlers. In 1987 a limited permit hunt for any bull was also established in Unit 13A West. Cow hunts were held in 1988 for the first time in over 15 years. However, in 1990 seasons were reduced in length and permit cow hunts were canceled in response to population declines attributed to severe winters. Moose seasons were again liberalized starting in 1993.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Population Objective

To increase the unit population to 25,000 moose with a minimum of 25–30 bulls:100 cows, with a wide range of age classes, but a minimum 10–15 adult bulls:100 cows in the population.

Human Use Objective

To achieve and maintain an average annual human harvest rate of cows and bulls that stabilize the population and bull:cow ratios at the current population objective.

METHODS

We conducted aerial surveys during the fall to learn sex and age composition and population trends in count areas located throughout the unit. Censuses have been conducted periodically in different portions of the unit for population estimates. Surveys were flown during calving season to determine percent twins at birth. we monitored harvests by requiring permit and harvest ticket reports from all hunters. Habitat conditions have been periodically monitored by examination of browse utilization transects located in different portions of the unit. Attempts at habitat improvement include updating the Copper River Fire Management Plan. In this plan large portions of the unit are included in a limited fire suppression category, in which wildfires would be allowed to burn once ignition occurs. In addition, staff evaluated and responded to land–use proposals that could affect moose habitat.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Annual moose counts are conducted in established trend count areas within the unit. By keeping search intensities consistent between years, the numbers of moose counted per hour is a reliable indicator of long-term trends in moose numbers. However, some yearly variation in count data does occur, which may be attributed to movement patterns of moose, weather conditions, ability and experience of observers, and other uncontrollable factors. To compensate for these factors, a 3-year average of moose counted per hour was used to analyze population trends. Moose per hour figures are presented in Table 1.

Between 1986 and 1988 the fall moose per hour figure averaged 73. During 1992–94 the average was 59, a 21% decline in the number of moose counted between the 2 periods. The Unit 13 moose population is not evenly distributed throughout all 5 subunits and moose per hour figures derived for the whole unit are less meaningful than those on a subunit basis. When comparing the moose per hour figures for each subunit for the periods 1986–1988 and 1992–1994, we find different population trends. Moose per hour figures declined by 29% in 13B, 24% in 13D, 20% in 13C, 18% in 13E, and 6% in 13A. Based on count data, moose are most abundant in portions of 13C, while some of the lowest densities are in 13D. Fall 1995 count data was not included because a number of count areas had poor count conditions. In fact, the count conditions in 1995 were, by far, the worst observed in over 18 years because of inadequate snow cover. When there is inadequate snow cover, moose are more difficult to see and search time increases, making the comparison of results from other years more difficult.

Moose census results are the most accurate way to determine population status and trend, as they are much more intensive than fall composition counts. Unfortunately, they are very expensive and therefore infrequent. The problem with using 2 census estimates is they reflect conditions only for the time of the census; survey conditions and moose movement patterns can affect results. Ideally, as with moose trend counts, we would have more census data and be able to obtain averages. In Unit 13 the only area where 2 censuses are available for comparison is a portion of 13A West. The 1987 point estimate was calculated at 5189 moose (Bill Taylor, pers. commun.), while the 1994 point estimate was calculated at 3384 (a 35% decline).

Population Size

Periodic moose censuses have been completed in various Unit 13 subunits in recent years. A 1987 census conducted throughout all of Unit 13A West resulted in a population estimate of 5913 ± 725 moose (3.1 moose/mi^2). A smaller portion of Unit 13A West was censused in 1994 with a resulting estimate of 3385 ± 361 moose. Units 13B and 13C were censused in 1991. Unit 13B had 4644 ± 512 moose (1.9 moose/mi^2), while 13C had 3096 ± 461 moose (1.6 moose/mi$^{2)}$. Density estimates from fall sex and age composition range from a low of 0.3 moose/mi^2 in Unit 13D to a high of 2.3 moose/mi^2 in Unit 13C (Table 2).

Population Composition

Population composition data collected during fall sex and age composition counts from 1990 through 1995 are presented in Tables 1 and 2. The bull:cow ratio in Unit 13 was stable between 1990 and 1992–93 but is currently 32% below that level. The unit yearling bull:cow ratio declined from 12 yearlings:100 cows in 1988 to 4:100 in 1994, then increased slightly to 6:100 in 1995. There were 11 large (i.e., older than 1 year) bulls:100 cows observed unitwide in 1995. The current figure does not meet the management objective of 15 adult bulls:100 cows for the unit.

Analysis of bull:cow and calf:cow ratio data collected on fall sex and age composition counts may not give indications of changes in abundance if decreases or increases between sex and age group occur simultaneously. Because of this, unit and subunit trends in composition are also examined by comparing the number of bulls, cows, and calves counted per hour. Between 1989 and 1992 both the number of bulls and cows counted per hour in Unit 13 showed declines during the same years. Thus, even though both bulls and cows declined in number, the bull:cow ratio remained unchanged between 1989 and 1992. In 1993 the bull/hour figure declined while the number of cows counted per hour increased slightly. The continued decline by bulls and stabilization of cow numbers are reflected by a decline in the bull:cow ratio during the last 3 years.

Comparison of the bull:cow ratio on a subunit basis shows all subunits except 13A follow a trend similar to that observed unitwide. In Unit 13A the bull:cow ratio declined 60% from 1992 to 1995 (38:100 compared to 15:100). This is a direct result of a change in hunting regulations during 1993 that allowed for a very high harvest of adult bulls, especially in 1993 and 1994 when the season first opened. Prior to 1993, bulls were increasing in 13A because the hunting regulations prohibited the harvests of most adult bulls. Currently, only 13C and 13D meet the management objective of 15 adult bulls:100 cows (Table 2).

Table 1 shows calf:cow ratio figures for Unit 13 during the past 6 years. Calf production and/or survival have been low except during 1992 and 1993. The 25 calves:100 cows observed in 1993 approaches the calf:cow ratios obtained in the mid-1980s, when moose numbers were increasing in Unit 13.

Unit fall sex and age composition data show a 13% decline in the average number of cows counted per hour between 1986–88 (n = 47) and 1992–94 (n = 41). Comparing census data for 1987 and 1994 in 13A West shows a much greater decline of 34%. It is apparent the magnitude of the decline in the cow base varies between subunits. Overall, the decline in cows does not appear to be as great as the decline in the number of bulls or calves. Adult cows are the least vulnerable segment of the moose population to wolf predation and severe winters. Analysis of cows per hour data by each subunit follows a similar trend except the number of cows per hour in Subunit 13C has increased the last 2 years instead of stabilizing.

Productivity

Twinning rate is considered an index of productivity of the moose population (Ballard et al. 1991). Rates below 20% are thought to mean low productivity, rates between 20% and 40% are considered moderate, while twinning in excess of 40% are considered indicative of a highly productive population.

Twinning rate surveys were flown in Units 13E and 13B during early June 1995 and were timed to occur after estimated peak parturition dates for moose in these areas. Resulting twinning rates were 39% in Unit 13E and 28% in Unit 13B. Between 1977 and 1984 Ballard et al. (1991) had average twinning rates of 35% and 38% in these areas, respectively. In 1991, following a severe winter, twinning rates in Units 13A and 13E were 17% and 25%, respectively. Ballard et al. (1991) obtained an average twining rate of 20% in Unit 13A. Recent twinning surveys have followed historic productivity patterns with Units 13E and 13B having higher rates than Unit 13A.

Distribution and Movements

Data from fall composition surveys, censuses, and stratification flights indicated in recent years moose densities were highest in Units 13C, 13B, and 13A. Moose were especially abundant along the southern slopes of the Alaska Range in Units 13C and 13B, and the eastern Talkeetna Mountains in Unit 13 A. Unit 13D had the lowest observed density.

Fall rutting and postrutting concentrations occur in subalpine habitats, after which moose move down to wintering areas as snow depths increase. Known winter concentration areas include the upper Susitna River, Lake Louise Flats, the Tulsona Creek burn and the Copper River floodplain in Unit 13C.

MORTALITY

Harvest

Season and Bag Limit. Season dates in 1990 were 5–9 Sept. The bag limit was 1 bull having a 36-inch antler or 3 brow tines on one side in all of Unit 13, except 13A West where the bag limit was 1 bull having a spike or forked antler on one side. A Tier II permit hunt was held from 1–31 December for any size bull; we issued 500 permits. Season dates for the 1991 hunt were 5–11 Sep. The bag limit was the same as in 1990, except in that portion of 13A West north of the Black River where bulls with 3 brow tines or a 50" spread could be taken. The 1992 season was increased in length by 7 days with the season dates 1–14 September; however, use of motorized vehicles (except boats) off a maintained highway or road between 1–7 Sep. was prohibited. Season dates in 1993 and 1994 were 20 Aug–20 September. The bag limit was 1 bull having 50-inch or larger antlers or 3 brow tines on one side or 1 bull having a spike or fork antler on one side. In 1994 a bag limit of 1 cow was added in 13A West by drawing permit only. A federal subsistence hunt was established in 1990 for Unit 13 residents only with only 1 permit issued per household and a bag limit of any bull. This hunt has been held since on federal lands open to subsistence hunting, with current season dates of 20 Aug–20 Sep.

Board of Game Actions and Emergency Orders. During the March 1993 meeting, the Board brought major changes to the Unit 13 moose hunting seasons and bag limits. The hunting season was lengthened (doubled) and the definition of legal bull changed from one with a minimum 36-inch antler spread or 3 brow tines on one side to a 50-inch minimum spread, but the 3-brow tine requirement was maintained. Also, spike or forked horn yearlings were added to the bag limit as a legal animal. The Board also opened Unit 13 to nonresident hunters after a 3-year closure. In 1994, during the March meeting, the BOG created a drawing permit hunt for cows in Unit 13A West. During the March 1995 scheduled meeting of the Board, a Tier II permit moose hunt was established in Unit 13. The bag limit was 1 bull with any size antlers. The season dates were 1–15 August. There were 150 permits issued, but only 1 permit could be issued per household. The general harvest ticket hunt remained unchanged, but cow hunts in 13A West were not authorized for 1995. The Board also made changes in the moose management objectives for Unit 13. The moose population objective was established as 20,000 to 25,000 moose. Composition objectives adopted include a calf:cow ratio of 30 calves:100 cows and a yearling bull ratio of 10:100 during fall composition counts. The human-use objective established for the Unit 13 moose hunt was to provide a human harvest of 1200–2000 moose per year. These human use figures were adopted in relation to Board findings that human consumption of moose is the preferred use of moose in Unit 13. The board also determined the annual subsistence need to be 600 moose.

Hunter Harvest. In 1994–95, the total reported harvest for Unit 13 was 955 moose from the combined state and federal subsistence seasons (Table 3). This represented a 25% decline in the total harvest from the previous year's take of 1278. However, the 1994–95 take was still well above (56%) the average harvest of 612 moose per year between 1990 and 1992. Shorter seasons decreased moose harvests between 1990 and 1992. During the late 1980s prior to severe winters, the moose harvest approached 1200 a year.

A total of 6075 hunters reported hunting in Unit 13 during 1994. This is the highest hunting pressure ever reported in Unit 13 and up 128% from the 1990 figure of 2665. Short seasons were again responsible for decreased hunting effort between 1990 and 1992. Moose harvest figures from state harvest ticket returns between 1990 and 1992 include spike/fork bulls (n = 47, 63, 72) taken from 13A West; 50-inch or 3 brow tine bulls (n = 38, 32) from 13A West in 1991 and 1992, respectively; and the remaining bulls (n = 335, 486, 464), having 36-inch spreads or 3 brow tines.

Harvest ticket returns from 1993 showed a total of 1185 bulls taken during the general state hunt. For those bulls with known antler measurements, 18% were spike/forked bulls, 31% were less than 50 inches, and 51% were 50 inches or more. The harvest in Unit 13A (n = 500) was unusually high in 1993 because this was the first time in 3 years that unrestricted subunit hunting of large bulls was allowed. Thus, the number of large bulls available was the highest in the unit. In 1994, hunters reported taking 873 bulls during the general harvest ticket hunt. Reported size distribution for the harvest was 25% spike-fork, 37% less than 50 inches, and 38% with 50 inch or larger. After the initial harvest of large bulls in 1993, the subsequent large bull harvest was almost equally divided between bulls with less than 50 inch antler spread and presumably legal because of the presence of 3 or more brow tines and bulls with antlers of 50+ inches in width. Yearling bulls having spiked or forked antlers became more important to hunters by composing 25% of the 1994 harvest. Harvest ticket reports also indicate only 20–25% of those moose with antler spreads of less than 50" had 4 or more brow tines, while 40–50% of the bulls with 50+ inch antlers had 4 or more brow tines. If harvests need to be reduced further, going to a 4-brow-tine minimum will greatly reduce the number of <50" bulls taken.

The harvest in 1994 by subunit includes 13A - 257; 13B, 207; 13C - 130; 13D - 67; 13E - 205. The 1994 harvest in Unit 13A was substantially below (49%) the 1993 figure of 500 bulls. The reason for this was that large bulls had been virtually unhunted for 3 years in 13A West in 1993, and a large number of big bulls were available. The harvest of large bulls also declined in every other subunit in 1994 from that observed in 1993. The declines, however, were much less (10% in 13B, 11% in 13C, 32% in 13D, 14% in 13E) than those in 13A.

<u>Permit Hunts</u>. The current federal subsistence hunt replaced a previous State registration subsistence hunt in 1990. This action was a result of federal takeover of subsistence hunting on federal lands, following the McDowell decision by the State Supreme Court. This decision disallowed rural preference under State law. Federal law includes a rural residency preference. The Bureau of Land Management (BLM) assumed management of subsistence moose hunting on federal land, and BLM issues registration permits to applicants who are rural residents of Unit 13. BLM representatives issue permits in Glennallen and in other rural communities. Only 1 permit is issued per household. The bag limit is any bull. Harvests under this permit hunt are presented in Table 4. The number of households obtaining permits reflects this hunt's popularity with unit residents. Hunter success has dropped appreciably in this hunt (72%) because large tracts of federal land were selected by the state; thus, subsistence hunting was disallowed on those state-selected lands. Data for 1994 is incomplete as the federal subsistence section stopped supplying hunt data to the state.

Cow moose hunts were held by drawing permit in Unit 13A West in 1993 and 1994. These were the first cow hunts held in 13A since 1989. The total cow harvest for these hunts was 36 in 1993 and 39 in 1994. Table 4 presents permit hunt data for these hunts. Two of these (DM306 and DM308) are more remote, and hunter success is lower.

A winter Tier II hunt was held for any size bull from 1–31 December 1990; data from this hunt are also presented in Table 4. This was a one-time hunt established to give subsistence hunters a chance to take a moose. The dramatic reduction in season length from 20 days in 1989 to a 5-day season in 1990 did not allow sufficient opportunity for subsistence hunters to take a moose. Both participation and harvests were lower than expected for a winter hunt when bulls are more vulnerable. Deep snow and extremely cold weather, with temperatures often to -50°, restricted travel throughout December.

Hunter Residency and Success. Local residents of Unit 13 took 9% of the 1994 moose harvested under the general season, according to the harvest ticket returns (Table 5). During this 5-year reporting period, local residents averaged between 7% and 9% of the harvest. Nonresident moose hunters took 7% (*n* = 78) of the unit moose harvest in 1993, the first year they could hunt since 1989 and 10% (*n* = 87) in 1994. Alaskans residing outside Unit 13 took the remainder of the harvest.

The hunter success rate for moose in Unit 13 was 16% during 1994, down from the 22% success rate in 1993. The success rate between 1990 and 1993, a period with reduced seasons, averaged 21% (range = 19–23%). The reason hunter success rate didn't decline more during the period between 1990–92 was that hunter participation dropped 45% from 3631 hunters in 1989 to 2015 in 1990. Hunter success rate during this 5-year report period is down appreciably from the 26% average success rate observed in 1988 and 1989.

Successful moose hunters reported spending an average of 8.4 days hunting in 1994 compared to 6.0 days in 1989, the last year the season length was long enough to make comparisons of effort data meaningful. Between 1990 and 1992, the seasons were so short they disrupted normal hunting patterns, and average days spent hunting reflect season length, not normal hunt patterns. Hunting effort increased dramatically during 1993 and 1994. In 1989 harvest ticket returns show that 3536 hunters reported an average of 5.9 days hunting for a total of 21,240 days hunting moose in Unit 13. Harvest reports in 1994 indicate 5549 hunters spent 8.7 days hunting for a total of 48,794 days afield. This represents a 130% increase in hunting effort in Unit 13.

Harvest Chronology. Chronology data in 1990 and 1991 have little meaning because the hunting seasons were only 5 and 7 days long. Chronology data for 1992 (Table 6) indicates most moose harvest occurred late in the season. Due to vehicle restrictions, the first part of the season was virtually a roadside hunt, but few moose are available along the road system. Comparison of chronology data between 1993 and 1994 show similar harvest patterns. There is an initial high harvest the first week because of an "opening day phenomenon," then a mid-season decline. The last 2 weeks are especially important with over half the 1994 harvest occurring then. This harvest pattern is predictable because moose are more vulnerable later in September. Leaf fall starts at this time and onset of the rut initiates calling and increased bull movements.

Transport Methods. During the last 2 years of this reporting period, 4-wheelers have been the most important method of transportation (Table 7). It is obvious that Unit 13 is an important 4-wheeler and off-road vehicle area for moose hunters. In the last 2 years hunters using either 4-wheelers or ORVs have accounted for 58% of the total moose harvest.

Other Mortality

Brown bear and wolf predation on moose directly influences moose abundance in Unit 13. Brown bears are major predators of moose calves and kill a high percentage of annual calf production (Ballard et al. 1981). Brown bears are considered relatively abundant in Unit 13 for an interior population. Brown bear harvests by sport hunters increased during the 1980s when the bear season was liberalized and bag limit reduced. The effect of increased sport harvests of brown bears on overall bear numbers in Unit_13 is unclear. Current harvest rates of brown bears are thought to exceed calculated sustainable harvest levels in some portions of the unit such as Unit 13E, and it was believed bear numbers had declined in heavily hunted areas. A 1987 census in the upper Susitna River of 13E indicated a 50% decline in bear numbers could have occurred; however, confidence level overlap of the estimates could also lead to the conclusion there was much less of a reduction (Miller 1988). A 1995 bear census in another portion of Unit 13E, adjacent to the 1987 study area but more remote, led to the conclusion that bear numbers in that area were stable or increased slightly since 1985, despite high bear harvests by sport hunters (Miller 1995).

Research to determine effects of increased brown bear harvests on moose calf survival has not been conducted. We know a large reduction in bear numbers (as much as 60%) during calving did result in increased calf survival in the upper Susitna River area in 1979 (Ballard et al. 1987). We do not know if lesser reductions in bear numbers will actually reduce predation on neonatal moose calves. The situation in Unit 13 is such that we cannot conclude from existing brown bear census data that bear numbers have even been reduced enough in portions of the unit to expect an increase in neonatal moose calf survival. Certainly the sport harvest has not reduced bear numbers as much as have translocations of bears out of the Upper Susitna calving area. Further complicating the issue is that wolves are more abundant now than during the translocation period. Any increased moose calf survival due to a small reduction in bear numbers may be negated by increased wolf predation.

Wolf numbers in Unit 13 increased in 1990 and have been high ever since. As a result, wolf predation has been considered a more important factor controlling moose abundance. Before 1990, spring estimates of wolf numbers in Unit 13 after hunting and trapping seasons averaged 150 wolves. Since 1990 spring estimates have averaged 232 wolves. The fall 1994 estimate was approximately 350 wolves (8.1 wolves/1000 km^2). During the last 5 years, wolf densities peaked in portions of Unit 13B at 23.2 wolves/1000 km^2. Field observations of wolf predation on moose have increased notably. Predation on caribou during the winter has not increased enough to take the pressure off the moose population because most of the Nelchina herd leaves Unit 13 for 6–7 months and winters in Units 12 and 20 and Canada. Even when caribou are present, wolves still prey on moose (Ballard et al. 1987).

Natural mortality attributed to deep snow conditions increased in the late 1980s. Between 1989 and 1994 every winter was classified as severe, based on deep snow depths observed at 17 snow courses scattered throughout the unit. Although we consider these winters severe unitwide, variation in snow depths occurred between subunits. Observations in different portions of Unit 13 over the years have led to the conclusion that moose mortality due to deep snow conditions has not been density dependent. There appears to be a threshold effect where once snow reaches a certain depth, calf mortality increases. As snow depths increase, yearlings, then adult bulls, and finally adult cows die, regardless of moose densities. In addition to killing moose, deep snows often make it easier for wolves to take moose; thus, predation rates also increased.

PRELIMINARY 1995 HARVEST

We obtained preliminary harvest figures for the 1995 moose season by hand-tabulating harvest report forms. To date, a total of 869 bull moose have been reported taken in Unit 13 during the 1995 season under the general state hunt. This figure is virtually identical to the prior year's take for the general hunt. Harvest composition under the general hunt as reported by hunters from harvest ticket returns is also similar to last year's with 23% yearlings, 41% bulls having a spread less than 50 inches and 36% having 50-inch or greater spread. The preliminary federal subsistence harvest is 32 bulls and the State Tier II subsistence hunt harvest is 26 bulls.

HABITAT

Assessment

Unit 13 has numerous areas where habitat improvement could produce more favorable browse conditions for moose. Because of the size and remoteness of much of the unit, wildfire is considered the only feasible tool for extensive habitat improvement. Wildfires occurred throughout much of Unit 13 before 1950, when fire suppression activities were initiated. Since then negligible acreage has burned. The most significant fire in recent years occurred in 1991, when approximately 5500 acres burned on the west-side of Tazlina Lake in Unit 13D. This was the first wildfire in a limited suppression area that was allowed to burn, following procedures mandated by the Copper River Fire Management Plan. This plan, established several years ago, has for the most part been ignored and most wildfires have been suppressed, even if they occurred in an area designated as limited suppression. Fire suppression has reduced seral habitat available as moose browse and has lowered the moose carrying capacity over extensive portions of Unit 13. Currently, climax upland and riparian willow communities are the most used habitat types for moose in the unit. Evaluation of browse in important moose areas from 1983 to 1986 indicates browse species were able to withstand the level of use occurring at that time and current estimates of moose numbers are lower now than then.

Use of prescribed fires is another method of improving moose habitat. However, the climate in Unit 13 typically limits the use of prescribed fire to only the very driest years. Also, liability associated with the use of prescribed fire decreases the possibility of extensive use of fire, especially near communities.

Habitat improvement by mechanical methods such as crushing is an alternative to burning. To be effective, mechanical treatment must be done on sites where moose concentrate during critical winter months which in Unit 13 means riparian habitats. However, mechanical treatment is expensive; costs limit mechanical treatment to small but important concentration areas near the road system where access is available for heavy equipment. A small strip of riparian willow habitat along the Gulkana River above Paxson that is important winter habitat and heavily browsed by moose during recent severe winters was cut with the use of a hydro-ax in the spring of 1993. Initial willow regeneration is good. Other sites for mechanical treatment have been identified along the Copper River in Unit 13C where moose also winter during deep snow years. However, despite funding availability, landowners have not granted permission to crush this area.

CONCLUSIONS AND RECOMMENDATIONS

We determined moose population trends by comparing changes in the number of moose counted per hour during fall sex and age composition surveys. A 3-year average was used in comparing trends to minimize the effect of movements, weather patterns, survey conditions, and observer biases in any one year. Moose per hour figure from the late 1980s until the present indicate moose numbers have declined in Unit 13 by 20%. Most of the unitwide decline occurred between 1989 and 1991, with subsequent reductions at a lower rate. Population trends by subunit have also been more variable since 1991. On a subunit basis, the largest declines occurred in 13B. Unit 13B is a large subunit with prior high moose density and a very popular hunting area. Surprisingly, Subunit 13D showed an appreciable decline in moose observed per hour. This subunit has had a relatively low moose density and appears to have been relatively stable for over 20 years. Unit 13A had the lowest decline in the number of moose sighted per hour during fall sex and age composition counts and was thought to have the smallest percent decline in moose numbers of any subunit. However, comparison of census data between 1987 and 1994 contradicts this conclusion. The reason for the large difference in estimating the decline is unknown. Explanations include the following: 1) moose movements in the composition count area have a larger influence on results because the count unit is much smaller than areas usually surveyed during a census; 2) moose per hour figures are an index of abundance and more affected by factors beyond control, such as movements, changes in sightability, and observer bias; 3) unusual moose movements between subunits or unusual weather conditions during one of the censuses can influence the count; thus, the contrasts will be greater even though the population changes were not as great.

The decline in moose numbers observed since 1989 in Unit 13 included all sex and age classes of moose. The duration and magnitude of the decline varies by sex and age class and by subunit. The number of bulls counted per hour has declined by 31% unitwide from the late 1980s. The bull:cow ratio also showed a decline of 31%. The decline in bulls has been in both the adult and yearling age classes. Bull:cow ratios declined the most in Unit 13A. This was due to the fact that large bulls had been only minimally harvested until 1993, when a very large harvest occurred the first year of a general open season.

The number of calves declined in Unit 13 between 1988 and 1992, increased for 2 years, but has declined again during the last 2 years. The largest decline in calves, based on calf per hour figures, was in Unit 13B, while Unit 13A had the smallest decline.

Cow moose exhibited the greatest decline unitwide between 1989 and 1991, yet the number of cows counted per hour the last few years has stabilized.

Declines in all sex and age categories indicate the decline in moose numbers was due to both increased adult mortality and decreased calf recruitment. Adult cow mortality declined after 1991. Calf production and survival to fall increased in 1992 and 1993, but overwinter mortality of calves remained high, based on low fall yearling bull counts. Severe winters and increased predation by wolves are considered the main causes of adult mortality and decreased calf production and survival. Variations in calf production and survival between subunits reflect both varying snow depths and wolf densities between subunits. Currently, overwinter survival of calves must improve if moose numbers are to increase. Determining overwinter survival will be more difficult under current hunting regulations that allow harvests of yearling bulls. Yearling bull:cow ratios have been used in the past to evaluate calf recruitment. Moose numbers are likely to decline further given current trends in winter severity and wolf numbers.

Many consider spring twinning rates as an index of productivity for a moose population. We assume twinning rates from spring aerial surveys are similar to those at birth. Twinning rates observed in 1995 in 13B and 13E indicate moderate to high productivity in these portions of Unit 13. Historic data shows variability between years. This variability may be due to differences in weather, particularly winter severity, or predation. Lower twinning rates in 1991, compared to those in 1995, were influenced by more severe weather during the winter of 1990–91.

During this reporting period, numerous management actions have taken place to limit harvests during a period of declining moose numbers. The initial approach to reducing harvests was to reduce season length. Between 1990 and 1992 the moose seasons were very short. The result of this management action was to reduce the harvest, thus maintaining a bull:cow ratio within the stated management objective. However, very short seasons created crowding problems and reduced opportunity to hunt; they were unacceptable on a long-term basis. As a result, the focus of management actions changed from season length to bag limit. Reducing the number of moose that fit the definition of a legal animal could also reduce the harvest. In 1993 the bag limit was in effect reduced by increasing the minimum antler spread required for a legal bull from 36" to 50". Because a large number of the bulls in Unit 13 are young with less than 50" spreads, the harvest was reduced. Some liberalization of hunting regulations did occur, however, as spike or forked yearlings were included as a legal bull. The theory behind this strategy is that at least half of the yearling bulls have antlers larger than spike/forks and will not be harvested, thus assuring annual bull recruitment. Also, 2- or 3-year cohorts of bulls with antlers smaller than 50" or having less than 3 brow tines will not be harvested and will be available to breed.

Harvest results from the 1993 and 1994 seasons in Unit 13 indicate this harvest strategy may work over the long term in Unit 13. Overall, the observed drop in the bull:cow ratio was attributed to a very high adult bull harvest in 13A West. In those subunits (13B and 13E) with adult bull:cow ratios below the current management objectives, much of the decline in bulls occurred prior to the spike-fork or 50-inch regulation taking effect. Low bull:cow ratios are due more to poor calf recruitment than high human harvests. If calf recruitment could be increased to levels observed during the mid-1980s, the bull:cow ratio could increase. Hunting pressure is so heavy that most legal bulls are taken during the current long season. Also, access has increased and few nonhunted areas, or refugia, are left in Unit 13. Recent predictions of the effect of continued low calf recruitment on bull:cow ratios, under the current hunting regulations, suggest bull:cow ratios will stabilize near the present level.

Predation by brown bears and wolves on moose in Unit 13 is a very important source of mortality and limits moose abundance. Hunting regulations for brown bears have been liberalized and bear harvests increased over the past few years. Current census data is inconclusive as to bear population trends in Unit 13. To date, it appears that liberalizing seasons and bag limits for bears increased the harvest, but may not have reduced bear numbers. Research is needed to determine if sport harvests of brown bears under current regulations can effect a reduction in bear numbers, and if so, will the reduction in bear numbers result in reduced predation of neonatal moose calves. Wolf predation on moose has increased in recent years due to increased wolf numbers. The increase in wolves is due to reduced harvests because of regulations restricting use of aircraft in harvesting wolves.

The Unit 13 wolf population is controlled by commercial trappers. Fur prices and access (snow conditions) influence commercial trapping activity. In years with low wolf harvests, wolf numbers and wolf predation have increased.

Moose mortality due to severe winter weather continues but at a lower rate. Although the last 2 winters have been classified as severe, snow depths were not as deep unitwide and mortality rates are thought to be lower. In very severe winters all sex and age classes exhibited mortality; adult cows had the lowest and calves the highest.

Recommendations for future management and research emphasis for moose in Unit 13 are listed.

- Maintain the current spike-fork 50-inch regulation for the full 5-year period initially requested to fully evaluate its effect.
- Reestablish cow hunts in Unit 13A West when research data shows yearly recruitment can allow the harvest of cows.
- Monitor wolf numbers yearly to determine wolf population trends and effects on moose abundance.
- Determine if brown bear harvests by sport hunters can effectively reduce brown bear numbers in all but a few small areas and evaluate the effect of reducing bear numbers on neonatal moose calf survivorship.

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Table 1 Unit 13 fall aerial moose composition counts and estimated population size, 1990–95

Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Adults	Total moose observed	Moose /hour	Density moose mi2 (range)
1990/91	25	5	18	13	5427	6209	59	1.5 (.5–2.8)
1991/92	25	6	17	12	5556	6295	58	1.4 (.6–2.6)
1992/93	25	9	24	16	5398	6438	61	1.6 (1.1–2.5)
1993/94	23	8	25	17	4072	4905	60	1.4 (0.4–2.8)
1994/95	18	4	17	12	4255	4854	55	1.3 (0.3–2.8)
1995/96	17	6	19	14	4259	4951	44	1.4 (0.8–3.4)

Table 2 Unit 13 fall aerial moose composition counts, 1994[a]

Subunit	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves %	Moose observed	Moose /hour	Density moose/mi^2 range
13A	12	1	13	10	1286	61	1.3
13B	18	5	21	15	2283	54	1.5
13C	21	6	16	12	539	72	2.3
13D	68	8	10	6	121	26	0.3
13E	15	4	10	8	455	59	1.0

Table 3 Unit 13 moose harvest[a] and accidental death, 1990–95

Regulatory Year	Hunter Harvest: Reported M	F	Total[b]	Estimated: Unreported	Illegal	Total	Accidental: Road	Train[c]	Total	Grand total
1990/91	521	0	521	25	10	35	50	31	81	637
1991/92	688	1	689	25	10	35	50	35	85	809
1992/93	624	0	627	25	10	35	50	93	143	805
1993/94	1240	34	1278	25	10	35	50	25	75	1388
1994/95	904	40	955	25	10	35	50	29	79	1069

[a] Includes permit hunt harvest, harvest tickets and federal subsistence hunts.
[b] Includes unknown sex.
[c] 13E - the Alaska Railroad.

Table 4 Unit 13 moose harvest data by permit hunt, 1990–94

Hunt Nr	Regulatory Year	Permits issued	Percent did not hunt	Percent Unsuccessful hunters	Percent Successful hunters	Bulls	Cows	Unk	Total harvest
Tier II									
900T	1990/91	500	35	80	20	65	0	0	65
BLM Subsistence									
913	1990/91	593	39	78	22	74	0	0	74
	1991/92	722	24	81	19	102	0	0	102
	1992/93	659	29	87	13	56	0	0	56
	1993/94	550	32	86	14	51	0	0	51
	1994/95	541	28	92	8	30	0	0	30
Drawing Permits – Cows									
DM 306	1993/94	25	33	38	62	3	7	0	10
	1994/95	25	25	44	56	0	10	0	10
DM 308	1993/94	25	24	57	43	0	8	0	8
	1994/95	25	17	50	50	0	10	0	10
DM 310	1993/94	25	16	15	85	1	17	0	18
	1994/95	25	12	14	86	2	17	0	19

Table 5 Unit 13 moose hunter residency and success for general harvest ticket hunt only, 1990–1994

Regulatory Year	Successful Local resident[a]	Successful Nonlocal resident	Successful Nonresident	Successful Total[b]	Unsuccessful Local resident[a]	Unsuccessful Nonlocal resident	Unsuccessful Nonresident	Unsuccessful Total[b]	Total hunters
1990/91	28	341	1	382	258	1325	2	1633	2015
1991/92	52	529	1	587	314	1579	4	1922	2509
1992/93	2	516	0	571	331	1799	10	2202	2773
1993/94	89	992	78	1191	447	3532	83	4175	5366
1994/95	83	707	87	886	480	4077	160	4765	5651

[a] Residents of Unit 13
[b] Includes unspecified residency

Table 6 Unit 13 moose harvest chronology percent by time period for general harvest ticket hunt only, 1990–94

Year	Season dates	Week of Season 1st	2nd	3rd	4th	5th	*n*
1990	5–9 Sep	93	7				361
1991	5–11 Sep	55	45				545
1992	1–14 Sep	6	28	66			535
1993	20 Aug–20 Sep	21	11	22	26	20	1132
1994	20 Aug–20 Sep	17	10	19	27	27	841

Table 7 Unit 13 moose harvest percent by transport method for general harvest ticket hunt only, 1990–94

Regulatory year	Percent of Harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	*n*
1990/91	11	3	11	20	0	33	19	2	382
1991/92	12	3	11	23	0	34	14	3	587
1992/93	16	5	10	18	0	25	23	3	571
1993/94	16	3	6	30	0	29	14	2	1191
1994/95	15	3	8	36	0	21	16	1	886

LOCATION

GAME MANAGEMENT UNIT: 14A (2,561 mi.^{2})

GEOGRAPHIC DESCRIPTION: Matanuska Valley

BACKGROUND

Moose numbers in the Matanuska Valley increased from low levels before 1930 to numbers ranging between 2000 and 7000. Moose numbers peaked in the late 1960s, but declined in the early 1970s, following 2 deep snow winters and large cow harvests. The population again peaked during the late 1980s and has remained high. During the deep snow winter of 1989–90, numbers of moose declined 15–25% (Griese 1993) but recovered by the next fall through reduced hunter harvest.

In the 34 years following statehood (1960–94), hunters reported a harvest of more than 19,220 moose in Unit 14A. Annual harvest levels in the first 12 years (1960–71) ranged from 200–1300. The harvest was predominantly bulls, averaging 350 annually, but harvest of antlerless moose reached high levels during 1962–63, 1965–66, and 1971–72. The antlerless moose harvest was highest, reaching 1131 in 1962–63. Antlerless moose seasons were eliminated during 1972–77, and the mean annual harvest of bulls declined to 251 (range = 167–346). Antlerless seasons were again allowed during 1978–1994, with the exception of 1990. Since 1978 annual cow harvest has averaged 125 (range = 0–242). Annual harvest of bulls during 1979–1992 averaged 367 (range 201–530), but during 1993–94 bull harvest declined to an average of 257 (233–281) in response to bag limit restrictions.

In 1993 bull harvest during the general season was restricted to moose with antlers having a spike or fork on at least 1 side or a minimum of 3 brow tines on at least 1 side or a minimum total width of 50 inches. This harvest strategy is referred to as "spike-fork–50-inch" (SF50). Retaining this strategy for a full 5 years was recommended for full evaluation (Griese 1995).

During the early 1980s nonhunting mortality became responsible for up to 25% of total annual moose mortality. A construction boom in the Matanuska Valley and a series of moderate snow depth winters resulted in increased conflicts between man and moose. Moose browse declined on traditional winter ranges while browse increased along roadways and in subdivisions. The new browse sources attracted moose to areas with increased vehicle traffic. Motorists began killing 100–250 moose on roadways annually. Trains killed 4–45 moose annually (100 moose were killed by trains in 1989–90). Illegal harvest was assumed to increase proportionally to the human population. With total annual human-caused mortality averaging 800 moose, population numbers stabilized at 5000–6000 moose (Griese 1995).

Efforts to maintain adequate quantities of winter habitat during the 1980s included promotion of timber sales, chaining or blading of mature habitat, and establishment of the Matanuska Valley Moose Range (MVMR) in 1984. In recent years we have improved methods for disturbing soils, using a disc trencher, following timber sales. During 1993 a cooperative effort between state agencies resulted in the first large-scale controlled burn to enhance wintering moose habitat (Collins 1996).

MANAGEMENT DIRECTION

MANAGEMENT GOALS

To produce high yields of moose for humans and to provide maximum opportunity to participate in hunting for moose

To provide opportunities for nonconsumptive uses.

POPULATION OBJECTIVES

To maintain a population of about 5000–5500 moose with a minimum sex ratio of 20 bulls:100 cows.

HUMAN USE OBJECTIVE

To achieve and maintain an average annual hunter harvest of 600–700 moose by 1995.

METHODS

During 25–29 November 1993, a "Becker survey" (E. Becker, pers commun) was conducted in the subunit. We sampled 27 sample units (SU) from 4 density strata, including 5 super-high strata, 11 high, 6 medium and 5 low-density strata. Stratification in a Becker survey is completed in the office, relying on existing knowledge of habitat and moose distribution. Intensive subsampling of 19 SU allowed the estimation of a sightability correction factor (SCF), applicable to this survey. MOOSEPOP (D. Reed, pers commun) was used to calculate population size and sex and age composition.

During 30 October–7 November 1994, 22 of the 28 SU sampled during the December 1991 random stratified survey (RSS) (Gasaway et al. 1986) were again surveyed without conducting intensive subsampling to estimate a SCF. Based on the strata assigned during 1991, the 1994 sample was composed of 3 low, 10 medium, 6 high and 3 super high-density SU. Two additional SU were surveyed to evaluate trends at Pt. McKenzie agricultural lands but were not included in overall composition calculations.

The fall 1994 subunit composition (Table 1) was estimated by comparing results of observed composition to calculated composition using MOOSEPOP. The relationship of the 1991 SU observed composition ratios to the calculated ratios of the population, derived from a RSS using MOOSEPOP, was assumed to be the same relationship between the 1994 observed ratio and the actual 1994 population composition.

$$\frac{\text{Calculated ratio}_{91}}{\text{Observed ratio}_{91}} = \frac{\text{Estimated ratio}_{94}}{\text{Observed ratio}_{94}}$$

This same method was used to correct composition ratios for the 1992 aerial survey data also presented in Table 1.

Population size (Table 1) and trend were evaluated by a direct comparison of total moose observed in 17 SU (subsample of the 22 SU mentioned above) which had been surveyed during 1991, 1992, and 1994 (Table 2).

Lack of snow during the fall and early winter of 1995–96 prevented collection of fall 1995 composition data. However, we aerially sampled a portion of the primary wintering habitat in the subunit during late March 1996 to assess percent short-yearlings in the population and potential recruitment. We conducted similar aerial surveys during 1994 and 1995 (Table 3).

We determined the harvest of bulls during the general season and antlerless moose from permit hunts by successful hunters' harvest and permit reports. Numbers of moose killed by trains was provided by the Alaska Railroad Corporation, and numbers of moose killed by highway vehicles, killed illegally, or killed in defense of life or property (DLP) were provided by Department of Public Safety. Age categories (calf, yearling, adult) and sex of road and railroad mortalities were taken from reports by charities receiving the carcasses. We required the charities to surrender moose incisors.

Incisors and antler characteristics (i.e., width, number of main palm points, and number of brow palm points) were collected from successful any-bull permit holders and a small number of bulls harvested during the general season. We will use the information collected from these samples to evaluate the appropriateness of the SF50 antler strategy in Units 14A, 14B, and 16A.

In February 1995, we captured and radiotagged 31 cow moose in the lower Matanuska River, primarily in the Palmer Hay Flats State Game Refuge adjacent to the Glenn Highway, in an attempt to identify the seasonal distribution of these moose. The high number of wintering moose in close association with the highway during the winter pose a threat to motorists but offer opportunity for viewing. We captured moose from a Hughes 500 helicopter, using carfentanil citrate (Wilnil, Wildlife Pharmaceuticals, Inc., Ft. Collins, Colorado, US) and dart gun. We radiotracked and located tagged moose 4 times before June 30. Their position was marked using global positioning system equipment. Wildlife Forever, a hunter sponsored organization, provided $4,000 to begin this project.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Moose numbers in Unit 14A remained stable at high densities (Table 1) during the period 1991–1994. Any declines observed in cow or calf segments were compensated by increases in the bull segment, especially the medium bull portion (Table 2), which was a product of the SF50 regulation.

Population Size

The December 1993 "Becker" survey resulted in an estimate of 5,672±798 (80% CI) observable moose, a density of 3.6 observable moose/mi^2 (Table 1). Snow and frost in trees caused the SCF to reach 1.31, which was higher than the 1.17 SCF obtained during December 1991.

Based on a 2% increase in observed moose in the comparable set of SU from 1991 and 1994 (Table 2), we assumed the population to be between 5500 and 6500 during fall 1994 (Table 1).

The subunit population declined during the winter of 1994–95, during which calf survival to yearling was below average (Table 3) and highway- and railroad-caused winter mortality was high (Table 4). These factors resulted in a population estimate for fall 1995 of 5000–6000 (Table 1). Lack of a fall aerial survey prevented documentation of the extent of the decline.

Population Composition

Between 1991 and 1994, the cow segment as observed in the 17 comparable SU in the subunit remained unchanged, whereas the bull segment declined in response to heavy hunting pressure and then recovered in response to SF50 regulations (Table 2). Following the persistent, deep snow winter of 1989–90 and the subsequent fall 1990 hunting season, the bull:cow ratio declined to 14 bulls:100 cows. The November 1992 fall composition survey suggested the ratio had declined further. The bull:cow ratio recovered from 9:100 during 1992 to 21:100 in 1994 (Table 1) as a product of reduced bull harvest (Table 4) in response to the SF50 regulation. The decline in bulls was caused by winter mortality and hunting (Griese 1993).

The fall calf component exhibited a declining trend during 1991–1994 (Table 1). The decline exhibited by calf:cow ratios and % calves in Table 1 reflected the 5% decline in total observed calves in Table 2. Of note is the increase in the number and proportion of cows with calves having twins (Table 2).

Distribution and Movements

We are conducting a population identification project that has given us unexpected results. Aerial relocation of the 31 radiotagged cow moose wintering in the Palmer Hay Flats State Game Refuge occurred on 3 April, 1 May, 31 May, and 13 June. By 13 June only 6 cows remained near or within the capture area, 1 cow had been killed by a highway vehicle on Knik-Goose Bay Road (west of the capture area), 1 died of unknown causes, 3 cows slipped their collars, and the remainder dispersed west or northwest as far as 20–30 miles. Surprisingly, no moose in the sample appeared to arrive at this wintering area from the portion of the subunit north of Palmer and Wasilla as postulated. Likewise, we had failed expectations when no moose in the sample arrived from the east in the Jim Lake–upper Knik River Valley portion of Unit 14A nor Unit 14C to the south.

The high percentage of collared animals lost from the sample was discouraging. As this project continues, we will attempt to minimize slippage of collars. To meet sample size objectives, we should capture additional cows during winter 1995–96.

MORTALITY

Harvest

Season and Bag Limit. The open season for resident and nonresident hunters included a general season from 20 August–20 September and antlerless permit hunts during 20 August–20 September and 1–15 November during 1993–1994. During the general season the bag limit was 1 bull with antlers having either a spike (1 point) or fork (2 points) on at least 1 side, or having a minimum of 3 brow tines on at least 1 side, or having a total antler width of 50 inches or greater. The department offered 400 permits for antlerless moose during 20 August–20 September for both 1993–94 and 1994–95 and 70 and 100 permits to take antlerless moose during 1–15 November during 1993–94 and 1994–95, respectively.

Board of Game Actions and Emergency Orders. Declining bull:cow ratios and increased hunting effort in the subunit caused by restricted opportunities in adjacent subunits prompted the Board of Game to adopt SF50 antler restrictions for Unit 14A (in addition to most road accessible areas of southcentral Alaska) during 1993. The Board also increased season length to 32 days (August 20–September 20).

During 1993 the Board adopted a department request to increase the potential antlerless moose permits from 400 to 600, to be divided between the early season, August 20–September 20, and a late season, November 1–15. The late season permit hunt was designed to intercept moose approaching residential areas. The late hunt was expected to reduce human–moose conflicts in the residential areas and on roadways.

During spring 1995 the Board adopted regulations that added any bull drawing permit hunts, a 10–17 August archery only SF50 season, and a 20 November–15 December spike-fork-only general hunt. We authorized 300 any-bull permits for 2 periods, 20 August–20 September and 1–15 November. These significant additions reflected the Board's desire to increase opportunities for hunters after receiving assurances from department staff that current SF50 restrictions adequately protected bull:cow ratios.

Hunter Harvest. Although the hunter harvest of bull moose declined in response to SF50 restrictions, harvest of cows increased to the highest levels since 1971. The reported harvest of 233 and 281 bulls during 1993–94 and 1994–95, respectively (Table 4), the first 2 years of SF50 restrictions, approached levels previously predicted through modeling (Griese 1995). Harvest was expected to reach 240 and 265 in the initial 2 years. Cow harvest exceeded 200 (Table 4) for the first time since 479 cows were reported killed during 1971. Harvest of cows increased in response to an additional 70–100 permits issued for antlerless moose for the November hunt.

As expected, the highest portion of the bull harvest during the first 2 years of the SF50 strategy were spike- or fork-antlered yearling bulls. Assuming that reported antler widths under 30 inches were bulls with spike or fork antlers (see "Antler–age comparision" below) and antler widths between 30 and 49.9 inches reflected antlers with 3 or more brow tines, the spike–fork segment averaged 69% of the bull harvest in which antler size was reported. Those bulls having 3 or more brow tines averaged 18%, while those with spreads of 50 inches or greater averaged 13% of the bull harvest.

Other human-caused moose mortality reached the second highest level in the last 20 years during 1994–95. Relatively deep persistent snow caused the highest recorded highway kill (260) in the subunit (Table 4), higher than the deep snow winter of 1989–90 when 250 kills were reported. Notably, trains killed 60 fewer moose in 1994–95 than during the record of 100 killed during 1989–90.

Adding to the high accidental mortality of 1994–95 was a higher than normal "illegal harvest." Moose reported killed in defense-of-life-or-property (DLP) reached 19 and are included in the illegal category of Table 4. The number of illegal moose, primarily illegal bulls, have increased in units where the SF50 regulation has been in effect (Schwartz et al. 1992). Enforcement officers (M. Kincaid, pers commun) indicated higher illegal bull harvests, and in 1993–94 we began including these illegal bull harvest estimates in our total estimates.

Antler–age Comparison. A preliminary sample of 130 sets of antlers and incisors of moose from Units 14A, 14B and 16A led us to 5 conclusions: 1) 62% of yearling males were spike or fork antlered bulls; 2) bulls attained 50-inch antler width at age 5 or 6; 3) 30-inch or less antler width best defines yearling bulls when looking only at antler width; 4) a significant portion of this population of moose may not ever meet 50-inch qualifications (Figure 1); and 5) antlers with 3 or more brow tines are not prevalent in the sample but begin a strong showing at age 4 (Figure 2). The sample also indicates that few spike–fork antlers exceed a 30-inch width and few 3- or-more-brow-tine antlers are less than 35 inches in width. These preliminary findings support dividing hunter reported harvest antler width, when only width information is provided, at 30 inches to separate spike–fork and 3- or-more-brow-tine antlers.

Continuation of the collection of specimens will be necessary to properly evaluate the effect antler characteristics will have on the SF50 strategy. Sample sizes for age groups greater than age 2 remain below minimum objectives of 30. Additional samples will help evaluate our concern for sampling bias from "any-bull" permit holders. A suspected behavior of "party hunters" is saving illegal bulls for the permit holder while SF50 bulls are taken by nonpermit holders. The result could be lower percentages of legal SF50 bulls in the sample. To reduce sample biases, sampling antlers from moose taken during the general SF50 season may also be necessary.

Permit Hunts. The addition of the November antlerless moose permit hunt resulted in the combined harvest of 250 moose during 1994–95 when we issued 500 permits (Table 6). An apparent increasing trend in hunter participation and hunter success by antlerless permit holders probably reflected reduced success by permittees at finding legal SF50 bulls.

Hunter Residency and Success. Hunter participation in the general SF50 hunting season returned to pre-1990 levels. The number of individuals hunting in Unit 14A during 1993–94 averaged 2612 (Table 5). Following the deep snow winter of 1989–90 and subsequent regulation changes in southcentral Alaska, number of hunters in the subunit declined to less than 2000, but by fall 1992–93 reached a record 3344 individuals (Griese 1995). Residency of hunters changed little despite fluctuations in numbers.

Hunter success declined from 16–17% during 1991–92 to an average of 10% during 1993–94 (Table 5). SF50 antler restrictions were directly responsible for the decline in hunter success. During 1986–89 hunter success was 18%, with 428–456 successful hunters (Griese 1993).

Harvest Chronology. Harvest chronology in Unit 14A changed following enactment of the SF50 regulation which also extended the season into late August (Table 7). Antler restrictions requiring good visibility of moose and 2 additional weeks to hunt dispersed hunter harvest, seeming to push the peak in harvest to the final week of the season. Several hunters commented they preferred not to hunt during August because of insect numbers, heat, and foliage density.

Transport Methods. Highway vehicles and 3- or 4-wheelers were the dominant means of transportation among successful moose hunters because of the many roads and trails in much of the subunit. The increase in use of 3- or 4-wheelers probably reflects increases in vehicle ownership, expanding trail systems, and a sense of increasing competition to access moose (Griese 1995) Hunters using these methods have accounted for 63% of the moose harvest in the past 5 years (Table 8).

Natural Mortality

Natural mortality for adult moose during 1993–94 was assumed to be 6–9% (R. Modafferi, pers commun), while we calculated overwinter calf mortality at 28% and 42% for 1993–94 and 1994–95, respectively. During 1989–90 and 1990–91 calf mortality through April reached an estimated 60% (Griese 1993). Winter calf mortality, previously calculated for the subunit for mild to moderate winters, was 20–25% (Griese 1995).

HABITAT

Enhancement

Funds were appropriated through legislation to enhance moose habitat in response to high levels of winter moose mortality during 1989–90. During 1993–94 expenditures within Unit 14A included a controlled burn of 900 acres southwest of Willow (Collins 1996). Remaining funds have been dedicated to an additional controlled burn in Unit 16A through a reimbursable service agreement with Division of Forestry, Alaska Department of Natural Resources.

CONCLUSIONS AND RECOMMENDATIONS

During 1993–94 the population size objective was not met, with the population rising above our objective. However, due to high accidental and winter mortality during winter 1994–95, the subunit population may have fallen within the upper limit of the 5000–5500 objective.

Bull:cow ratios reached objective levels as the result of restrictions imposed on bull harvest by the SF50 regulations. This recovery to objective levels occurred more rapidly than predicted. It appears from trends in bull:cow recovery that any-bull permits will be immediately necessary to maintain the ratio below 25:100.

The human–use objective (600–700 moose harvested by hunters) for the period 1993–1994 was not reached; average harvest was 485 moose. Harvest fell below the minimum objective of 600 moose primarily due to the SF50 antler restriction.

Human–use objectives are unlikely to be reached before 1997. The department adopted current goals and objectives during a predator/prey management evaluation open to public and Board scrutiny. The need to add antler restrictions to the harvest to correct bull:cow ratios was not anticipated in that evaluation. To reach an average harvest of 600 moose sooner would require the conversion of a significant portion of highway-killed moose to the hunter harvest. However, conversion of a significant number of highway-killed moose to the hunter harvest is unlikely, given current options (Griese 1995).

After 2 years of enactment, SF50 antler restrictions caused hunter effectiveness to decrease 39%, increased bull:cow ratios 133%, increased participation and success by hunters holding antlerless moose permits for Unit 14A, and increased the number of illegal moose reported during the hunting season. In years of comparable hunter and bull densities, 1989 and 1994, hunter success declined from 18% to 11%. Bull:cow ratios climbed from 9:100 during fall 1992 to 21:100 during fall 1994, following initiation of SF50 in 1993. Antlerless moose permittees prior to SF50 used the permit as an alternative harvest source if a legal bull could not be found. Permittee success during the early fall hunt increased 15% in response to their poorer success finding legal bulls.

The SF50 strategy also eliminated the need to reduce season length following a winter when the subunit population suffered a 10% decline from the deep snow winter of 1994–95. In this case, SF50 effectively weatherproofed the hunting season. In fact, it allowed additional opportunity to be added by the Board of Game. Thirty-four days were added to the season. The necessity to issue any-bull permits for a 15-day season could also be considered new opportunity.

I continue to recommend annual assessment of fall population size and composition and spring composition to optimize opportunity to harvest annual recruitment. Random stratified surveys (RSS) should be conducted during fall every fifth or sixth year, with alternating Becker surveys and comparable composition surveys between RSS. Spring composition surveys assure recruitment levels. This pattern of surveys has allowed maximum allocation of antlerless and any-bull moose permits and improves opportunity to achieve human–use objectives.

The population identity study initiated during 1994 should be continued through 1997 to allow a full 2-year record of movement of replacement subjects to be collared during 1995. Consideration for expansion of this movement study should be evaluated at that time.

Preliminary results of the antler–age study indcate continuation of sample collection would be valuable for evaluation of the SF50 strategy or modifications to it. Efforts should be made to collect samples from hunters killing moose qualifying under SF50 to identify any biases from sampling only any-bull permittees. Check stations during the general season, strategically timed and located, may produce a small sample. However, advertisement of incentives, in the form of a cash reward for teeth presented with antlers, may prove more cost effective.

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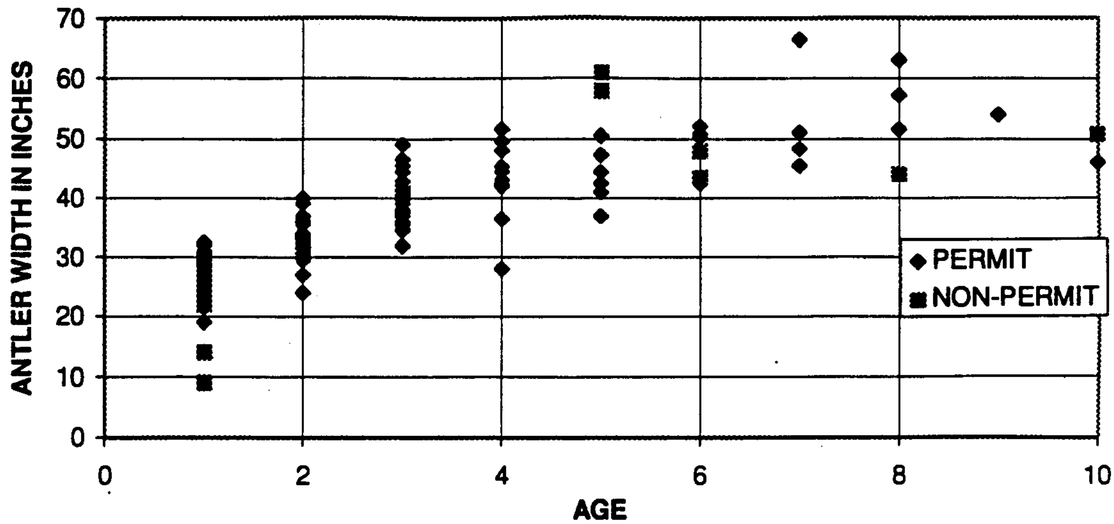

Figure 1. The relationship of age versus antler width for bull moose harvested by permit (N=112) and in general seasons (N=18) during fall and early winter in Game Management Units 14 and 16, 1993-1995.

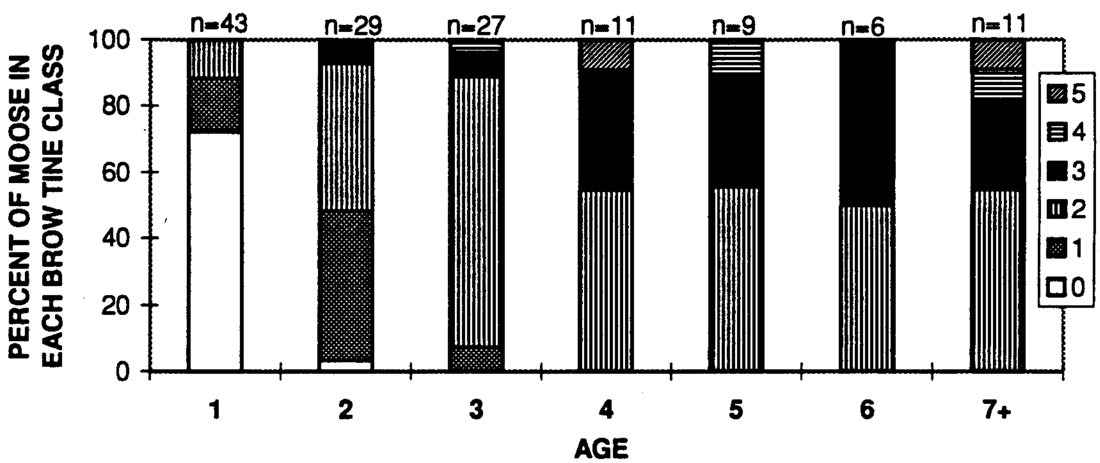

Figure 2. The relationship of age versus maximum number of brow tines on one antler for 136 bull moose killed in Game Management Units 14 and 16, 1993-1995.

Table 1 Unit 14A fall aerial moose composition surveys and censuses, 1990–95

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose/ mi^2	Estimated population size
1990/91[a]	--	--	--	--	--	--	--	4,000-5,500
1991/92[b]	14	5	39	26	1,110	1,472	3.7	5,885±706[c]
1992/93[d]	9	6	40					
	27	697	934	n/a	5,200-6,200			
1993/94[f]	16	11	37	24	942	1,232	3.6	5,672±798[c]
1994/95[d]	21	8	35	22	1,098	1,398	n/a	5,500-6,500
1995/96[a]	--	--	--	--	--	--	--	5,000-6,000

[a] No surveys flown.
[b] Gasaway, et al (1986) census.
[c] 80% confidence intervals.
[d] A sampling of 1991 survey units with composition based on relation of observed data to calculated results (see Methods).
[e] Becker survey.

Table 2 Comparison of moose fall survey data[a] for Unit 14A, 1991, 1992 and 1994

Survey year	Bulls				Cows				Calves		Grand total[b]
	Yearling	30-49"	≥50"	Total	w/0	w/1	w/2	Total	Lone	Total	
1991	41	58	10	109	400	220	8	628	1	237	974
1992	27	39	6	72	402	206	17	625	0	240	934
% Δ '91	*-34*	*-33*	*-40*	*-34*	*1*	*-6*	*113*	*<1*	*-100*	*1*	*-4*
1994	44	90	9	143	424	171	26	621	4	227	993
% Δ '91	*7*	*55*	*-10*	*31*	*6*	*-22*	*225*	*-1*	*400*	*-4*	*2*
% Δ '92	*63*	*131*	*50*	*99*	*5*	*-17*	*53*	*-1*	*--*	*-5*	*6*

[a] Combined results from survey units 4, 8, 33, 72, 73, 77, 82, 85, 90, 95, 96, 99, 100, 104, 105, 110, 118 and 120.
[b] Includes unidentified moose.

Table 3 Unit 14A late winter aerial moose composition surveys, 1990–95

Regulatory year	Date	Count Areas	Total moose	Calves[a]	% Calves
1990/91	03/04-11	5,6&8	1,348	167	12
1991/92	02/25	7	121	26	21
	04/10	3,4,5,6 & 8	546	76	14
1992/93	03/24	4,5,6,7 & 8	693	131	19
1993/94	03/05-09	4,5,6,7 & 8	981	175	18
1994/95	04/03-04	4,5,6,7, 8 & Pt. McKenzie	518	75	14
1995/96	03/28	6 & Pt. McKenzie	471	85	18

[a] Calves = short yearlings

Table 4 Unit 14A moose harvest[a] and accidental death, 1990–94

Regulatory year	Reported M	Reported F	Reported Total[b]	Estimated Unreported[c]	Estimated Illegal[d]	Estimated Total	Accidental deaths[e] Road	Accidental deaths[e] Train	Accidental deaths[e] Total	Grand total
1990/91	258	0	259	13	35	55	140	22	162	476
1991/92	490	39	534	25	25	50	166	15	181	765
1992/93	530	157	694	27	30	57	132	7	139	890
1993/94	233	204	438	12	40	52	166	18	193	683
1994/95	281	242	532	14	60	74	260	40	300	906

[a] Includes permit hunt harvest.
[b] Total includes moose of unknown sex.
[c] This estimate was derived by taking minimum of 5% of the reported kill under harvest tickets.
[d] Includes moose taken in defense of life or property.
[e] Road and train are minimum numbers; in most years actual kill was probably higher.

Table 5 Unit 14A moose hunter[a] residency and success, 1990–94

Regulatory year	Successful Local[b] resident	Successful Nonlocal resident	Successful Nonres.	Successful Unk.	Successful Total (%)	Unsuccessful Local[b] resident	Unsuccessful Nonlocal resident	Unsuccessful Nonres.	Unsuccessful Unk.	Unsuccessful Total (%)	Total hunters
1990/91	242	3	8	6	259 (14)	1,466	22	14	26	1,528 (86)	1,787
1991/92	469	11	9	6	495 (17)	2,286	39	12	23	2,360 (83)	2,855
1992/93	500	12	12	15	539 (16)	2,629	50	24	102	2,805 (84)	3,344
1993/94	215	4	1	6	226 (9)	2,291	59	11	68	2,429 (91)	2,655
1994/95	274	6	1	1	282 (11)	2,208	46	4	18	2,286 (89)	2,568

[a] Does not include hunters participating in drawing permit hunts.
[b] Includes Unit 14 residents.

Table 6 Moose harvest data by permit hunts in Unit 14A, 1990–94

Hunt(s)	Regulatory Year	Nr Applicants	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total
418 (Antlerless - late fall)									
	1993/94	3,760	70	13	40	47	3	30	33
	1994/95	5,464	100	10	13	77	5	71	76
419 & 420 (Antlerless - early fall)									
	1990/91	---	0	---	---	---	---	---	---
	1991/92	7,057	100	13	48	39	0	39	39
	1992/93	11,000	400	12	49	39	3	154	157
	1993/94	10,390	400	10	44	46	4	174	179
	1994/95	11,185	400	10	46	44	4	169	174

Table 7 Unit 14A moose harvest chronology[a], 1990–94

Regulatory year	Week of season 1st	2nd	3rd	4th	5th	Unknown	Total
1990/91[b]	--	--	211	36	--	12	259
1991/92[c]	--	--	260	109	110	20	499
1992/93[c]	--	--	260	120	144	15	539
1993/94[d]	76	27	21	41	56	6	227
1994/95[d]	62	39	51	45	67	15	279

[a] Does not include harvest from drawing permit hunts.
[b] Open season = Sept. 1-10.
[c] Open season = Sept. 1-20.
[d] Open season = Aug. 20- Sept. 20.

Table 8. Unit 14A percent transport methods[a] of successful moose hunters, 1990–94

Regulatory Year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unk	Total sample size
1990/91	7	7	12	22	0	10	35	7	259
1991/92	4	4	12	24	0	12	38	6	499
1992/93	4	5	13	22	0	7	42	5	539
1993/94	4	5	12	23	0	7	43	6	228
1994/95	4	3	13	26	0	7	40	7	292

[a] Does not include transport data from drawing permit hunts.

LOCATION

GAME MANAGEMENT UNIT: 14B (2,152 mi.^{2})

GEOGRAPHICAL DESCRIPTION: Western Talkeetna Mountains

BACKGROUND

Masteller (1996) described a Unit 14B moose subpopulation that recently peaked in number during the mid-1980s, reaching 2566–3062 animals in fall 1987. Following the deep snow winter of 1989–90, the subpopulation declined 35% to 1548–2042 moose during fall 1990. The number of moose was even lower during fall 1992, with a range of 1404–1760. He described subpopulation composition after 1989 that averaged 26 bulls:100 cows and 23 calves:100 cows. The 1987 herd composition was 37 bulls:100 cows and 30 calves:100 cows.

Population identity studies conducted during 1980–1990 in the Susitna Valley indicated moose from Unit 14B also winter in Unit 14A and along the boarder with Unit 16A (Modafferi 1992). These moose share winter range with moose from units 16A and 13E. This herd's range is within a major transportation corridor for Alaska Railroad Corporation (ARC) and the George Parks Highway. Human settlement in this transportation corridor (TC) has produced attractive moose browse.

Because wintering areas are associated with the main transportation route between Fairbanks and Anchorage, accidental mortality (which includes moose from Subunits 16A, 13E and 14A) often exceeded Unit 14B hunter harvest. During 1989–90 411 moose died in auto–train collisions; previous peaks in accidental mortality occurred during 1970–71, 1978–79, 1982–83, 1984–85 and 1987–88.

Hunter harvest of moose has been dependent on access, weather related population changes and season and bag limit restrictions. From 1966 to 1970 hunters killed an average of 144 moose annually, predominantly bulls. Liberal cow seasons allowed peak harvests to reach 372, 534, and 347 moose during 1971, 1984 and 1987, respectively (Griese 1993). There have been no cow seasons since 1987. Antler restrictions, enacted prior to fall 1992, restricted harvest even more. Harvest during fall 1992 was 34 bulls.

To meet population objectives, Masteller (1996) recommended a public opinion survey to help develop management direction. He also suggested a controlled use area be established in the Willow Mountain Critical Habitat Area (WMCHA) that restricted ORV use to provide diversity in hunting opportunity. However, he identified postseason snowmachine use as the potential for biological impacts within the WMCHA.

MANAGEMENT DIRECTION

MANAGEMENT GOAL

The moose management goals for Unit 14B are to produce high yields of moose for humans and to provide maximum opportunity to hunt moose.

MANAGEMENT OBJECTIVE

The moose management population objective for Unit 14B is to increase the population to 2500–2800 moose by 1995, with a posthunting sex ratio of no less than 20 bulls:100 cows. The human–use objective is to achieve and maintain an average annual harvest of 200–300 moose by 1997.

METHODS

During late October and early November 1994 we conducted a "Becker survey" (E. Becker pers commun), a modified version of the stratified random sampling census technique (Gasaway, et al. 1984). This survey produced confidence intervals for estimates of observable moose but did not produce a sightability correction factor (SCF). SCFs were estimated for each density strata (1.0, 1.41, and 1.0 for low- , medium- and high-density areas respectively). Composition data recorded during the survey allowed estimation of observable moose by sex and age. No survey was conducted during 1993.

Hunter harvest of moose was monitored with harvest reports from any person who reported hunting in the subunit. Bulls taken by permittees were required to provide antlers for measurement and lower front teeth for age determination. The ARC provided numbers of moose killed by trains, and the Department of Public Safety provided numbers of moose killed by highway vehicles, killed illegally, or killed in defense of life or property (DLP).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Moose numbers in Unit 14B increased following several years of low levels after the deep snow winter of 1989–90 (Table 1).

Population Size

During October–November 1994, under ideal counting conditions, the moose population in Unit 14B was estimated at 2337 +/- 527 (80% CI) moose (Table 1). To derive this estimate, we applied SCFs (by strata) to the estimate of 2027 +/- 331 observable moose.

The substantial increase in estimates between 1992 and 1994 (Table 1) reflect count timing and conditions. During 1992 moose had begun leaving postrut concentrations, and counting conditions were fair to excellent. During 1994, moose remained in subalpine postrut concentrations and counting conditions ranged from good to excellent.

POPULATION COMPOSITION

The bull:cow ratio during fall 1994 was 31 bulls:100 cows (Table 1). Masteller (1996) suggested the decline in the proportion of bulls between 1987 and 1989 was possibly aided by the cessation of cow harvest and improved hunter access. Antler restrictions during hunting seasons and ideal counting conditions probably aided the apparent increase in the bull portion during 1994.

Calf survival to fall reached low levels during 1994; however, survival of the previous cohort, indicated by yearling bulls:100 cows, improved over 1992 (Table 1). Higher predation rates and the cumulative effects of several deep snow winters (Mech et al 1987) between 1989 and 1993 possibly caused calf:cow ratios to fall to 17:100. These effects were not apparent in the previous cohort because 8 yearling bulls:100 cows is above the 10-year average. Reduced hunter harvest of yearling bulls due to antler restrictions was partly responsible for this inconsistency.

MORTALITY

Harvest

Season and Bag Limit. Beginning in fall 1993–94 the open season in Unit 14B for resident and nonresident hunters was 20 August–20 September. The bag limit was 1 bull with a spike or fork antler on at least 1 side or with an antler spread that measures at least 50 inches or with antlers that have 3 or more brow tines on at least 1 side.

Board of Game Actions and Emergency Orders. The Board adopted additional hunting opportunities beginning with fall 1995–96 in response to the population safeguards offered by SF50 antler restrictions. In addition to the existing 20 August–20 September SF50 season, the Board added a 10–17 August SF50 bull hunt for bow and arrow hunters only. Bow hunters were required to attend the state sanctioned bow hunter education course. In addition the Board allowed permits to be issued to take any bull during the periods of 20 August–20 September and 1–15 November. Finally, they added a spike or fork bull only season for the period of 20 November–15 December. These hunts equal 81 days of hunting opportunity.

Hunter Harvest. Reported hunter harvest was low (31–36) during both 1993–94 and 1994–95 (Table 2). The harvest was low because of limited access, low legal bull densities, and SF50 antler restrictions. However, harvest was comparable to the previous 10-day any-bull seasons.

Hunter Residency and Success. Since 1991 numbers of moose hunters have scarcely fluctuated, remaining between 314 and 347 (Table 3). The proportions of hunters (i.e., unit resident, other state residents, and nonresidents) have also remained stable. Since 1991 unit residents have composed 87–97% of successful hunters.

Combined hunter success was 10% during 1993–94 and 1994–95. This compares to a combined hunter success of 13% during 1991–92 and 1992–93. The difference is a product of the SF50 antler restrictions.

Harvest Chronology. During both 1993–94 and 1994–95 over 50% of the harvest occurred during the final 2 weeks of the 32-day season (Table 4).

Transport Methods. Most successful hunters used 3- or 4-wheelers or ORVs during the 1992–93 and 1994–95 seasons, but successful hunters using highway vehicles increased (Table 5). The increase in use of highway vehicles is probably a reflection of lifted hunting restrictions within the transportation corridor in western 14B west of the Anchorage–Fairbanks electrical intertie.

Other Mortality

During 1994–95 deep snow conditions prompted an increase in moose mortality due to auto–train collisions (Table 2). Although 90 moose killed accidentally seems high, it contrasts sharply to the 411 moose deaths reported during winter of 1989–90 (Griese 1993).

Deep snow conditions also produced low overwinter calf survival to spring in 1995. During an April aerial sample of 117 moose in northern Unit 14A, we found 9% calves. We assumed calf survival would be less for moose remaining in the deeper snow of Unit 14B; thus, we estimated overwinter survival of calves at 30–40%. Typical overwinter survival probably approaches 60% in "normal" winters.

HABITAT

Enhancement:

Although we had no enhancement projects other than local timber sales, sites in Unit 14B remain possibilities for future controlled burns (W. Collins, pers commun).

CONCLUSIONS AND RECOMMENDATIONS

While population estimates for fall 1994 indicate population objectives are within reach, human–use objectives were clearly not met. A minimum population of 2500 moose by fall 1995 was possible if survival during 1994–95 was better than estimated and recruitment compensated for any overwinter losses. Determining whether the objective is met would require a Gasaway et al (1986) survey.

Hunter harvest under the SF50 harvest strategy is unlikely to produce harvest higher than 50–70 bulls due to access and opportunity limitations. It is possible that recent additions to hunting opportunities, adopted by the Board, may allow harvest levels to increase. However, reaching 200 bulls in the harvest would require relaxation of antler restrictions or a substantial increase in access opportunities. The nature of vegetation, terrain, and season timing eliminate many opportunities.

The SF50 strategy was adopted for Unit 14B because it shared common boundaries with Units 13A and 14A where hunting pressure and access have allowed an overharvest of bulls. Concern for enforcement of the antler restriction along the boundary and the concern for false reporting were principal reasons for its inclusion in the program. However, pre-existing healthy bull:cow ratios due to previous low hunter success, a function of hunters' limited access, indicated Unit 14B would be a poor candidate for this harvest strategy. Ongoing evaluation (begun in 1993) of the SF50 harvest strategy after 5 years of application will probably confirm the inappropriateness of the restrictions.

If sequence of Board consideration is such that change will not be possible before a 6th year of SF50 antler restrictions, a fifth year of testing the antler restrictions should be considered unnecessary.

I concur with Masteller's (1996) recommendation calling for a public opinion survey to identify public desire for management direction. We should also try to better inform the public on this and related issues.

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Table 1 Unit 14B fall aerial moose composition counts and census, 1989–1994

Regulatory Year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Adults observed	Total moose observed	Observable moose/mi^2	Population estimate
1987/88[a]	37.1	8.7	29.6	17.6	906	1097	2.6	2,814+248[b]
1988/89[c]	---	---	---	---	---	---	---	---
1989/90[d]	24.4	5.1	26.0	15.8	474	563	2.6	2760 ±550[b]
1990/91[d]	27.1	8.5	20.1	13.6	609	754	1.7	1795 ± 247[b]
1991/92[c]	---	---	---	---	---	---	---	---
1992/93[e]	27.2	4.4	21.7	14.5	580	659	1.1	1582 ± 178[b]
1993/94[c]	---	---	---	---	---	---	---	---
1994/95[f]	31.1	8.2	17.3	12.0	862	969	2.2	2336 ± 527[b]

[a] These data derived from a Gasaway census conducted in December 1987.

[b] 80% C.I.

[c] No surveys conducted.

[d] These data derived from "Becker Surveys" conducted in November. SCF estimated at 1.30.

[e] These data derived from "Becker Surveys" conducted in November. SCF estimated at 1.40, 1.35 and 1.25 for low, medium and high density strata, respectively.

[f] These data derived from "Becker Surveys" conducted in late October/early November. SCF estimated at 1.00, 1.41 and 1.00 for low, medium and high density strata, respectively.

Table 2 Unit 14B annual moose harvest and accidental death, 1990–94

Regulatory	Reported			Estimated			Accidental[d]			
year	M	F	Total[a]	Unreported[b]	Illegal[c]	Total	Road	Train	Total	Total
1990/91	0	0	0	0	4	4	8	17	25	29
1991/92	53	0	53	3	5	8	17	46	63	124
1992/93	34	0	34	2	5	7	10	24	34	75
1993/94	30	0	31	3	15	18	15	13	24	73
1994/95	36	0	36	4	20	24	34	56	90	150

[a] Total includes moose of unknown sex.
[b] This estimate was derived by taking 5% of the total reported kill prior to SF-50 (1993) and 10% after.
[c] Includes moose taken in defense of life or property.
[d] Road and train are minimum numbers; in most years actual kill was probably higher.

Table 3. Subunit 14B moose hunter residency and success 1990-94.

Regulatory year	Successful							Unsuccessful					Total hunters
	Local[a] resident	(%)	Nonlocal resident	(%)	Nonres	Unk	Total	Local[a] resident	Nonlocal resident	Nonres	Unk	Total	
1990/91[b]	0	---	0	---	0	0	0	10	1	0	0	11	11
1991/92	50	(94)	1	(02)	0	2	53	282	6	5	1	294	347
1992/93	31	(91)	0	---	3	0	34	259	10	5	6	280	314
1993/94	27	(87)	1	(03)	2	1	31	279	3	2	11	295	326
1994/95	35	(97)	0	---	1	0	36	290	8	3	4	305	341

[a] Unit 14 residents.
[b] No open moose season.

Table 4 Unit 14B moose harvest chronology, 1990–1994

Regulatory year	Before season opened	Weeks of season						After season closed	Unk	Total
		1st	(%)	2nd	3rd	4th	5th			
1990/91[a]	0	---	---	---	---	---	---	0	0	0
1991/92[b]	0	41	(77)	8	---	---	---	3	1	53
1992/93[b]	0	24	(70)	5	---	---	---	5	0	34
1993/94[c]	0	5	(16)	2	7	7	9	0	1	31
1994/95[c]	0	8	(22)	1	1	10	14	0	2	36

[a] No open season.
[b] 1–10 September season.
[c] 20 Aug–20 Sept. season, spike/fork-50" bull selective harvest strategy.

Table 5 Transport method used by successful moose hunters in Unit 14B, 1990–94

Regulatory year	Percent of successful moose hunters							Number moose harvested
	Airplane	Horse	Boat	3- or 4-wheeler	Orv	Highway vehicle	Unk	
1990/91[a]	---	---	---	---	---	---	---	0
1991/92	9	0	2	38	40	11	0	53
1992/93	26	0	0	41	15	15	3	34
1993/94	23	0	6	32	10	23	6	31
1994/95	8	6	6	36	14	25	6	36

[a] No open season.

LOCATION

GAME MANAGEMENT UNIT: 14C (1,912 m^2) and Portage and Placer river drainages in Unit 7

GEOGRAPHIC DESCRIPTION: Anchorage Area

BACKGROUND

Moose were uncommon in the Anchorage area before the 1940s. They increased in the late 1940s as brushy regrowth replaced mature forests cut or burned during the development of Anchorage and the Fort Richardson Military Reservation. Numbers increased considerably during the early 1950s, and by the late 1950s and early 1960s moose were abundant. The moose population has remained high during the past 3 decades.

Prime browse occurs in open-canopied, second-growth willow, birch, and aspen stands on burned-over military lands and on several hundred acres of military lands that have been rehabilitated during the last 2 decades. Some parks, greenbelts, and residential areas in the Anchorage Bowl also contain considerable browse. Quality riparian habitat abounds along area streams and rivers. Extensive stands of subalpine willow exist on south-facing slopes in most drainages in the area.

Annual harvests have fluctuated dramatically in recent decades. A record harvest of nearly 500 moose (50% females) occurred in 1965, while only 18 moose were harvested in 1978. These diverse harvests were due to changes in seasons and bag limits rather than changes in the moose population. Annual harvests increased steadily during the late 1980s and early 1990s, but declined beginning in 1992–93. The 5-year mean harvest during this reporting period is 175 moose (34% cows).

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVE

The moose management objective for Unit 14C is to maintain a population of 2000 moose and a posthunting sex ratio of no less than 25 bulls:100 cows.

METHODS

We conducted aerial surveys annually in most hunt areas to estimate sex and age composition during fall and early winter (Table 1).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Moose populations were relatively stable during the 1980s. Population stability was partially due to a series of mild winters beginning in 1979–80. However, we predicted a population reduction if the Anchorage area had a series of severe winters because the quantity of critical winter browse has continued to decline, as a consequence of maturation and urban development.

The Anchorage area has had a series of severe winters. The USDA's Natural Resources Conservation Service has measured snowpack at several locations in Unit 14C for several decades (Alaska Basin Outlook Reports). Local snow depths can vary substantially within moose winter habitat. Three locations—Hillside (el. 2080 feet), South Campbell Creek (el. 1200 feet), and Portage Valley (el. 50 feet)—are indicative of winter snow depths in the Anchorage area. Average annual snowpacks (1961–1990) measured on or about 1 February do not exceed 28 inches in any of these locations. Average annual snowpacks are less than 36 inches from 1 March to 1 May at all 3 sites.

Moose are adversely affected by snow depths from 70–90 cm (28–36 inches), which impede movement, and depths greater than 90 cm, which restrict movement to the extent that adequate food intake may be unattainable (Coady 1974). Therefore, mean snow depths in the Anchorage area are not particularly challenging to wintering moose.

However, the last 7 winters (1988/89 to 1994/95) have all had snowpacks greater than average from 1 February through 1 April. Of 63 snowpack measurements (i.e., 3 locations x 3 months x 7 years), 52 (83%) have been greater than the 30-year average, while 53 (85%) of the measurements have been greater than 28 inches and 34 (54%) have been greater than 36 inches. The worst 2 winters were 1991–92 and 1994–95, when snow depths from 1 February to 1 April were over 36 inches in all three sites and remained deep until at least 1 May.

Vehicles and trains collided with moose more frequently than average in 1991–92 and 1994–95 (Table 2) because moose were using cleared areas as movement corridors. Natural mortality probably increased during the severe winters as well. The unit's moose population has been maintained near the management objective of 2000 by reducing harvests. Vehicle–moose collisions have also increased, maintaining moose numbers within our objective. Continued severe winters will exacerbate overbrowsing, which is likely to result in substantial losses of moose in subsequent years.

Population Size

We estimate a population of 2100 moose in Unit 14C, including the Placer and Portage river drainages (Table 1). About 300 moose are believed to inhabit the Anchorage Management Area (excluding the Hillside count area) when composition counts are conducted in adjacent areas. The population is declining in all recently counted areas, but incidental observations, including number of complaints about nuisance moose and moose-vehicle collisions, indicate the population may not be declining in the Anchorage Bowl, Anchorage Hillside, and Eagle River count areas.

Population Composition

The bull:cow ratio ranged from 31:100 to 37:100. It has increased on Fort Richardson and in the Peters Creek drainage; remained stable in the Twentymile, Portage, and Placer drainages; and declined in Eklutna, Knik, and Hunter drainages (Table 1). The greatest declines are in the

Knik River and Hunter Creek drainages and are probably due to increased hunting pressure for bulls after the remainder of southcentral Alaska adopted a spike-fork/50-inch bull regulation. The percentage of calves in the herd ranged from 19–22%. The calf:cow and yearling bull:cow ratios and percentage of calves in the population have declined in most count areas (Table 1). Calf birth and survival rates are adversely affected by severe winter conditions.

Distribution and Movements

Moose are year-long residents, ranging from sea level to an elevation of 3500 feet. During winters with substantial snow accumulation, most moose are found at elevations below 1500 feet. Movements of several miles or more by both sexes occur during the breeding season in late September through October and again before green-up in late March and early April.

MORTALITY

Harvest

Season and Bag Limit. The open seasons for resident and nonresident hunters in the Fort Richardson Management Area were 7 September–15 November and 15 December–15 January in 1993–94, and 6 September–15 November and 15 December–15 January in 1994–95. The bag limit was 1 moose by drawing permit. Hunting was limited to archery only, except in the fall season when muzzleloading rifles were permitted north of Eagle River. Up to 102 permits for bulls and antlerless moose were issued, 25 for muzzleloading rifle hunters. We issued an additional 15 drawing permits for both sexes for Elmendorf Air Force Base in 1993 and 1994. The bag limit was 1 moose, and the season was 7–30 September in 1993 and 6–30 September in 1994. There was no open season in the Anchorage Management Area. The open season for resident and nonresident hunters in the Peters Creek Management Area was 7–30 September in 1993 and 6–30 September in 1994. The bag limit was 1 moose by drawing permit and archery only; 25 permits were issued in 1993 and 1994. The open season for resident and nonresident hunters in the Eklutna Lake Management Area was 7–30 September in 1993 and 6-30 September in 1994. The bag limit was 1 bull by archery only. The hunt was administered by registration permit for 10 bulls. The open season for resident hunters in the remainder of Unit 14C was 7–20 September in 1993 and 6–20 September in 1994. The bag limit was 1 bull moose; however, hunters could take antlerless moose by drawing permit only (20 permits were issued in 1993 and 15 in 1994). The open season for the Twentymile River area was 20 August-30 September for bulls and 20 August–31 October for antlerless moose in 1993 and 1994. The bag limit was 1 moose by drawing permit with 40 permits for bulls and 35 permits for antlerless moose issued in 1993 and 40 permits for bulls and 10 permits for antlerless moose issued in 1994.

Board of Game Actions and Emergency Orders. The Board of Game adopted a regulation that prohibits intentional feeding of moose, except under terms of a permit issued by the department, which took effect in July 1993. Beginning in 1995, the Board of Game adopted a spike-fork/50-inch regulation for the remainder of Unit 14C. In 1995 and 1996 the Board considered several proposals for a moose hunt in the Anchorage Management Area but delayed a final decision until the March 1997 meeting in Anchorage. The department was directed to complete a public planning process and make a recommendation at that time. All antlerless moose hunts were reauthorized. No emergency orders were issued during the past 5 years.

Hunter Harvest. During the 1993–94 and 1994–95 seasons, 158 and 166 moose were harvested, respectively, with averages of 124 bulls and 37 cows annually (Table 2). Approximately 50% of the bulls were taken during the general season. The remaining moose were taken in permit hunts.

Permit Hunts. During the 1993–94 season we issued 457 hunters permits to hunt moose in Unit 14C. Of these, 105 (29%) were successful. In the 1994–95 season, 441 permits were issued and 92 (28%) hunters were successful (Table 4). Drawing permit hunts were very popular. In 1993, 7933 hunters applied for 360 available drawing permits (3958 of the applications were for the 75 permits available for the combined Placer/Twentymile hunt), and in 1994, 7799 hunters applied for 207 available drawing permits (3311 of the applications were for the 50 permits available for the combined Placer/Twentymile hunt). An additional 232 hunters in 1993 and 234 hunters in 1994 obtained registration permits for the Eklutna Valley registration archery hunt. Despite its popularity, the success rate for this hunt, while never high, has steadily declined to 1–2% in the early 1990s (Table 4).

Hunter Residency and Success. Residents of Unit 14 accounted for 85% and 93% of the moose harvested in Unit 14C in 1993 and 1994, respectively (Table 3). Nonresidents accounted for 0% and 1% of the total harvest, respectively.

Harvest Chronology. It is difficult to compare annual harvests for the first week in September (Table 5) because season opening dates are variable (i.e., the day after Labor Day). After the general season was shortened by 10 days (from 30 September to 20 September) in 1990, harvests shifted primarily to the second week in September, rather than being compressed into the third week, as might be expected (Table 5). The second week in September is essentially the opening week of moose hunting for much of the unit when the day after Labor Day is later than usual (e.g., 8 September in 1992). Therefore, many hunters have switched from late to early-season hunts since 1990. In recent years, a permit archery hunt has been held on military land from mid-December through mid-January, after many moose summering in the Fort Richardson–Elmendorf–Ship Creek area become accessible in lowland areas of Fort Richardson.

Transport Methods. Approximately two-thirds of all successful moose hunters reached their kill sites by highway vehicle (Table 6). The high proportion of walk-in hunters is due to moose habitat being near roads and trails and prohibition of motorized vehicles in most of Chugach State Park. The percentage of successful hunters using boats has declined in recent years.

Other Mortality

Moose killed by vehicles and trains accounted for about one-third to one-half of total known mortality. Vehicles killed at least 239 moose and trains killed 22 in 1994–95, a record high because of near-record snow depths, which forced many moose into town. Over the past 5 years, a mean of at least 145 moose were killed in collisions annually (Table 2). These are conservative figures because not all collisions are reported and some moose undoubtedly die from injuries without being discovered.

Significant natural mortality was low in the Anchorage area from the mid-1950s to the late 1980s due to moderate annual snowpacks and relatively low numbers of predators. More moose have probably starved in recent winters due to 1) greater than average snowpacks that cover potential browse and require greater expenditure of energy and 2) overbrowsing in previous winters. In recent years, 1 or more packs of wolves have moved into the Knik and Twentymile River drainages and 2 packs are taking moose on Fort Richardson, Elmendorf Air Force Base, and the Anchorage Hillside.

HABITAT

Assessment

Large tracts of subalpine and riparian habitat are protected throughout the 500,000-acre Chugach State Park and Chugach National Forest land between Girdwood and Portage. Several thousand acres of prime lowland habitat are on military lands between lower Ship Creek and Eagle River. Extensive urbanization has reduced winter range on portions of the military reservation and on private lands throughout the unit. However, roads and trails associated with development provide movement corridors, which reduce energy expenditures for moose during years of heavy snowfall.

Enhancement

Extensive habitat enhancement on military, state, and municipal lands is probably not economically feasible because the most cost-effective method–burning–is difficult to do safely in such a densely populated area. Habitat enhancement is not a desirable alternative in Chugach State Park. The Chugach National Forest is preparing a plan for enhancing moose habitat in a limited area near Portage, primarily to enhance viewing opportunity. Winter habitat will inevitably decrease over time in the Anchorage area, as will the number of moose that depend on it.

CONCLUSIONS AND RECOMMENDATIONS

Major population objectives for the unit were met. The bull:cow ratio exceeded 25:100 and over 2000 moose are estimated in the unit.

Existing management programs were developed over the past decade during which numerous consultations were held with staffs from Fort Richardson, Elmendorf Air Force Base, and Chugach State Park. Through restrictions on harvest methods and compromises on open and closed areas, management regimes have been developed and are acceptable to all parties.

Current regulations adequately address management concerns by providing for substantial hunting opportunities and harvests from a productive moose population in an area where several land management agencies have limited access modes.

Two Anchorage residents were killed by moose during this reporting period. An elderly woman, found dead in her fenced backyard in October 1993, was probably stomped to death by a moose, based on tracks in the snow and the nature of her injuries. Neighbors and police investigators speculated that she may have entered the fenced yard at night to check on or rescue her dogs and encountered the moose. An elderly man was stomped to death in January 1995 by a cow defending her calf at an entrance to the University of Alaska Sports Center. Many people witnessed this attack, and a videotape received international distribution on television news and human-interest programs. Authorities shot the cow several days later, after it charged another person. These are not the only known human fatalities resulting from moose attacks in the Anchorage area; an old newspaper column referred to 2 other fatalities between 1970 and 1983 (Moon, K. C. 1983. *Anchorage Daily News*. December 30). Several people are injured each year by moose in Anchorage, and a phone survey asking local veterinary clinics about moose-related injuries to dogs tallied over 70 incidents in 1 year (1994–95) serious enough to be treated by a veterinarian.

Nuisance moose in residential areas remain a significant problem. A recent study by the Alaska Department of Transportation and Public Facilities estimated moose-vehicle collisions cost an average of $15,150 for vehicle repairs; emergency, medical, and legal services, and lost wages (ADOTPF 1995). This is an average annual cost of at least $2,197,000, based on the number of moose-vehicle collisions reported during this 5-year report period. Moose also cause considerable damage to ornamental plants, vegetable gardens, and fruit trees in winter and spring. Residents fed more moose after the severe winter of 1989–90. Some residents have continued feeding local moose and, when a handout is not immediately forthcoming, these moose are often highly aggressive toward people. Area staff spend considerable time listening and responding to complaints about property damage, public safety, and injured moose. On the other hand, much damage is tolerated by residents, and moose are considered a desirable species by many residents and visitors. Public education regarding moose behavior and biology may improve public tolerance and reduce conflict situations.

During this period, a workshop was organized by the Anchorage area biologist and Anchorage School District to teach moose safety and moose hazing techniques to all elementary and middle school principals and assistant principals. A fact sheet on moose safety was prepared for distribution to teachers and parents of elementary school children. A moose safety video for the elementary level would be a very useful tool in Anchorage and other areas where school children live near moose.

Planning for a moose hunt in the Anchorage Management Area is underway. A consultant conducted 3 focus group sessions in February 1996 to compare attitudes of hunters, Anchorage residents, and Hillside residents regarding wildlife in Anchorage and, specifically, a moose hunt in Chugach State Park near the Hillside area (Craciun & Associates 1996*a,b*). A random sample of 2200 Anchorage residents, from a list of registered voters, will be mailed a detailed survey of attitudes, experiences, and expectations about wildlife in Anchorage in November 1996. Much of the survey focuses on moose and possible changes in management. Preliminary results of the survey will be provided to the Board of Game for their March 1997 meeting.

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Table 1 Unit 14C fall aerial moose composition counts and estimated population size, 1990–94

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Total moose observed	Moose /hour	Estimated population size[1]
Twentymile River	1990/91	44	20	60	29	333	108	
Portage River	1991/92	36	12	50	27	303	96	
Placer River	1992/93	35	11	47	26	232	73	
	1993/94	40	10	50	26	207	77	
	1994/95	38	9	47	25	207	74	300
Hillside	1990/91	81	27	31	15	110	60	
	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	
	1993/94	--	--	--	--	--	--	
	1994/95	--	--	--	--	--	--	165
Anchorage Bowl	1990/91	--	--	--	--	--	--	
(except Hillside)	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	
	1993/94	--	--	--	--	--	--	
	1994/95	--	--	--	--	--	--	300[2]
Fort Richardson	1990/91	--	--	--	--	--	--	
Elmendorf AFB	1991/92	38	34	38	21	490	32	
Off-base Ship Cr.	1992/93	35	12	33	20	355	--	
	1993/94	47	16	30	17	468	35	
	1994/95	40	16	28	17	401	--	600

Table 1 Continued

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Total moose observed	Moose /hour	Estimated population size[1]
Eagle River	1990/91	--	--	--	--	--	--	
	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	
	1993/94	--	--	--	--	--	--	
	1994/95	--	--	--	--	--	--	165[3]
Peters Creek	1990/91	18	14	47	29	84	61	
	1991/92	14	4	28	20	71	37	
	1992/93	--	--	--	--	--	--	
	1993/94	23	13	23	16	58	25	
	1994/95	21	3	29	19	57	43	90
Eklutna River Thunderbird Cr.	1990/91	32	2	35	21	104	23	
	1991/92	19	3	22	16	95	25	
	1992/93	18	3	21	15	92	32	
	1993/94	--	--	--	--	--	--	
	1994/95	--	--	--	--	--	--	140
Bird Creek Indian River	1990/91	--	--	--	--	--	--	
	1991/92	--	--	--	--	--	--	
	1992/93	--	--	--	--	--	--	
	1993/94	--	--	--	--	--	--	
	1994/95	--	--	--	--	--	--	130[4]

Table 1 Continued

Area	Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves (%)	Total moose observed	Moose /hour	Estimated population size[1]
Hunter Creek	1990/91	29	11	23	15	194	58	
Knik River	1991/92	25	7	16	11	180	64	
	1992/93	--	--	--	--	--	--	
	1993/94	16	5	18	13	164	86	
	1994/95	11	4	18	14	150	39	220
Unit 14C	1990/91	37	12	38	22	645	53	
Total	1991/92	31	9	34	21	1,139	42	
	1992/93	32	10	36	21	679	111	
	1993/94	37	12	31	18	897	44	
	1994/95	33	11	31	19	846	41	2100

[1] Estimate based on most recent count, using sightability index of 0.67 except for Fort Richardson.
[2] No aerial surveys; estimate is best guess.
[3] Last surveyed in 1987.
[4] Last surveyed in 1988.

Table 2 Unit 14C moose harvest and accidental death, 1990–1994

	Hunter harvest									
	Reported			Estimated			Accidental death[b]			
Regulatory year	M (%)	F (%)	Total[a]	Unreported	Illegal	Total	Road	Train	Total	**Total**
1990/91	94 (55)	77 (45)	173	10	10	20	91	12	103	296
1991/92	118 (56)	91 (44)	210	10	10	20	129	24	153	383
1992/93	116 (67)	53 (33)	170	10	10	20	90	10	100	290
1993/94	115 (74)	40 (26)	158	10	10	20	100	9	109	287
1994/95	132 (80)	33 (20)	166	10	10	20	239	22	261	447

[a] Includes those with unreported sex.
[b] Confirmed deaths only.

Table 3 Unit 14C moose hunter residency and success, 1990–94

	Successful				Unsuccessful				
Regulatory year	Local resident[a]	Nonlocal resident	Nonresident	Total (%)[b]	Local resident[a]	Nonlocal resident	Nonresident	Total (%)[b]	Total hunters
1990/91	160	6	6	173 (27)	426	20	3	475 (73)	648
1991/92	193	10	4	210 (29)	486	26	5	520 (71)	730
1992/93	162	2	3	170 (24)	489	21	7	530 (76)	700
1993/94	130	23	0	158 (25)	431	35	2	478 (75)	636
1994/95	154	9	2	166 (24)	488	20	6	519 (76)	685

[a] Residents of Unit 14 (majority from Unit 14C).
[b] Includes hunters with unspecified residency.

Table 4 Unit 14C moose harvest data by permit hunt, 1990–94

Hunt no.[a] /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[b]
DM210, 211	1990/91	100	8	33	67	42	58	62
Twentymile	1991/92	130	13	31	69	44	56	78
Portage	1992/93	130	12	36	64	46	54	73
Placer	1993/94	75	16	51	49	61	39	31
(910, 911)	1994/95	50	6	52	48	68	32	22
DM424,425,427	1990/91	125	11	59	41	35	65	45
Fort Richardson	1991/92	125	9	39	61	41	59	69
(archery only)	1992/93	125	15	64	36	61	39	38
	1993/94	75	28	47	53	60	40	36
(924,925,927)	1994/95	77	16	41	59	58	42	38
DM422,423	1990/91	25	12	36	64	29	71	14
Fort Richardson	1991/92	25	8	43	57	62	38	13
(muzzleloader)	1992/93	25	0	44	56	57	43	14
	1993/94	25	4	46	54	77	23	13
(922,923)	1994/95	25	13	38	62	69	31	13
RM445[c]	1990/91	220	27	94	6	75	25	9
Eklutna	1991/92	292	32	98	2	60	40	5
(archery only)	1992/93	229	24	99	1	100	0	2
	1993/94	232	26	98	2	100	0	3
(975)	1994/95	234	22	99	1	100	0	2

Table 4 Continued

Hunt no.[a] /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[b]
DM441	1990/91	15	27	36	64	0	100	7
Hunter	1991/92	15	7	29	71	0	100	10
Knik	1992/93	15	20	42	58	14	86	7
	1993/94	10	0	70	30	0	100	3
(941)	1994/95	5	20	100	0	0	0	0
DM428, 429	1990/91	15	7	0	93	57	43	14
Elmendorf AFB	1991/92	15	13	8	92	58	42	12
(archery only)	1992/93	15	0	13	87	46	54	13
	1993/94	15	0	13	87	77	23	13
(921,929)	1994/95	15	13	8	92	67	33	12
DM442	1990/91	0	--	--	--	--	--	--
Ship	1991/92	0	--	--	--	--	--	--
	1992/93	10	20	100	0	0	0	0
	1993/94	0	--	--	--	--	--	--
(942)	1994/95	10	40	100	0	0	0	0
DM443								
Peters and	1990/91	15	20	92	8	0	100	1
Little Peters	1991/92	15	20	33	67	0	100	8
	1992/93	15	7	57	43	0	100	6
	1993/94	10	0	70	30	0	100	3
(943)	1994/95	10	20	88	12	0	100	1

Table 4 Continued

Hunt no.[a] /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Total harvest[b]
DM448, 449	1990/91	25	16	76	24	40	60	5
Birchwood[d]	1991/92	25	8	87	13	33	67	3
(archery only)	1992/93	25	12	86	14	67	33	3
	1993/94	15	7	79	21	67	33	3
(948,949)	1994/95	15	20	67	33	75	25	4
Totals for all permit hunts	1990/91	540	18	65	35	37	63	157
	1991/92	642	21	61	39	41	59	198
	1992/93	589	16	68	32	48	52	158
	1993/94	457	17	71	29	63	37	105
	1994/95	441	18	72	28	63	37	92

[a] Hunt numbers in parentheses are prior to 1993-94.
[b] Includes moose with unspecified sex.
[c] Registration hunt.
[d] Formerly Peters Creek Management Area.

Table 5 Unit 14C moose harvest[a] chronology, 1990–94

Regulatory year	Percent of harvest					
	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	*n*
1990/91[b]	38	42	20	--	--	49
1991/92[c]	13	21	12	--	--	46
1992/93[d]	0	37	14	--	--	51
1993/94[e]	7	27	14	--	--	48
1994/95[f]	18	22	29	--	--	69

[a] Excludes permit hunt harvests.
[b] Season 9/4-9/20.
[c] Season 9/3-9/20.
[d] Season 9/8-9/20.
[e] Season 9/7-9/20.
[f] Season 9/6-9/20.

Table 6 Unit 14C moose harvest percent by transport method, 1990–94

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Off-road vehicle	Highway Vehicle	Unknown	*n*
1990/91	3	9	20	3	0	1	62	3	173
1991/92	5	8	18	1	0	2	60	6	210
1992/93	6	9	17	2	0	1	59	5	172
1993/94	9	9	13	1	0	3	63	3	140
1994/95	7	6	10	2	0	1	71	3	154

LOCATION

GAME MANAGEMENT UNIT: 15A (1,314 mi^2)

GEOGRAPHIC DESCRIPTION: Northern Kenai Peninsula

BACKGROUND

Historical records and reports from residents indicate moose were abundant throughout the century in Subunit 15A. The most recent population peak was in 1971. The near absence of wolves from 1913 to 1968 and increased moose survival following a 500 mi^2 forest fire in 1947 were 2 events that increased moose numbers throughout the 1950s and 1960s. Although seasons were long and either sex harvest allowed, the moose population increased beyond its carrying capacity and extensive overbrowsing occurred by the late 1960s. Harsh winters from 1971 to 1974 reduced the moose population over the entire Kenai Peninsula. Estimates for Units 15A and 15B indicate the combined population estimate declined from 7900 in 1971 to 3375 by 1975. Unit 15A represents approximately 75% of these estimates or a decline from 5925 to 2531 moose. By 1982 the moose population estimate for Unit 15A had increased to 3041.

In 1987 and 1990 estimation methods described by Gasaway (1986) were used in the unit for the first time. They indicated a stable population trend in the range of 3014–3850 moose. Although a census has not been completed since 1990, the population is probably slightly declining due to forest maturation, high predation, and effects of the 1994–95 winter.

No large wildfires have occurred since the fires in 1947 and 1969 on the Kenai Peninsula. Consequently, relatively less browse associated with successional forest stages was available to moose, and we anticipate a gradual decline in moose population during normal winters.

Increased human presence and impact of the Alaska National Interest Lands Conservation Act on the Kenai Peninsula have increased the necessity for cooperative interagency management of renewable resources. To this end, the department works closely with a variety of agencies and landholders, while still clearly retaining management authority for wildlife on nonfederal lands and nonsubsistence wildlife species on federal lands. The Kenai National Wildlife Refuge is the largest landholder in Unit 15A and actively participates in a variety of cooperative moose management programs. These include support of the ADF&G Moose Research Center near Sterling, cooperative management of Skilak Loop as a wildlife viewing area, and recent attempts to provide increased access for Alaskans with disabilities, including those hunters confined to wheelchairs. Close coordination and cooperation should continue.

A selective harvest strategy with a spike/fork-50 inch bag limit was initiated on the Kenai Peninsula in 1987. The proportion of males in the population has subsequently increased and hunters seem generally satisfied with the selective harvest strategy. We completed a 5-year evaluation of selective harvest on the Kenai (Schwartz et al. 1992).

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Maintain a healthy population of moose with a posthunting bull to cow ratio of at least 15:100 in Unit 15A, excepting the Skilak Loop Wildlife Management Area (SLWMA).

Skilak Loop Wildlife Management Area (SLWMA) management objectives are as follows:

- View moose in a natural setting throughout the year.
- Provide opportunities to view all components of the moose community including their behavior and habitat.
- Provide opportunities to harvest moose when a reduction in numbers is desirable to achieve other objectives.
- Maintain the resident population at approximately 130 animals or a density of 1.8 to 2.0 moose per mi^2.
- Increase the bull to cow ratio to at least 40 bulls:100 cows. Resident moose in excess of 130 will be available for harvest.

In addition to the resident population, moose from surrounding areas commonly winter in SLWMA. Winter numbers reach 300 animals. Habitat will be managed to provide for 130 resident moose and 170 additional wintering moose.

METHODS

We conducted aerial surveys in November and December of each year in selected trend count areas to ascertain sex and age composition. In 1991 and 1992 we counted 8 of 13 count areas in Unit 15A.

We developed a population estimate for Unit 15A from data collected in February 1990. The techniques used were described in Gasaway (1986). In 1987 we completed the first estimate using these techniques. The 1987 results were not strictly comparable with the 1990 estimates. Poor weather prevented our completing a small number of sample units containing unexpectedly high densities of moose in 1987. The 1987 calculation subsequently underestimated the 15A moose population (Taylor 1990). A complete census of Unit 15A has not been conducted since 1990.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The February 1990 estimate for moose wintering in the unit was 3432 ± 12.18% (3014–3850) at the 90% C.I. The 1987 estimate was 2702 ± 9.6% (2441–2963) at the 90% C.I. These data indicated a substantial 3-year population increase. However, the 1987 calculation significantly underestimated the Unit 15A population size when some sample units containing high densities of moose were not counted (Taylor 1990). The 1990 survey was more complete and, consequently, the estimate of 3014–3850 moose more accurate. The number of moose in the unit probably remained stable between 1987 and 1990.

POPULATION COMPOSITION

Poor weather prevented us from completing a fall sex and age composition survey in 1993. In 1994, 1199 moose were observed in fall composition surveys, compared with 1331 in 1992 (Table 1). Calves comprised 20% of the 1994 sample and occurred in the proportion of 32:100 cows. Calf composition data has remained relatively stable since 1990. Bulls were observed at a ratio of 24:100 cows, 8 bulls:100 cows more than in 1992. Yearling bulls increased from 5:100 in 1992 to 9:100 in 1994, following the mild winter of 1993–94.

MORTALITY

Harvest

Season and Bag Limit. The general open season in Unit 15A was from Aug 20 to Sep 20. Bag limit was 1 bull with spike-fork or 50 inch antlers or at least 3 brow tines on 1 antler. An archery season was held from 25–29 August, with the same bag restrictions. We issued 30 permits in a drawing permit hunt in Skilak Loop Wildlife Management Area from Sep 21–30. The bag limit was 1 antlerless moose; taking of calves and females accompanied by calves was prohibited.

Board of Game Actions and Emergency Orders. A proposal establishing a selective harvest strategy for bull moose was adopted during the 1987 spring Board of Game meeting. This proposal, specifying a legal bull as one with specific antler size, was adopted for both Units 7 and 15. The impetus for this program was both biological and social. The previous management program allowing hunters to harvest any age class bull (including male calves) led to skewed sex ratios favoring females and a male age structure favoring young bulls. Heavy harvest limited opportunities to view and photograph mature bulls.

The Board of Game initiated a spike/fork-50 inch antler restriction for the 25–29 August archery-only season and 1–20 September general season in 1987–88. A permit hunt for antlerless moose in SLWMA began in fall 1989. The following year, 1990–91, bow hunter education for the early archery-only season became mandatory.

In 1993–94 the Board of Game increased the season length to Aug 20 to Sep 20 for the general open season. The archery season was eliminated with the season increase. This season remained in place during 1994–95 and the SLWMA season was unchanged since 1989. No other Board action, affecting harvest of moose in Unit 15A, was taken during this reporting period.

Hunter Harvest. In 1993, 1427 hunters harvested 232 moose (229 bulls, 2 cows and 1 unspecified) during the general open season (Tables 2 and 4). The 1994 harvest increased by 2% when 1425 hunters harvested 238 moose (233 bulls, 2 cows and 3 unspecified). This dramatic increase in harvest during the past 2 years compared to harvest from 1990 to 1992 reflects moderate winter losses during the early 1990s and benefits from selective harvest management.

Of the 232 moose harvested in 1993, 193 (83%) were reported with antler spread data. Since the current bag limit was designed to focus harvest on a portion of the yearlings and on mature bulls, we assumed bulls with an antler spread <35 inches met the yearling (spike–fork) requirement and ≥35 inches were mature bulls having 3 brow tines or an antler spread >50 inches. Sixty-one percent (n = 118) of the harvest were spike-fork bulls and 39 percent (n = 75) mature bulls. Forty-five (60%) of the mature bulls had an antler spread 50 inches or larger, and 3 of these exceeded 65 inches.

In 1994, 215 (90%) of the 238 moose harvested were reported with antler spread data. The harvest comprised 144 (67%) spike-fork bulls and 71 (33%) mature bulls. Twenty-eight (39%) of the mature bulls had an antler spread 50 inches or larger, and 2 of these exceeded 65 inches.

Permit Hunts. We received 1373 and 1426 applications for 30 permits issued to hunt antlerless moose in SLWMA in 1993 and 1994, respectively. Ninety-three percent of the permittees hunted in 1993, resulting in 10 moose taken. In 1994, 87 percent of the permittees hunted and 13 moose were killed (Table 3). All moose harvested were females with an age range of 1–16 years, with a mean age of 4.5 years for the two years. The 2-year combined moose harvest comprised 60 percent ≤2 years and 20 percent 10 years old or older. Hunter success was 38 percent in 1993 and 50 percent in 1994.

Hunter Residency and Success. The 1993 hunter success for the general open season was 16 percent compared with 17 percent in 1994. In 1993, 193 (85%) successful hunters were unit residents, 27 (12%) were nonunit residents, and 8 (4%) were nonresidents (n = 228). Four (2%, n = 232) successful hunters failed to report their residency. Residency reported for unsuccessful hunters was unit residents 968, nonunit state residents 193, nonresidents 13, and unspecified residency 21 (Table 4). Successful hunters averaged 5.9 days compared to 7.6 days for all hunters.

In 1994, 197 (85%) successful hunters were unit residents, 30 (13%) were nonunit residents and 5 (2%) were nonresidents, n = 232 (Table 4). Six (3%, n = 238) successful hunters failed to report their residency. Residency reported for unsuccessful hunters was unit residents 943, nonunit residents 204, nonresidents 15, and unspecified residency 25. Successful hunters averaged 6.3 days compared to 7.6 days for all hunters.

Transport Methods. Fifty-nine percent of the 1993 successful hunters reported highway vehicles as their means of transportation. Boats were the second most common (12%) means of transportation. Hunters using ATVs or horses accounted for 13% of the reported harvest. Ten percent of hunters reported using aircraft as their means of access. The 1994 transportation data compared closely with 1993, when 63% of the successful hunters reported using highway vehicles (Table 5). Six percent of the hunters reported using aircraft.

Harvest Chronology. Thirty-five percent of the 1993 and 34 percent of the 1994 harvest occurred during the first 5 days of the August season (Table 6). The second highest harvest period in 4 of the past 5 years was the last 5 days of the season.

Other Mortality

Crippling loss by hunters and loss due to predation was unknown. In 1993–94, 119 moose were reported killed in Unit 15A by automobile–wildlife accidents. Composition of the 1993–94 road kill was not recorded. The 1994–95 reported kill of 168 moose by vehicles, comprising 84 (60%) calves, 48 (34%) cows, and 8 (6%) bulls (n = 140), was 29 percent higher than 1993 (Table 2). A public awareness program begun in 1990 to reduce the number of automobile–moose collisions (Del Frate and Spraker 1991) and the mild winter of 1993–94, reducing the concentration of moose, may have contributed to the reduced number of collisions in 1993–94.

The winter of 1994–95 was severe, compared to the 2 previous winters in Unit 15A. Snow came early with accumulations of 3 to 4 feet over large portions of the western part of the subunit. Mortality due to starvation was common with 178 documented deaths. Calves comprised 85 percent of the mortality for known-aged animals (n = 132). The increased number of animals killed on local roads and by starvation in 1994–95 reflected the severity of the winter and resulting concentration of moose at lower elevation near developed areas and roads.

HABITAT

Assessment

The 1969 burn (85,000 ac) is still providing browse for most of the moose wintering in Unit 15A. However, this area and small areas of improved habitat north of Skilak Lake comprise only 10–15% of moose habitat in the subunit. The remaining moose habitat is unproductive, due to forest succession away from species and browse heights optimal for moose.

Enhancement

In May 1991, approximately 8,320 acres burned in the southeastern portion of 15A near Pothole lake. This burn is expected to increase available moose habitat; however, due to its small size and location, it may only benefit animals in the immediate area of the burn.

Substantial statewide publicity regarding beneficial effects of wildfire for forest succession derived from the Pothole Lake fire.

A 10,369 acre area near Mystery Creek Road was scheduled to be burned by FWS in the fall of 1991. Unfavorable weather conditions or lack of trained staff since 1991 has prevented this prescribed burn project. Approximately 40 percent of this area is scheduled to be left untreated as scattered islands for wildlife cover and seed source for re-vegetation.

CONCLUSIONS AND RECOMMENDATIONS

A thorough review of selective harvest management on the Kenai Peninsula was published in *Alces* (1992) and as an appendix in the 1993 Unit 15A moose management report. Primarily resulting from this management approach, the bull to cow ratio increased from a 5-year (1982–86) average of 13:100 to 22:100 in 1991 but declined to 16:100 in the fall of 1992, following the moderately severe winter of 1991–92. The ratio then increased to 24:100 in 1994. However, the sharp increase in bull to cow ratio was strongly influenced in 1994 by the 60:100 ratio in SLWMA. Bulls have not been hunted in SLWMA since 1986. The 1994 bull to cow ratio, without SLWMA, was 19:100 for the remainder of Unit 15A. Ratios have remained above management objectives since season length was increased by 12 days, and in 1993 and 1994 the mean harvest rose an average of 40%, when compared to the mean (142) from 1990 to 1993. Hunter effort also showed an increasing trend over the past 2 years, and compares with the numbers of hunters afield before the selective harvest program. The season expansion and increased number of bulls available contributed to the increase in hunter effort and success. The longer season better served the demands of the public, while maintaining the selective harvest strategy objective of protecting bulls in the age classes of 2 to 4 years of age.

With an increase in the number of bulls, opportunity for viewing and photography increased. Public perception of improved population health has also increased, along with public support for continuation of the program.

During this 2-year report period, the 1994–95 severe winter exerted significant mortality on segments of the Unit 15A moose population, particularly calves of the year. This winter-caused mortality should be seen in the reduced number of yearlings observed in fall 1995 composition surveys. Decreased hunter effort and success are also expected in 1995. The number of moose killed by automobiles increased substantially during the severe winter of 1994–95, compared to the winter of 1993–94.

Unlike other game management units where season length and bag limits are sensitive to past winter survival, no changes in season length or bag limits were recommended for 1995–96 in Unit 15A. The conservative nature of the spike/fork-50 inch management program on the Kenai Peninsula allowed the department to continue to offer the same recreational opportunity as in previous years. Increased availability of yearling and mature bulls due to mild winters, an increase in hunter effort from increased season length, and the previous benefits of selective management were important factors in the rise in harvest.

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Table 1 Unit 15A aerial moose composition counts and estimated population size, 1990–95

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1990/91	23	3	35	22	1231	1580	--	3432
1991/92	22	7	34	22	1321	1690	--	--
1992/93	16	5	36	23	1019	1331	--	--
1993/94[a]								
1994/95	24	9	32	20	955	1199	--	--

[a] No data available.

Table 2 Unit 15A moose harvest[a] and accidental death, 1990–95

Regulatory year	Hunter Harvest					Accidental death		Total
	Reported				Estimated			
	M (%)	F (%)	Unk	Total	Total	Road	Total	
1990/91	92	2	2	97	40	119	119	256
1991/92	184	0	1	185	40	169	169	394
1992/93	141	2	0	143	40	99	99	282
1993/94	229	2	1	232	40	119	119	391
1994/95	233	2	3	238	40	168	346[b]	584

[a] Excludes permit hunt harvest.
[b] 178 moose died due to starvation during winter.

Table 3 Unit 15A moose harvest data by permit hunt, 1990–95

Hunt Nr /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
DM524	1990/91	20	15	50	35	0	7	0	7
Skilak	1991/92	20	0	45	55	0	11	0	11
Loop	1992/93	20	0	70	30	0	6	0	6
	1993/94	30	7	62	38	0	10	0	10
	1994/95	30	13	50	50	0	13	0	13

Table 4 Unit 15A moose hunter[a] residency and success, 1990–95

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1990/91	77	14	3	97	662	199	18	901	998
1991/92	151	26	2	185	813	185	13	1,021	1,266
1992/93	121	14	2	143	874	171	15	1,064	1,207
1993/94	193	27	8	232	968	193	13	1,195	1,427
1994/95	197	30	5	238	943	204	15	1,187	1,425

[a] Excludes hunters in permit hunts.
[b] Local = residents of Unit 15.

Table 5 Unit 15A moose harvest[a] percent by transport method, 1990–95

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1990/91	6	4	13	8	0	4	54	8	97
1991/92	4	6	16	5	0	5	61	4	185
1992/93	13	3	12	5	0	4	59	4	143
1993/94	10	2	12	4	0	7	59	6	232
1994/95	6	1	15	6	0	4	63	4	238

[a] Excludes permit hunt harvest.

Table 6. Subunit 15A moose harvest[a] chronology percent by time period, 1990-95.

Regulatory year	Harvest periods							
	8/20-25	8/26-8/31	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	*n*
1990/91	--	5[b]	37[c]	13	16	20	6	97
1991/92	--	5[b]	34[c]	11	23	23	4	185
1992/93	--	8[b]	33[c]	18	13	25	4	143
1993/94[d]	35	7	10	8	13	23	5	232
1994/95[d]	34	11	8	6	15	21	6	238

[a] Excludes permit hunt harvest.

[b] Archery season - 8/25-29, 90, 91 and 92; S/F-50".

[c] General open season Sept. 1-Sept. 20; S/F-50".

[d] General open season Aug. 20-Sept. 20, S/F-50"; archery season (Aug. 25-29) was closed in 1993 & 1994.

LOCATION

GAME MANAGEMENT UNIT: 15B (1,121 mi^2)

GEOGRAPHIC DESCRIPTION: Kenai Peninsula

BACKGROUND

Historical records and reports from Kenai Peninsula residents indicate moose in Subunit 15B have been relatively abundant throughout the century with the most recent peak in 1971. The near absence of wolves from 1913 to 1968 is believed to be one of the primary reasons for the growth of this population. A wildfire that burned approximately 500 square miles in Unit 15A in 1947 also benefited moose with improved winter range. A series of harsh winters from 1971 to 1974 subsequently reduced the moose population in Unit 15B. Population estimates show a decline from 1975 moose in 1971 to 843 by 1975. A census in February 1990 indicated a slight increase since 1975, estimating the moose population at 1042. Since habitat conditions are generally declining with plant succession and predation effects unchanged, the slight increase in population size is attributed to moderate winters and a reduction in harvest due to the selective harvest program initiated in 1987.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Central Kenai Peninsula

Maintain a population of moose with a bull to cow ratio of 15:100 and allow maximum opportunity to participate in hunting in 15B West. In 15B East, maintain a population of moose with a bull to cow ratio of 40:100 and provide opportunity to harvest a large antlered bull under aesthetically pleasing conditions.

METHODS

We aerial surveyed in November and December of each year in selected trend count areas to determine the sex and age composition of the moose population.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

A 1990 census of the 650.4 mi^2 of suitable moose habitat in Unit 15B revealed a population estimate of 1042 moose, with a 90 percent confidence interval ranging from 779 to 1305 or $\pm$25 percent. The estimated mean density was 1.2 moose per $mile^2$, with a range of 0.3–3.0. Since we conducted the census during February, after most bulls shed their antlers, herd composition by sex was not determined. However, we did determine age composition of the population, and calves comprised 9.5 percent. The range for estimated percent calves of the population was 6.8–12.2% or ±28 percent at the 90 percent confidence interval.

This estimate indicates a slight increase in population size when compared to 843 animals estimated in 1975. Winters have been normal or mild since the mid seventies with the exceptions of 1989–90 and 1994–95 when record snow depths were reported and 1991–92 when we recorded slightly higher than normal snow depths. Although a census has not been completed since 1990, the moose density in Unit 15B is probably unchanged due to the relatively normal winters since that time.

Pop*ulation Composition*

Insufficient data was collected to determine sex and age composition for the entire subunit. Aerial surveys were completed in the 5 count areas in Unit 15B East in 1994, and we observed 489 moose (Table 1). Composition for this count was 29 calves and 57 bulls per 100 cows and calves, with calves comprising 15 percent of all moose observed (Table 1).

Season and Bag Limit.

Unit 15B	Resident Open Season	Nonresident Open Season
that portion bounded by a line running from the mouth of Shantatalik Creek on Tustumena Lake, northward to the west fork of Funny River to the Kenai Nat'l Wildlife Refuge; then east along the refuge boundary to its junction with the Kenai River and Skilak Lake; south along the westernside of Skilak River, Skilak Glacier and Harding Icefield; then west along the Unit 15B boundary to the mouth of Shantatalik Creek. *Limit* One bull with 50 inch antlers by drawing permit only; up to 100 permits will be issued.	1 Sep–20 Sep 26 Sep–15 Oct	1 Sep–20 Sep 26 Sep–15 Oct
Remainder of Unit 15B One bull with spike-fork or 50 inch antlers.	20 Aug–20 Sep	20 Aug–20 Sep

Board of Game Actions and Emergency Orders. Due to the success of the selective harvest program, the Board of Game increased season length from 1 Sep–20 Sep to 20 Aug–20 Sep during their spring 1993 meeting.

Hunter Harvest. In Unit 15B West, 46 moose (45 bulls and 1 moose of unspecified sex) were reported by 350 hunters in 1993. In 1994, 323 hunters (Tables 2 and 4) harvested 56 moose (bulls). The mean harvest of 51 during this 2-year period represents an 8% increase compared with the mean harvest of 47 from 1990 to 1992.

Of the 46 moose reported by hunters in 1993, 44 (96%) included antler spread data. Since the current bag limit is designed to focus harvest on yearling and mature bulls, we assumed an antler spread <35 inches met the yearling (spike-fork) requirement and antlers ≥35 inches wide were from mature bulls. The harvest comprised 30 (68%) spike-fork and 14 (32%) mature bulls. Ten (23%) of the harvested bulls had an antler spread ≥50 inches. Successful hunters averaged 5.7 days afield compared to 8.1 for all hunters.

Fifty-four (96%) of the 56 moose harvested in 1994 were reported with an antler spread. Forty-four (82%) of these were yearling and 10 (19%) were mature bulls. Five (9%) of these bulls had an antler spread 50 inches or larger. Successful hunters averaged 7.0 days afield compared to 7.9 for all hunters.

In addition to harvest, 77 moose were reported killed in 15B west by vehicles from July 1, 1993 to June 30, 1994. Composition of moose killed on the highways was not recorded for 1993–94. In the same period for 1994–95, 59 moose were killed in automobile/wildlife accidents; comprising (37%) cows, 27 (46%) calves, 7 (12%) bulls and 2 (3%) unspecified sex of adults. The reduction in automobile/moose accidents in 1994–95 was probably a result of the severe winter that forced moose into Unit 15A, resulting in an increased number of animals killed on the roads there. In Unit 15B West at least 35 moose starved to death in 1994–95 (Table 2).

Permit Hunts. Unit 15B East is managed as an area where hunters are able to view and harvest large antlered bulls. Hunters are allowed to harvest bulls with an antler spread of 50 inches or larger or bulls with antlers having 3 brow tines on at least 1 antler. It was also mandatory for successful hunters to present the antlers of their harvested bull for an official measurement by department staff. Hunters were selected by a random drawing with 100 permits issued for 2 separate seasons. A total of 2342 and 2543 applications were received during 1993 and 1994, respectively. Permittees reported harvesting 24 bull moose in 1993 and 21 in 1994 (Table 3). In 1993, 69 (69%) of the 100 permit holders hunted, yielding a success rate for hunters of 35 percent. In 1994, 66 (66%) of the permit holders hunted, with a success rate of 32 percent. The mean antler spread from bulls harvested during 1993 was 52.7 inches with a range of 39–69 (n = 21). Sixty-seven percent (14 of 21) of these bulls had an antler spread of 50 inches or larger and 14 percent (3 of 21) had spreads of 60 inches or larger. The mean age of bulls in the harvest was 5.0 years, with a range of 3–10. The average antler of a bull harvested in 1994 was 51.7 inches with a range of 33–68. Seventy percent (14 of 20) of the bulls taken had an antler spread of 50 inches or larger and 10 percent (2 of 20) had a spread 60 inches or more. In 1994, successful hunters averaged hunting 3.9 days and observed an average of 5 bulls per hunt.

Hunter Residency and Success. Thirty-nine (85%) of the 46 successful hunters in 1993 were unit residents, 6 (13%) nonunit residents and 1 (2%) was a nonresident (Table 4). Unsuccessful hunters comprised 269 (89%) unit residents, 32 (11%) nonunit state residents, 1 (0.3%) nonresidents and 2 (1%) unspecified residency. Hunter success was 13 percent (n = 46 of 350).

In 1994, forty-six (82%) of 56 successful hunters were unit residents, 4 (7%) nonunit residents, 1 (2%) nonresident, and 5 (9%) hunters did not report residency. Two hundred sixty-seven hunters reported as unsuccessful with similar residency percentages as unsuccessful hunters in 1993. Hunter success was 17 percent for 1994, (n = 56 of 323).

Transport Methods. In Unit 15B West, 65 and 66 percent of successful hunters reported highway vehicles as their primary means of transportation in 1993 and 1994, respectively (Table 5). The second most common mode of transportation was boats (9%) in 1993 and horses (11%) in 1994. Aircraft were not used in 1993, but 2% of successful hunters used aircraft in 1994. In Unit 15B East, over 90% of successful hunters used horses as their primary transport method to access their hunting area in each year.

Harvest Chronology. In 1993 37% of harvest occurred during the first 5 days of the season; in 1994 30% of harvest occurred during this period (Table 6). In 1993, the second highest harvest (17%) occurred during the second 5 days and the third highest (15%) during the last 5 days of the season. In 1994, the highest harvest (39%) occurred during the last 5 days of the season.

Other Mortality

The extent of weather related mortality and predation by wolves and bears is unknown in Unit 15B. However, due to the moderately high density of black and brown bears and wolves, predation is believed to be controlling moose numbers at this time.

In addition to losses by predation, at least 35 moose starved to death in the severe winter of 1994–95.

HABITAT

Assessment

Moose habitat quality in Unit 15B is relatively poor and declining due to natural plant succession.

Enhancement

The last large acreage habitat enhancement occurred when a wildfire burned most of the subunit in about 1890. No significant habitat enhancement, with the exception of the 1947 wildfire that burned 30,600 (8%) of the 398,000 acres below timberline, has occurred in this subunit since 1890. In 1968 FWS enhanced approximately 3,700 acres of primarily winter habitat, using a variety of mechanical tree removal techniques. Since 1968, 1 controlled burn and 5 wildfires have occurred, burning 11,500 acres, 3% of the acres below timberline. Several small areas (less than 50 acres) have also been designated as wood cutting areas for noncommercial use. Judging from the relative density of moose found in the wood cutting areas, I believe these small logged areas provide additional moose browse.

CONCLUSIONS AND RECOMMENDATIONS

In Unit 15B West hunters reported harvesting 46 moose in 1993 and 56 in 1994, which indicates a normal harvest when compared with a mean of 47 moose killed annually from 1990 to 1992. The mean annual harvest since the initiation of the selective harvest program in 1987 to 1994 was 48, ranging from 39 to 56. A mean of 72 bulls were harvested annually during the 5-year period (1982-86) before the selective harvest program began. A comparison of these mean harvests indicates a mean reduction of 33% in harvest during the first 8 years of the program. A similar comparison of hunting effort shows an initial decline followed by a slight increasing trend from 272 in 1988 to 323 in 1994. A population modeling effort using estimated recruitment and mortalities parameters predicted harvest would approach the 72 mean reported before the selective harvest program by 1991. The current level with no upward trend does not indicate this harvest objective will be met. One possible explanation was moderate to severe winters resulting in high calf mortality during 1987–88, 1989–90, 1991–92 and 1994–95. The model prediction was based on normal winter mortality. Although winter mortality was not determined for these years, it was significant, reducing the number of bulls available for harvest. The decline in hunting effort also contributed to reduced harvest.

The permit hunt in Unit 15B East continues to provide excellent hunting opportunities and is popular among resident hunters. The harvests of 24 bulls during 1993 and 21 in 1994 were the two lowest harvests since the permit area was established in 1977. The harvest decline began in 1992, following the moderately severe winter of 1991–92, and has continued through 1994. This decline in harvest is the result of 2 factors: the loss of mature bulls during the winter of 1991–92 and the increased price charged by outfitters to transport hunters into the area. Since only older bulls can be harvested in this area, the loss of bulls in these older age classes will take several years to replace. The only practical means of access into this area is by horse. The cost of contracting with a local outfitter has increased beyond what most hunters are willing to pay. Although the number of hunters going afield has not declined, the number of hunters hunting in areas accessible by horses has declined. These more remote areas have higher moose densities and provide a greater opportunity to harvest a moose.

Harvest levels are well within acceptable guidelines to maintain a minimum bull to cow ratio of 40:100. Since the objective for this area is to provide an opportunity to take a large bull and hunt under aesthetically pleasing conditions, I recommend no change in season. I would further recommend the bag limit be maintained to preserve this area as a control area to evaluate changes in the male segment of the moose subpopulations in adjacent areas where both small and large bulls are harvested.

Summer and winter moose ranges on the Kenai National Wildlife Refuge in Unit 15B continue to deteriorate due to wilderness lands management policies which favor advanced forest succession. The department and FWS should cooperate on selected habitat enhancement projects (mechanical manipulation and prescribed burns) to improve moose habitat in the Slikok and Coal Lake areas.

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Table 1 Unit 15B aerial moose composition counts and estimated population size, 1990–95

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1990/91[a]								
1991/92[a]								
1992/93[b]	50	--	20	12	126	143	--	1,042
1993/94[a]								
1994/95[b]	57	15	29	15	414	489	--	

[a] No data available.
[b] Survey data from 15B East permit area only.

Table 2 Unit 15B moose harvest[a] and accidental death, 1990–95

Regulatory year	Hunter Harvest: Reported M (%)	F (%)	Unk.	Total	Estimated Total	Accidental death: Road	Train	Total	Total
1990/91	54	0	0	54	20	65		65	139
1991/92	38	0	1	39	20	72		72	131
1992/93	47	0	1	48	20	42		42	110
1993/94	45	0	1	46	20	77		77	143
1994/95	56	0	0	56	20	59		94[b]	170

[a] Excludes permit hunt harvest.
[b] Thirty-five moose died due to starvation during winter.

Table 3 Unit 15B East moose harvest data by permit hunt, 1990–95

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
Totals for all permit hunts DM530-DM539	1990/91	100	29	56	44	31(100)	0	0	31
	1991/92	100	34	42	58	38(100)	0	0	38
	1992/93	100	24	66	34	26(100)	0	0	26
	1993/94	100	31	65	35	24(100)	0	0	24
	1994/95	100	34	68	32	21(100)	0	0	21

Table 4 Unit 15B West moose hunter[a] residency and success, 1990–95

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1990/91	53	0	0	54	202	28	4	241	295
1991/92	31	3	0	39	197	42	5	247	286
1992/93	40	6	1	48	247	24	1	272	320
1993/94	39	6	1	46	269	32	1	304	350
1994/95	46	4	1	56	222	31	2	267	323

[a] Excludes hunters in permit hunts.
[b] Local means residents of Unit 15

Table 5 Unit 15B moose harvest[a] percent by transport method, 1990–95

Regulatory year	Percent of harvest								
	Airplane	Horse	Boat	3 or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1990/91	2	15	2	2	0	2	63	15	54
1991/92	0	15	8	10	0	0	59	8	39
1992/93	4	6	2	8	0	2	67	10	48
1993/94	0	7	9	2	0	0	65	17	46
1994/95	2	11	4	2	0	0	66	16	56

[a] Excludes permit hunt harvest.

Table 6 Unit 15B moose harvest[a] chronology percent by time period, 1990–95

Regulatory year	Harvest periods							
	8/20-25	8/26-8/31	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	*n*
1990/91[b]	--	--	39	20	13	29	4	54
1991/92[b]	--	--	36	10	21	26	8	39
1992/93[b]	--	--	48	13	19	17	4	48
1993/94[c]	37	17	4	9	9	15	9	46
1994/95[c]	30	5	5	9	4	39	7	56

[a] Excludes permit hunt harvest.

[b] General open season Sep 1-20, S/F-50".

[c] General open season Aug 20-Sep 20, S/F-50".

LOCATION

GAME MANAGEMENT UNIT: 15 C (2,441 mi^2)

GEOGRAPHIC DESCRIPTION: Southern Kenai Peninsula

BACKGROUND

Moose are considered the region's most economically important wildlife species because of their popularity as a big game animal and their visible presence in developed areas. A rapid population decline occurred in the early 1970s after 3 severe winters in 4 years. The population increased during the 1980s in spite of high predator densities. In some areas the moose population has approached or exceeded carrying capacity.

Declining availability and quality of winter habitat are serious factors limiting moose on the lower Kenai Peninsula. During heavy snow accumulations, moose in Unit 15C are restricted to low elevation riparian habitats and south-facing benchlands. Some of the region's most important winter ranges include the Ninilchik River, Stariski Creek, Anchor River, Fritz Creek, the lower reaches of Fox River and Sheep Creek, and the Homer Bench. Community development in these areas is a serious threat to moose habitat.

Recently, bark beetles have established in many old-growth spruce stands in Unit 15. In 1993 an aerial survey showed 265,972 acres of land were infested with spruce bark beetles (Jim Peterson ADNR, pers commun) and much of the mature overstory had died. Several prescriptive logging cuts have been initiated in response. To date, most logging has occurred on private land, although state timber sales have been planned. Over 32,000 acres of forested land are scheduled for logging in 1996. Reduction of old-growth forests may be beneficial to the moose population by enhancing nutritional quality and availability of winter food plants.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

The moose management objectives are to maintain a population of 3000 moose and a minimum posthunting sex ratio of 15 bulls:100 cows.

METHODS

We collected annual moose harvest data through the statewide harvest reporting system and reported through the Wildlife Information Database (WIDB) software. We documented winter moose mortalities from the Homer Bench incidental to ADF&G field activities or reported by the public. Whenever practical, we inspected carcasses to determine their location, sex, age class, and approximate time and cause of death. A leg bone was collected to examine bone marrow for fat content.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Results from aerial surveys and harvest reports indicate the moose population has remained relatively stable since the mid 1980s. The 1993–94 winter was considered normal with very little winter mortality. The 1994–95 winter was considered moderately severe in most of the region. We believe the moose population has remained stable at 2500–3000 animals.

Population Size

A complete Gasaway (1986) style census was completed during late winter when snow conditions were optimal. The lowland portion of Unit 15C (1190 mi^2) was censused. A population estimate of 2079 moose was calculated from survey results. Confidence intervals around the estimated population ranged $\pm$19.81% for 80 % CI (1677–2491) to $\pm$31.48% for 95 % CI (1425–2734). Low sightability of moose was the largest factor for a high CI. The true population for the census area probably was near the upper confidence limits. We estimated an additional 200–300 moose in the mountainous portion of Unit 15C outside the census area.

Population Composition

Poor survey conditions precluded any moose surveys in 1993. Four of 13 count areas were surveyed during 1994 fall sex and age composition surveys. We classified 1727 moose with ratios of 41 calves:100 cows and 19 bulls:100 cows. Calf percentage was 26%, reflecting excellent neonatal survival (Table 1).

MORTALITY

Harvest

Season and Bag Limit. There was a Tier II subsistence season from 1–30 September in a portion of Unit 15C southwest of a line from Point Pogibshi to the point of land between Rocky and Windy Bay. The bag limit was 1 bull. The remainder of Unit 15C moose season was from 20 August–20 September for 1 bull with spike-fork or 50-inch antlers.

Board of Game Action and Emergency Orders. During the Spring 1993 Board of Game Meeting, the Board extended the general moose season by 11 days, creating a new season opening of 20 August. In addition, the Board made it illegal for the public to feed moose. The board of Game considered proposals to change or eliminate the Lower Kenai Controlled Use Area during the spring 1994 Board of Game Meeting. The Board allowed a 2-day "window" during the last 10 days of the general season for hunters to use motorized vehicles.

A limited entry antlerless moose season was proposed for the Spring 1993 meeting. The local advisory committee failed to support this hunt and, therefore, the Board decided not to consider the proposal without committee support. A modified version of this proposal was again proposed to the Board for the Spring of 1995 meeting with the support of the local advisory committees. The Board passed this proposal, creating a series of antlerless moose hunts for the 1995 season. Hunters were restricted to taking cows without calves and had to be accompanied by department personnel.

The department issued an emergency order extending the Tier II moose season by 1 week to correct for an administrative error. No additional bulls were taken.

Hunter Harvest. In 1993 hunters (1314) harvested 270 moose during the general season (Table 2). One hundred fifteen (43%) hunters reported taking spike/fork bulls (less than 35 inches) compared to 114 (43%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Forty one (15%) indicated either unknown size or illegal classification. Many of these were in the spike-fork category.

In 1994 hunters (1427) harvested 307 moose during the general season (Table 2). One hundred seventy-nine (58%) hunters reported taking spike/fork bulls compared to 85 (28%) hunters who harvested bulls with an antler spread of at least 50 inches or having 3 brow tines on at least 1 antler. Forty-three reports (14%) indicated either unknown size or illegal classification. Many of these were in the spike-fork category. Successful hunters averaged 7.5 and 7.6 days hunting in 1993 and 1994, respectively.

Permit Hunts. There was 1 moose harvested in both 1993 and 1994 for hunt TM549 (Table 3).

Hunter Residency and Success. Hunter success in 1993 was 21%. Two hundred thirty (85%) successful hunters were Unit 15 residents, 28 (10%) were non-unit residents, and 6 (2%) were nonresidents (Table 4). Six successful hunters did not specify residency. Residency reported for unsuccessful hunters was 854 unit residents, 159 non-unit residents, 8 nonresidents, and 23 with unspecified residency.

Hunter success in 1994 was 22%. Two hundred fifty two (82%) successful hunters were unit residents, 31 (10%) were non-unit residents, and 9 (3%) were nonresidents (Table 4). Fifteen successful hunters did not specify residency. Residency reported for unsuccessful hunters was 910 unit residents, 143 non-unit residents, 21 nonresidents, and 46 with unspecified residency.

Harvest Chronology. Reported chronology of harvest indicates the highest percentage of hunting occurred during the first 5 days of the season in all years. When the season began 20 August, this trend did not change (Table 5).

Transport Methods. In 1993, 47% of successful hunters reported ATVs (ORVs and 4-wheelers) as their means of transportation (Table 6). The second most common transportation means for successful hunters was highway vehicles (30%). Hunters using horses (12%), aircraft (3%), or boats (3%) were the least common transport modes.

In 1994, 42% of successful hunters reported ATVs as their means of transportation (Table 6). The second most common transportation means for successful hunters was highway vehicles (38%). Hunters using horses (9%), boats (5%), or aircraft (2%) were the least common transport modes.

Other Mortality

In addition to reported harvest, a minimum of 75 moose were killed in Unit 15C by motor vehicles during 1993. At least 53 moose were killed in 1994 by motor vehicles (Table 2). Approximately 75% of these animals were salvaged for human use. The "Give Moose A Brake" program (Del Frate and Spraker 1991) continued its awareness activities throughout the peninsula. Crippling loss by hunters is unknown, but is believed to be less than 10% of the reported harvest.

The 1993–94 winter was considered mild; however, 2 cases of winter-related mortality were documented. In 1994–95 a moderately severe winter caused the deaths of a high proportion of moose calves, especially near Homer. Fifty seven cases of winter mortality were documented with at least 4 (7%) older than calves. Of 33 known calves, 20 (61%) were male and 13 (39%) female.

HABITAT

Assessment

Reduction of some old-growth forest in response to spruce bark beetle infestations through logging has begun in Unit 15C. We recommended logging prescriptions and reforestation techniques that encourage hardwood production. If hardwood production increases in these affected areas, moose will probably benefit from higher quality habitat. However, if site preparation is not adequate, grass (*Calamagrostis* spp.) will compete with hardwood and spruce seedlings, creating less desirable moose habitat.

Enhancement

As part of licensing requirements, the Alaska Energy Authority (AEA) produced a mitigation plan to maintain or improve habitat within the Bradley Lake hydroelectric area. Moose were significantly affected through project construction and operation. Mitigation focused on compensation for habitat lost from the rising lake. Four options were considered, three of which were implemented. A total of 456 acres of land in the Fritz Creek drainage near Homer was purchased for $345,279. The AEA secured 2 interagency Land Management Agreements (137 acres) with the Department of Natural Resources. A $150,000 trust fund was established to provide money for moose management. Trustees were selected (one each) from ADF&G, AEA, and the Homer Fish and Game Advisory Committee. An operational plan will be drafted to direct use of the above lands and funds.

The department initiated 2 habitat enhancement projects on the Homer Bench. The public was encouraged to plant cuttings in a willow shoot-planting program. We also scarified abandoned hay fields. Approximately 24 acres were scarified using a Percheron disc trencher pulled by a 518 log skidder during late June 1993. An average of 1.5 acres per hour was scarified at a cost of approximately $36.00 per acre, including the cost of equipment mobilization. We visited this area in 1995 and willow shoot densities had increased. Further analysis will be completed during the summer of 1996.

CONCLUSIONS AND RECOMMENDATIONS

The 1993–94 winter was considered normal with little documented mortality. Winter conditions in Unit 15 during 1994–95 were moderately severe, and many calves were lost regionwide. Human-caused moose mortality, including road kills and harvest, represented 10–16% of the estimated moose population of 2500.

We identified 2 solutions to address the problems of declining habitat quality and starvation, habitat enhancement and population reduction within the affected areas. For best results, we believe both should occur simultaneously. In response to public outcry about moose calves' starving to death during the 1991–92 winter, we initiated a habitat enhancement program. The objectives of the program were to enhance moose habitat near Homer by replacing undesirable plants with beneficial browse species. Approximately $150,000 remains in a moose–mitigation trust that has been set aside for use in the Homer area. We recommend a portion of this money be allocated to habitat enhancement as soon as possible. We also began population reduction efforts.

We proposed an antlerless moose season by drawing permit to the Board of Game during the spring of 1993. This controversial issue failed to gain enough local support, so the Board of Game refused to consider the proposal. However, in 1995 we resubmitted the proposal (no more than 50 antlerless moose) during the spring meeting with support from the local Advisory Committee. The goal of this program was to reduce the wintering moose population in the Homer area to allow browse to regenerate.

The harvest of moose and hunter success under spike-fork/50 inch regulations fluctuated in response to previous winter severity. Spike-forks are almost always yearlings and the proportion of young animals in the harvest should provide a "barometer" of the health of that particular cohort. By properly evaluating severity of a particular winter, we can also forecast the upcoming harvest. Schwartz et al. (1992) thoroughly reviewed the selective harvest system.

Impact of predation by wolves and bears is unknown. The unit supports an estimated 50–70 wolves in 5 to 6 packs, a ratio of at least 1 wolf:35 moose and no more than 1 wolf:50 moose. Bears exert additional pressure on unit 15 moose. Black bear are abundant throughout the unit, and brown bear are common in all drainages supporting salmon. Predation should prevent the moose population from increasing, except in years with mild winters.

Bull to cow ratios have been higher than the recommended objectives of a minimum of 15 bulls per 100 cows since the selective harvest program was initiated. Adequate bull to cow ratios minimize the length of the rut and ensure that most cows conceive during their first estrous cycle (Schwartz et al 1994).

To avoid shifts in hunting pressure, Unit 15C season length or bag limit should not be altered until similar changes are recommended for the remainder of Unit 15.

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Table 1 Unit 15C fall aerial moose composition counts and estimated population size, 1990–95

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total moose observed	Moose /hour	Estimated population size
1990/91	37	16	22	14	253	294	--	2500
1991/92	36	18	40	23	705	913	66	2500
1992/93	28	10	33	21	663	834	62	2500
1993/94[a]								
1994/95	19	7	41	26	1,283	1,727	91	2500

[a] No surveys conducted.

Table 2 Unit 15C moose harvest[a] and accidental death, 1990–95

	Hunter Harvest										
Regulatory	Reported				Estimated			Accidental death			
year	M	F	Unk.	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1990/91	200	0	0	200			30	83	--	83	313
1991/92	294	0	0	294			30	49	--	49	372
1992/93	185	0	0	185			30	45	--	45	260
1993/94	270	0	0	270			30	75	--	75	375
1994/95	307	0	0	307			30	53	--	53	390

[a]Excludes permit hunt harvest.

Table 3 Unit 15C moose harvest data by permit hunt, 1990–95

Hunt No. /Area	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls (%)	Cows (%)	Unk	Total harvest
TM549	1990/91	8	50	100	0	0	0	0	0
PointPogibshi	1991/92	15	13	100	0	0	0	0	0
	1992/93	8	12	50	38	3	0	0	3
	1993/94[a]	5	0	80	20	1	0	0	1
	1994/95	5	20	75	25	1	0	0	1

[a] Tier II moose hunt 940T changed to TM549.

Table 4 Unit 15C moose hunter[a] residency and success, 1990–95

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Total(%)	
1990/91	162	27	3	200 (21)	608	90	12	733 (79)	933
1991/92	244	29	9	294 (26)	717	117	5	846 (74)	1131
1992/93	163	13	7	185 (16)	850	127	7	988 (84)	1171
1993/94	230	28	6	270[c] (21)	854	159	8	1044[d] (79)	1314
1994/95	252	31	9	307[e] (22)	910	143	21	1120[f] (78)	1427

[a] Excludes hunters in permit hunts.
[b] Local = residents of Unit 15.
[c] Six successful hunter did not specify residency.
[d] Twenty-three unsuccessful hunters did not specify residency.
[e] Fifteen successful hunters did not specify residency.
[f] Forty-six unsuccessful hunters did not specify residency.

Table 5 Unit 15C moose harvest[a] chronology percent by time period, 1990–95

Regulatory year	Harvest periods 8/20-25	8/26-8/31	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	Unknown	*n*
1990/91[b]	--	--	--	--	--	--	--	200
1991/92[b]	--	--	45	19	12	21	2	294
1992/93[b]	--	--	43	18	14	21	4	185
1993/94[c]	29	12	14	17	9	14	4	270
1994/95[c]	34	11	16	10	11	13	4	307

[a] Excludes permit hunt harvest.
[b] General open season Sept. 1-Sept. 20.
[c] General open season Aug. 20-Sept. 20.

Table 6 Unit 15C moose harvest[a] percent by transport method, 1990–95

Regulatory year	Percent of harvest Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
1990/91	4	16	3	29	0	14	29	6	200
1991/92	4	15	2	24	0	13	35	6	294
1992/93	4	17	3	24	0	14	31	7	185
1993/94	3	12	3	35	0	12	30	5	270
1994/95	2	9	5	35	0	7	38	5	307

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 16A (1,850 mi^2)

GEOGRAPHIC DESCRIPTION: West side Susitna River (Yentna River to Chulitna River)

BACKGROUND

Griese (1996) described a low-density, pre-1940 Subunit 16A moose population that responded to habitat changes and reduced predator populations by increasing substantially, only to be negatively influenced by deep snow winters. Significant winter die-offs occurred at least once during each decade beginning with the 1950s. The most recent die-off occurred during 1989/90. That deep snow winter caused a 30-40% decline in the population, estimated before the die-off at 4000–5500. During 1991–1992, the unit posthunt population was estimated at 2400–3400 moose, well below objective levels. The slow recovery was caused by continuing deep snow winters and growing predation from wolves.

Historical annual hunter harvest in Unit 16A fluctuated as a result of population levels, bag limits, and improving hunter access but did not exceed 308 moose (52 cows) reported for 1984–85. Harvest dropped to 37 bulls in an abbreviated fall 1990 hunting season, the product of the 1989–90 winter and remained below 140 moose under a 15-day season during 1991–1992. A spike-fork-50 inch antler (SF50) harvest strategy was adopted in fall 1993, with evaluation of its effects to take place after a 5-year period.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

To conserve all populations of wildlife while producing moderate, sustainable levels of moose, allowing sustainable harvest levels of predators to meet desirable predator prey ratios, and enhancing wildlife viewing opportunities within state and national parks.

Population Objectives

To maintain a posthunting moose population of 3500–4000 with a sex ratio of no less than 20 bulls:100 cows.

Human-Use Objectives

To achieve by 1997 a minimum annual average (3-year) harvest of 300 moose.

METHODS

During December 1993 a "Becker survey" (E. Becker, pers commun), a modified version of a stratified random sampling census (Gasaway, et al. 1986), was conducted. The survey produced an estimate of observable moose and subpopulation composition with confidence intervals. A total subpopulation estimate was developed by multiplying observable moose by an estimated overall sightability correction factor (SCF) of 1.3. Although during this survey we attempted to develop SCF by sampling strata, a small sample size and high variability in samples caused us to use a standardized SCF of 1.3 for subpopulation and composition projections.

During November 1994, we conducted a trend and composition survey. An aerial survey of 25 sample units (SU), previously surveyed during fall 1990, provided an opportunity to compare and adjust estimates based on observed numbers and composition of the subpopulation. The relation between the 1990 observed herd composition (in the 25 SU) to the population and composition estimated through the MOOSEPOP (Reed et al. 1988) program was assumed the same as that observed in 1994. An estimate for fall 1994 subpopulation composition derived from a full Gasaway et al (1986) survey. Among the assumptions of this method is similar distribution of moose by number and sex and age groups for 1990 and 1994. No confidence intervals were calculated for this method.

Hunter harvest during the general season was summarized from hunter harvest reports and 1 reminder letter. Harvest from permit hunts also came from required hunter reports. Successful any-bull permit hunters were also required to provide front teeth and antlers from their moose for measuring. Antler width and number of brow palm and main palm tines were recorded for each side. Teeth were ground and age determined from cementum lines.

The Department of Public Safety provided the number of moose killed on highways, killed illegally, or killed in defense of life or property (DLP).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

The Unit 16A moose subpopulation size increased slightly from 1990–91 through 1993–94, but recent trends were stable.

Population Size

The 1994 posthunting subpopulation was estimated at 3000–3600 moose (Table 1), or 1.7–2.0 moose/mi^2 of moose habitat.

Population Composition

Fall sex and age composition during 1993 reflected stresses of the deep snow winter during 1992–93 (Table 1). The ratio of 36 bulls:100 cows:33 calves observed during fall 1994 indicated composition recovery to pre-1989–90 levels.

MORTALITY

Harvest

Season and Bag Limit. During 1993–94 and 1994–95 the general hunting season was 20 August–20 September and moose hunting by drawing permit was allowed during 1 November–15 November. A legal animal during the general season was 1 bull with a spike or fork antlers on at least 1 side or antlers that measured 50 inches or more in width or antlers that had 3 or more brow tines on at least 1 side. Drawing permits, up to 200 annually, were issued to take any bull.

Board of Game Actions and Emergency Orders. In spring 1995 the Board adopted regulations that liberalized opportunities to hunt under the SF50 strategy. In addition to the pre-existing 20 August–20 September and 1–15 November season, the Board adopted a 20 November–15 December spike or fork bull only season and additional any-bull drawing permits for the period 20 August–20 September. The Board adopted this liberalization in response to low hunter harvest and surplus of bulls evident during posthunt surveys.

Hunter Harvest. Hunter harvest levels under the SF50 strategy fell short of previous unrestricted levels (Table 2). During 1993–94 and 1994–95 harvest during the general SF50 season was 66–70 moose. The permitted any-bull harvest produced an additional 28 and 49 moose during November of 1993 and 1994, respectively (Table 3). These combined harvest levels fell short of the 138 bulls harvested during the 15-day season and unrestricted bag limit of 1991 and 1992.

Hunter Residency and Success. Fewer nonlocal residents hunted in Unit 16A under the SF50 restriction (Table 4). Overall, general season hunter participation declined 31% from the 1991–1992 average of 853 hunters to 592 under the SF50 strategy. The bulk of the decline was in the nonlocal residents (-27%) and nonresidents (-61%). Local resident participation remained unchanged.

Under the SF50 restrictions hunter success declined to an average of 11% (Table 4). During the falls of 1991 and 1992 (pre-SF50), hunter success averaged 16%. This decline in success was not unexpected, despite a growing density of bulls and reduced competition caused by reduced participation.

Harvest Chronology. Under the 32-day SF50 season, harvest was centered around the last 2 weeks of the season (Table 5). The prerut activities of bulls make them more mobile and visible to hunters. Hunters have a greater chance of seeing a bull with legal antler configuration. Several hunters contacted during the hunt complained about the heat, insects, foliage density, and velvet on antlers typical of the opening week. Many long time hunters of the subunit apparently chose to hunt only during the later part of the season.

Transport Methods. The largest segment of successful hunters in Unit 16A use 3- or 4-wheelers or ORVs as transportation (Table 5). In previous years, successful hunters primarily used boats (Griese 1993). The shift to 3- or 4-wheelers reflects increased ownership by hunters and increased trail development. This trend is expected to continue.

Age vs Antler Size. We collected samples of age and antler data this period; however, sample size was modest and data analysis was delayed.

Other Mortality

Reported accidental mortality within the subunit boundary was at low to average levels during 1993–1994 (Table 2).

Estimates of moose killed illegally or DLP probably increased as the result of the new SF50 regulations. The estimate was 20 illegal moose killed annually (Table 2). Similarly, the estimate of unreported legal harvest doubled. Estimates from years 1990–91 to 1992–93 were reevaluated and reassigned estimates of unreported and illegal kills, differing from that reported by Griese (1996).

Mortality by predation from wolves and bears probably increased (Griese 1996), indicated by a growing wolf and brown bear population.

Mortality from deep snow winters was less of a mortality factor during 1993–94; however, during 1994–95 deep snow reduced short-yearling survival. Based on a small April sample of 49 moose surveyed along the Susitna River near Willow (see Unit 14B), overwinter survival was 30–40% for short yearlings. That survival level is below average for the subunit.

Habitat

Enhancement

Although a controlled burn of 1000–2000 acres of upland black spruce forest along lower Trapper Creek is planned in the next 2 years (W. Collins, pers commun), the department has not manipulated large areas specifically for moose in Unit 16A. Collins (pers commun) found that manipulation of riparian habitat within the Susitna River floodplain was counter-productive and recommended against it.

CONCLUSIONS AND RECOMMENDATIONS

Fall population estimates were approaching the lower end of population objective levels by fall of 1993. The population estimate for fall 1994 was similarly close. In spite of low population levels, bull:cow ratios exceeded objective levels, reaching at least 24 bulls:100 cows and no more than 36 bulls:100 cows.

The 3-year average hunter harvest was 117, which is 39% of the desired human–use objective of 300 moose. The prospect of achieving that level by 1997 is unlikely under the current SF-50 strategy. Antler restrictions imposed beginning fall 1993, by design, reduced harvest rates, and most of the subunit is inaccessible during the fall hunting season. While meeting the objective is unlikely, we made efforts to increase harvest by increasing the number of any-bull drawing permits and by adding a late (20 November–15 December) spike-fork only season. The effectiveness of this late season will depend on snow depth and conditions that influence moose distribution and hunter mobility.

I recommend semiannual fall composition surveys to allow evaluation of the influence by SF-50 restrictions on subpopulation composition. Hunter demand for moose in southcentral Alaska far exceeds the harvestable surplus. Frequent surveys also allow for semiannual adjustment of permit numbers to optimize hunter harvest.

While the SF50 strategy was expected to allow acceptable harvest levels and produce desirable bull:cow ratios in several road accessible game management units, we estimated SF-

50 restrictions would unnecessarily restrict harvest in 16A. Bull:cow ratios, which far exceeded the objective of 20:100, were evidence of the resulting surplus. Providing this surplus of bulls to hunters through special any-bull permit hunts was part of the selling point when SF50 was offered to the public. But now it appears that to reach objective harvest levels, we would have to issue as many any-bull permits as there are hunters during the general season. Evaluation of the SF50 harvest strategy after 5 years of application will probably confirm the inappropriateness of the restrictions in Unit 16A for biological reasons.

If sequence of Board consideration is such that change will not be possible before a 6th year of SF50 antler restrictions, a fifth year of testing the antler restrictions should be considered unnecessary.

I recommend continued effort to collect age–antler formation data from lower Susitna River valley bulls. Management decisions, especially those related to antler formation and size, are dependent on a firm grasp of antler growth tendencies. Statistical validity may require a minimum sample of 30 bulls in each of the 7 tested age classes (age 1–7+).

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Table 1 Unit 16A fall aerial moose composition counts and estimated population size, 1988–1994

Regulatory year	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Population estimate
1988/89	36	12	35	19	392	484	4000-5500
1989/90[a]	--	--	--	--	---	---	3800-5300
1990/91[b]	27	7	31	29	1105	1366	2961±256[c]
1991/92[a]	--	--	--	--	---	---	2700-3200
1992/93[d]	36	11	32	19	779	963	2900±564[c]
1993/94[d]	24	10	24	16	698	828	3284±903[c]
1994/95[e]	36	11	33	19	804	981	3000-3600

[a] No surveys conducted.

[b] These data were derived from a population census conducted in December 1990. SCF calculated by strata.

[c] 80% C.I.

[d] These data were derived from a "Becker Survey." SCF calculated by strata.

[e] Data obtained during sex and age composition survey of sample of SU surveyed during 1990–91.

Table 2 Unit 16A annual moose harvest and accidental death, 1990–94

Regulatory	Reported				Estimated			Accidental			
year	M	F	Unk	Total	Unreported	Illegal[a]	Total	Road[b]	Train[c]	Total	Total
1990/91	37	0	0	37	10	5	15	6	0	6	58
1991/92	135	0	3	138	7	15	22	15	0	15	175
1992/93	136	0	2	138	7	5	12	9	0	9	159
1993/94	96	0	2	98	15	20	35	9	0	9	142
1994/95	115	0	0	115	15	20	35	4	0	4	154

[a] Includes moose taken in defense of life or property.

[b] Road and train are minimum numbers; in most years actual kill was probably higher.

[c] While the train does not travel through Unit 16A, up to 60% of moose killed by trains in Unit 14B are from Unit 16A.

Table 3 Unit 16A moose harvest data by permit hunt, 1990–1994

Regulatory year	# Applicants	Permits issued[a]	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Bulls	Cows	Total
1990/91	--	0	--	--	--	0	0	0
1991/92	--	0	--	--	--	0	0	0
1992/93	--	0	--	--	--	0	0	0
1993/94	1310[b]	100	20	64	36	28	0	28
1994/95	1715[b]	100	12	51	49	49	0	49

[a] Combines data from DM554 and DM556.

[b] Applicants could apply for both hunts (DM554 and DM556).

Table 4 Unit 16A moose hunter residency and success 1990–94

	Successful					Unsuccessful					
Regulatory year	Local[a] resident (%)	Nonlocal resident(%)	Nonres	Unk	Total	Local[a] resident	Nonlocal resident	Nonres	Unk	Total	Total hunters
1990/91	4 (11)	35 (84)	1	1	37	23	448	9	16	473	510
1991/92	9 (07)	123 (89)	4	2	138	28	673	12	8	721	859
1992/93	7 (05)	126 (91)	4	1	138	34	630	24	21	709	847
1993/94	5 (07)	62 (89)	1	2	70	37	529	6	13	548	618
1994/95	6 (09)	57 (86)	2	1	66	32	488	8	4	500	566

[a] Unit 16 residents.

Table 5 Unit 16A moose harvest chronology, 1990–1994

Regulatory year	Before season opened	Weeks of season 1st (%)	2nd	3rd	4th	5th	After season closed	Unk	Total
1990/91[a]	1	21 (57)	11	---	---	---	2	2	37
1991/92[b]	0	72 (52)	53	7	---	---	1	5	138
1992/93[b]	0	75 (54)	51	6	---	---	1	5	138
1993/94[c]	0	13 (19)	6	9	22	18	0	2	70
1994/95[c]	1	6 (09)	8	11	13	25	2	0	66

[a] 1-10 September season.

[b] 1-15 September season.

[c] 20 Aug–20 Sept. season, spike/fork-50" bull selective harvest strategy

Table 6 Transport methods used by successful moose hunters in Unit 16A, 1990–94

Regulatory year	Percent of Successful Moose Hunters: Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Orv	Highway vehicle	Unk	Number moose harvested
1990/91	22	3	24	14	0	24	14	0	37
1991/92	15	0	25	30	0	11	17	1	138
1992/93	16	0	21	28	0	14	18	3	138
1993/94	13	0	23	34	0	11	19	0	70
1994/95	21	0	17	33	0	8	20	1	66

LOCATION

GAME MANAGEMENT UNIT: 16B (10,405 mi^2)

GEOGRAPHIC DESCRIPTION: West side of Cook Inlet and Kalgin Island

BACKGROUND

Before 1940 moose were uncommon in Unit 16B. Habitat changes and reduced predator numbers, because of federal predator control, allowed higher densities. Moose numbers peaked during the 1950s, the late 1960s, and late 1970s. Though the population exhibited a declining trend since the 1970s, peaks in numbers were reported during 1984 and again in 1988. Winter die-offs occurred in response to deep snow, but the population recovered during periods of mild winters. The most significant die-offs occurred during the winters of 1971–72 and 1989–90.

The fall 1989 unit population was assumed to be 8000–9000 moose (Griese 1995). During the winter of 1989–90 overwinter moose mortality was estimated at 15–20%, but during fall 1990 a stratified random survey revealed an estimated 7300–7500 moose (Harkness 1993). Griese (1995) estimated a 4–5% annual decline in unit moose numbers between 1990 and 1993. That portion of the unit north of Skwentna River, where a 20–30% decline was observed, was primarily responsible for the overall declining trend.

Though deep snow was primarily responsible for major die-offs, Faro (1989) implied that predation on neonatal moose calves by bears began influencing recruitment and caused a declining trend. Predation by wolves was not considered an important factor until 1992. During March 1993 an aerial survey was conducted to estimate wolf numbers in Unit 16 (Masteller 1994). The minimum population of Unit 16 was calculated to be 39–42 wolves, an increase from the previous 5–10 years. Masteller estimated the 1993 moose:wolf ratio as at least 161:1 and as high as 208:1

From 1972, when Unit 16 was divided into units A and B, through 1992, annual reported harvest in Unit 16B averaged 426 moose. Annual harvest ranged from a low of 99 during 1990 to the peak of 842 during 1973. The harvest reported for 1973 did not reflect the population size, but rather an effort to reduce moose numbers to improve winter habitat. Peaks in harvest also occurred during 1978 (589 total and 147 cows) and 1984 (616 total and 173 cows). Harvest subsequent to the 1984 peak reflected a general population decline. During fall 1989 the harvest was 345 moose, including 32 cows. During 1990 the shortened season length (in response to the previous winter's die off) caused a harvest decline of 99 moose.

Hunting seasons in mainland Unit 16B have reflected a Board of Game effort to take advantage of a poorly accessed, underused moose resource. During 1962–74 hunting seasons in Unit 16B were liberal, including August 20–September 30 and November 1–30 seasons for either-sex moose. Although 5–20-day antlerless moose hunts during September continued through 1989 (except 1975), late season hunts were absent during 1976–82. Increasing numbers of hunters and lower moose recruitment caused late season hunts to be converted to permit hunts beginning in 1983. To assure local residents an opportunity to meet subsistence needs, permits were issued in the unit or, in later years, as Tier II permits.

During 1992 the Board adopted antler restrictions for bull moose beginning fall 1993 for most of southcentral Alaska, and portions of Unit 16B were included. In those portions of 16B north of Beluga River and west of the Kustatan River, legal bulls were required to have a spike, fork or 3 brow tines on 1 side or have an antler spread of 50 inches or greater (SF50). The antler restriction imposed in Unit 16B was a precautionary regulation to aid in enforcement of the regulation on the road system, where it was needed. Antler restrictions were unnecessary for moose population management in Unit 16B (Griese 1995).

The Kalgin Island moose population resulted from a translocation of calves during 1957–59. Numbers grew but were also affected by prolonged deep snow winters. Hunting was allowed during 1969–78 and again in 1981. Annual harvest peaked at 80 moose during 1981–82 but declined to under 10 annually since 1985. The population peaked at 7 moose/mi^2 during 1981 (Taylor 1983) but was intentionally reduced to 1 moose/mi^2 by 1985. High moose densities severely degraded habitat and caused the adoption of restrictive population objectives, which maintained moose densities at less than 1 moose/mi^2 while vegetation recovered (Faro 1990). During fall 1991 harvest was restricted to bulls only because the fall 1990 population was estimated at 20–35 moose (Harkness 1993).

MANAGEMENT DIRECTION

MANAGEMENT GOALS

To produce high yields of moose for humans and to provide maximum opportunity to participate in hunting moose

POPULATION OBJECTIVES

Unit 16B (excluding Kalgin Island)

To maintain a minimum fall moose population of 6500 with a posthunting sex ratio of 20–25 bulls:100 cows.

Kalgin Island

To maintain a fall population of 20–40 moose with a posthunting sex ratio of no less than 15 bulls:100 cows.

HUMAN–USE OBJECTIVES

To achieve and maintain a minimum 3-year average harvest of 300 moose by 1999.

METHODS

During November 15–December 3, 1993, a "Becker" aerial survey (E. Becker, pers commun) was conducted in the portion of Unit 16B north of Beluga River. Survey samples included 7 high- , 7 medium- , and 4 low-density strata survey units (SU) south of Skwentna River (middle subpopulation) and 5 high, 13 medium and 6 low SU north of the Skwentna River (northern subpopulation). We included sightability correction factors (SCF). Estimated subpopulation size and composition was calculated using MOOSEPOP (D. Reed, pers commun).

During aerial surveys in fall 1994, we sampled all subpopulations of the unit. In the north a subsample, 16, of 30 SU, previously flown during a stratified random survey of the area during 1990, was surveyed during 13–18 November. The survey included 4 low, 5 medium, and 7 high SU. The results of the composition from these SU were considered directly proportional to the results from the 1990 survey from the same SU and the final composition estimated through MOOSEPOP (see Unit 14A, Methods). We collected no data to generate a SCF.

During 18–25 November in the middle subpopulation, we attempted a Becker survey, sampling 3 low, 12 medium, and 3 high SU. No data were collected to generate a SCF.

During 29 November–2 December, a modification of the Gasaway et. al. (1986) survey was attempted on the mainland south of Beluga River (southern subpopulation). The method, designed by Jay VerHoef (ADF&G Fairbanks) and applied by Earl Becker (ADF&G Anchorage), used SU with densities stratified along a regression line. We assigned SU a "predicted density"(Y_{SU}) based on observations of number of moose and number of tracks (1 track = 0.2 moose) during stratification flights, on past relationships of stratified counts to final observed densities and modified by correction factors related to vegetation type (sightability). Predicted densities, Y_{SU}, were calculated as:

$$Y_{SU} = (0.42 + S_V(SC_{SU}/A_{SU}));$$

where:

S_V = sightability value of 1.35 for good sightability due to "open" vegetation or 2.41 for poorer sightability limited by a forest canopy;

SC_{SU} = stratification count (nr observed moose + 0.2(tracks));

A_{SU} = area of survey unit in mi^2

We selected sample units proportional to the expected density and weighted probability of selection (E. Becker, pers commun). A sightability factor was generated. We used the same data for the southern population to compare results generated by using low- , medium- , and high-density strata of the Gasaway method with MOOSEPOP (SCF pooled across strata).

Kalgin Island was aerially surveyed in its entirety for sex and age composition during 18 November 1994 and 9 February 1996. The island was surveyed from a PA-18 Super Cub at 5–7 min/mi^2. No SCF was generated.

During 27–28 February 1996 a high-graded aerial composition count was conducted in the northern subpopulation. Moose were categorized as adults or calves (short yearlings).

During 29 February–3 March 1996, we surveyed the southern subpopulation, using a Gasaway et al (1986) survey. Moose were categorized as adults or calves (short yearlings). SCF were calculated by density strata. Estimated population size and composition were calculated using MOOSEPOP (D. Reed, pers commun).

We collected harvest and hunter effort data from harvest and Tier II permit reports.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Survey technique results

Attempts to generate subpopulation estimates for the middle subpopulation using the Becker survey proved difficult during both 1993 and 1994 due to unpredicted moose movement patterns. During 1993 the subpopulation estimate generated 80% confidence intervals at 38% of the point estimate. Whereas, the Becker method provided a useful estimate for the northern subpopulation during 1993. Consequently, the composition for the middle subpopulation was drawn directly from survey results. A thorough mixing of the subpopulation due to movement justified composition estimates for 1993.

The method used to estimate composition and density for the northern subpopulation during 1994 lacked confidence intervals but reduced survey costs by 71% of a Gasaway survey and 56% of a Becker survey. Survey costs for this method were $3309, and costs were $11,481 for the 1990 Gasaway and $7593 for the 1993 Becker. The method relies on a previous Gasaway being conducted for the comparison and calculation.

Jay VerHoef's regression sampling method applied in the south subpopulation required sequential days of good flying weather. Because of poor weather conditions, the method could be applied only to the 1/3 of the south subpopulation with the highest density. This method produced an estimate of 612.5 $\pm$ 150.8 (25%) (80% CI) moose for the area between Beluga River and Straight Creek. A SCF of 1.18 was generated.

The subpopulation estimate generated for the same area using the Gasaway/MOOSEPOP method proved less precise. The estimate was 589.6 $\pm$ 206.5 (35%) (80% CI). The SCF generated by this method of analysis was 1.16.

The decision to use the Gasaway/MOOSEPOP over the J. Ver Hoef regression sampling method for the winter survey of 1996 was based primarily on convenience. The estimate for winter 1996 for the southern subpopulation was 1080.5 $\pm$ 145 (13.4%)(80% CI). SCF estimated by strata were 1.02, 1.31, and 1.13 for low- , medium- , and high-density strata, respectively.

Population size

The best point estimate of the unit population during 1993–1995 was 6470 moose, estimated from all subpopulation estimates for fall 1994 (Table 1). In that year, estimates for northern and middle subpopulations were based on results from 1993 surveys.

The Becker survey during 1993 of the north and middle subpopulations, when combined, produced an estimated 5847±1419 (80% CI) observable moose (Table 1). A SCF, pooled for all strata, was estimated at 1.21. Estimates for the same subpopulations for fall 1994 were 4400–6400 moose.

Despite poor results using the Becker method in assessing the middle subpopulation, the point estimate during 1993 (3653 moose) (Table 1) was within 80% CI of the 1990 Gasaway estimate.

The southern subpopulation of moose was estimated at 810–1210 during 1994 by adding 350–550 moose (an estimate of the unsurveyed portion of the subpopulation) to the calculated estimate from the J. VerHoef method (Table 1). The following winter the southern subpopulation was estimated (by a Gasaway survey) at 1081, which was within the range of the previous year's estimates.

Kalgin Island was estimated to have 55–65 moose after hunting in 1994–95 and 50–60 moose in 1995–96 (Table 1).

Trend. The unit moose population appeared to decline since 1990, when the entire unit population could last be estimated (Table 1). The point estimate for the unit population during 1990 was approximately 7440 moose and 6470 moose in 1994, a 13% decline.

While the northern subpopulation contributed substantially to the declining trend, it was apparent the southern subpopulation and Kalgin Island population had increased since 1990 (Table 1). The estimated degree of decline in the northern subpopulation was estimated at 28% between 1990 and 1994 and 5% between 1993 and 1994. However, the southern subpopulation exhibited a 22% increase in observable moose between 1990 and 1996. And Kalgin Island's observed moose increased by almost 80% between 1990 and 1994. This island population may have declined following 1994 after the board reinstituted an antlerless moose permit hunt during fall 1995.

Population Composition

Bull:cow ratios depicted in Table 1 indicate the middle and southern subpopulation composition approached population objectives of 20–25 bulls:100 cows, while excess bulls were in the northern subpopulation and on Kalgin Island. The 42–50 bulls:100 cows in the northern subpopulation during 1993 and 1994 indicate poor hunter access and limitations on hunters imposed by the SF50 regulation. The Kalgin Island population exhibited 35 bulls:100

cows during 1994 in spite of standing alone as one of the few "any-bull" areas in southcentral Alaska.

Low bull segment recruitment led to the ratio of 4–5 yearling bulls:100 cows in the middle and southern subpopulations during 1994 (Table 1). Low bull recruitment could be a function of survey classification errors, hunter selection and/or predation.

We observed extremes in calf survival to fall during 1994 (Table 1). The northern subpopulation had a low of 12 calves:100 cows while predator-free Kalgin Island exhibited 65 calves:100 cows. Middle and southern subpopulations had 24–25 calves:100 cows.

Overwinter calf survival in February–March 1996 survey results (Table 1) were higher than average predation levels for the northern and southern subpopulations. Despite a winter with little snow on the ground until early February, percent calves observed for northern and southern subpopulations reached only 6–7%. The relatively low calf percentage values for the middle subpopulation also indicate possible low calf recruitment the previous spring. The winter of 1994–95 produced deeper, more persistent snow depths than average, which may have affected calf nutrition in utero.

MORTALITY

Harvest

Season and Bag Limit. During 1993–94 and 1994–95 the resident and nonresident open season on Kalgin Island was 20 August–20 September with a bag limit of 1 bull.

Within that portion of the unit including the mainland drainages south and west of, and including, the Kustatan River drainage, the season for resident hunters was 20 August–20 September with a bag limit of 1 bull with SF50 antlers. The nonresident season was closed in this portion of the unit during both years.

Between the Kustatan River drainage and Beluga River, Beluga Lake and Triumvirate Glacier (remainder of the unit), the hunting season was 20 August–20 September with a 2-week season by emergency order during 1 January–28 February, with a bag limit of 1 bull by Tier II permit only for Alaska residents (TM569). Twenty bulls were allowed to be taken annually. The 1993–94 late season was open during 24 January–13 February. The third week was added to this season because the state failed to deliver 1994 hunting licenses to the local vendor until after the hunt had begun. During 1994–95 the late season dates were 1–14 January. We issued 60 permits each year (Table 4).

During 1993–94 in the portion of the unit north and east of Beluga River, Beluga Lake and Triumvirate Glacier, the resident and nonresident season was 20 August–20 September with a bag limit of 1 bull with SF50 antlers. In addition, only residents could hunt during 10 January–23 January for a SF50 antlered bull or, by Tier II permit, for antlerless moose. Tier II. permit hunters could take 30 cows; we issued 45 permits for 2 hunt areas (TM565 and TM567) (Table 4).

During 1994–95, in the same portion of the unit, the resident and nonresident season was, again, 20 August–20 September with a bag limit of 1 bull with SF50 antlers. Only residents possessing Tier II permits were allowed to take any bull during 1 December–15 January. The hunt was limited to 100 bulls; we issued 200 permits (Table 4).

Board of Game Actions and Emergency Orders. During 1992 the Board of Game adopted SF50 antler restrictions for bull moose hunting beginning in fall 1993 for most of southcentral Alaska, including portions of Unit 16B. Those portions included were north of Beluga River and west of and including the Kustatan River drainage. The antler restriction imposed in Unit 16B was a precautionary regulation to aid in enforcement of the regulation where it was needed, along the road system.

In 1992 a group of local residents filed a class action suit bringing to question the method for allocating Tier II permits. After changes to regulations made by the Board during March of 1994 they amended that suit. The complainants first argued that the point system for allocation was unfair to local residents. Their amended suit argued that subsistence hunting and general season hunting could not occur in the same population unless subsistence needs were met first. The suit remained unresolved.

The Board wrestled with the issue of meeting local subsistence needs within the portion of the unit north of Beluga River. During 1993–94 they adopted Tier II permit hunts that allowed the harvest of antlerless moose during the 10–23 January season. For those residents not receiving a permit, the Board offered SF50 bulls during a general, residents only, season with the same season dates. However, because the moose subpopulation north of Beluga River in a steady decline, during March 1994 the opportunity to harvest cows was eliminated. The Board authorized the harvest of any bull during a 1 December–15 January season for the 1994–95 regulatory year by Alaska residents holding a Tier II permit. The Board determined the subsistence demand for moose could be met through the late season harvest of an additional 100 moose offered by this hunt.

During March 1995 the Board adopted seasons for the 1995–96 regulatory year that added additional moose hunting opportunity in the unit. For that portion of the unit north of Beluga River, they adopted a 20 August–30 September resident and nonresident season for SF50 bulls and a resident only 15 November–31 December season for any bull by Tier II permit. The Board also extended the early fall season through 30 September on the mainland south of Beluga River, still not allowing nonresidents to hunt there. The late season Tier II permit hunt between Beluga River and the drainages of the Kustatan River was set for 1 December–15 January, eliminating the need to open the season by emergency order. Finally, the Board added an antlerless moose drawing permit hunt for Kalgin Island in response to an observed population well above objective levels. They authorized the department to issue no more than 100 permits for the 20 August–20 September concurrent season.

Hunter Harvest. During 1993–94 reported hunter harvest continued to decline as a result of SF50 restrictions (Table 2). The harvest of 21 cows during 1993–94 under the Tier II permit hunt was the first legal cow harvest in the unit since the 1989 season (Griese 1995). During

1994–95 the Tier II harvest, 105 bulls, reached 46% of the total reported harvest for the unit (Table 4), in part due to effects of SF50 on hunter participation and success.

On Kalgin Island, 30 hunters reported taking 8 bulls during 1993–94, and 32 hunters reported taking 11 bulls during 1994–95.

Permit Hunts. Tier II permit holders' harvest reached 104 moose during 1994–95 (Table 4). The number of permits issued, 255, was the highest since 1990 when Tier II permits were first issued. Hunter success for permit holders also reached a record level of 64% during this period, despite low (44%) hunter participation and low (37%) hunter success by TM569 permittees.

Hunter Residency and Success. Combined hunter success (23%) during the 1993–94 and 1994–95 general seasons (Table 3) was substantially less than the combined 1988–89 and 1989–90 success rate (30%) (Griese 1995). In addition, overall hunter population declined to an average of 555 annually. During this period, Unit 16 residents accounted for 8% of the general harvest, while other residents took 62% and nonresidents took 28%. While the proportion taken by nonresidents increased from 18% to 28% over the past 4 years, their actual harvest has remained stable.

Harvest Chronology. The chronology of the general harvest during this period reflected the longer SF50 season and the one-time January hunt of 1994 (Table 5). During 1993–94 the 2-week season in January produced 9 reported moose or 7% of the annual reported harvest. The extension of the fall season into August failed to deflect the pattern of hunters taking greater than 50% of the harvest during the last 11 days of the season.

Transport Methods. The high percentage of successful hunters reporting the use of snowmachines for transportation in Unit 16B reflects a shift of harvest toward local residents during winter Tier II permit hunts (Table 6). Seldom has snow been measurable before 20 September nor streams and rivers frozen, making snowmachine use during the August–September season unlikely. Use of airplanes has declined steadily since 1988–89 (Griese 1995).

Other Mortality

Winter snow depths during 1993–94 were average, but during 1994–95 snow accumulation was prolonged and at greater depths. Consequently, calf survival through the winter of 1994–95 was 20–30%. During November 1994 aerial surveys, we observed 3 sites on rivers where moose had broken through ice in an attempt to cross. Early deep snow prevented ice from getting thick enough to support moose, yet the snow depth was forcing moose to move to lower elevations. Consequently, the incidence of drowning that winter was probably higher than normal.

Effects of predation by wolves and bears were apparent in southern and northern subpopulations during winter 1995–96 (Table 1). During aerial surveys of the southern subpopulation of moose, we saw a pack of 32–35 wolves near the higher moose density SU. Associated with their tracks were at least 2 recent moose kills. Those observations and only

6% calves observed in this somewhat restricted subpopulation indicate predation was significantly affecting recruitment.

CONCLUSIONS AND RECOMMENDATIONS

The Unit 16B moose population is at or below population objectives and will probably go lower, given growing predator levels and continuing low calf recruitment. However, with the exception of the northern subpopulation and Kalgin Island, desired bull:cow ratios are being approached. Kalgin Island, only recently surveyed, was identified as exceeding population limits by almost 100%.

The most recent 3-year average (1992–94) hunter harvest was 215 moose. This level of harvest is well below the unit's human–use objectives of 300.

Reaching human–use objectives may require eliminating or modifying antler restrictions in the unit. Working with the Board and local advisory committees to develop acceptable hunter opportunities and concurrently improving moose harvest could be a challenge. But opportunities to fashion permit hunt boundaries and zones of less restrictive bag limits on bulls could temporarily increase average annual harvest by 100–150 moose. However, to ultimately reach and maintain an average harvest of 300 moose may require a substantial shift in predator:prey ratios and/or several years of favorable winter weather patterns.

I recommend that cow moose harvest be limited in Unit 16B to specific areas where predation is not causing a moose population decline, such as Kalgin Island. Since the 1980s (Faro 1989), we have known that bear populations influence fall calf numbers in Unit 16B. Recently, wolves have increased in numbers and few effective harvest options are available for limiting their numbers. Growing numbers of wolves reduce the likelihood of future moose population growth. The expected decline in moose numbers will eliminate the option for future antlerless moose hunts if optimum sustainable harvest is desired.

We need to evaluate habitat conditions on Kalgin Island and in major wintering areas of the mainland (Griese 1995). Population objectives for Kalgin Island depend on the status of vegetation recovery. Harkness (1993) also suggested that habitat on the mainland should be evaluated and implied that we should consider enhancement through controlled burning. We have conceptualized a controlled burn for an area within the range of the unit's middle subpopulation.

Methods tried in Unit 16B for surveying moose have produced varying levels of success. While Gasaway or VerHoef's regression sampling surveys are most precise, they are also most costly and time consuming, making them also most dependent on favorable weather patterns. The method of similarly surveying SU, selected during the most recent Gasaway, in following years and assuming a direct proportion relation between observed and calculated values holds promise. The cost of this method is substantially less, and we may eliminate moose population composition biases of the past with this method. Survey timing is absolutely critical; we must conduct surveys before snow depths cause moose movement.

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Table 1 Unit 16B fall aerial moose composition counts and estimated subpopulation sizes, 1990–1995

Regulatory year	Area	Date	Bulls: 100 cows	Yearling bulls: 100 cows	Calves: 100 cows	Calves(%)	Adults observed	Total moose observed	Moose /mi.^{2}	Population estimate
1990/91	Northern [a]	11/21-27	32	9	23	15	650	745	1.4	2,650$\pm$412 [b]
	Middle [a]	12/8-21	35	5	25	16	673	789	1.4	3,880$\pm$326 [b]
	Southern [a]	2/27-3/1	--	--	--	7	260	282	0.4	884$\pm$262 [b]
	Kalgin Is.	n/a	n/a	n/a	n/a	n/a	n/a	10	n/a	20-35 [c]
1991/92 [d]	--		--	--	--	--	--	--	--	
1992/93	Southern [e]	12/15	36	5	12	12	109	124	--	--
1993/94	Northern [f]	11/15-20	50	10	16	10	374	416	1.1	2,006$\pm$432 [b]
	Middle [f]	11/28-12/3	21	9	25	17	391	463	1.4	3,653$\pm$1,965 [b]
1994/95	Northern [g]	11/13-18	42	10	12	7	405	431	1.0	1,400-2,400
	Middle [g]	11/18-25	26	4	24	16	314	374	--	3,000-4,000
	Southern [h]	11/29-12/2	25	5	25	17	220	261	1.0	810-1,210g
	Kalgin Is. [i]	11/18	35	15	65	33	27	40	1.7	55-65
1995/96	Northern [e]	2/27-28	--	--	--	7	298	321	--	--
	Middle [e]	2/27-28	--	--	--	12	855	969	--	--
	Southern [a]	2/29-3/3	--	--	--	6	505	537	0.8	1,081$\pm$145 [b]
	Kalgin Is. [i]	2/9	--	--	--	28	26	36	1.5	50-60

[a] Data from a Gasaway, et al (1986) random stratified survey.
[b] 80% confidence intervals
[c] Harkness (1993).
[d] No surveys conducted.
[e] Data from trend area composition survey (2-4 min./mi^2)
[f] Data from Becker survey.
[g] Data from sex and age composition survey (4-7 min./mi^2) of sample units previously surveyed during 1990 survey.
[h] Data from J. VerHoef's regression sampling method for 1/3 of area (612$\pm$151 (80% CI)) plus 350-550 estimated for remainder of area.
[i] Data from sex and composition survey (5-7 min./mi^2)

Table 2 Unit 16B annual moose harvest and accidental death, 1990–95

Regulatory year	Reported				Estimated			Accidental			
	M	F	Unk	Total	Unreported	Illegal[a]	Total	Road	Other	Total	Total
1990/91	93	5	1	99	15	25	40	2	0	2	141
1991/92	262	0	0	262	20	25	45	1	0	1	308
1992/93	234	1	3	238	20	25	45	0	0	0	283
1993/94	155	21	0	176	15	35	50	0	0	0	226
1994/95	230	0	0	230	15	35	50	2	3	5	285

[a] Includes moose taken in defense of life or property.

Table 3 Unit 16B moose hunter[a] residency and success 1990–95

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonres	Total	(%)	Local[b] resident	Nonlocal resident	Nonres	Total	(%)	
1990/91	3	64	2	69	(16)	24	322	1	351	(84)	420
1991/92	15	156	35	210	(26)	26	511	41	585	(74)	795
1992/93	14	136	38	193	(25)	26	480	53	570	(75)	763
1993/94	15	78	36	132	(23)	28	358	40	437	(77)	570
1994/95	5	82	38	126	(23)	23	352	35	413	(77)	539

[a] Does not include individuals participating in permit hunts.

[b] Unit 16 residents.

Table 4 Unit 16B moose harvest data by permit hunt, 1990–95

Hunt No.[a]	Regulatory year	Permits issued	Percent did not hunt	Percent unsuccessful hunters	Percent successful hunters	Harvest Bulls	Cows	Total
979T[b]	1990/91	141	45	34	21	30	0	30
(879T)	1991/92	151	34	23	34	51	0	51
	1992/93	150	29	41	29	43	0	43
TM565	1993/94	30	13	10	73	7	15	22
	1994/95	138	32	23	40	55	0	55
TM567	1993/94	15	33	0	67	4	6	10
	1994/95	59	19	14	66	39	0	39
TM569	1993/94	60	45	35	20	12	0	12
	1994/95	58	43	29	17	10	0	10
916F[c]	1991/92	10	60	10	30	1	0	1
(973F)	1992/93	3	0	67	33	2	0	2
	1993/94	n/a	n/a	n/a	n/a	0	0	0
	1994/95	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total	1990/91	141	45	34	21	30	0	30
all State	1991/92	161	38	24	37	52	0	52
permit	1992/93	153	29	42	29	45	0	45
hunts	1993/94	105	35	23	42	23	21	44
	1994/95	255	33	24	43	104	0	104

[a] T(M) = Tier II permit, F = federal subsistence permit.
[b] Hunt 979T was formerly 879T and was replaced by 3 hunts (TM565,TM567 and TM569)
[c] Federal subsistence hunt; hunt no. changed between years.

Table 5 Moose harvest chronology during general season in Unit 16B, 1991–95

Regulatory year	Percent of Harvest							
	8/20-26	8/27-9/2	9/3-9	9/10-16	9/17-20	1/10-23	Unk	*N*
1991/92 [a]	--	12	24	32	28	--	3	204
1992/93 [a]	--	7	26	39	24	--	4	191
1993/94 [b]	8	8	7	30	36	7	5	132
1994/95 [c]	13	13	19	32	22	--	2	125

[a] Season dates = 1-20 September

[b] Season dates = 20 August-20 September, 10-23 January

[c] Season dates = 20 August-20 September

Table 6 Successful moose hunter[a] transport methods in Unit 16B, 1990–95

Regulatory year	Percent of Harvest							
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	*n*
1990/91	52	0	14	1	28	2	3	95
1991/91	54	1	17	3	19	1	2	262
1992/93	52	3	15	3	16	3	2	238
1993/94	43	9	15	1	22	1	3	176
1994/95	33	7	10	2	39	1	2	230

[a] All unit hunts except federal.

LOCATION

GAME MANAGEMENT UNIT: 17 (18,800 mi^2)

GEOGRAPHIC DESCRIPTION: Northern Bristol Bay

BACKGROUND

Moose are relatively new inhabitants in the Bristol Bay area, possibly immigrating into the area from middle Kuskokwim River drainages during the last century. Until recently, populations were low, and moose primarily inhabited the Nushagak/Mulchatna River system. Local residents harvested moose opportunistically; however, caribou, reindeer, and beaver were historically the main sources of game meat. The department began collecting data on the Unit 17 moose population in 1971. At that time, Faro (1973) reported that moose were not abundant in the unit and that animals close to the villages were subject to heavy hunting pressure.

Hunting seasons have varied over the years, but the bag limit has always been restricted to bulls. A general disregard for seasons and bag limits by unit residents was suspected to be the principle factor contributing to historically low densities of moose in the unit (Taylor 1990).

In the last decade, moose populations in subunits 17B and 17C have increased substantially both in number and range. Reasons for this increase include: 1) moderate snowfalls in several successive winters; 2) low predation rates by wolves; and, 3) decreased human harvest of female moose. The reduction in the female harvest was caused in part by a positive response by unit residents to department education efforts and an abundance of an alternative big game resource with the growth and range extension of the Mulchatna caribou herd (Van Daele 1995).

Moose are now common along the Nushagak/Mulchatna rivers and all of their major tributaries. They also occur throughout the Wood/Tikchik Lakes area. Moose continually attempt a westward expansion of their range into the Togiak and Kulukak River drainages of Subunit 17A. In spite of an abundance of suitable habitat, a viable population has not become established in the subunit because of suspected illegal harvest by subunit residents.

MANAGEMENT DIRECTION

MANAGEMENT OBJECTIVES

Unit 17A

To establish a minimum population of 100 moose;

Unit 17B

To achieve and maintain a density of 1 moose/mi^2 on good moose range;

Unit 17C

To maintain a minimum density of 0.5 moose/mi^2.

METHODS

Aerial surveys of trend count areas in Units 17B and 17C were used to sample the sex and age composition of the moose population and to collect data on the population trend in representative portions of the unit. Optimal survey periods were from 1 November through 15 December. During this time moose were usually established on their winter ranges and bulls still retained their antlers. In many years, however, suitable weather conditions, snow cover, and survey aircraft were not available during the optimal period. Late winter surveys of the upper Nushagak and Mulchatna River drainages were initiated in 1992–93 to investigate population trends.

Moose populations in Unit 17A were monitored in cooperation with personnel from the Togiak National Wildlife Refuge (TNWR). We conducted late winter aerial surveys of the Togiak River drainage annually. Movements along the border of Units 17A and 17C were monitored during a radio telemetry study from 1989 to 1994.

Aerial censuses of the population have been conducted in 3 portions of Unit 17. In 1983 we censused a portion of Unit 17C, in 1987 we censused the upper-Mulchatna River area in Unit 17B, and in 1995 western Unit 17C and most of Unit 17A.

We collected harvest data from harvest ticket reports and registration permit reports. We contacted nonreporting hunters by telephone and/or mailed them 1 reminder letter. Harvest monitoring and an enforcement presence were maintained along the Nushagak and Mulchatna rivers during the September portion of the hunting season.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The population size in Unit 17A is probably between 100–150 moose. In February 1995, I worked with staff from the TNWR to census the moose population in Units 17A and 17C (west). The 1395 mi^2 study area contained an estimated 458 moose (+\-11.95% at 90% CI). We also derived an estimate of 100.9 moose (+\- 21.11% at 90% CI) for the Unit 17A portion of the study area (1042 mi^2) (Aderman et al. 1995).

The moose population in Unit 17B was estimated to be 2500–3000 moose in 1987 (Taylor 1990). That estimate was based on extrapolations from a census in the upper-Mulchatna area. Assuming that 50% of the subunit is good habitat for moose, our management goal is 4900 moose for the subunit. Survey data for this subunit were inconsistent and difficult to interpret. Taylor (1988) noted that trend count data were of limited use in estimating moose density in Unit 17, and periodic censuses were the only objective method of assessing trends. Lacking such information, we initiated late winter surveys of major drainages to investigate population trends (Table 1). From all available data, the moose population size in the subunit was stable and remained below the management objective.

The moose population in Unit 17C was estimated to be 1400–1700 moose in 1987 (Taylor 1990). That estimate was based on extrapolations from the moose census conducted in Unit 17C in 1983. The management objective for the subunit is about 1750 moose. Survey data indicated the size of the subunit population has been increasing since the extrapolated estimates were made and the population probably meets the management objective.

Population Composition

Bull:cow ratios in all areas of Units 17B and 17C have remained consistently high (Tables 2, 3, and 4). Some counts reflected an unrealistic representation of the sexes because of sexual segregation and distribution during the surveys. Calf production and survival have fluctuated between areas and years, but they have generally been good to excellent.

Distribution and Movements

Much of Unit 17 is wet or alpine tundra, and moose inhabit the riparian areas in Units 17B and 17C. We know little about specific movement patterns, except they are influenced primarily by the rutting season in late September and by snow conditions in early winter.

Data from a joint ADF&G–TNWR radio telemetry study indicated that most moose radiocollared in Unit 17C stayed in the subunit, with some movement into Unit 17A. One radiocollared moose and her calf moved from Weary River to Kulukak River (Jemison 1994). During the February 1995 census, 29 moose moved into 17A from the upper Sunshine Valley in Unit 17C (Aderman et al. 1995). The dramatic increase in moose numbers between 1992 (6 moose) and 1995 strongly indicates immigration into 17A.

MORTALITY

Harvest

Season and Bag Limit. Unit 17A was closed to moose hunting.

Unit 17B was divided into 2 sections, the Mulchatna River drainage upstream including the Chilchitna River and the remainder of the subunit. The upstream section was open for resident/subsistence and nonresident hunters from 1–15 September. The remainder of Unit 17B was open to all hunters from 1–15 September and for resident/subsistence hunters with a registration permit from 20 August to 15 September and from 1–31 December. The nonresident bag limit was 1 bull with 50" or greater antler spread or with 3 or more brow tines on at least 1 side. The bag limit for residents was 1 bull with spike/fork or 50" antlers (3+ brow tines). Registration permit holders could take 1 bull, regardless of antler size.

Unit 17C was also divided into 2 sections, the Iowithla River drainage, Sunshine Valley, and all portions of the subunit west of the Wood River and south of Aleknagik Lake; and the remainder of the subunit. Open season for resident hunters was from 1–15 September throughout the subunit. An additional season was open in the remainder of the subunit for resident/subsistence hunters with a registration permit from 20 August to 15 September and from 1–31 December. Nonresidents were prohibited from hunting in Unit 17C. The bag limits in Unit 17C were the same as in 17B.

The registration hunt permits (RM583) were valid for both Units 17B and 17C. Permits were available to any Alaska resident who applied in person at Dillingham.

Board of Game Actions and Emergency Orders. In March 1993 the Board of Game made substantial changes to moose hunting regulations in Unit 17. These changes were intended to offset anticipated increases in hunting pressure resulting from liberalized seasons and bag limits for the Mulchatna caribou herd. The Board also adopted spike/fork–50" antler restrictions for much of southcentral Alaska, including Unit 17. A registration hunt was established to provide Alaska residents with an opportunity to harvest any-sized bulls during an extended season.

Hunter Harvest. Moose harvests in Unit 17 have increased 87% over the past 10 years (1984/85–158; 1994/95–296), primarily because of 133% increase in hunters afield (1984/85–344; 1994/95–800). The total harvest in the past 5 years in Unit 17B has ranged from 150 to 178, with an annual average harvest of 165.4 moose. In Unit 17C the 5-year mean annual harvest was 78.2, with a range of 44 to 94 moose (Table 5).

Hunters continued to harvest moose with large antlers throughout this reporting period. During 4 of the last 5 seasons, over 50% of the harvest has consisted of moose with antler spreads of 50" or greater. The largest antlers reported for each of these seasons have exceeded 70" (Table 6).

General Hunt. Unit 17A has not had an open moose hunting season since 1980–81; however, from 10 to 25 moose, of both sexes, were probably killed annually (Table 7). The reported harvest in the past 5 years for the general moose season in Unit 17B has ranged from 126 to 178, with a mean annual harvest of 148.8 moose (Table 8). In Unit 17C, the 5-year mean annual harvest has been 40.8 moose, with a range of 18–56 (Table 9).

Permit Hunts. Longer seasons and more liberal bag limits enticed many resident hunters to participate in the registration hunt (RM583) rather than the general hunt. Over 400 hunters signed up for permits in the Dillingham office each year, resulting in harvests of 101 moose (Tables 10 and 11).

Hunter Residency and Success. The 5-year mean number of moose hunters participating in general moose hunting season in Unit 17 was 496.6. Resident participation in the general hunt declined in 1993–94 and 1994–95 due to increased interest in the registration hunt. Nonresident participation, however, continued to increase in spite of more restrictive regulations. Hunter success declined, ranging from 33% to 46% (Table 12). The 5-year mean annual hunter success for the unit was 38.6%.

Nonresidents accounted for 47% of reporting hunters, residents of Unit 17 accounted for 21%, and other residents of Alaska accounted for 33% of the total number of hunters in the general hunt from 1990–91 to 1994–95 (Table 12). The number of unit residents participating in the hunt was underreported because many individuals fail to obtain or submit harvest tickets.

The percentage of local residents participating in the registration hunt declined from 92% in 1991–92 to 75% in 1994–95. Hunter success in the registration hunt ranged from 21% to 44%, with a 4-year mean of 33% (Table 13).

Harvest Chronology. Because of changes in seasons and weather, chronology data did not indicate any consistent patterns (Table 14 and 15). Unit residents were the main participants in the August and December seasons. These seasons were originally established to provide local residents with an opportunity to harvest moose that are not rutting. The regulatory intent was to discourage the illegal killing of female moose and harvests during closed seasons.

Transport Methods. Aircraft were the primary means of access for moose hunters in the general hunt in Unit 17 (5-yr mean = 66%, Table 16). Most participants in the registration hunt used boats for access (4-yr mean = 74%, Table 17). In 1990–91 off-road vehicles, including 3- and 4-wheelers, were prohibited modes of transportation for big game hunters in Unit 17B

Other Mortality

During this reporting period there was little evidence of significant mortality caused by factors other than humans. Predation by wolves and bears occurred regularly and wolf numbers appeared to be increasing unitwide; however, predation did not appear to be limiting the moose population. Snow depths were below normal during winters 1993/94–1994/95, so moose found abundant forage on winter ranges in riparian areas and winter mortality was light. During the spring of 1994, I received several reports from Nushagak River villagers of moose carcasses floating downstream during breakup. The moose had probably fallen through thin ice earlier in the winter.

We received no reports of moose killed by motor vehicles. A Dillingham resident killed 1 young bull when it attacked dogs chained near the resident's house. All meat was salvaged and donated to the local Senior Center.

Illegal harvest continued to be a problem in Unit 17A where residents actively pursued moose with aircraft and snowmachines during the winter and spring. Both male and female moose were taken. Illegal harvests in Units 17B and 17C have decreased dramatically in the past 10 years. The number of female moose taken has also declined significantly. Moose were commonly seen near Nushagak River villages throughout the winters during this reporting period.

HABITAT

Assessment

We have not conducted formal habitat monitoring programs in Unit 17. Winter range condition was subjectively assessed while monitoring the September hunting season. Moose winter range along the Nushagak and Mulchatna Rivers and along the lower reaches of the major tributaries to these rivers seemed in very good to excellent condition. Although there was evidence of heavy browsing, willow stands on gravel bars were abundant and included a good mix of brush heights. Winter range conditions in the middle and upper reaches of the tributaries have not been assessed.

Enhancement

No habitat enhancement activities have been documented in Unit 17. Because of the relative inaccessibility of most of the unit, and the occurrence of natural habitat change, habitat enhancement activity was impractical and unnecessary.

Lightning-caused wildfires are not uncommon in the unit each summer, particularly in Unit 17B. Fires rarely consumed large areas before they were naturally suppressed. The most important natural force responsible for enhancing moose habitat was the scouring of gravel bars and low-lying riparian areas by ice and water during spring thaw. This was especially true for the Nushagak and Mulchatna rivers and the lower reaches of their major tributaries.

NONREGULATORY MANAGEMENT PROBLEMS

Dramatic increases in the number of caribou in the Mulchatna herd were affecting the moose population in the unit, even though there was little direct competition between these ungulates. Short-term effects of large caribou populations include decreased illegal moose harvest by local residents and increased hunting pressure by other residents and nonresidents interested in combination hunts for moose and caribou. The most significant long-term effect on moose may be the prey–shift response of predator populations to abundant prey resources. Wolf numbers increased in the unit during this reporting period. There was no evidence of large predators following the caribou herd; when the herd moved out of a pack's territory, moose became the wolves' primary source of meat. The same prey shift can be expected when the caribou herd crashes.

CONCLUSIONS AND RECOMMENDATIONS

Predation by wolves, bears, and humans continued to increase in recent years; however, good browse conditions coupled with a continuing series of mild winters resulted in stable moose populations in Unit 17 this reporting period. The population in Unit 17C was at or approaching the management objective. Bull:cow ratios and percent calves observed during annual composition counts of trend areas in Unit 17C indicated the population was healthy and productive. Although objective habitat evaluations were lacking, browse quality and quantity were sufficient to support the population on most of the winter ranges.

Fall trend counts are notoriously unreliable in providing consistent data on moose populations in Unit 17. Suitable survey conditions, including complete snow coverage, light winds, and moose movements to winter range rarely occur before antler drop. Late winter surveys of the major drainages were initiated in 1992–93 to supplement fall composition counts. Periodic censuses of portions of the unit would provide the best population information.

Moose harvest has increased in Units 17B and 17C the past decade. This increase was partially caused by the increase in the number of hunters afield; as more nonlocal hunters were attracted to the Nushagak/Mulchatna river drainages by the number of caribou in the area.

Improved hunter success also increased harvest. Harvest chronology and hunting methods have remained consistent in recent years, so the increased success in the subunits may indicate greater moose density.

Moose population in Unit 17A has increased dramatically in the past 2 years. Subunit residents are anxious to take advantage of this increase and have submitted a proposal to the Federal Subsistence Board for a fall hunting season. Our management objective calls for at least 100 moose in the subunit, but it does not identify a target level. We intend to work closely with local residents and with staff from TNWR to: 1) document population trends; 2) evaluate moose habitat in the subunit and estimate carrying capacity; and 3) develop appropriate management goals and regulatory proposals. It is critical these cooperative efforts be coupled with continued efforts to curtail illegal harvest of moose in the Togiak valley.

The Board of Game has considered the effects of liberalized caribou seasons on the Unit 17 moose population and adjusted the moose season for 1993–94. The Board and the department will need to continue to manage these 2 ungulate populations in conjunction with each other and with predator populations.

Recommended management actions for the next few years include:

1 Establish 5 moose census areas within Unit 17 and attempt to census 1 area each winter on a rotating basis;

2 Develop a moose management plan for 17A in cooperation with Togiak National Wildlife Refuge, local advisory committees, and local citizen groups;

3 Continue to manage Unit 17 moose populations conservatively as long as large numbers of hunters are attracted to the area in pursuit of Mulchatna caribou;

4 Retain current antler restrictions for at least 5 years, and reevaluate the effects of these regulations before the 1999 Board of Game meeting; and,

5 Continue to seek cost effective and accurate methods to obtain bull:cow ratios within the unit.

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Table 1 Units 17B and 17C Upper Mulchatna and Nushagak river drainages moose trend count areas, late winter aerial moose counts, 1990-94

Regulatory Year	Survey area						
	Mulchatna River[a]	Mosquito River[a]	Stuyahok River[a]	Old Man River[a]	Nushagak River[a]	Nuyakuk River[a]	Wood River[b]
1990/91[c]	---	---	---	---	---	---	---
1991/92[c]	---	---	---	---	---	---	---
1992/93[d]	304	64	13	126	319	12	19
1993/94[e]	201	47	6	102	---	---	---
1994/95[f]	354	96	9	83	484	4	42

[a] Survey area within Subunit 17B
[b] Survey area within Subunit 17C
[c] Surveys initiated in 1992–93.
[d] Mulchatna River drainages surveyed on 25 Jan 1993, other drainages surveyed on 9 Feb 1993. Snow depths low to moderate.
[e] Mulchatna River drainages surveyed on 15 Mar 1994, other drainages not surveyed. Snow depths low.
[f] Mulchatna River drainages surveyed on 23 Feb 1995, other drainages surveyed 24 Jan 1995. Snow depths moderate.

Table 2 Unit 17C Iowithla River moose trend count area, fall aerial moose composition counts, 1990–94

Regulatory Year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Total Moose Observed	Moose /hour	Estimated population size[a]
1990/91[b]	59	7	52	38(25)	116	154	69	---
1991/92[c]	58	15	57	51(27)	141	192	98	---
1992/93[d]	74	21	60	48(26)	139	187	56	---
1993/94[e]	34	9	102	57(43)	75	132	55	---
1994/95[f]	---	---	---	---	---	---	---	---

[a] No population estimates for this count area have been made.
[b] Survey flown on 29 Oct 1990.
[c] Survey flown on 23 Dec 1991.
[d] Survey flown on 19 Nov 1992.
[e] Survey flown on 19 Nov 1993.
[f] No survey flown in 1994–95.

Table 3 Unit 17C Sunshine Valley moose trend count area, fall aerial moose composition counts, 1990–94

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Moose Observed	Moose /hour	Estimated population size[a]
1990/91[b]	63	22	43	21(21)	80	101	51	---
1991/92[c]	88	58	49	21(21)	81	102	56	---
1992/93[d]	---	---	---	---	---	---	---	---
1993/94[e]	---	---	---	---	---	186	98	---
1994/95[f]	---	---	---	---	---	---	---	---

[a] No population estimates for this count area have been made.
[b] Survey flown on 13 Dec 1990.
[c] Survey flown on 21 Nov 1991.
[d] No survey flown in 1992/93.
[e] Survey flown on 04 Feb 1994. No composition data collected.
[f] No survey flown in 1994/95.

Table 4 Unit 17C Lower Nushagak moose trend count area, fall aerial moose composition counts, 1990–94

Regulatory year	Bulls: 100 Cows	Yearling bulls: 100 Cows	Calves: 100 Cows	Calves (%)	Adults	Moose Observed	Moose /hour	Estimated Population size[a]
1990/91[b]	61	20	63	26(28)	66	92	69	---
1991/92[c]	---	---	---	27(33)	55	82	98	---
1992/93[d]	23	13	86	48(41)	69	117	56	---
1993/94[e]	34	9	102	57(43)	75	132	55	---
1994/95[f]	---	---	---	---	---	---	---	---

[a] No population estimates for this count area have been made.
[b] Survey flown on 13 Dec 1990.
[c] Survey flown on 30 Jan 1992. Sex determination not attempted.
[d] Survey flown on 14 Nov 1992.
[e] Survey flown on 19 Nov 1993.
[f] No survey flown in 1994–95.

Table 5 Moose harvest data for all hunts in Unit 17, 1964–95

Regulatory Year	Reported Harvest	Hunters Afield	Success Rate	Subunit[a]			
				17A	17B	17C	Unk
1964/65	32	---	---	---	---	---	---
1965/66	42	---	---	---	---	---	---
1966/67	26	90	29%	---	---	---	---
1967/68	38	77	49%	---	---	---	---
1968/69	46	66	70%	---	---	---	---
1969/70	15	31	48%	---	---	---	---
1970/71	25	35	71%	---	---	---	---
1971/72	37	63	59%	---	---	---	---
1972/73	38	74	51%	---	---	---	---
1973/74	42	93	45%	---	---	---	---
1974/75	69	119	58%	---	---	---	---
1975/76	115	207	56%	---	---	---	---
1976/77	49	168	29%	---	---	---	---
1977/78	54	113	48%	---	---	---	---
1978/79	65	160	41%	---	---	---	---
1979/80	33	68	49%	---	---	---	---
1980/81	89	212	42%	---	---	---	---
1981/82	76	209	36%	---	---	---	---
1982/83	49	149	33%	---	---	---	---
1983/84	127	293	43%	0	72	48	0
1984/85	158	344	46%	0	86	70	0
1985/86	148	401	37%	0	94	52	0
1986/87	202	486	42%	0	122	73	0
1987/88	207	499	42%	0	152	42	0
1988/89	187	457	41%	0	157	28	0
1989/90	175	438	40%	0	122	48	0
1990/91	225	489	46%	0	178	44	0
1991/92	268	590	45%	0	172	85	0
1992/93	263	561	47%	0	160	90	13
1993/94	249	705	35%	1	150	78	20
1994/95	296	800	37%	0	167	94	69

[a] Harvest data not broken down by subunit prior to 1983–84.

Table 6 Unit 17 moose antler sizes (percent) in the reported harvest, 1990–94

Regulatory year	Antler size			Largest antlers
	<30"	30–50"	>50"	
1990/91	4	47	49	74"
1991/92	4	33	63	72"
1992/93	6	36	57	80"
1993/94	3	30	68	73"
1994/95	9	29	62	73"

Table 7 Unit 17A moose harvest[a] and accidental death, 1990–94

Regulatory year	Hunter Harvest							Accidental death	**Total**
	Reported				Estimated				
	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total		
1990/91	0	0	0	0	0	10	10	0	10
1991/92	0	0	0	0	0	20	20	0	20
1992/93	0	0	0	0	0	10	10	0	15
1993/94	1 (100)	0	0	1	0	20	20	0	21
1994/95	0	0	0	0	0	25	25	0	25

[a] Excludes permit hunt harvest.

Table 8 Unit 17B moose harvest[a] and accidental death, 1990–94

Regulatory	Hunter Harvest								
	Reported				Estimated				
year	M (%)	F (%)	Unk.	Total	Unreported	Illegal	Total	Accidental death	**Total**
1990/91	177 (100)	0	1	178	0	0	0	0	178
1991/92	155 (100)	0	1	156	0	0	0	0	156
1992/93	152 (100)	0	0	152	0	0	0	0	152
1993/94	125 (100)	0	1	126	0	0	0	0	126
1994/95	132 (100)	0	0	132	0	0	0	0	132

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this subunit.

Table 9 Unit 17C moose harvest[a] and accidental death, 1990–94

Regulatory year	Hunter Harvest								
	Reported				Estimated				
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Accidental death	**Total**
1990/91	44(100)	0	0	44[c]	0	0	0	0	44
1991/92	56(100)	0	1	57[d]	0	0	0	0	57
1992/93	56(100)	0	0	56[e]	0	0	0	0	56
1993/94	18 (100)	0	0	18	0	0	0	0	18
1994/95	28 (100)	0	0	28[f]	0	0	0	1[h]	29

[a] Excludes permit hunt harvest.
[b] No estimates of unreported/illegal harvests have been made for this subunit.
[c] Does not include 3 bulls from an unspecified portion of Unit 17.
[d] Does not include 5 bulls from an unspecified portion of Unit 17.
[e] Does not include 3 bulls from an unspecified portion of Unit 17.
[f] Does not include 1 bulls from an unspecified portion of Unit 17.
[g] Includes 1 bull killed in defense of life or property.

Table 10 Unit 17B moose harvest data by permit hunt, 1990–94

Hunt No /Area	Regulatory year	Permits Issued	Percent did not hunt	Percent Unsuccessful Hunters	Percent Successful Hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1990/91	0[a]	---	---	---	0	0	0	0
	1991/92	318[b]	22	60	16	15 (100)	0	1	16
	1992/93	277[b]	30	49	18	8(100)	0	0	8
583	1993/94	433	19	38	24	23 (100)	0	1	24
	1994/95	438	18	40	31	35 (100)	0	0	35

[a] No registration hunts were held in 1990/91, and there was no August moose season in Unit 17.
[b] Registration permits were valid for both Subunits 17B and 17C. Permit data are for both areas combined, harvest data are specific to Unit 1

Table 11 Unit 17C moose harvest data by permit hunt, 1990–94

Hunt No /Area	Regulatory year	Permits Issued	Percent did not hunt	Percent Unsuccessful Hunters	Percent Successful Hunters	Bulls (%)	Cows (%)	Unk.	Total harvest
983	1990/91	0[a]	---	---	---	0	0	0	0
	1991/92	318[b]	22	60	16	28[c] (100)	0	0	28
	1992/93	277[b]	30	49	18	31[d] (100)	0	3	34
583	1993/94	433	19	38	24	59[e] (100)	1	0	60
	1994/95	438	18	40	31	65[f] (100)	0	1	66

[a] No registration hunts were held in 1990/91, and there was no August moose season in Unit 17.
[b] Registration permits were valid for both Units 17B and 17C. Permit data are for both areas combined, harvest data are specific to Unit 17B.
[c] Not included are 6 bulls from an unspecified portion of Unit 17.
[d] Not included are 8 bulls from an unspecified portion of Unit 17.
[e] Not included are 20 bulls from an unspecified portion of Unit 17 and 1 bull from Subunit 17A.
[f] Not included are 34 bulls from an unspecified portion of Unit 17.

Table 12 Unit 17 moose hunter[a] residency and success, 1990–94

Regulatory year	Successful				Unsuccessful				Total hunters
	Local resident	Nonlocal resident	Nonresident	Total (%)	Local Resident	Nonlocal Resident	Nonresident	Total(%)	
1990/91	60	52	104	225(46)[b]	53	77	122	264 (54)[b]	489
1991/92	68	72	67	218(40)[c]	95	96	131	328 (60)[c]	546
1992/93	61	79	64	212(41)[d]	65	114	124	310 (59)[d]	522
1993/94	21	28	93	144 (33)[e]	27	117	142	292 (67)e	436
1994/95	22	41	91	161 (33)[f]	24	117	180	329 (67)[f]	490

[a] Excludes hunters in permit hunts.
[b] Includes 9 successful and 12 unsuccessful hunters of unknown residency.
[c] Includes 11 successful and 6 unsuccessful hunters of unknown residency.
[d] Includes 8 successful and 7 unsuccessful hunters of unknown residency.
[e] Includes 2 successful and 6 unsuccessful hunters of unknown residency.
[f] Includes 7 successful and 8 unsuccessful hunters of unknown residency.

Table 13 Unit 17 moose hunter residency and success by permit hunt, 1990–94

Regulatory year	Successful				Unsuccessful				Total hunters
	Local resident	Nonlocal resident	Nonresident	Total (%)	Local Resident	Nonlocal resident	Nonresident	Total(%)	
1990/91[a]	0	0	0	0 (---)	0	0	0	0	0
1991/92	48	2	0	50 (21)	173	16	0	189 (79)	239
1992/93	43	7	0	50 (27)	122	11	0	133 (73)	183
1993/94	84	21	0	105 (39)	130	33	0	164 (61)	269
1994/95	106	29	0	135 (44)	128	45	0	175 (56)	310

[a] No registration hunt held in 1990–91.

Table 14 Unit 17 moose harvest[a] chronology percent by time period, 1990–94

Regulatory year	Harvest periods Aug 10-20	Aug 21-31	Sep 1-10	Sep 11-20	Sep 21-30	Dec 1-10	Dec 11-20	Dec 21-31	Unk	n[b]
1990/91[c]	0	0	36	45	1	2	3	4	9	225
1991/92[c]	0	5	30	51	1	1	3	4	5	218
1992/93[c]	0	3	44	41	0	2	2	4	3	212
1993/94[d]	1	2	54	35	0	0	1	1	6	144
1994/95[d]	1	3	47	37	3	1	2	3	5	161

[a] Excludes permit hunt harvest.

[b] Reported harvest

[c] General season dates:
Unit 17B (upstream) - Sep 1–20
Unit 17B (remainder) - Residents: Sep 1–20, Dec 1–31
Nonresidents: Sep 5–15
Unit 17C (Iowithla, etc.) - Residents: Sep 1–15
Unit 17C (remainder) - Residents: Sep 1–15, Dec 1–31

[d] General season dates:
Unit 17B - Sep 1–15
Unit 17C - Residents: Sep 1–15

Table 15 Unit 17 moose harvest by permit, chronology percent by time period, 1990–94

Regulatory year	Harvest periods									
	Aug 10-20	Aug 21-31	Sep 1-10	Sep 11-20	Sep 21-30	Dec 1-10	Dec 11-20	Dec 21-31	Unk	n[a]
1990/91[b]	---	---	---	---	---	---	---	---	---	0
1991/92[c]	14	74	0	0	2	0	0	0	10	50
1992/93[c]	20	72	2	0	0	0	0	0	6	50
1993/94[d]	9	40	19	10	2	3	6	5	8	105
1994/95[d]	7	30	29	10	1	2	7	8	6	135

[a] Reported harvest
[b] No registration hunts were held in 1990/91.
[c] Registration permits valid for Aug 20–31.
[d] Registration permits valid for any bull, Aug 20 - Sep 15 and Dec 1–31.

Table 16 Unit 17 moose harvest[a] percent by transport method, 1990–1994

Regulatory year	Percent of harvest								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	
1990/91	64	0	26	0	5	0	1	3	489
1991/92	61	0	31	0	4	0	1	3	546
1992/93	64	0	29	0	2	0	1	3	522
1993/94	71	0	26	0	9	0	0	1	436
1994/95	71	0	22	0	2	0	1	3	490

[a] Excludes permit hunt harvest.

Table 17 Unit 17 moose harvest by permit hunt, percent by transport method, 1990–1994

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	ORV	Highway vehicle	Unknown	*n*
	Percent of harvest								
1990/91[a]	---	---	---	---	---	---	---	---	0
1991/92	8	0	81	0	0	0	3	8	241
1992/93	9	0	83	1	0	1	1.6	5	185
1993/94	15	0	73	0	6	0	4	3	269
1994/95	18	0	59	0	12	0	3	8	310

[a] No registration hunts were held in 1990–91.

LOCATION

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

GEOGRAPHIC DESCRIPTION: Yukon–Kuskokwim Delta

BACKGROUND

Moose probably began immigrating to the lower Yukon–Kuskokwim Delta during the mid-to-late 1940s and have since colonized the riparian corridors of the Yukon and Kuskokwim rivers in low to moderate numbers (Helmericks 1944, Alaska Dep of Fish and Game 1976). Spring flooding, availability of winter habitat, and hunting pressure prevent further range extension and population growth. Most of the Yukon–Kuskokwim Delta is lowland treeless tundra, which is unsuitable as winter habitat for moose. During winter, moose are confined to riparian zones (forest and willow habitats) along the major rivers.

Moose densities seem moderate and growing in the Yukon River drainage upriver from Pilot Station but very low in the remainder of the Yukon drainage and in the entire lower Kuskokwim River drainage. Although moose are now more common than in the past, overall densities are still extremely low relative to habitat availability.

Heavy hunting pressure from many communities along the lower Yukon and Kuskokwim rivers has effectively limited moose population growth in many areas of Unit 18. Extensive habitat is available for colonization and range expansion. Moose densities in adjacent Units 19A and 21E are much higher than moose densities in Unit 18. To help establish the moose population in the lower Yukon Delta, the Board of Game closed the moose season downstream of Mountain Village in 1988.

MANAGEMENT DIRECTION

MANAGEMENT GOALS AND OBJECTIVES

1 Allow the lower Yukon River moose population to increase above its estimated size of 1100 to 3000 moose. Allow the lower Kuskokwim River moose population to increase above its estimated size of 200–400 moose to 1000–2000 moose.

2 Maintain the current age and sex structure for both populations, with a minimum of 30 bulls:100 cows.

3 Conduct fall sex and age composition surveys and winter recruitment surveys of both populations.

4 Allow a small harvest of bull moose without hindering a high rate of population increase.

5 Improve harvest reporting and compliance with hunting regulations.

6 Minimize conflicts among user groups harvesting moose in Unit 18.

METHODS

We operated a hunter check station during late August through September 1993 and 1994 at Paimiut Slough along the Yukon River near the border of Unit 18 and Unit 21E. We monitored hunting activity and harvest by voluntary cooperation of hunters from 13 communities in the area.

We have delineated 5 census areas along the vegetated corridors of the Yukon and Kuskokwim rivers to estimate the size of the moose population in Unit 18 (Figure 1). We are using intensive surveys in 1 area and census methods developed by Gasaway et al. (1986) in 4 areas. The 5 areas include (Figure 1):

1 The Yukon River from Pilot Station upriver to old Paimiut Village, previously censused with Gasaway methods in late February and early March 1992,

2 The Kuskokwim River corridor between Kalskag and Kwethluk, previously censused with Gasaway methods in March 1993,

3 The Yukon River downstream of Mountain Village, where moose populations on 1700 mi^2 of forested habitat were estimated with intensive surveys in March 1994,

4 The Yukon River from Pilot Station downstream to Mountain Village, censused with Gasaway methods in March 1995, and

5 The tributaries of the lower Kuskokwim River, planned for census with Gasaway methods in March 1996.

After 1996 we will have 5 moose census areas delineated and surveyed in Unit 18. After the fifth census is completed, all censuses will be repeated on an annual rotational basis beginning with the first census area. In addition, aerial surveys were flown along the Yukon River between Pilot Station and old Paimiut Village in November 1994. We have surveyed the entire riparian corridor of the lower Yukon River between 1992 and 1995.

We discontinued the cooperative radiotelemetry study documenting seasonal movements of moose in the Yukon and Kuskokwim drainages because the collared moose did not move very far from the original capture locations. The cooperative study was initiated with the U.S. Fish and Wildlife Service (FWS) in 1990. Seven of 14 cow moose radiocollared during 1990 in the Aniak River–Kwethluk River study area remained active. Two cow moose of 4 cows and 5 bulls radiocollared during 1989 and 1990 in the Yukon River study area remained active.

Enforcement efforts have been increased during the winter months along the lower Yukon and lower Kuskokwim rivers during the reporting period to prevent illegal hunting.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We completed 4 censuses (3 in the Yukon drainage and 1 in the Kuskokwim drainage) in Unit 18 between March 1992 and March 1995 (Table 1). Based on census results and other survey information, we believe the moose population in Unit 18 is 1300–1600 moose.

In the Yukon drainage we estimate the population size is between 1000 to 1200 moose. The number of moose observed during winter surveys along the riparian corridor of the Yukon River, especially on islands located upriver of Marshall, stabilized during the reporting period. Sections of the Yukon River corridor from Paimiut village to Pilot Station were censused during spring 1992, and a portion of this census area was surveyed during late winter 1993. The total number of adult moose and short yearlings observed during both years increased from previous years.

A Gasaway-type census of the Yukon River area (Figure 1, Area 1), consisting of 159 polygons (N), was completed in March 1992. The sample size was 39 polygons (n), each ranging in size from 6.01 to 20.64 mi^2. We estimated 994 moose (s = +12.5%); we calculated 80% CI.

Moose densities were very low and possibly decreasing in the Kuskokwim drainage (Table 4). We believe the population ranges between 300–400 moose. A Gasaway-type moose census was conducted between Kalskag and Kwethluk along the riparian corridor of the Kuskokwim River during March 1993 (Figure 1, Area 2). The census area comprised 41 polygons (N), and the sample included 18 polygons (n), each ranging in size from 6.08 to 23.38 mi^2. We calculated a population of 217 moose (s = 27.6% at 80% CI) (Table 1).

We counted moose in the riparian zone of the Yukon River area downstream of Mountain Village (Figure 1, Area 3), using intensive aerial surveys on March 16–17, 1994. The moose densities were too low for a Gasaway-type census, so we modified the technique and surveyed 19 polygons, ranging in size from 41 to 156 mi^2 for a total survey area of 1700 mi^2. The polygons followed the vegetation boundaries of the riparian zone. Four aircraft were used for a total survey time of 38.7 hours, averaging 1.36 minutes per mi^2 survey time in each polygon. Although average survey times were low, sightability was very good. We counted 65 moose during the survey. The average moose density of 0.038 moose per mi^2 is surprising, considering no moose were present in this area when it was surveyed in 1988.

During March 1995, a Gasaway-type census was attempted along the lower Yukon River between Pilot Station and Mountain Village (Figure 1, Area 4). This area was located downstream of census Area 1 (census completed in 1992) and upstream census Area 3 (surveyed intensively in 1994). We sampled all the vegetated river corridor between Mountain Village and Pilot Station, including the Andreafsky River, the Atchuelinguk River, and the upper Kashunak River. The census area comprised 111 polygons (N), and the sample consisted of 29 polygons(n), each ranging in size from 5.40 to 31.40 mi^2. Densities of moose were very low and only 2 strata could be classified as low and medium density. The population estimate of 52 moose, s = +/- 46% (80% CI), has high variability because of the low densities of moose. Although a Gasaway-type census is not often applied to low-density populations, we find the results useful for comparison to the neighboring census areas and for comparisons for future counts in this area. The population was probably higher than the census estimate revealed. We suspect human densities and hunting pressure may have significantly reduced immigration to this area, reducing the population size and its growth rate. Considering the low degree of confidence in the estimate, it may not be profitable to repeat the Gasaway-type census if the population remains at low density.

Population Composition

One composition survey was completed during this reporting period. Lack of snow cover before antler drop on bulls has often hindered our ability to gather annual composition data, and this is the first successful count since 1989. Additional recruitment information was collected during spring aerial surveys and censuses. On the Yukon River during the 1993 survey, 27% of observed moose were short yearlings. On the Kuskokwim during the 1993 survey, 25% of the moose observed were short yearlings. These recruitment estimates were taken from very small samples. The sample size for the Yukon survey was 98 moose and 44 moose for the Kuskokwim survey.

Age composition information was collected on November 30, 1994 along the Yukon River between Paimiut Slough and Pilot Station. Of 321 moose observed, 61 (19%) were bulls (3 yearling bulls, 34 medium bulls, and 24 large bulls), 156 (49%) were cows (75 without calves, 58 with single calf, and 23 with twin calves), and 104 (32%) were unclassified. In this sample, the calf:cow ratio was 66:100 and the bull:cow ratio was 37:100.

Additional age composition information is also available from incisors of hunter-killed moose harvested in the Yukon drainage between Russian Mission and Innoko River. This area represents the eastern portion of Unit 18 and the western portion of Unit 21E. Of the teeth collected, 70% were from male moose between 1 and 3 years of age. If this sample is representative of the composition of the local moose population, recruitment appears favorable during the previous 3 years.

Distribution and Movements

Small numbers of moose migrate during late summer to coastal regions from the mouth of the Kuskokwim to Scammon Bay, Nelson Island and the lower Yukon Delta. The Yukon Delta Wildlife Refuge staff sporadically monitored radiocollared moose in Unit 18 and portions of Unit 19A during the reporting period. The telemetry data indicate most moose were migratory over relatively short distances. Bulls remained away from riparian zones during summer, fall, and early winter until snow depths pushed them closer to the river. Only one of the collared moose along the lower Yukon showed any signs of moving long distances. This particular bull moose was collared near Pilot Station during March 1990 and had been seen below Mountain Village during the spring of 1991. Little or no movement occurred among the remaining 5 collared moose resident along the Yukon River. In the Kuskokwim drainage, cow moose collared near Aniak had moved into the Russian and Horn Mountain area north of the

Kuskokwim and east to the Holukuk River. Very little movement occurred among collared moose elsewhere in the drainage.

Some moose retreat with the advent of winter and fall hunting pressure to the forested regions of the Yukon River. Other moose inhabit alpine and subalpine regions of the Kilbuck and Andreafsky Mountains during summer but descend to yards along the Aniak River in forested tributaries of the Kuskokwim and along the lowlands and islands of the Yukon–Kuskokwim during late winter.

The density of moose at locations along the Yukon and Kuskokwim rivers is related to the distance upriver from the mouths of these drainages. The further upriver on both drainages, the greater the number of moose. This is evident from both aerial survey and harvest data. We believe this distribution and density is related to the presence of more quality habitat and escape cover in the upriver, forested portions of these drainages.

MORTALITY

Harvest

Season and Bag Limits. Seasons and bag limits have changed little since 1988 with the exception of additional winter seasons and new federal moose hunting regulations on federal land. Table 2 lists the seasons and bag limits and the exceptions for the state and federal seasons in Unit 18 since 1961. The Yukon River delta was closed to moose hunting in 1988–89 and was opened for 20 days in the fall of 1994–95 with a bag limit of 1 bull. For both regulatory years in the reporting period, the open season for subsistence and resident hunters in the remainder of Unit 18 was a 30-day fall season with an additional 10-day to-be-announced winter season opened by emergency order between December 20 and January 20 with a bag limit of 1 bull.

Board of Game Actions and Emergency Orders. During 1995, the Alaska Board of Game adopted a regulatory proposal effective for the 1995–96 season that changes the winter moose season from "To-Be-Announced by emergency order between December 20 and January 20" to "To-Be-Announced by emergency order between December 1 and February 28." This proposal was submitted to make our regulations more consistent with federal subsistence regulations and to accommodate local hunters who desire an open season when weather and snow conditions are adequate for snowmachine travel.

Two emergency orders for moose were issued during the reporting period. The first order shortened the state season by 5 days in September 1994 along the Kuskokwim drainage to match the September 25 closing date of the federal season. The federal season opened August 25, one week earlier than the state season, and because of high public interest for August hunting, the state season was closed early to minimize the potential for overharvest of moose. The second order was issued to open the winter moose season.

Hunter Harvest. Hunting remains the most significant source of moose mortality in Unit 18. Historical harvest records indicate that above average reported harvest occurred during the 1993–94 regulatory year, and higher harvests continued through the 1994–95 hunting season

(Table 3.). During the 1993–94 open season, 339 hunters reported a harvest of 96 moose. For the 1994–95 season, 271 hunters reported a harvest of 87 moose. Weather conditions during the fall 1993 and 1994 were generally milder and wetter than in previous years with no snowfall during the early season. Most hunters were afield during the first 2 weeks of September (66%); the remainder hunted until the end of September. Moose rutting activity near the check station began September 20.

Hunters took 93 bull moose in Unit 18 during the September 1993 season, and during the December 1993 season only 3 were reported. Hunters harvested 74 bull moose in Unit 18 during the September 1994 season; hunters took 2 during the extended federal season in August, and 11 were taken during the winter 1994–95 season.

For 15 years prior to 1992 the average reported harvest has been relatively stable at 65 male moose per year. During 1992 to 1994 the harvest increased significantly, partly a response to the high population. However, the heavy reported harvests during 1993 and 1994 may have substantially reduced the annual recruitment of yearling bulls. During the fall 1994 season, 30% of the harvest from the Yukon River upstream of Mountain Village was yearling bulls and over 90% of the harvest downstream of Mountain Village was yearling bulls. Preliminary harvest records for the fall 1995 season downstream of Mountain Village indicate a high harvest of yearling bulls, 13 of 14 animals taken. A similar pattern of harvest occurs along the lower Kuskokwim River, although the number of harvest reports was very low. Reported antler widths indicate that much of the lower Kuskokwim harvest was yearling bulls (antler width <35 inches).

Local residents rely heavily on the moose population in Unit 18, and the combined reported and unreported harvest is estimated to exceed or equal 5–10% of the population annually on the Yukon and may exceed the annual recruitment rate on the Kuskokwim. Estimated unreported harvest may equal or exceed the reported harvest in the Kuskokwim drainage. The estimated unit harvest, including the unreported harvest, is 100–200 moose annually.

On the Yukon River harvest reporting has improved dramatically in the last 9 years because of the presence of the Paimiut hunter check station, the acceptance of using harvest tickets, and the willingness of some hunters to harvest only bulls. Although reporting has improved in some areas, many hunters throughout Unit 18 do not report their hunting activities and success.

Many unit residents are aware that hunting opportunities are significantly better in adjacent Units 19A, 19B, 21A, and 21E. The number of hunters reporting in Unit 18 depends upon their success in these adjacent units. Harvest reports collected since 1980 show that hunters from Unit 18 regularly use large boats during the fall season to access hunting areas upriver in adjoining units (Table 4). On the Kuskokwim River, more than half of the residents hunting moose between Kalskag and McGrath (Unit 19A) are from Unit 18. Similarly, on the Yukon River, many hunters use boats to travel from Unit 18 to Unit 21E. During the fall season, between 85% and 95% of the hunters at the Paimiut hunter check station who reported hunting in Unit 21E were residents of Unit 18. As a consequence, fall moose hunting activity in the central Kuskokwim region of Unit 19A and the Innoko and Iditarod region of Units

21E and 21A has become a controversial allocation issue between the residents of Units 18 and the upriver residents of Units 19A and 21E. The concern among upriver residents is that continued heavy influx of hunters from downriver communities and harvest pressure of local residents may increasingly restrict seasons and bag limits.

In previous years the reported harvest of moose in Unit 18 did not reflect the actual harvest, but only that of people who operate within the regulatory system. The percentage of local residents hunting in season with valid hunting licenses and harvest tickets is increasing, particularly during fall. However, the magnitude of the harvest taken during the closed season probably has not significantly declined.

During the 1993–94 season, approximately 77% of the reported harvest occurred in the Yukon drainage with the remainder in the Johnson and Kuskokwim River drainages (Table 5). During the 1994–95 season, 86% of the harvest (49 moose) was reportedly taken in the Yukon drainage upstream of Mountain Village (Table 4). During September 1994, 10 moose were harvested downstream of Mountain Village during the first open season since 1987.

During September 1993 and 1994, department staff operated the Paimiut check station for the eighth and ninth consecutive years, respectively, at the junction of Twelve-Mile Slough and Paimiut Slough on the Yukon River. The check station was located near the border of Units 18 and 21E. Voluntary participation with the check station has increased from previous years. During the fall 1993 and 1994 seasons, 245 and 246 hunters, respectively, stopped at the check station. As in previous years, nearly all hunters going through the check station were residents of Unit 18, representing 13 towns and villages along the lower Yukon River (Table 4).

We estimate between 80 to 100 moose were harvested from an area extending from the upper Innoko River and Iditarod River in Unit 21E and 21A to Russian Mission in Unit 18. Most of these moose were brought through or processed near the Paimiut check station. The moose examined at the check station were primarily young bulls in good condition.

During 1993, hunters reported that 77 of 96 moose taken in Unit 18 were predominantly young bulls with an average antler width of 37.5 inches. During 1994, hunters reported that 68 moose taken in Unit 18 had an average antler width of 38.0 inches. Tooth sectioning data indicated that 70% of the moose examined at the check station during fall 1993 and 1994 were between 1 and 3 years old.

During the December season moose are concentrated on islands with large cottonwood stands and bushy willow fringes along the Yukon and the Kuskokwim rivers and their tributaries. These moose are vulnerable to snowmachine hunting and harassment by snowmachine travelers. We believe much of the winter harvest is taken during the closed season and not reported. Surveillance by Fish and Wildlife Protection on the Yukon River near Russian Mission revealed that 14 female moose were harvested between December 1994 and January 1995.

Much of the habitat in Unit 18 is marginal for moose and cannot support large densities of moose and heavy harvests. However, areas along the Yukon and Kuskokwim River corridors have adequate browse and should support larger densities of moose. Moose along the river corridors and numerous forested tributaries in Unit 18 seem to be responding with high calf production, despite mortality from severe winters, floods, predation, regulated hunting, poaching, disease, competition, and accidental deaths. Moose populations in the poorer habitat in Unit 18 may have low initial calf production and survival and cannot endure significant natural and hunting mortality.

Hunter Residency and Success. As reported in past years, Alaska residents accounted for most of the hunting activity in Unit 18. Only 2 nonresidents hunted in Unit 18 during the 1993–94 season, and no nonresidents were successful in the 1994–95 season. Hunter success rate based on harvest reports was 28% for the 1993–94 season and 32% for the 1994–95 season. Successful hunters spent an average of 5.2 days hunting moose in Unit 18.

Transport Methods. During the reporting period boats were the most frequently used mode of transportation by successful hunters in Unit 18 (89%). Other reported modes of transportation used by successful hunters were snowmachines (10%) and aircraft (1%).

Natural Mortality

Predation by bears or wolves is a significant source of moose mortality in Unit 18. During the reporting period large numbers of black and grizzly bears inhabited the major river corridors and the large tributaries in Unit 18, although many of these predators also live in Units 17, 19, 21, and 22.

We estimate 75 to 100 wolves in 6 to 7 packs reside in Unit 18. There are 2 wolf packs in the Kilbuck Mountains and 2 packs near Russian Mission and Paimiut Slough. One pack of 13 wolves, with 11 black and 2 gray animals, was observed on the Yukon River during an aerial survey on November 30, 1994. Throughout most of Unit 18, the distribution of wolves reflects the distribution of moose, especially in the Yukon drainage. In the Kuskokwim drainage, caribou are alternative prey for wolves and the distribution of wolves is not as closely linked to moose in this area as in the Yukon drainage. Wolf numbers may be slightly increasing in the unit as ungulates increase, but overall numbers of wolves remain very low.

Grizzly bears probably outnumber moose in the Andreafsky and Kilbuck Mountains. Black bears are abundant along both the Kuskokwim and Yukon drainages in the forested portions and are very uncommon further downstream. Predation by bears, particularly on calves, may have a significant effect on moose population growth although quantitative data are lacking. Subsistence hunters often take black and grizzly bears near their camps; their hunting may be locally depressing the bear populations.

The spring floods of 1985 and 1989 were typical of spring flooding of lowlands along the Yukon and Kuskokwim rivers after winters with heavy snowfall and severe temperatures. During flooding, calves may drown; we suspect this happened during the flood of 1985. No significant flooding and subsequent loss of calves has occurred on the lower Yukon River since 1989.

HABITAT

Assessment

We estimate a minimum of 8000 mi^2 of moose habitat in Unit 18. Approximately 4500 mi^2 is along the riparian zone of the Yukon River and the remaining 3500 mi^2 is along the Johnson and Kuskokwim rivers and their tributaries. The islands and adjacent sloughs along the Yukon River corridor from Paimiut to Mountain Village represent the most productive moose habitat. No overbrowsing is evident in this area. However, some overbrowsing is evident in the better winter yarding areas upstream of Paimiut on the Innoko River, and moose may migrate downriver into the better browsing areas between Paimiut and Pilot Station. The narrow bands of willows downriver from Mountain Village in the Yukon delta are overgrown and senescent, except for the expanse of willows toward Kusilvak Mountain and Kashunak River and those islands flooded each spring. Because the Yukon Delta has many mouths fringed by willows and cottonwoods and yet supports very few moose, the availability of forage is not a limiting factor. Lack of escape cover from hunters, predators, and weather may be the most significant limiting factors affecting moose numbers in these low-density areas.

The riparian habitat along the Kuskokwim River in Unit 18 downstream of Kalskag represents good moose habitat. Between Lower Kalskag and Akiachak, the forest and brush along the Kuskokwim may provide sufficient escape cover for moose. Pilots in this area observe moose, standing in meadows surrounded by thick willow, spruce, and cottonwood mixed forest. Downstream of Akiachak toward the mouth of the Kuskokwim, the riparian corridor narrows and lacks escape cover. Along the Kanektok, Goodnews, and Arolik rivers, moose are rarely found in the forest fringes because cover and browse are 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, Kisaralik, Kasigluk and Kwethluk rivers to the east. Each of these tributaries supports a small, low-density moose population.

CONCLUSIONS AND RECOMMENDATIONS

Within the last 50 years, moose have colonized the Yukon-Kuskokwim Delta in moderate densities along the Yukon River from Paimiut to Pilot Station but remain at very low densities throughout the remainder of the unit. Although much of Unit 18 is lowland tundra unsuitable as moose winter habitat, moose should be present in higher numbers because extensive areas of habitat remain unoccupied. Although calf production and yearling recruitment are high during years without major flooding, hunting pressure from the relatively dense human population in the unit has restricted moose population growth.

Illegal harvest, particularly of cows and calves, remains the most serious moose management problem in Unit 18. Although compliance is improving, a lack of alternative ungulate resources, a poorly developed cash economy, and high density of people and villages along the major rivers complicate moose management considerably. Approximately 20,000 rural residents live in 39 communities throughout Unit 18, and we need a serious effort to curb illegal harvest of moose.

Differing state and federal seasons and bag limits for moose have also hampered our ability to effectively manage moose and enforce hunting regulations. For example, in the last 4 years the Federal Subsistence Board (FSB) has lengthened the state season on federal lands. The FSB added 5 days to the 1991–92 season, 10 days to the 1992–93 season, 4 days to the 1993–94 season and 8 days to the 1994–95 season. We feel the management goal of increasing the low moose population is best achieved by restricted bull-only moose harvests. The FSB, working independently of the state system, has liberalized seasons and bag limits, reducing the rate of population increase. Because most of Unit 18 is classified as federal public lands, cooperative management goals and objectives need to be established between our 2 agencies to promote moose population growth and future sustainable harvests.

Recent actions by user groups within the unit, especially along the lower Yukon, to shoulder responsibility for the growth of local moose populations are welcome signs of increasing participation with existing management systems. However, some members of local Fish and Game advisory committees and the recently established Federal Subsistence Regional Advisory Council continue to submit or support proposals liberalizing moose seasons and harvest opportunities in Unit 18, regardless of the biological status of the moose population.

The growth of the Kilbuck caribou herd and recent migrations of the Western Arctic caribou herd into the unit may eventually reduce hunting pressure on the moose population. However, we anticipate the demand for moose will probably continue to exceed supply.

We recommend that monitoring and inventory of the moose population remain a priority in Unit 18, especially the continuation of the Gasaway (1986) type censuses along the Yukon and Kuskokwim rivers. We should continue to attempt fall composition counts in the Yukon and Kuskokwim drainages. However, poor winter weather and snow conditions frequently hamper efforts to complete composition counts before bulls drop their antlers during late fall. We should continue to conduct censuses in the 5 census areas delineated in Unit 18 at intervals of 5 years or less. The census results, with annual composition surveys, will provide the department baseline demographic information and recruitment rates to properly manage the moose population.

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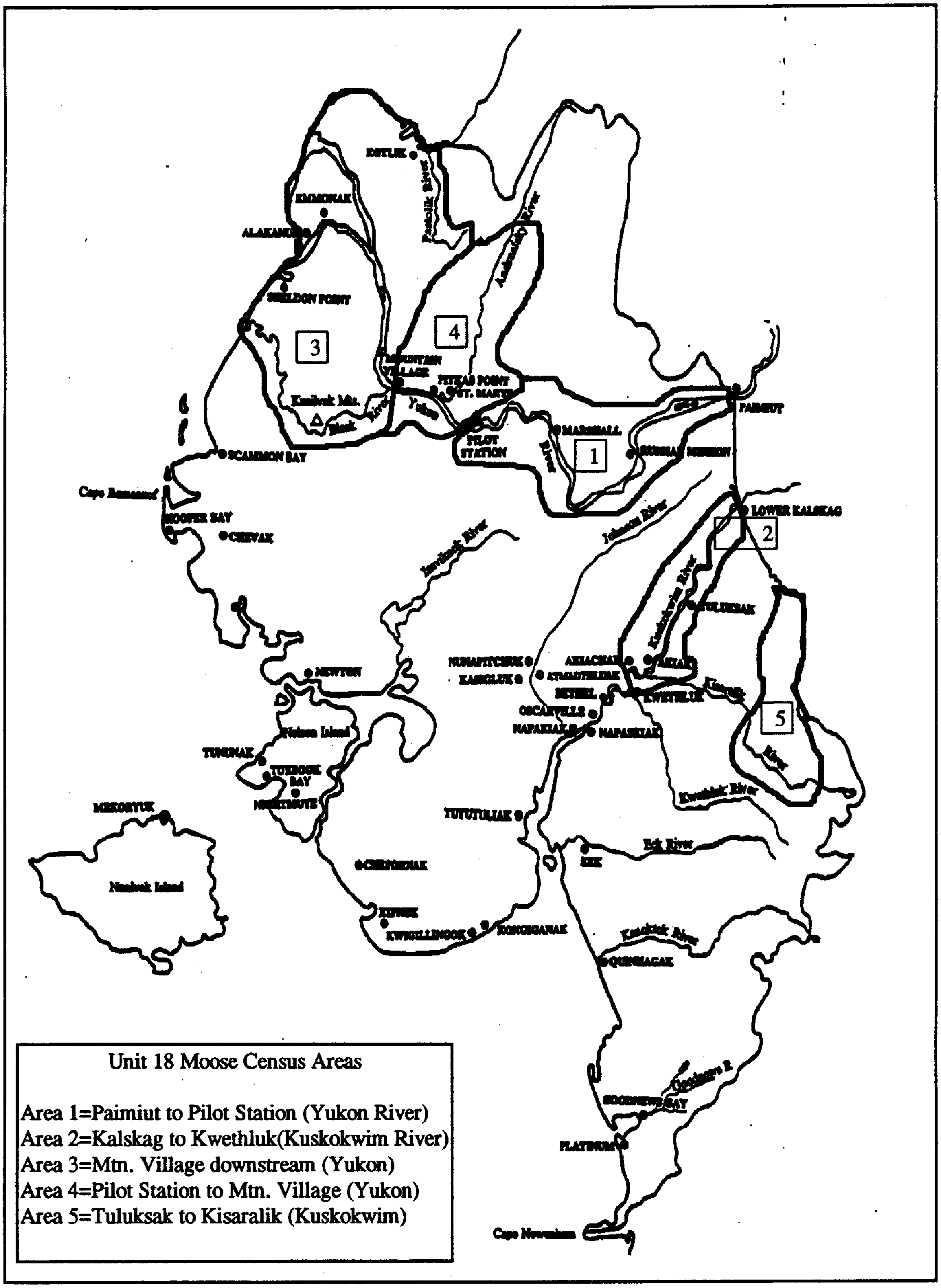

Figure 1. Game Management Unit 18, showing major drainages, communities, and census areas

Table 1 Unit 18 moose census area results, 1992–95

Census Area	Date	Total Area (mi^2)	Total polygons (N)	Area sampled (mi^2)	Polygons sampled (n)	Population estimate	80% confidence interval (%)
1. Yukon River: Paimiut to Pilot Station	March 1992	1,558	159	628	39	994	± 12.5
2. Kuskokwim River: Kalskag to Kwethluk	March 1993	648	41	249	18	217	± 27.6
3. Yukon River: downriver from Mountain Village	March 1994	1,700	19	1,700	19	65	not applicable
4. Yukon River: Pilot Station to Mountain Village	March 1995	1,984	97	513	29	52	± 46.3
5. Kuskokwim River: (NYAC block) Tuluksak to Kisaralik – proposed	March 1996	892	65	(proposed)	(proposed)	(proposed)	(proposed)

Table 2 Summary of moose hunting regulations for Unit 18, 1961–95

Regulatory year	Season dates	Harvest Total	Bag limit and area affected
1961 - 62	August 20 – Sept. 30	73	1 bull
	Nov. 20 - Dec. 10		
1962 - 75	August 20 – Dec. 31	134	1 bull
1975 - 82[a]	Sept. 1 - Sept. 20	20	1 bull; Yukon River delta
	Sept. 1 - Dec. 31	122	1 bull; remainder of Unit 18
1982 - 85	Sept. 1 - Sept. 20	20	1 bull; Yukon River delta redefined[c]
	Sept. 1 - Sept. 30	77	1 bull; remainder Unit 18
	Nov. 15 - Dec. 31		
1985 - 88[de]	Sept. 1 - Sept. 20	20	1 bull; Yukon River delta[c]
	Sept. 1 - Sept. 30	40	1 bull; remainder of Unit 18
	Feb. 1 - Feb. 10		
1988 - 92[f]	CLOSED	0	Yukon River delta[c]
	Sept. 1 - Sept. 30	41	1 bull; remainder Unit 18
	Dec. 20 - Dec. 30[g]		
1993 - 94	CLOSED	0	Yukon River delta[c]
	Sept. 1 - Sept. 30	40+	1 bull; remainder Unit 18
	Winter Season TBA[h]		
1994 - 1995	Sept. 5 - Sept. 25	20	Yukon River delta[c]
	Sept. 1 - Sept. 30	40+	1 bull; remainder Unit 18
	Winter Season TBA[h]		

[a] The Alaska Board of Game established the Kalskag Controlled Use Area in 1977, incorporating a triangular-shaped region from Russian Mission upriver to the old Paimiut village site, south to Lower Kalskag, and northwest back to Russian Mission.
[b] That area north & west of a line from Cape Romanzof to Mountain Village, & west of & excluding the Andreafsky River drainage.
[c] That portion north & west of a line from Cape Romanzof to Kusilvak Mountain, to Mountain Village, & west of & excluding the Andreafsky River drainage.
[d] In 1985-89, hunting regulations were divided into subsistence and general hunts.
[e] In 1987, residents of communities within Unit 18 and upper Kalskag were found to have customary and traditional uses of moose in Unit 18.
[f] In 1990, all hunts became general hunts and federal regulations took place. The 1990 federal regulations were the same as the state regulations, except for the Kanektok and Goodnews River drainages, and only Unit 18 residents and residents of Upper Kalskag could hunt moose in Unit 18 under federal regulations. In 1991 the federal season was Dec. 15 - 24, which overlapped the state season.
[g] The fall season for state and federal lands is the same, the federal winter season was Dec. 31 - Jan. 9 (1992-93).
[h] The state winter season is To Be Announced by Emergency Order (Dec. 20 - Jan 20); the federal winter season will also be a To Be Announced season by the Refuge Manager (Dec. 1 - Feb. 28). state season: Dec. 20 - Dec. 29, 1994; federal season Dec. 21 - Dec. 30, 1994. The federal fall season in the Kuskokwim drainage was from August 25 - Sept. 25, while the state fall season was Sept. 1 - Sept. 30, 1994. An Emergency Order was written to close the last 5 days of the state season so that both the federal and state fall seasons would end on September 25, 1994. The USFWS extended the winter hunt from Feb. 4 -10,1994.

Table 3 Fall and winter moose harvests for Unit 18, 1978–95

Regulatory year	Fall harvest (N)	Fall harvest (%)	Winter harvest (N)	Winter harvest (%)	Unknown harvest (N)	Unknown harvest (%)	Total harvest (N)
1978-79	42	88	6	12	0	0	48
1979-80	11	92	1	8	0	0	12
1980-81	45	94	3	6	0	0	48
1981-82	72	90	8	10	0	0	80
1982-83	54	93	4	7	0	0	58
1983-84	61	97	2	3	0	0	63
1984-85	63	87	7	10	2	3	72
1985-86	43	83	8	15	1	2	52
1986-87	54	90	6	10	0	0	60
1987-88	40	83	8	17	0	0	48
1988-89	67	98	0	2	0	0	68
1989-90	31	94	1	3	1	3	33
1990-91	55	90	6	10	0	0	61
1991-92	63	94	4	6	0	0	67
1992-93	64	83	13	17	0	0	77
1993-94[c]	93	97	3	3	0	0	96
1994-95[d]	76	87	11	13	0	0	87

[a] Between 1977-82, the moose season was September 1 - December 31 in all Unit 18, except the Yukon River delta; the delta season was September 1-20 beginning in 1982, until 1988, when a moose harvest moratorium was established on the delta. In 1985, the fall season was September 1-30 in the remainder of Unit 18. The bag limit in Unit 18 has been 1 bull throughout this time period

[b] In 1982-85, the winter season was November 15 - December 31 in Unit 18, excluding the Yukon River delta. There was no winter season in the delta. In 1977-85, only bulls were reported caught in the winter seasons. In 1985-88, the winter season was February 1-10. Unconfirmed harvest of cows was reported during 1985-86. Of the total 1986-87 moose harvest, 3.7 percent was cows. During the 1987-88 season, cow moose harvests accounted for between 2.1 to 10.4 percent of the annual harvest, depending on the sex of unknown animals. During the 1988-89 regulatory year, the winter season was December 20-30. During the 1992-93 season the Federal Refuge Managers added 10 days to the State season from December 31, 1992 to January 9, 1993; the State's season was December 20 through December 30, 1992.

[c] The state winter season was Dec. 20 - Dec. 29, 1993, while the federal season was Dec. 21 - Dec. 30. The federal season was also extended from Feb. 4 - Feb. 10, 1994.

[d] The state fall season was September 5 - 25, 1994 on the Kuskokwim drainage, while the federal season was August 25-Sept. 25, 1994. The winter season for both the state and federal seasons was Dec. 27, 1994-Jan. 5, 1995.

Table 4 Moose hunting effort and harvest by 13 communities in Unit 18 based on hunters interviewed at the Paimiut moose hunter check station, 1988–95

Village	1988		1989		1990		1991		1992		1993		1994		1995	
	No. of hunters	Moose Killed	No. of hunters	Moose killed	No. of hunters	Moose killed	No. of hunters	Moose killed	No. of hunters	Moose killed	No. of hunters	Moose killed	No. of hunters	Moose killed	No. of hunters	Moose killed
Alakanuk	29	17	11	5	15	5	13	2	4	1	24	3	16	2	10	2
Bethel	4	3	9	5	14	6	26	15	16	3	11	5	6	5	12	3
Emmonak	32	6	25	13	32	15	24	10	24	13	20	15	27	12	23	9
Hooper Bay	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0
Kotlik	23	13	26	11	24	8	33	11	23	8	16	5	18	12	6	5
Marshall	15	6	6	3	16	2	21	3	7	1	6	2	13	5	16	4
Mountain Village	74	29	39	13	44	14	79	26	65	14	81	29	77	17	62	23
Pilot Station	15	3	4	1	8	4	12	0	12	4	5	0	9	5	34	7
Pitkas Point	3	1	0	0	0	0	0	0	0	0	3	0	1	1	3	0
Russian Mission	20	11	8	5	9	1	17	9	8	8	23	23	32	20	26	21
Saint Marys	12	4	14	2	13	1	22	2	9	1	10	2	5	2	13	4
Scammon Bay	5	3	3	2	8	3	12	6	10	4	18	8	7	5	17	3
Sheldons Point	8	6	4	1	6	3	6	1	6	2	9	2	6	1	5	0

Table 5 Moose harvest in the Yukon River, Kuskokwim River and Johnson River drainages, Unit 18, 1981–95

	Moose harvest (%)		
Regulatory year	Yukon River	Kuskokwim River	Johnson River
1981-82	57	32	11
1982-83	58	36	6
1983-84	63	33	4
1984-85	62	32	6
1985-86	67	17	16
1986-87	66	34	0
1987-88	52	42	6
1988-89	81	19	0
1989-90	55	39	6
1990-91	80	15	5
1991-92	75	24	1
1992-93	64	33	3
1993-94	77	24	2
1994-95	86	14	0
Average	67	28	5

LOCATION

GAME MANAGEMENT UNIT: 19 (36,486 mi^2); 21A and 21E (23,270 mi^2)

GEOGRAPHIC DESCRIPTION: All of the drainages into the Kuskokwim River upstream from Lower Kalskag; Yukon River drainage from Paimiut upstream to, but not including, the Blackburn Creek drainage; the entire Innoko River drainage; and the Nowitna River drainage upstream from the confluence of the Little Mud and Nowitna rivers.

BACKGROUND

Moose are a relatively recent faunal addition to western Interior Alaska. Their initial occurrence was apparently sometime after the turn of the century. As recently as the 1970s, populations were probably at record highs. Currently, moose are found throughout this area, with the exception of the rugged peaks of the Alaska Range. Major factors influencing moose abundance in the area include predation, weather, and hunting. Hunting pressure is thought to be moderate, except in a few easily accessible areas. Failure to report harvests, particularly by local residents, is a chronic problem.

Unit 19, as well as Units 21A and 21E, can be conveniently divided into 2 regions that have distinctive differences in moose habitat, user access, and hunting practices. Units 19A, 19D, and 21E are generally lower elevation areas that are accessible by boat. Hunters are generally local residents, living in either Unit 19, Unit 21, or adjacent Unit 18. Most hunt moose primarily for food. Units 19B, 19C, and 21A are generally higher elevation areas where access is largely restricted to aircraft. Few people live in these areas, and those traveling there to hunt are mainly seeking large bulls for their trophy quality, although acquisition of meat is also an important consideration.

Aerial composition surveys have been the primary means of assessing population status and trend in this large area. There is a history of surveys dating back several decades. Unfortunately, these data are of limited value because of inconsistencies in survey areas and methods that have compounded the usual problems caused by annual variations in snow and weather conditions.

MANAGEMENT DIRECTION

Subunit boundaries within the area were designed to provide for 2 major uses of the resource. The lowland areas along the Kuskokwim River (Units 19A and 19D) and along the Yukon and lower Innoko rivers (Unit 21E) have been managed to provide a sustained, relatively high harvest of moose. The higher elevation portions (Units 19B, 19C, and 21A) are managed largely for trophy quality animals. Because topography directly affects access, management of the area will continue to be based on these premises.

Management Goals and Objectives

- Develop statistically sound population estimates for select portions of the area beginning in spring 1993.
- Annually assess population status and trend in portions of the area where harvest levels make significant impacts on moose populations.
- Maintain a Unit 19 reported harvest of at least 500 moose.
- Maintain an areawide reported hunter success rate of at least 45%.
- Maintain an annual average antler spread measurement of at least 48 inches in Units 19B, 19C, and 21A.
- Assess accuracy of harvest reporting in selected portions of the area.
- Encourage landowners to reduce fire suppression efforts on wildfires that do not threaten human life, property, or valuable resources, so that fire can fulfill its natural role in maintaining young, highly productive, and diverse habitats.

METHODS

Population composition surveys have continued in selected portions of the area using standard aerial survey techniques. A thorough census of the Holitna/Hoholitna Controlled Use Area was planned for fall 1992 but was thwarted by early, deep snow conditions causing moose to move from areas where they are normally distributed during October/November and concentrate in winter habitat in the lowland riparian areas. A population estimation survey in the Lime Village Management Area was conducted in March 1992, and a portion of the Unit 19D East Intensive Management Zone was surveyed in spring 1996. Information received from harvest tickets was used to monitor hunter demographics and harvest parameters.

We have limited browse utilization surveys to areas along the main Kuskokwim River near McGrath. An index of the overall importance of each willow species was made by 1) multiplying the median value for each browse use category in the survey by the number of plants in each category, 2) dividing by the total number of plants sampled in each area, and 3) multiplying by the frequency of the species found in the site sampled.

We conducted late winter–spring aerial surveys periodically between 1991 and 1996 to assess effects of severe weather conditions on moose in Unit 19D. Mortality rates and causes were assessed. Data were collected during that time on condition of moose as reflected in marrow fat contents. Calving rates and timing have also been monitored in selected portions of Unit 19D.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size and Trend

Historical data from composition/trend surveys indicate moderate moose numbers and generally stable or declining populations. No trend data were collected during fall 1995 due to inadequate snow cover in the various survey areas. Population surveys were conducted in the Lime Village Management Area portion of Units 19A and 19D, revealing a population density of 0.73 ± 16.6% moose/mi^2. In February 1996 the moose population density in an 1819-mi^2 area within Unit 19D East was estimated at 0.42 ± 24.6% moose/mi^2.

Long-term historical data, which can be used to depict population trends, are available from only 2 areas within Unit 19. However, annual changes in survey areas, timing, and conditions prohibit attempts to compare the data over time. In Unit 19A, the lower reaches of the Holitna and Hoholitna rivers (Table 1) have been surveyed 16 times since 1976. However, some of these surveys were conducted in late winter when moose distribution and observability are entirely different than during early winter surveys. The only other area that has been repeatedly surveyed over a long period is in the Farewell (Bear Creek) Burn/Alaska Range foothills area (Table 2). Seventeen surveys have been completed in that portion of Unit 19C between 1976 and 1996.

In early winters of 1987 and 1988, 6 additional composition/trend count areas were established in Unit 19, as well as 3 count areas in Units 21A and 21E. This will significantly broaden our ability to assess moose population trends in the area if funding and weather patterns allow them to be surveyed periodically. Unfortunately, snow conditions were poor in both 1991 and 1995, and few surveys were completed.

In Unit 19A, trend information is available only from the Holitna/ Hoholitna River trend area. An additional survey area was established in 1988 in the Kiokluk/Chuilnuk Mountains but has not been repeated.

Moose per hour figures from the Holitna/Hoholitna River count area (Table 1) have increased dramatically since 1976 when we completed the first fall surveys. Four surveys completed between 1976 and 1984 averaged 39 moose/hour. Surveys completed during the 4-year period 1987–1990 averaged 126 moose/hour. Standardization of the survey route in 1987 to include early winter concentration areas partially explains the observed 3-fold increase. Because of standardization, future data should better reflect actual trends in the population. No counts were conducted in this area in 1991 or 1993, but counts during intervening years confirmed continued population growth.

Moose population trend data within Unit 19B are available from 2 survey areas: Cairn Mountain/Sparrevohn Hills and Upper Stoney River. The Cairn Mountain/Sparrevohn Hills count area (Table 2) was surveyed 6 times between 1982 and 1992. Moose per hour figures indicate the moose population there is increasing. In the Upper Stoney River, 5 surveys between 1982 and 1990 reveal vastly fluctuating moose per hour figures, signifying that particular count area is probably a poor location for obtaining meaningful trend data. Surveys there have been discontinued.

The Farewell Burn and Windy/Pingston count areas have been used to document moose population trends in Unit 19C (Table 3). Moose per hour figures dropped from 94 to 31 between 1974 and 1979 surveys. The 1977 Bear Creek Burn undoubtedly caused this sharp reduction. However, during the period 1983–1989, moose per hour figures increased dramatically, from 22 in 1983 to 194 in 1989, even in the face of increased hunting pressure. This same wildfire caused tremendous habitat enrichment to the area. As spruce reinvades the burn, willow growth will continue to decline. Habitat deterioration has probably influenced the 1990–1994 declines in moose per hour data from the count area.

In the Windy/Pingston count area, moose per hour figures have fluctuated widely at relatively high levels. The trend count area has not been a good indicator of moose population trends in the area, as local snow conditions vary greatly and apparently affect moose abundance and composition on the site.

Unit 19D also contains 2 established composition–trend count areas. The White Mountains count area was established in 1988 and the Candle–Wilson count area in 1989. In the White Mountains 4 surveys from 1988–1992 indicate a stable population during that time. In the Candle–Wilson area (Table 4), 1 partial survey and 5 complete surveys indicate a relatively stable moose population exists at low density. Because of concern for the low densities in this important subsistence hunting area, 2 additional count areas were established in November 1994. Preliminary data indicate the moose densities are extremely low; the trends of those subpopulations are not available.

Population Composition

In Unit 19A bull:cow ratios from 10 fall surveys between 1976 and 1994 in the Holitna River drainage reveal a decline (Table 1) and are probably an accurate reflection of actual population trends. Hunting pressure is intense and is probably responsible for the ratio declines. However, because the overall population is expanding, the absolute number of bulls available is increasing. Calf:cow ratios in this area have remained relatively high, indicating favorable range conditions, low neonatal mortality rates, and sufficient bull:cow ratios.

Unit 19B bull:cow ratios appear to be higher than in Unit 19A, probably because of less intensive hunting pressures. Bulls per 100 cows in the Cairn–Sparrevohn count area between 1982 and 1992 ranged from 131 to 51, with an average of about 80. This is a relatively low-density area, and the survey area is located largely in a rut/postrut area. Obviously, concentrations of cows with calves do not generally partake in the postrut aggregations, thus bull:cow ratios observed are probably not an accurate reflection of the overall population. Calf:cow ratios in the same area have ranged from 24 to 41 calves per 100 cows, with no apparent trend in direction.

Unit 19C is represented in the survey data by the Farewell and the Windy–Pingston count areas. In 14 surveys in the Farewell area from 1973 to 1994, the moose herd notably increased. This is due in large part to the 1977 Bear Creek Burn. By 1983 moose numbers had increased dramatically, and bull:cow ratios averaged over 50:100. Despite recent increases in hunting pressure in the area, the 1994 data from the area indicated over 50 bulls:100 cows. Like the Cairn–Sparrevohn area in Unit 19B, the Farewell count area is located in a rut–post-rut area, and consequently calf percentages in the herd are relatively low. Since 1987 calves per 100 cows has averaged about 20. In the Windy–Pingston count area, bull:cow ratios have remained very high, ranging from a low of 59 to a high of 148. Averaging data from 7 surveys between 1984 and 1994, bull:cow ratios were 89:100. Calf:cow ratios ranged from 22:100 to 40:100 during that same time period, averaging 28:100.

In Unit 19D the situation is bleak. Moose per hour figures, as indicated above, are quite low. Bull cow ratios in the Candle–Wilson count area have been highly variable, probably a reflection of the low sample sizes rather than an indication of population fluctuations. Similarly, calf:cow ratios have been highly variable. In a population survey completed in early spring 1996, following a mild winter, calves comprised 17% of the herd.

We gathered Unit 21 sex and age composition data from 2 count areas. The Holy Cross count area has extremely high moose densities and, despite high hunter interest, bull:cow ratios have remained relatively high, averaging 28:100 when we combine 5 fall surveys between 1987 and 1994. Calf:cow ratios in the area during the same period ranged from 20:100 to 63:100, with no discernible trends. Bull:cow ratios in the North Fork Innoko River count area in Unit 21A ranged from 52:100 to 86:100 between 1980 and 1994. Calves per 100 cows ranged from zero to 41, with recent lows probably a reflection of high predation rates and high winter mortality due to deep, long-lasting snows.

MORTALITY

Harvest

<u>Seasons and Bag Limits</u>

Unit 19A that portion within the Lime Village Management Area		
Resident Hunters: 2 moose of either sex by Tier II permit.	10 Aug-25 Sep 20 Nov-31 Mar	No open season

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 19A outside of the Lime Village Management Area and upstream of the Kolmakof and Holukuk rivers.		
Resident Hunters: 1 bull; either sex may be harvested between 1 Feb and 10 Feb.	1 Sep-20 Sep 20 Nov-30 Nov 1 Feb-10 Feb	
Nonresident Hunters: 1 bull with antlers at least 50 inches (or at least 4 brow tines on 1 or both sides).		1 Sep-20 Sep
Unit 19A outside of the Lime Village Management Area and downstream of the Kolmakof and Holokuk drainages.		
Resident Hunters: 1 bull.	1 Sep-20 Sep 20 Nov-30 Nov	
Nonresident Hunters: 1 bull with 50-inch antlers or greater, or with at least 4 brow tines on 1 or both sides.		1 Sep-20 Sep
Units 19B and 19C		
Resident Hunters: 1 bull.	1 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers or greater.		1 Sep-25 Sep
Unit 19D, upstream from and including the Selatna River drainage.		
Resident Hunters: 1 bull.	1 Sep-25 Sep 1 Dec-31 Dec	No open season

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 19D, remainder.		
Resident Hunters: 1 bull.	1 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.	1 Dec-31 Dec	1 Sep-25 Sep
Unit 21A.		
Resident Hunters: 1 bull.	5 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.	1 Nov-30 Nov	5 Sep-25 Sep
Unit 21E.		
Resident Hunters: 1 bull between 5 Sep and 25 Sep or any moose between 1 Feb and 10 Feb.	5 Sep-25 Sep 1 Feb-10 Feb	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on at least 1 side.		5 Sep-25 Sep

Season dates during the past 10 years have generally become more restrictive. In 1990 nonresident hunters were restricted to harvesting bull moose having antlers at least 50 inches in spread or with a minimum of 3 brow tines on at least 1 side. Brow tine limits were changed to a minimum of 4 on at least 1 side beginning with the 1993–1994 season throughout those areas of the Interior where 50-inch regulations had been established.

Board of Game Actions and Emergency Orders. No emergency orders have been enacted concerning moose seasons or bag limits in the area during this reporting period.

Hunter Harvest. Reported moose harvest in Unit 19A seems relatively stable, with an actual harvest of more than 200 moose annually. Nearly all of those moose are bulls (98%), with light cow harvesting during the February seasons. There remains a very poor reporting rate by hunters in this area. Based on data collected in 1988 at the Holitna River check station, only 45% of the harvest is reported. Reported harvest in Units 19B and 19C is probably much more accurate and averaged as high as 138 moose over the last 5 years. In Unit 19D compliance with reporting requirements has also been poor, averaging 107 reported harvests of moose between 1991 and 1995, a slight decline from the previous 5-year average of 122 moose. Overall, reported moose harvests for Unit 19 (Table 6) began a 3-year decline in the 1989–1990 season but have largely rebounded since then, with 531 as the current 5-year reported mean.

In Unit 21A reported moose harvests have declined somewhat since the late 1980s. The reported harvest of 116 moose in the 1995–1996 season was the lowest since the early 1980s, but probably reflects a decline in effort rather than an actual decline in moose populations. In Unit 21E reported harvests generally increased through the late 1980s, but harvest has largely remained stable from 1990 to 1995. Reported harvest of 162 moose in 1995–1996 was the second highest on record. Combined harvest data for Units 21A and 21E are shown in Table 7.

Permit Hunts. In the 1990–1991 season, a Tier II drawing permit hunt was established for moose hunting in the Lime Village Management Area. During 1990, 10 permits were issued with a harvest quota of 25 either-sex moose. The bag limit was changed to 28 moose with a limit of 2 per permit for the 1993–1994 regulatory year. Reported harvests have been relatively light; the 1995–1996 harvest was 7 moose. The season had 1 unsuccessful hunter and 7 permittees that did not attempt to hunt.

Hunter Residency and Success. Local residents continue to account for the major portion of the harvests in Units 19A, 19D, and 21E, while most hunters in Units 19B, 19C, and 21A were nonlocal Alaska residents or nonresidents of the state (Tables 8 and 9). This segregation by residence location is caused largely by access differences. Access (Table 10) is largely by boat in Units 19A, 19D, and 21E, while aircraft provide most of the moose hunting access in Units 19B, 19C, and 21A.

In Unit 19A, during the past 10 years (1986–1987 through 1995–1996), hunter residence has not changed dramatically. Hunters from Unit 19 accounted for 24% of reporting hunters. Those residing in Unit 18 accounted for 47% of reporting hunters, while hunters from other locations in Alaska accounted for 10%. Nonresident hunters account for very few of the hunters, averaging less than 12% over 10 years. Over these last 10 years, Unit 19B hunters have consisted largely of nonlocal Alaskan (45%) and nonresident (50%) hunters. Very few people live in the subunit, and even Unit 19 residents (from other Unit 19 subunits) are few (2%). Likewise, hunters in Unit 19C are primarily nonlocal Alaskans (65%) and nonresidents (33). Unit residents accounted for less than 2% of reporting hunters. Unit 19D hunters are largely local residents (51%). Alaska residents from other areas compose an additional 35% of the reporting hunters. Nonresidents only account for 12% of the hunters who have reported during the previous 10-year period. Unit 21A hunters consist largely of nonlocals (50%) and nonresidents (35%). Hunters reporting from Unit 21E are generally from Unit 18 (40%) or from 1 of 4 villages in the subunit (30%). Nonresidents generally make up less than 5% of all hunters in the subunit.

Harvest Chronology. Most Unit 19, 21A, and 21E moose harvests are during September. During the most recent hunting season (1995–1996), almost 97% of reported harvests were during this month. Winter harvests (December and February) vary yearly and are largely dependent on snow conditions. Heavy early winter snows concentrate moose along riparian corridors and enable hunters easier access with snowmachines. Years with lighter snowpack generally have higher proportions of moose taken during winter seasons. In Unit 21A, virtually the entire legal harvest occurs during September, with November seasons contributing very few additional harvests. In Unit 21E the harvest is also predominantly during September, with February seasons contributing very little to the overall harvest.

Transport Methods. As in previous years, the Unit 19A, 19D, and 21E most common method of transport was by boat (1995–1996 data, 78%, 72%, and 82%, respectively). In Units 19B, 19C, and 21A, the use of aircraft for transportation is predominant, with 87%, 81%, and 71%, respectively, of all access provided by aircraft. Because of the access differences, "local" hunters are largely separated from "nonlocal" users.

Other Mortality

Illegal harvests, defense of life or property kills, wounding loss, and funeral potlatch harvests probably account for an additional 100 to 150 moose deaths annually in Unit 19, and probably 50 to 75 additional kills in Units 21A and 21E. Of much greater importance to the dynamics of the moose population, however, is predation mortality. Although poorly documented, predation on calves, yearlings, and adults by wolves has been extremely high in recent years, as has calf mortality exerted by black bears. Starvation mortality during recent years has also affected survival rates of calf cohorts in certain areas.

We collected bone marrow samples from moose killed by hunters ($n = 7$), from moose killed by wolves ($n = 40$), and from moose killed by other natural causes ($n = 3$) during winters 1993–1996. Samples were collected in November–December ($n = 20$), January–February ($n = 16$), and March–April ($n = 14$) from both adult ($n = 32$) and calf ($n = 18$) moose. Among the total sample, pooled for all years and for all months, marrow fat percentages averaged 79% among adult moose and 27.5% among calves. Fat contents of less than 20% in adult moose and of less than 10% in calf moose are considered evidence of death from malnutrition, while fat contents at winter's end of greater than 55% indicate good to excellent condition. Samples taken from both adult and calf moose killed by wolves during March and April 1994 all exceeded 50% marrow fat, indicating that nutritional status of all moose was high during the average winter of 1993–1994.

HABITAT

Assessment

It is unlikely the moose population is limited by the available habitat. In Alaska, optimal moose forage is generally associated with willow bands and in seral growth stages following wildfires. In Unit 19D East alone, over 2300 linear miles of riparian habitat is maintained by shifting rivers in a wide band along the Kuskokwim River and its major tributaries. Additional riparian habitat is along smaller creeks and around hundreds of boreal lakes and ponds. Limited suppression of naturally occurring wildfires has created a mosaic of vegetation successional stages. During most summers, hundreds of square miles of boreal forest burns in small isolated fires throughout the area, creating increased potential for rejuvenation of moose winter forage plants. In addition, climax stands of subalpine willow persist in bands around the treeline of the boreal forest in the hills that lie along the north side of the Kuskokwim drainages.

The rate at which moose produce twin calves is a reliable indicator of moose nutritional condition. We conducted aerial surveys of moose during June 1991, 1992, 1994, and 1996 in the McGrath area. An average of 22 cows with newborn calves were observed during those surveys, and an average of 28% (range 18–33%) of those cows had twins. That level of twinning compared with other rates documented throughout North America indicates that productivity was not food limited.

Enhancement

Ongoing assessment efforts will continue to document browse utilization on heavily used winter ranges along the Kuskokwim River. Habitat enhancement efforts have also continued. Close cooperation with Alaska Department of Natural Resources fire management personnel has resulted in relatively high-acreage burns in recent years. Education efforts to dispel myths concerning wildfires and gather support to allow more areas to burn have continued in schools and on radio programs. In cooperation with the US Bureau of Land Management and Alaska Department of Natural Resources, a prescribed fire plan to maintain habitat quality is in its final stages for portions of Units 19C and 19D in the Farewell area.

CONCLUSIONS AND RECOMMENDATIONS

As early as 1980, Alaska Department of Fish and Game biologists recognized resident moose populations were diminished in the upper Kuskokwim River drainages. At the time, the situation was characterized as a "predator problem." In 1989 a series of severe winters began. Four of 7 winters between 1989 and 1995 were "severe," with deep, persistent snow. Those conditions commonly contribute to increased overwinter mortality of moose through increased vulnerability to wolf predation and by decreasing availability of moose forage. Many areas throughout the management area have very high populations of wolves, and their impact on moose populations is substantial. Even if future winter conditions remain relatively mild, some moose populations will probably not increase without increased harvest of wolves.

A comprehensive moose census in the upper Kuskokwim River in spring 1996 documented densities at 0.28–0.46 moose/mi^2 in an 1800-mi^2 area (90% CI). During February 1995, a wolf population estimate in roughly the same area documented 164 wolves in a 5200-mi^2 portion of Unit 19D East. Wolves, however, are not expected to persist at the densities documented during that census. Based on other North American research on the relationships of wolves and moose (Keith 1983, Fuller 1989, Gasaway et al. 1992), the current moose population would be expected to support a wolf population of roughly half of the 1995 level. Wolves will naturally decline through mechanisms of reduced productivity (Boertje and Stephenson 1992), dispersal, and increased mortality (Meir et al. 1996). However, wolves are expected to persist, and wolf predation on moose during winter will probably continue to be a significant factor limiting moose population growth for decades (Gasaway et al. 1992).

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Table 1 Holitna/Hoholitna Count Area (Unit 19A) fall aerial moose composition counts, 1987–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1987-1988	22	4	72	50	36	84	140[a]	85
1988-1989	31	16	56	103	30	240	343	95
1989-1990	24	13	55	160	30	361	528[b]	163
1990-1991	26	10	52	139	29	336	475	162
1991-1992[c]								
1992–1993	31	15	63	172	32	360	542[d]	169
1993–1994[c]								
1994–1995	14	2	42	203	27	568	778[e]	251
1995–1996[c]								

[a] Six unclassified moose.
[b] Seven unclassified moose.
[c] No survey.
[d] Ten unclassified moose.
[e] One unclassified moose.

Table 2 Farewell Burn Count Area (Unit 19C) fall aerial moose composition counts, 1987–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1987-1988	53	10	19	32	13	207	242[a]	115
1988-1989	58	20	34	47	18	218	265	126
1989-1990	47	15	22	55	13	361	416	194
1990-1991	43	8	26	58	16	315	373	159
1991-1992	44	8	29	59	17	293	352	156
1992-1993	46	8	38	58	21	220	278	100
1993-1994[b]								
1994-1995	52	10	19	45	11	353	404	170
1995-1996[b]								

[a] Three unclassified moose.
[b] No survey.

Table 3 Holy Cross (Unit 21E) fall aerial moose composition counts, 1987–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1987-1988	19[a]	9	43	150	26	420	570	83
1988-1989[b]								
1989-1990	31	12	45	148	25	432	584[c]	161
1990-1991	29	7	51	211	28	536	758[d]	253
1991-1992[b]								
1992-1993	26	5	22	67	14	412	483	163
1993-1994[b]								
1994-1995	29	9	63	216	32	444	674[e]	234

[a] Total bulls:100 cows in 1987-1988 may have been unrealistically low because surveys were done in late Nov/early Dec after some large bulls had already shed their antlers.

[b] No survey.

[c] Four unclassified moose.

[d] Eleven unclassified moose.

[e] Fourteen unclassified moose.

Table 4 White Mountains (Unit 19D) fall aerial moose composition counts, 1987–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1987-1988[a]								
1988-1989	189	27	17	5	11	84	89	40
1989-1990	157	14	33	7	11	55	62	29
1990-1991	96	6	46	15	19	63	78	34
1991-1992[a]								
1992-1993	133	0	40	11	14	63	74	37
1993-1994	50	11	34	9	18	39	48	60
1994-1995[a]								
1995-1996[a]								

[a] No survey.

Table 5 Candle/Wilson A, B, C, and D count area (Unit 19D) fall aerial moose composition counts, 1988–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
A and B count area								
1988-1989[a]								
1989-1990	14	6	34	17	23	56	73	34
1990-1991	34	6	23	11	14	63	74	39
1991-1992	20	0	31	14	20	53	67	37
1992-1993	4	2	28	12	21	45	57	34
1993-1994	14	9	28	6	20	24	30	12
1994-1995	18	3	21	13	15	72	85	47
C and D count area								
1988-1989[a]								
1989-1990	25	5	70	14	35	25	39	41
1990-1991	11	0	26	7	19	29	36	40
1991-1992[a]								
1992-1993	17	4	26	6	18	27	33	22
1993-1994	37	18	50	8	26	22	30	30
1994-1995	23	6	10	3	7	38	41	32

[a] No survey.

Table 6 Unit 19 moose harvest, 1986–1995[a]

Regulatory Year	Harvest by hunters							Total
	Reported						Estimated	
	M (%)		F (%)		Unk	Total	Unreported	
1986-1987	454	(98)	8	(2)	2	464	153	617
1987-1988	530	(97)	17	(3)	2	549	181	730
1988-1989	615	(98)	15	(2)	7	637	210	847
1989-1990	546	(99)	7	(1)	6	559	184	743
1990-1991	383	(95)	20	(5)	1	404	133	537
1991-1992	461	(97)	13	(3)	2	476	157	633
1992-1993	485	(96)	22	(4)	3	510	168	678
1993-1994	539	(99)	2	(1)	2	543	179	722
1994-1995	588	(99)	8	(1)	0	596	197	793
1995-1996	522	(99)	1	(1)	6	529	175	704

[a] Excludes permit hunt harvest.

Table 7 Units 21A and 21E moose harvest, 1986–1995

Regulatory year	Harvest by hunters: Reported M (%)		F (%)		Unk	Total	Estimated Unreported	Total
1986-1987	227	(95)	11	(5)	0	238	79	317
1987-1988	251	(98)	6	(2)	0	257	85	342
1988-1989	306	(98)	6	(2)	5	317	105	422
1989-1990	277	(99)	1	(<1)	0	278	92	370
1990-1991	304	(99)	3	(1)	3	310	102	412
1991-1992	284	(99)	4	(1)		288	95	383
1992-1993	222	(99)	2	(<1)		224	74	298
1993-1994	240	(98)	3	(1)	0	243	80	323
1994-1995	276	(97)	10	(3)	0	286	94	380
1995-1996	272	(98)	6	(2)	0	278	92	370

Table 8 Unit 19 moose hunter[a] residency and success, 1986–1995

Regulatory year	Successful						Unsuccessful						Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	
1986-1987	89	191	119	47	446	(54)	101	183	77	15	376	(46)	822
1987-1988	121	245	162	21	549	(54)	95	280	94	6	475	(46)	1024
1988-1989	110	285	188	54	637	(54)	132	271	105	28	536	(46)	1173
1989-1990	114	134	185	36	469	(45)	95	305	162	5	567	(55)	1036
1990-1991	81	189	111	23	404	(37)	94	329	232	20	675	(63)	1079
1991-1992	87	259	123	7	476	(47)	122	266	141	5	534	(53)	1010
1992-1993	100	256	113	41	510	(48)	123	257	149	18	547	(52)	1057
1993-1994	89	271	153	30	543	(53)	57	247	166	6	476	(47)	1018
1994-1995	121	276	181	18	596	(45)	124	368	224	16	732	(55)	1328
1995-1996	89	262	173	5	529	(44)	155	325	197	4	681	(56)	1210

[a] Excludes hunters in permit hunts.

[b] Local resident means those living in Unit 19.

Table 9 Units 21A and 21E moose hunter residency and success, 1986–1995

Regulatory year	Successful						Unsuccessful						Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	(%)	
1986-1987	43	135	45	15	238	(75)	10	63	7	0	80	(25)	318
1987-1988	21	164	43	29	257	(68)	9	83	20	9	121	(32)	378
1988-1989	13	177	69	58	317	(75)	2	62	28	16	108	(25)	425
1989-1990	19	178	53	28	278	(73)	9	66	18	9	102	(27)	380
1990-1991	40	203	52	15	310	(72)	13	80	25	3	121	(28)	431
1991-1992	41	200	42	4	287	(64)	22	104	34	0	160	(36)	447
1992-1993	20	152	35	19	226	(63)	8	91	26	5	130	(37)	356
1993-1994	39	141	45	14	239	(67)	9	71	36	1	117	(33)	356
1994-1995	35	184	47	17	283	(67)	8	87	43	2	140	(33)	423
1995-1996	35	197	46	1	279	(71)	7	74	31	3	115	(29)	394

[a] Local resident means those living in Units 21A or 21E.

Table 10 Unit 19 moose harvest[a] percent by transport method, 1986–1995

Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	n
1986-1987	44	< 1	44	2	3	< 1	1	5	822
1987-1988	38	< 1	44	3	7	2	< 1	5	1024
1988-1989	45	< 1	43	2	5	1	< 1	4	1173
1989-1990	47	< 1	41	2	2	< 1	< 1	5	1036
1990-1991	53	1	35	2	4	< 1	< 1	4	1079
1991-1992	49	< 1	41	3	4	< 1	< 1	1	1010
1992-1993	41	1	45	2	9	0	< 1	2	1057
1993-1994	57	1	33	3	2	< 1	< 1	3	1019
1994-1995	52	1	35	2	4	< 1	< 1	4	1328
1995-1996	50	2	37	3	1	< 1	< 1	5	1210

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 20A (6796 mi^2)

GEOGRAPHIC DESCRIPTION: Tanana Flats, Central Alaska Range

BACKGROUND

Moose are throughout the foothills of the Alaska Range and the Tanana Flats. Preferred moose habitat is composed of riparian willow, second growth forest, and subalpine shrub communities. Approximately 5040 mi^2 of the subunit comprises moose habitat.

Moose numbers increased in Unit 20A during the 1950s and reached high densities in the early 1960s. During the 1960s, habitat overutilization may have limited moose population growth (Boertje et al. 1995). During that period, the moose density may have been as high as 4–5 moose/mi^2. With an abundance of moose, wolf numbers also increased to high levels.

Annual moose harvests averaged 311 moose between 1963 and 1969 (McNay 1993). From 1969 to 1974, harvest increased to an average of 617 moose per year. Cow moose composed 34% of the annual harvest from 1963 to 1974.

The moose population began a decline in the late 1960s, reaching its lowest point in the mid-1970s. Beginning in 1975, seasons and harvests were dramatically reduced and taking of cows prohibited. In late winter 1976 a program to reduce wolf numbers was begun. During the first 4 years of these changes (1975-1978), mean annual moose harvest was only 64 bulls. A detailed history of the moose population through 1978 was published by Gasaway et al. (1983).

Following wolf reduction efforts in Unit 20A (1976–1982) and Unit 20B (1980–1986), the moose population again increased. From 1979 to 1982 harvests averaged 226 bulls/year (McNay 1993). During the most recent 10 years (1983-93), the mean annual harvest increased to 358 bulls. A wolf control program to reduce effects of predation on the declining Delta Caribou Herd began in October 1993 but was discontinued in December 1994. Wolf numbers were reduced by trapping and snaring in the foothills and may have influenced moose population dynamics. Browse availability does not seem to have limited moose population growth in recent years; however, utilization is high in certain areas.

Unit 20A has been managed to provide a variety of hunting opportunities. The southwestern portion of the subunit currently includes the Wood River Controlled Use Area (no motorized access except aircraft), the Ferry Trail Management Area (harvest limited to bulls with spike-fork or 50-inch antlers), the Healy Lignite Management Area (bowhunting only), and the Yanert Controlled Use Area (no motorized access except aircraft, with harvest limited to bulls with spike-fork or 50-inch antlers). Approximately one-third of Unit 20A is military land, including 1003 mi^2 of Fort Wainwright Army property, 893 mi^2 of Fort Greely Army property, and 17 mi^2 of Clear Air Force Station property.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.

MANAGEMENT OBJECTIVES

- Manage for a November population of between 10,000 and 12,000 adult (i.e., excluding calves) moose by 1995.
- Manage for at least 30 bulls:100 cows overall and at least 20 bulls:100 cows in the Tanana Flats, Western Foothills, and Eastern Foothills census areas.
- Maintain an annual harvest of no more than 300 bulls ≥ 2 years of age and a total harvest of less than 400 bulls, until the population objective is reached.
- Allow harvest of cow moose when the population is above the population objective of 10,000 adult moose.

METHODS

From 18–28 November 1993, we completed 2 superstratifications in 2691 mi^2 in Unit 20A, 1 in the Central Tanana Flats (1525 mi^2), and 1 in the Western Foothills (1166 mi^2). We chose the "superstrat" technique to collect data on moose composition and to use as an index to population trend. We did not have enough money and personnel to conduct a census, yet we wanted information over a broader area than trend counts provide. The superstrat technique provides an estimate of observable moose, not total moose, because no intensive surveys are done to calculate sightability correction factors (SCF) (Gasaway et al. 1986). We stratified more intensively (33–57 sec/mi^2) than during a census (26 sec/mi^2). We compared data from these superstrats with data from the exact same area censused in 1991. In 1993 we did not stratify or survey the Yanert drainage or 6 sample units south of Blair Lakes (ADF&G, Eagan RM, memorandum 1/11/94).

In November 1994, we surveyed 28 sample units from that portion of Unit 20A east of the Little Delta River. Survey units were distributed among 2 strata defined from 1988–1993 observations. Seventeen survey units were chosen from the high stratum and 11 from the low-medium stratum. No SCF was estimated, but a conservative SCF of 1.05 was applied. Data from this survey were compared with data from previous surveys and a subunit estimate was generated by extrapolation.

We conducted annual surveys to estimate overwinter survival of calves on the Tanana Flats on 9 May 1994 and 16 May 1995. Annual surveys to determine twinning rates on the Tanana Flats were conducted 20 and 22 May 1994 and 21 and 22 May 1995.

We estimated annual harvest from harvest report cards which were summarized in the Wildlife Information Database (WIDB) files. We considered bulls with antler spreads less than 30 inches to be yearlings.

RESULTS AND DISCUSSION

WEATHER

Unusual weather may have influenced aspects of moose population dynamics during the last few years. Winter of 1990–1991 had the highest snowfall on record in Fairbanks (147.3 inches) and was closely followed by 1992–1993 (139.1 inches). These record snowfalls are well over twice as high as the long-term average of 68 inches.

Summer 1992 was probably the shortest on record. It was bracketed with snowfall in mid May, then 24 inches of snowfall (3 times the previous record) and cold temperatures (13° colder than previous record) in September. In contrast, 1993 was probably the longest summer on record, with an early spring leafout, warm summer, and late fall. Winter of 1993–1994 was a relatively mild snow year, as was 1994–1995.

POPULATION STATUS AND TREND

Population Size

During our last census of the moose population in Unit 20A in November 1991, McNay (1993) estimated the population included 11,072 moose (4989 in the Tanana Flats and 6083 in the foothills). Of these, he estimated 8788 were adults (3893 in the Tanana Flats and 4895 in the foothills). The overall subunit density was 2.2 moose (all ages) per mi^2.

Population size and trend become less certain through this reporting period (Table 1). In November 1993 survey data indicated the number of observable moose declined by 23% in the Central Tanana Flats and 21% in the Western Foothills during this 2-year period. A SCF was not calculated. We estimated the 1524 mi^2 portion of the Central Tanana Flats included 2362 observable moose ± 13.6% (90% CI, 20 df), or 1.5 observable moose/mi^2 (Table 1). We estimated the 1163 mi^2 portion of the Western Foothills included 2629 observable moose ± 15.3% (90% CI, 15 df), or 2.3 observable moose/mi^2.

Contrary to the 1993 survey, data collected in 1994 over much of the same area indicated moose numbers had increased at an average of 6% per year since 1988. Employing a conservative SCF (1.05) and assuming 6% annual growth for areas not surveyed, we estimated 10,600–16,000 moose at 90% CI for all of Unit 20A.

A complete survey across Unit 20A is necessary to reconcile these estimates and more accurately estimate population size relative to management objectives.

Population Composition

If the population did decline significantly between 1991 and 1993, we expected to see evidence in composition counts of lower calf:cow ratios and yearling bull:cow ratios. The data, however, support the 1994 conclusion that the population continues to increase (Table 1).

Calf:Cow Ratios. Despite the severe winters of 1990–1991 and 1992–1993, which could have affected 1991 and 1993 calf productivity and neonate survival, November calf:cow ratios were moderate in both the Central Tanana Flats (34:100 in 1991, 40:100 in 1993) and Western Foothills (32:100 in 1991, 38:100 in 1993) (Table 1). The 1993 cohort probably benefited from the early spring and late fall in 1993, which made for a very long growing season. Calves composed 24% of the 1993 population in the Central Tanana Flats and 23% in the Western Foothills. In 1994 the population consisted of 25% calves.

Survival of calves through winter 1992–1993 were higher than we expected. In February 1993, 18% to 25% of the moose we surveyed on the Tanana Flats were calves. On 5 May 1993, we observed 29 short yearlings:100 cows, with 19% short yearlings in the sample. Short-yearling ratios in May 1994 were 18:100 from a sample of 718 moose (Table 2). The ratio for 1995, 33 short yearlings:100 cows, was the highest recorded since 1984.

Twinning Rates. Twinning rates were 18% in 1994 ($N = 51$) and 7% in 1995 ($N = 46$) (Table 3). Twinning rates can be affected by numerous factors, including timing of survey, sightability, and number of pregnant yearlings. Expansion of twinning rate surveys in 1996 should help to determine if the lower rates observed in 1995 represent a decline in productivity or an artifact of that sample.

Yearling Bull:Cow Ratios. Although improved in 1993 and 1994, autumn yearling:cow ratios have declined in recent years in Unit 20A (Table 1). Reasons for the decline are unknown, but possibilities include predation, weather, food regulation, harvest, and interactions among those factors. It is also not clear whether this trend, if real, involves both male and female recruits or just males. Overall bull:cow ratios have not declined. Calf and short yearling ratios have not shown a declining trend, indicating that the loss of yearlings occurs from May through November. However, the short-yearling data are questionable because they are collected in calving areas shortly before calving. At least some, 50–80% (Gasaway et al. 1983) of moose observed in the short-yearling surveys, are seasonal migrants from Unit 20B and did not winter in Unit 20A. Furthermore, significant events such as wolf control and severe winters are not detectable in the short-yearling data set but are apparent in autumn calf and yearling:cow ratios.

Bull:Cow Ratios. In November 1993 the bull:cow ratio increased to 30:100 in the Central Tanana Flats and decreased slightly to 29:100 in the Western Foothills. In November 1994, 35 bulls:100 cows were observed over a slightly larger area. These bull:cow ratios easily meet management objectives.

Antler Restricted Area. Since 1988 the bag limit in the southwestern portion of Unit 20A has been limited to 1 bull with spike-fork or 50 inch antlers (SF50). That regulation was adopted in response to declining bull:cow ratios (17:100–21:100) in this area where numerous trails provide motorized access; bull:cow ratios have subsequently improved. In the Walker Dome trend area 31 bulls:100 cows were observed in November 1993. In 7 survey units surveyed in the Ferry Trail Management area in 1994 we observed a ratio of 26 bulls:100 cows in a sample of 187 adult moose. These ratios exceed the management objective for the Western Foothills of 20 bulls:100 cows.

Distribution and Movements

The moose population is distributed throughout Unit 20A, consisting of nonmigratory and migratory subpopulations (Gasaway et al. 1983). From February to April some bull and cow moose migrate from the surrounding foothills (Alaska Range and Chena and Salcha river drainages) to calving areas on the Tanana Flats in Unit 20A. They remain there for the summer and return to the foothills from August through October. Although we do not know what proportion of the moose migrate, Gasaway et al. (1983) estimated the seasonal migrants probably increase the density of moose on the Tanana Flats 2- to 4-fold over the density of resident moose. However, the moose population in Unit 20A has grown much more rapidly than surrounding areas so the proportion of seasonal immigrants on the Flats is now reduced.

MORTALITY

Harvest

Season and Bag Limit. Seasons and bag limits in Unit 20A during regulatory years 1993 and 1994 were as follows:

Unit and Bag Limit	Resident Open Season	Nonresident Open Season
20A	1 Sep-20 Sep	1 Sep-20 Sep
In 1991 and 1992, 50-inch antlers were defined as antlers with at least a 50-inch spread or with at least 3 brow tines on at least 1 antler. In 1993 the bag limit was redefined as 1 bull with a spike-fork antler configuration, 50-inch antler spread, or antlers with 4 or more brow tines on 1 side.	1 Sep-20 Sep	1 Sep-20 Sep

Board of Game Actions and Emergency Orders. In June 1993, after much public debate, the Board of Game approved a ground-based wolf control program in a portion of Unit 20A to reduce predation on the declining Delta Caribou Herd and to determine whether ground-based control methods can effectively reduce wolf numbers temporarily to reverse declines in prey populations. The control program proceeded during winter 1993–1994 and through December 1994 when it was suspended.

Harvest by Hunters. During this reporting period, we met our objective of maintaining an annual harvest of no more than 300 bulls 2 years or older in 1993 (299), but did not meet it in 1994 (302). We met our objective for a total harvest of less than 400 bulls in both years (386 in 1993, 382 in 1994). However, including unreported harvest probably places us above our objectives. These management objectives should be reevaluated in light of the increasing moose population size and, perhaps eliminated, as the bull:cow ratio objectives suffice in protecting the bull segment of the population.

Hunter Success and Residency. Overall success rates during the last 5 years averaged 30% (Table 4). Nonresidents had higher success rates than residents.

Harvest Chronology. Moose harvest in Unit 20A has traditionally been well distributed throughout the season (Table 5).

Transport Methods. During the last 9 years, in general, 29–40% of the successful moose hunters used airplanes, 25–37% used boats, 13–27% used ORVs or 3- or 4-wheelers, and 2–6% used horses (Table 6). Hunting by horseback is popular in the Yanert Controlled Use Area and in the Montana Creek drainage.

Other Mortality

Wolves are the primary predator of moose in Unit 20A, with densities as high as 4 wolves per 100 mi^2 in fall 1991.

Wolf numbers were reduced to less than 2 per 100 mi^2 by late winter 1993–1994, primarily in the foothills. Black and grizzly bears are also significant predators of moose in Unit 20A.

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years but was not excessive during this reporting period.

HABITAT

In recent years we have had considerable discussion about the potential for Unit 20A to support many more moose. We are concerned about not exceeding the habitat capacity as occurred in the early 1970s. Several studies have been proposed to investigate the potential to increase the carrying capacity for moose with habitat manipulation.

In moose populations on good range or below carrying capacity, yearling ovulation and pregnancy occur (Schwartz 1992). A 65% pregnancy rate among yearling cows indicates a population below carrying capacity, a 41% yearling pregnancy rate indicates a population near carrying capacity, and an 18% yearling pregnancy rate indicates a population above carrying capacity. By radiocollaring short-yearling cows, we could estimate yearling pregnancy rates as an indicator of range quality or carrying capacity.

The Tanana Valley State Forest (TVSF) Management Plan is currently being revised. If future management of the TVSF results in a substantial increase in logging, browse conditions for moose may be enhanced. Although little of the TVSF is in Unit 20A, many moose that migrate seasonally to Unit 20A either winter on TVSF lands or move through them and would be affected by changes in forest management.

NONREGULATORY PROBLEMS/ISSUES

An electric intertie to be constructed from Healy to Fairbanks has been proposed that potentially bisects important moose habitat in western Unit 20A. Construction on routes bisecting Unit 20A will likely have 2 main effects on moose. Access may be dramatically improved by the wide intertie corridor and changes in regulations to prevent local overharvest of bulls may be necessary. More importantly, increased fire suppression near the corridor may affect habitat capability for moose over time. The department is actively trying to increase fire through prescribed burns and to reduce fire suppression in this area. The department should work with utility planners to resolve wildlife/intertie conflicts.

CONCLUSIONS AND RECOMMENDATIONS

It is important to determine the status of the Unit 20A moose population relative to nutrient/climate limitations, increasing predator numbers, and interactive effects of these factors. Antlerless moose harvest should be evaluated as a tool to prevent an overabundance of moose that are vulnerable to weather and predation, resulting in reduced harvests or a major population decline.

I recommend the following projects to increase our knowledge of moose population dynamics and how they may relate to habitat conditions in Unit 20A:

- Radiocollar calves in November to determine recruitment rates and investigate the decline in yearling bull:cow ratios. Recollar female yearlings the following November and estimate pregnancy rates. Schwartz (1992) stated that yearling pregnancy rates are an indicator of range condition and carrying capacity.
- Expand spring twinning rate surveys. Twinning rates vary with range quality and also may be a good indicator of carrying capacity (Schwartz 1992).
- Conduct a census in Unit 20A. Conduct annual monitoring in a manner that represents the entire unit.
- Monitor the 4 snow survey courses established in Unit 20A in 1993 in cooperation with Soil Conservation Service.

I recommend that management Objective 3, which limits harvest of bulls to 400, be eliminated. In addition, I recommend that an appropriate antlerless harvest be implemented in accordance with Objective 4. If an antlerless harvest is not acceptable, I recommend that all objectives be reviewed for feasibility and public acceptance.

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Table 1 Unit 20A fall aerial moose composition counts and estimated population size, 1990–1994

Regulatory year	Bulls:100 Cows	Yearlings[a]: 100 Cows	Calves:100 Cows	Percent calves	Adults	Moose observed	Moose/mi^2	Estimated[a] population size
1990-1991[b]	23, 24, 26	17	52			292, 180, 158	2.1	10,500
1991-1992[c]	22, 32	16	37			949, 1531	2.3	11,500
1992-1993[b]	28, 31, 36	15	39			0.07, 105, 137	2.3	11,600
1993-1994[c]	29, 30	21	42			852, 883	2.4	12,300
1994-1995[d]	35	25	52			1391	2.7	13,800

[a] From Boertje et al. 1995.

[b] Windy, Walker Dome, and Japan Hills trend areas, respectively.

[c] Central Tanana Flats and Western Foothills, respectively.

[d] Central Tanana Flats and Western Foothills combined

Table 2 Precalving moose surveys in Unit 20A, 1977–1995

Date	Area[a]	Survey time (hrs)	Number of moose: Bulls	w/0	w/1[b]	w/2[b]	Lone yrlgs	Unk	Total	Total yrlgs	Total cows	Yrlgs: 100 Cows	% yrlgs	Bulls:100 Cows
5/17-21/77	1,2,3	8.1	43	103	38	2	18	0	280	60	159	38	21	15
5/9-11/78	1,2,3	13.1	52	173	55	7	1	0	357	70	235	30	20	15
5/9-10/79	1,2,3	14.0	65	194	61	6	2	0	401	75	261	29	19	16
5/9-15/80	1,2,3	7.7	67	107	37	9	8	1	280	63	150	42	23	24
5/11-12/81	1,2,3	11.2	52	165	53	7	4	0	348	71	225	32	20	23
1982[c]														
5/9-11/83	1,2,3	21.5	126	301	114	5	9	3	690	133	428	31	19	29
5/14-16/84	1,3AB	13.0	133	255	103	6	3	0	615	119	363	33	19	37
1985[c]														
1986[c]														
5/12-14/87	1ABCD		104	248	73	0	10	0	508	83	321	26	16	32
1988[c]														
1989[c]														
5/4/90	--[d]	2.0	37	85	16	0	0	0	154	16	101	16	10	37
1991[c]														
1992[c]														
5/5/93	1ABCDE	10.3	67	237	92	0	3	0	491	95	329	29	19	20
5/4-5/94	1ABCDE	8.2	103	430	87	2	4	1	718	95	519	18	13	20
5/8-9/95	1ABCDE[e]	6.2	67	301	134	2	6	0	648	144	437	33	22	15

[a] Boundaries for each numbered/lettered area were not checked and are assumed to be consistent from year-to-year.

[b] With short-yearlings (11-month-olds).

[c] No survey.

[d] Boundaries of survey area included approximately 50 mi^2 of NE Tanana Flats in sample units 118, 119, most of 125, and all of the NE half of 120.

[e] The northern portions of 1A and 1E were not surveyed, nor was the portion of 1A in Restricted Area 2211.

Table 3 Results of twinning rate surveys for moose in the Tanana Flats, 1987–1995

Year	Date	Number of cows			% Twins[a]
		w/Single calf	w/Twins	Total	
1987		45	5	50	10
1988		52	8	60	13
1989	20-24 May[b]	43	8	51	16
1990	24 May	25	7	32	22
1991	20-21 May	19	5	24	21
1992[c]					
1993	28 May	28	0	28	0
1994	22 May	42	9	51	18
1995	22 May	43	3	46	7

[a] Percentage of cows with calves that had twins.

[b] Includes data from surveys when paired helicopter/fixed-wing observations were made (20-21 May) and when only fixed-wing observations were made (24 May).

[c] No calving surveys done.

Table 4 Unit 20A moose hunter[a] residency and success, 1990–1994

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Total	Successful: (%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Total	Unsuccessful: (%)	Total hunters
1990-1991	257	43	61	370	(31)	651	122	52	840	(69)	1210
1991-1992	264	62	48	382	(33)	566	148	48	772	(67)	1154
1992-1993	150	51	32	246	(25)	549	113	59	736	(75)	982
1993-1994	281	54	39	386	(34)	571	108	32	735	(66)	1121
1994-1995	270	67	45	399	(34)	605	103	43	767	(66)	1166

[a] Excludes hunters in permit hunts.

[b] Residents of Unit 20.

Table 5 Unit 20A moose harvest[a] chronology percent by time period, 1990–1994

Regulatory year	Harvest periods					Unk/Other	*n*
	9/1-9/5	9/6-9/10	9/11-9/15	9/16-9/20	9/21-9/25		
1990-1991	27	12	27	29	1	3	370
1991-1992	24	19	28	25	0	3	382
1992-1993	45	24	13	16	0	2	246
1993-1994	34	19	25	17	1	4	386
1994-1995	27	20	23	25	0	5	382

[a] Excludes permit hunt harvest.

Table 6 Unit 20A moose harvest[a] percent by transport method, 1990–1994

Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990-1991	37	6	31	9	0	9	4	3	370
1991-1992	34	5	29	14	0	10	5	3	382
1992-1993	33	4	27	16	2	10	7	2	246
1993-1994	34	2	37	12	0	6	7	2	386
1994-1995	29	3	33	22	0	8	5	0	399

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 20B (9114 mi^2)

GEOGRAPHIC DESCRIPTION: Drainages into the north bank of the Tanana River between Delta Creek and Manley Hot Springs

BACKGROUND

Moose numbers increased in Unit 20B throughout the 1950s and early 1960s after extensive wildfires improved moose habitat and federal predator reduction programs reduced wolf predation on moose (McNay 1993). Moose numbers declined following severe winters in 1965, 1970, and 1974. Increasing wolf predation and liberal either-sex hunting seasons contributed to the moose population decline. By 1976 moose densities were low and the hunting season had been reduced to 10 days in most of Unit 20B. Moose populations again increased following wolf reduction programs conducted from 1980 to 1986. Hunting seasons were extended from 10 days in 1981 to 20 days from 1983 to 1987. Reported harvests increased to approximately 300 bulls per year from 1983 to 1986. Harvests increased further from 377 bulls in 1987 and 1988 to 493 in 1992, despite a 5-day reduction in the season.

Demand for moose hunting opportunities is high and increasing in Unit 20B. Extensive road systems and trails provide overland access, and numerous waterways such as the Tolovana, Tatalina, Chatanika, Goldstream, Salcha, and Chena rivers provide boat access.

There are 2 permit moose hunts in Unit 20B, 1 in the Minto Flats Management Area (MFMA) and 1 in the Fairbanks Management Area (FMA). The MFMA was established in 1979 to restrict harvest in a low-density moose population and has been open to hunting only by registration or Tier II permit since then. In 1988 the Alaska Legislature established the Minto Flats State Game Refuge to ensure protection and enhancement of habitat, the conservation of fish and wildlife, and the continuation of hunting, fishing, trapping, and other compatible public uses within approximately 500,000 acres of the Minto Flats area.

The FMA was established in 1983 to provide moose hunting opportunities around the Fairbanks urban area by bow and arrow only. The area was closed to hunting in the late 1970s and early 1980s. Although boundaries of the FMA have changed several times, the FMA currently includes 217 mi^2, with about 50 mi^2 heavily inhabited by people. Since 1990 moose hunting in the FMA has been by registration permit only, with a requirement for permittees to have completed the International Bowhunter Education Program (IBEP) and a proficiency test. Even though harvest is generally low, this hunt is very popular, with over 500 permits issued annually since 1993.

For management purposes Unit 20B has been divided into 3 geographic zones: 20B West (3955 mi^2), roughly west of a line from Fairbanks along the Elliott Highway to Washington Creek, then north; Unit 20B East (2392 mi^2) including the Little Salcha and Salcha River drainages; and Unit 20B Central (2741 mi^2), the remainder. The Unit 20B Central boundary was shifted westward in 1993. Game Management Unit boundaries changed in 1981, increasing the size of Unit 20B and creating Unit 25C. Prior to 1981, the eastern and western portions of present-day Unit 20B and all of Unit 25C were considered part of Unit 20C.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued subsistence use of moose by Alaska residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Protect human life and property in human–moose interactions.

MANAGEMENT OBJECTIVES

- Manage for a population of 10,000 moose older than calves by 1993: 4,000 in Unit 20B West and 6000 distributed over Units 20B Central and 20B East.
- Manage for a minimum bull:cow ratio of 20:100 in each count area and an overall Unit 20B bull:cow ratio of at least 30:100.
- Sustain an annual harvest of 300–400 bulls in Unit 20B until the population objective is reached.

METHODS

We did not conduct a complete population estimation survey in Unit 20B during this reporting period. We did complete a survey of 51.9 mi^2 in the FMA (approximately 31% of moose habitat in the FMA) in November 1993 and 1994 to collect composition data. In addition, a survey was conducted in the MFMA and in a 642 mi^2 area in Unit 20B Central.

Standard survey techniques were used in the FMA. However, to avoid disturbing people, we did not always make low-level passes to classify moose. In the MFMA we surveyed 16 randomly chosen sample units composing approximately 19% of the study area. A sightability correction factor was not estimated in 1993.

The Unit 20B Central survey employed a regression-based modification to the stratified random sample technique (Gasaway et al. 1986) to estimate moose numbers and composition in portions of the Chatanika and Goldstream drainages. For this survey, a low-intensity search of all sample units was conducted in a C-185 aircraft carrying a pilot and 3 observers. A sample of units was selected wherein the probability of selection was proportional to the number of moose seen during the low-intensity search. Selected sample units were surveyed at standard search intensities (4–6 min/mi^2). The relationship between moose seen during the low-intensity search and standard searches was evaluated via linear regression. The resulting model was used to estimate observable moose numbers. Sightability correction followed Gasaway et al. (1986).

We estimated harvest based on harvest report cards summarized in the Wildlife Information Database (WIDB). This included data from report cards from the general season, the FMA registration hunt, and the MFMA Tier II permit hunt. One reminder letter was sent to nonreporting general season hunters through a statewide mailout, and no more than 2 reminder letters were sent to permit holders who failed to report. We considered bulls with antler spreads of < 30 inches to be yearlings. Results from the federal subsistence hunting season were not included in these results unless specifically noted.

We estimated mortality from reports of illegal harvest, Department of Public Safety records of collisions with motor-vehicles, Alaska Railroad records of collisions with trains, and public reports of winter-killed moose along roadways and on private property.

RESULTS AND DISCUSSION

WEATHER

Unusual weather probably influenced many aspects of moose population dynamics during the last few years. Winter of 1990–1991 had the highest snowfall on record in Fairbanks (147.3 inches), exceeding the previous record in 1970–1971 (145.7 inches), and was closely followed by 1992–1993 (139.1 inches) (National Weather Service, pers commun). These record snowfalls are well over twice as high as the long-term average (68 inches). However, based on a winter severity index, the long winter of 1992-1993 was slightly more severe (5.0) than 1970–1971 (4.9), but still lagged behind 1990–1991 (5.3) (Boertje et al. 1993). Summer 1992 was probably the shortest on record. In contrast, 1993 was probably the longest summer on record, with an early spring leafout, warm summer, and late fall.

POPULATION STATUS AND TREND

Population Size

The 1990 overall Unit 20B moose population was estimated to include 9800 moose (about 1.1 moose/mi^2): 3400 in Unit 20B West, 4200 in Unit 20B Central, and 2200 in Unit 20B East (McNay 1993). Excluding calves, this included approximately 7600 adult moose: 2500 in Unit 20B West, 3300 in Unit 20B Central, and 1800 in Unit 20B East. At that time, the moose population was increasing and expected to reach the objective of 10,000 adult moose (excluding calves) by 1993. Because of changes in priorities, we have been unable to complete surveys planned to verify population status in Unit 20B since then.

The density observed in a small portion of Unit 20B Central surveyed in 1994 was 1.3 moose mi^2 (Table 1). In 1990 the density across all of Unit 20B Central was estimated at 1.2 moose mi^2, indicating moose numbers may have increased slightly. Autumn calf:cow ratios were quite good in the 1994 survey. A more complete survey is required to draw definite conclusions on population trend for Unit 20B Central.

Surveys of the FMA indicate moose numbers continue to increase in this area (Table 1).

The 1994 observable moose density in the MFMA was 2.9 moose/mi^2, assuming the average SCF for western Interior (1.13) (Table 1). Comparing that estimate with the 1989 estimate of 1.7 moose/mi^2 indicates the population has grown considerably in recent years.

Population Composition

Bull:Cow Ratios. In 1990 McNay (1993) estimated that the overall Unit 20B bull:cow ratio averaged 40:100, which was well above our management objective of at least 30:100. The ratios varied by harvest intensity within the unit. For instance, the less intensively harvested Salcha River and Minto Flats had ratios of 44:100 (1990) and 49:100 (1989), respectively. The MFMA had 47:100 in 1994 (Table 1). In contrast, the more intensively harvested Chena River had 28:100 (1990), and the most intensively harvested FMA had only 9:100–13:100 (1989, 1993).

During the last 2 surveys bull:cow ratios in the FMA (9:100 in 1993, 13:100 in 1994) have been far below our objective of at least 20:100. Hunting pressure during fall, before our surveys, is very high and most bulls killed are yearlings. Therefore, low yearling bull:cow ratios observed during the same surveys (4:100 in 1993, 3:100 in 1994) do not necessarily reflect poor calf recruitment from the previous year but result in part from the high proportion of yearlings killed in September.

Calf:Cow Ratios. Calf production and summer calf survival was good in all areas surveyed (Table 1).

Distribution and Movements

Moose are distributed throughout Unit 20B, consisting of nonmigratory and migratory subpopulations (Gasaway et al. 1983). From February to April, some bull and cow moose migrate from the Chena and Salcha River drainages to calving areas on the Tanana Flats in Unit 20A. They remain there for the summer and return to the foothills from August through October. Although we do not know what proportion of the moose migrate, Gasaway et al. (1983) estimated that seasonal migrants probably increase the density of moose on the Tanana Flats 2- to 4-fold over the density of resident moose. Therefore, the summer densities in Unit 20B are probably much lower than during winter.

MORTALITY

Harvest

Season and Bag Limit

Seasons and bag limits have not changed since the 1991–1992 regulatory year and were as follows:

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Fairbanks Mgmt Area. 1 bull, bow and arrow only by registration permit	1-30 Sep 21-27 Nov	1-30 Sep 21-27 Nov
Minto Flats Mgmt Area. 1 bull by Tier II permit only. Up to 150 permits may be issued.	1-20 Sep 10 Jan-28 Feb	No open season
Middle Fork drainage of Chena River, and Salcha River drainage upstream from and including Goose Creek. 1 bull.	1-20 Sep	1-20 Sep
Remainder of Unit 20B. 1 bull.	1-15 Sep	5-15 Sep

In 1993-1995 up to 250 MFMA Tier II permits could be issued; however, only 200 permits were issued during those regulatory years.

Board of Game Actions and Emergency Orders. In the MFMA, the department issued 150 Tier II permits per year from 1990–1991 through 1992–1993 to provide for an annual harvest quota of 50 bulls. However, harvests only ranged from 28–42 per year. In spring 1993 we calculated a new harvest quota of 100 bulls and recommended that the BOG authorize us to issue up to 250 permits. The BOG passed our recommendation and the department issued 200 permits in 1993–1994 and 1994–1995. In spring 1995 the BOG approved changes for the MFMA and FMA. The Tier II bag limit was changed from any bull to any moose and the number of permits was reduced to 50. A general hunt for spike-fork or 50-inch bulls with 4 or more brow tines was added in a shorter season than the Tier II hunt.

The BOG also approved a drawing hunt for cow moose in the FMA for the 1995–1996 regulatory year.

Hunter Harvest

General Season - In the general season, reported harvests have ranged from 299 to 438 bulls per year since 1984 (Table 2). The 1992 harvest was only 71% of the 1987–1991 mean of 391 bulls. The age distribution, as estimated from antler spread, was relatively even but skewed toward younger bulls (< 40 inch antlers) (Table 3).

FMA - Interest in moose hunting continues to increase in the FMA. The number of hunters registering to hunt moose in the FMA has risen steadily from 333 (1991) to 597 (1994). Similarly, the number of permittees actually hunting increased from 260 to 470 during the same period (Table 2).

In the FMA, where hunting pressure is high, most bulls harvested in 1991 and 1992 (61% to 75%) were yearlings (< 30 inch antlers). There were substantially fewer yearlings (39%) represented in the harvest in 1993, but the proportion was again high in 1994. The reduced proportion of yearlings in 1993 probably reflected decreased recruitment from the 1992 cohort. Very little of the harvest (10% or less) included bulls older than about 3 years (Table 3).

The number of moose harvested in the FMA ranged from 23–28 bulls/year from 1990–1992, then increased to 48 bulls in 1994. Only 2 to 6 bulls/year have been taken during the winter season (21–27 Nov).

MFMA - Moose hunting interest and opportunity in the MFMA has also increased in recent years (Table 2). When the Tier II hunt was established in 1990, the harvest quota was 50 bulls/year. This quota, approximately 3% of the population, would allow for 6% growth and did not adversely affect bull:cow ratios. Reported harvest has been below that quota but has steadily increased from 21 in 1990 to 49 in 1994. Usually less than 8 moose per year are harvested in the winter season. In the MFMA, where hunting pressure is relatively low, there is a more even distribution of the harvest among the 4 antler categories (Table 3).

Hunter Residency and Success. Since 1984 most of the moose hunters in the general season have been local residents (residents of Unit 20) (Table 2). Participation by nonlocal residents and nonresidents was relatively low.

Since 1987 approximately 5% of the MFMA permittees have been "nonlocals," or not residents of Unit 20. In 1994–1995 most permittees were from the Fairbanks vicinity (61%) and the Minto, Nenana, Manley area (32%), with a few (7%) from the MatSu Valley, Anchorage area, or Kenai Peninsula.

Hunter success is generally lower in Unit 20B than elsewhere in Unit 20. Since 1984 only 14% to 19% of the general season hunters per year have been successful (Table 2). Many Fairbanks residents obtain harvest tickets but hunt only along the road system where hunting pressure is high and the number of bulls is limited. The FMA has even lower hunter success rates (7% to 11%) but has provided much hunting opportunity. In the MFMA, success rates have been much higher (15% to 43% since 1987) than elsewhere in Unit 20B, with the highest success in recent years.

Harvest Chronology. As in other Interior areas, declining availability of bull moose toward the latter part of the season is compensated by higher success rates resulting from leaf drop and increased activity of bulls in mid September (Table 4).

Transport Methods. Airplane access, which is a significant means of access in many other Interior subunits, has been used by 6% or less of the Unit 20B general season successful hunters since 1984 (Table 5). Instead, highway vehicles were the primary method of transportation for successful hunters.

Other Mortality

During the last 5 years, we have been collecting more systematic information on nonhunting mortality of moose because of its potential influence on harvest quotas and population trends. Motor vehicle and railroad kills continue to be an important source of mortality. Mitigation measures, including public education, are continuing.

The fall 1993 wolf population in Unit 20B was estimated to include 150 to 225 wolves in 20 to 30 packs, and wolves are likely the most important predator for moose in this subunit. Bears are probably also important predators on moose in Unit 20B.

HABITAT

Assessment/Enhancement

The Division of Forestry (Department of Natural Resources) has proposed substantial increases in timber harvests in the Tanana Valley State Forest and on adjacent state lands classified for forest management, and some Native landowners have expressed interest in cooperative ventures with the state to enhance timber harvests.

The department is planning moose habitat enhancement for portions of the Goldstream Valley. This effort would include regeneration of decadent willows by mechanical crushing and planting willows in recently logged areas. In addition, habitat improvement projects for grouse in Unit 20B should also have positive benefits for moose.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

The number of moose killed in accidents with motor vehicles and trains has been substantial in some years. Staff should work with Department of Transportation and the Alaska Railroad to modify road designs, add fences, clear right-of-ways, etc. to help minimize this mortality.

Within the Fairbanks urban area, we also receive a considerable number of complaints about human–moose conflicts, such as moose in gardens or yards, moose attacking dogs along dogsled trails, and moose "trapped" within the confines of the urban area. Departmental policy for the treatment of nuisance moose should be formalized for public consideration.

CONCLUSIONS AND RECOMMENDATIONS

It is unlikely the November 1994 Unit 20B moose population reached our objective of 10,000 adults. To have met this objective, the population would have had to grow at a mean annual rate of at least 9% since our last estimate in 1990. The annual growth rate between 1985 (5700 adults) and 1990 (7600 adults) was approximately 7% per year. Winters have been more severe since 1990. A significant increase in motor vehicle- and train-caused moose mortality occurred during the deep snow winters of 1989–1990 and 1990–1991. In addition, mortality from winter-induced starvation also increased in the immediate Fairbanks area. Moose population growth was probably suspended during 1990–1991 because of high calf and yearling overwinter mortality, but McNay (1993) did not believe the adult segment of the Unit 20B moose population was substantially affected. We recommend replacing this objective with one that reads, "To estimate the Unit 20B moose population size by 1997."

We are unable to determine whether we are meeting our objectives for bull:cow ratios throughout Unit 20B because, during this reporting period, we only completed composition counts in the FMA, MFMA, and Unit 20B Central. Bull:cow ratios in the FMA and the Unit 20B Central count area remain below our objective of at least 20:100 in each count area. However, low bull:cow ratios appear limited to more populated and accessible areas, and we may be meeting our overall objective. In the FMA, the newly adopted antlerless moose season may help to improve bull:cow ratios. In Unit 20B Central, bull:cow ratios are near our count area objective and calf production is good. Therefore, we would not recommend any regulatory changes at this time. However, efforts should be made to monitor the situation as closely as possible.

Although the 1992–1993 harvest was within our objective of 300–400 bulls per year (346), harvest exceeded this quota during the previous 3 years (1989–1991) and in 1993–1994. Because it is unclear whether the population objective can be reached in the near future and we believe that seasons and bag limits are appropriate at this time, we recommend the harvest objective be increased to 300–500 moose.

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Table 1 Unit 20B fall aerial moose composition counts, 1993–1995

Count area	Regulatory year	Bulls:100 Cows	Yearlings[a]: 100 Cows	Calves:100 Cows	Percent calves	Moose observed	Moose/mi²
FMA[a]	1993-1994	9		30	27	65	1.3
FMA	1994-1995	14		61	40	165	2.6[b]
20B Central[c]	1994-1995	18	5	47	28	428	1.3[b]
MFMA[d]	1994-1995	47	11	47	24	489	2.6

[a] Fairbanks Management Area.
[b] Corrected for sightability (SCF = 1.23).
[c] A 642 mi² count area north and west of Fairbanks.
[d] Minto Flats Management Area.

Table 2 Unit 20B moose hunter[a] residency and success, 1990–1994

Area/Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Unk	Successful: Total	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Unk	Unsuccessful: Total	Total hunters
<u>All hunts</u>:											
1990–1991	371	31	8	29	439	1699	114	82	294	2189	2628
1991–1992	393	43	17	40	493	1198	115	93	255	2451	2944
1992–1993	297	25	15	9	346	2059	131	179	55	2424	2770
1993–1994	468	30	21	14	533	2101	92	100	40	2333	2866
1994–1995	428	17	27	3	475	2281	136	87	23	2527	3002
<u>General hunt</u>:											
1990–1991	343	31	8	5	387	1164	107	82	36	1871	2258
1991–1992	359	41	17	12	429	1194	110	93	24	2170	2599
1992–1993	229	24	15	9	277	1726	114	166	53	2059	2336
1993–1994	376	27	21	14	438	1683	70	93	40	1886	2324
1994–1995	334	17	27	3	381	1869	104	83	23	2079	2460
<u>MFMA</u>:											
1990–1991	21				21	48	7			55	76
1991–1992	34	2			36	43	5			48	84
1992–1993	41	1			42	64	2			66	108
1993–1994	44	3			47	74	3			77	124
1994–1995	49				49	81	5			86	135
<u>FMA</u>:											
1990–1991				23	23				258	258	281
1991–1992				28	28	1			231	232	260
1992–1993	23				23	263	15	13	2	293	316
1993–1994	48				48	344	19	7		370	418
1994–1995	45				45	331	27	4		362	407

[a] Excludes hunters in permit hunts.
[b] Residents of Unit 20.

Table 3 Antler spread of moose harvested in Unit 20B, 1988–1994

Hunt	Regulatory year	% Moose harvested by antler spread[a]				No. of moose[b]
		<30"	30–39"	40–49"	50"+	
General season	1988	36	36	17	11	312
	1989	35	39	17	9	397
	1990	24	37	18	20	371
	1991	27	28	21	23	397
	1992	33	30	20	17	255
	1993	26	36	20	18	414
	1994	21	33	20	26	360
Fairbanks Mgmt Area	1990	38	62	0	0	16
	1991	61	29	7	4	28
	1992	75	15	10	0	20
	1993	39	43	11	7	46
	1994	62	28	10	0	40
Minto Mgmt Area	1990	5	20	20	30	20
	1991	24	31	21	24	29
	1992	26	26	26	22	27
	1993	16	34	19	31	32
	1994	22	28	28	22	32

[a] Percent of moose with known antler spread.

[b] Only includes moose with antler spreads reported.

Table 4 Unit 20B moose harvest[a] chronology percent by time period, 1990–1994, general hunt

Regulatory year	Harvest periods 9/1–9/5	9/6–9/10	9/11–9/15	9/16–9/20	9/21–9/25	Unk/Other	*n*
1990–1991	32	22	29	5	1	4	439
1991–1992	33	22	29	6	2	5	493
1992–1993	37	27	18	6	0	11	346
1993–1994	37	27	27	5	0	4	438
1994–1995	34	23	32	7	0	2	381

[a] Excludes permit hunt harvest.

Table 5 Unit 20B moose harvest[a] percent by transport method, 1990–1994, general hunt

Regulatory year	Method of transportation Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990–1991	3		30	14		9	35	9	439
1991–1992	5	1	24	18	1	6	37	9	493
1992–1993	4		19	19	6	6	41	4	346
1993–1994	5		21	24		6	41	3	438
1994–1995	6		24	25		6	37	3	381

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 20C (11,822 mi^2), 20F (6318 mi^2) and 25C (5252 mi^2)

GEOGRAPHIC DESCRIPTION: Unit 20C includes drainages into the west bank of the Nenana River, and into the south bank of the Tanana River west of the Nenana River. Most of Denali National Park and Preserve (DNPP) is within Unit 20C. Unit 20F includes drainages into the north bank of the Tanana River west of Manley, and into the Yukon River approximately between the village of Tanana and the Dalton Highway bridge. Unit 25C includes drainages into the south bank of the Yukon River upstream from Circle to, but not including the Charley River drainage. The subunit also includes the Birch Creek drainage upstream from the Steese Highway bridge, the Preacher Creek drainage upstream from and including the Rock Creek drainage, and the Beaver Creek drainage upstream from and including the Moose Creek drainage.

BACKGROUND

Moose densities in Units 20C, 20F, and 25C have been low for many years. However, factors limiting growth of these moose populations are not well understood. Harvest is thought to be low relative to the population size, although unreported harvest may be substantial. Predation is suspected as a major limiting factor, but data on predator populations are lacking.

These areas contain large tracts of mature black spruce (poor quality moose habitat). However, many riparian areas, subalpine hills, and old burns appear to have suitable moose habitat capable of supporting more moose.

Trends in moose populations have also been difficult to identify. Approximately 26% (6034 mi^2) of the area has been stratified to determine overall moose density and distribution. Surveys to determine density and composition were often inconclusive because of small sample sizes or poor survey conditions.

Moose within Denali National Park and Preserve (DNPP) have been studied more intensively than moose in the rest of the subunits. These studies include moose composition surveys and population estimation surveys (censuses) conducted by DNPP biologists since 1970 and a study of the movements and behavior of radiocollared moose.

Moose are an important source of food for many local rural residents. In addition, hunters throughout the Interior hunt moose in these subunits for food and/or trophies.

MANAGEMENT DIRECTION

The management objectives listed in the FY96 moose performance reports (Boudreau 1996) for this area were to:

- Estimate hunting mortality and document nonhunting mortality when possible.
- Estimate moose densities in Units 20C, 20F, and 25C by 1996.
- Cooperate with BLM to superstratify approximately 1000 mi^2 in central Unit 25C in November 1996.
- Promote moose habitat enhancement by allowing natural fires to alter vegetation.
- Establish definitive moose population objectives for Units 20C, 20F, and 25C by 1997.
- Provide for a sustained yield harvest of these low-density populations until specific population management guidelines have been established.

METHODS

We estimated annual moose mortality with data from harvest report cards, reports to our office of nonhunting mortality of moose, records of moose/motor vehicle collisions (Fish and Wildlife Protection log sheets), and records of moose/train collisions (Alaska Railroad [ARR] summary sheets). The ARR travels through Unit 20C between railroad mileposts 327 (Windy) and 371 (Ferry).

Annual trends in moose composition and density were not documented during this reporting period. No surveys were completed. The last surveys were conducted during November 1994, when DNPP biologists completed population estimation surveys (Gasaway et al. 1986) in the Lake Minchumina Area (1007 mi^2).

To estimate unreported harvest, I used information from a Subsistence Division study conducted in 1987 to assess wild resource use in the village of Tanana. This study estimated that residents of Tanana harvested 0.5 moose per household and approximately half of the hunting effort was spent in Units 20F and 20C (Case and Halpin 1987).

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

We estimate that 3500–4500 moose reside in Unit 20C; 2000 within Denali National Park (DNP) and 1500–2500 outside DNP (but including Denali National Preserve). These estimates assume an average density of 0.58 moose/mi^2 inside DNP (October 1991 census; T Meier, pers commun) and 0.25 moose/mi^2 outside DNP. During the November 1994 survey of the Lake Minchumina area, a DNP biologist estimated the density at 0.34 moose/mi^2 (K Stahlnecker, pers commun) (Table 1)

We estimate that 1000–2000 moose reside in Unit 20F. This assumes 0.25–0.50 moose/mi^2, with roughly 4250 mi^2 of moose habitat (M McNay, pers commun).

Population estimation surveys have not been conducted in Unit 25C. Densities are believed low with a total estimated population of 500–2000 moose. This low estimate is based on the fact that nearly half the subunit contains mountainous nonmoose habitat or open mountainous tundra interspersed by small drainages with localized, good moose habitat. The Bureau of Land Management (BLM) and the department have discussed a cooperative census but have been unsuccessful in acquiring the necessary funding.

Population Composition

The only composition data available during this reporting period were collected by DNP (Denali National Preserve) biologists during a November 1994 moose census in the Lake Minchumina area within DNP (Table 1). They reported 36 calves:100 cows and 25 bulls:100 cows.

Distribution and Movements

Between 1984 and 1988, stratification surveys of over 6000 mi^2 (approximately 26% of Units 20C, 20F, and 25C) confirmed the impression of overall low-density moose populations in these subunits. Seventy-three percent of the stratified area was considered "low density" (0.1–0.2 moose/mi^2), 21% "medium density" (0.2–1.2 moose/mi^2), and only 6% "high density" (2.3–3.6 moose/mi^2) (McNay 1990).

In Unit 20C areas with medium or high densities of moose included the burn in the hills north of Minchumina and southwest of Wien Lake, the foothills of the Alaska Range in the southwestern portion of the subunit, the lower Kantishna River along the eastern floodplain, the low shrub area near Black Bear Lake, the area along the Tanana River, and the burn near Dune Lake.

Within DNP, surveys indicated a prevalence of bulls in the northwestern foothills of the Alaska Range and a relative scarcity of bulls in the flats to the north, indicating a possible interchange of moose between these 2 areas (Meier 1986). However, according to data from radiocollared moose, most of the eastern park moose are residents with only a few venturing to the Toklat, Stampede, or Yanert areas (J Dalle-Molle, pers commun).

In Unit 20F the highest densities of moose seen during the 1985 and 1988 stratification flights were in the headwaters of the drainage of the Tozitna River and along the Yukon River, in the Fish Lake/Harpers Bend area, and near the mouth of the Tanana River.

In Unit 25C moose are distributed throughout most of the subunit with the highest densities in the riparian zones of the major drainages. Radiotelemetry studies documented seasonal movement of moose to the Tanana Flats in Unit 20A (Hobgood and Durtsche 1990). Radiocollared moose returned to wintering areas in Unit 25C during fall.

MORTALITY

Harvest

Season and Bag Limit.

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 20C		
Resident Hunters: 1 bull; however, white-phased or partial albino (more than 50 percent white) moose may not be taken	1 Sep-20 Sep	
Nonresident Hunters: 1 bull; however, white-phased or partial albino (more than 50 percent white) moose may not be taken.		5 Sep-15 Sep
Unit 20F, drained by the Yukon River excluding the Tanana River drainage downstream from the drainage of Hess Creek.		
Resident Hunters: 1 bull.	1 Sep-20 Sep or 1 Dec-10 Dec	No open season
Unit 20F, drained by the Tanana River.		
Resident Hunters: 1 bull.	1 Sep-20 Sep	No open season
Remainder of Unit 20F.		
Resident Hunters: 1 bull.	1 Sep-15 Sep	No open season

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 25C.		
Resident Hunters: 1 bull.	1 Sep-15 Sep	
Nonresident Hunters: 1 bull.		5 Sep-15 Sep

Table 2 summarizes changes in the hunting seasons since 1984. In 1993 the Federal Subsistence Board created a 1–30 September moose season for local residents (Cantwell, Lake Minchumina, Nikolai, and Telida) on federal public lands within DNPP.

Board of Game Actions and Emergency Orders. At the March 1995 meeting, the BOG adopted a proposal that changed the Unit 20F season to 1–20 September, lengthening it by 5 days.

Hunter Harvest. In 1994, 130 moose were reported killed by 389 hunters in Unit 20C, 24 moose were reported killed by 91 hunters in Unit 20F, and 55 moose were reported killed by 219 hunters in Unit 25C (Table 3). In 1995, 152 moose were reported killed by 419 hunters in Unit 20C; 31 moose were reported killed by 137 hunters in Unit 20F, with none reported taken during the December season; and 55 moose were reported killed by 226 hunters in Unit 25C (Table 3).

Nuchalawoyya Potlatch — In spring 1989, the BOG authorized the department to issue permits to take up to 3 moose/year for the Nuchalawoyya Potlatch in June. No potlatch was held in 1994 or 1996 and no moose were taken; 3 moose were taken in 1995.

Federal Permit Hunt 990 — In 1992 the Federal Subsistence Board created a 1-25 September moose season on federal public land in Unit 20F for qualifying local subsistence users by federal registration permit. The federal public land is located within the Dalton Highway Corridor. During the 1994 season 1 permit was issued and that permittee was successful. In 1995 2 permits were issued with no successful permittees (C Miller, pers commun, September 1996).

Unreported Harvest — The number of unreported kills in Units 20C, 20F, and 25C is not easily estimated. Harvest report card returns from Tanana, Rampart, Manley, Livengood, Central, Circle, and Circle Hot Springs within these subunits are minimal. For example, Subsistence Division research information from the village of Tanana illustrates the magnitude of the nonreporting problem. They found that only 10% to 20% of the actual harvest was reported in Tanana.

Hunter Residency and Success. During the last 5 years, less than 5% (139/2801) of the hunters reporting in Units 20C and 25C have been nonresidents (Table 4). There is no nonresident season in Unit 20F. The 5-year average success rate for hunters was 34% (606/1800) in Unit 20C, 24% (157/641) in Unit 20F, and 24% (238/1001) in Unit 25C. Most successful hunters were "nonlocal" hunters, primarily from the Fairbanks area (Table 5). During 1994 within Unit 20C, 80% (122/152) of successful hunters were from communities other than Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, or Denali Park. In Unit 20F, 81% (26/32) of successful hunters were from communities other than Tanana or Manley Hot Springs. In Unit 25C, 95% (52/55) of successful hunters were from communities other than Central, Circle, or Circle Hot Springs (Table 4).

Harvest *Chronology*. In 1994 in Unit 20C, the moose harvest was initially low ($\bar{x}$ = 5.2 moose/day) but increased during the last 10 days of the season ($\bar{x}$ = 9.0 moose/day).

In Unit 20F the September harvest was low and evenly distributed throughout the season (Fig 1). During the December season in Unit 20F the moose harvest was 1 moose early in the month. In Unit 25C the harvest was moderate ($\bar{x}$ = 4.8 moose/day) during the first 5 days, and decreased ($\bar{x}$ = 2.6 moose/day) during the last 10 days of the season (Fig 1).

Transport Methods. In Unit 20C successful hunters used boats, airplanes, and 3- or 4-wheelers for transportation most often, with a definite increase in 3- or 4-wheelers in recent years. Boat use ranged from 32% to 44%, airplane use ranged from 22% to 32%, and 3- or 4-wheeler use ranged from 11% to 21% over the last 5 years. Extensive river systems, many lakes, gravel bars, and an expanding trail system make these transport methods most versatile. In Unit 20F, boats were the primary mode of transportation for successful hunters with use ranging from 38% to 63% over the last 5 years. In Unit 25C successful moose hunters used highway vehicles and 3- or 4-wheelers most often with use ranging from 24% to 44%. This is due to the great amount of road access along the Steese Highway and the extensive trail/mining road system throughout the subunit (Table 5).

HABITAT

BLM is reclaiming mine tailings within the White Mountains National Recreation Area in Unit 25C. Native willows are being planted to enhance the revegetation process and increase moose browse.

The most recent habitat improvement was the 1995 burn that started near Wickersham Dome in Unit 20B and went to upper Beaver Creek in Unit 25C. I believe this fire was of sufficient size and intensity to help moose habitat.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Harvest reporting in these subunits is poor. We need to contact more people in these remote areas to emphasize the importance and benefits of reporting harvest. It would be especially helpful to contact young people in the village schools.

Fire is an integral part of Interior ecosystems and essential to good moose habitat. The department should continue to coordinate wildlife needs with fire suppression activities and encourage more controlled burns to enhance habitat.

Collisions with trains are a significant mortality factor for moose in some areas. Efforts to reduce these mortalities should continue.

CONCLUSIONS AND RECOMMENDATIONS

Low-density moose populations are found in Units 20C, 20F, and 25C. Hunting pressure is relatively low. Current regulations are addressing our management objectives and no regulatory changes are recommended at this time.

We are meeting our objective to estimate hunting and nonhunting mortality. However, it would be beneficial to gather information on reporting rate from other rural communities so we can produce a more comprehensive total estimate of mortality.

We did not meet the objective to estimate moose density in Units 20C, 20F, or 25C by 1996. Nor will we be able to cooperate with BLM for a Unit 25C superstratification in fall 1996. Hopefully we will do density estimates in the more remote units in the next few years. We are making progress on our objective to promote natural fires to enhance moose habitat through the department's efforts on the Interagency Fire Management Team. We are not meeting the objective of establishing population objectives for Units 20C, 20F, and 25C by 1997. We first need to estimate current moose densities before we can establish population objectives. We are meeting our objective of providing a sustained yield harvest from these low-density populations.

We need to direct research to find more cost-effective methods to estimate moose densities that can be used in characteristically low-density areas. We have used the Gasaway et al. (1986) method to estimate moose for at least the last 10 years. I believe there are methods available, but research has not made much progress on this issue.

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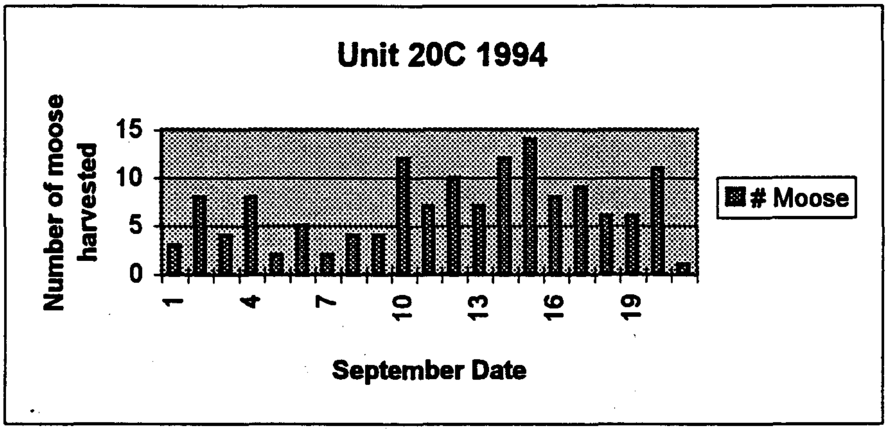

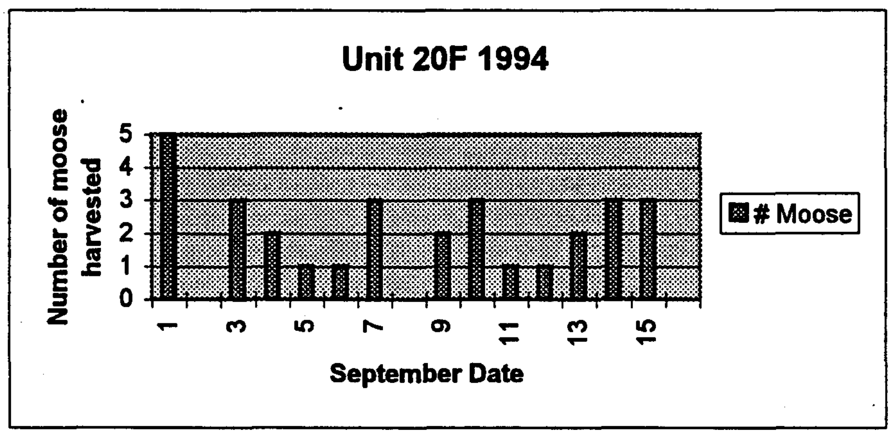

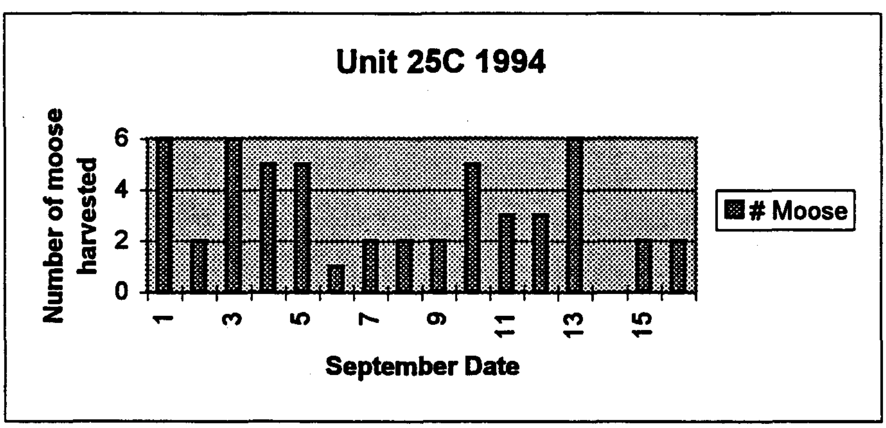

Figure 1 Chronology of moose harvest in Units 20C, 20F, and 25C

Table 1 Results of Unit 20C fall aerial moose censuses in Denali National Park, November 1994 (range of estimates with 90% confidence limits in parentheses)

Location	Bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Corrected density (moose/mi^2)	Estimated population size	Survey area size (mi^2)
Minchumina	25	36	77	22	265		0.34	342 (287-397)	1007

[a] T Meier, pers commun, April 1992. Small mathematical errors were corrected from his data.
[b] All sample units censused, therefore, no variance.

Table 2 Moose hunting seasons for Units 20C, 20F, and 25C, 1984–1995

	Unit 20C		Unit 20F		Unit 25C	
Regulatory year	Season[a]	Hunters allowed[b]	Season	Hunters allowed[b]	Season	Hunters allowed[b]
1984-1985	1-20 Sep	A	1-15 Sep	A	5-15 Sep	A
			1-10 Nov	A		
1985-1986	1-20 Sep	A	1-15 Sep	A	5-15 Sep	A
			1-10 Nov	S		
1986-1987	1-20 Sep	A	1-15 Sep	A	5-15 Sep	A
			1-10 Nov	SR		
1987-1988, 1988-1989, and 1989-1990	1-15 Sep	RN	1-15 Sep	A	5-15 Sep	A
	1-20 Sep	S	1-10 Dec	S		
1990-1991	1-15 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N[c]	1-10 Dec	R (Tier II)	5-15 Sep	N[c]
1991-1992	1-20 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N	1-10 Dec[d]	R	5-15 Sep	N
			1-25 Sep	FS[e]		
1992-1993	1-20 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N	1-10 Dec[f]	R	5-15 Sep	N
	1-30 Sep	FS[g]	1-25 Sep	FS[e]		
1993-1994	1-20 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N	1-10 Dec[f]	R	5-15 Sep	N
	1-30 Sep	FS[g]	1-25 Sep	FS[e]		
1994-1995	1-20 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N	1-10 Dec[f]	R	5-15 Sep	N
	1-30 Sep	FS[g]	1-25 Sep	FS[e]		
1995-1996	1-20 Sep	R	1-15 Sep	R	1-15 Sep	R
	5-15 Sep	N	1-10 Dec[f]	R	5-15 Sep	N
	1-30 Sep	FS[g]	1-25 Sep	FS[e]		

[a] Since 1987 the taking of white-phased or partial albino (more than 50%) white moose has been prohibited.
[b] A = all, R = residents, N = nonresidents, and S = subsistence.
[c] Bag limit bulls with ≥ 50-inch antler spread.
[d] Only that portion of Unit 20F drained by the Yukon River downstream from the mouth of Hess Creek.
[e] Federal subsistence season for residents of Minto, Manley, and Stevens Village to hunt moose in Unit 20F on federal public lands.
[f] Only that portion of Unit 20F drained by the Yukon River excluding the Tanana River drainage downstream from the drainage of Hess Creek.
[g] Federal subsistence season for residents of Cantwell, Lake Minchumina, Telida, and Nikolai to hunt moose in Unit 20C on federal public lands within DNPP.

Table 3 Number of successful and unsuccessful moose hunters by Alaska residency, Units 20C and 20F, 1986–1994

Regulatory	Successful hunters				Unsuccessful hunters				Total
year	Resident	Nonresident	Unk	Total (%)	Resident	Nonresident	Unk	Total (%)	hunters
Unit 20C:									
1986-1987	98	3	4	105 (34)	196	4	3	203 (66)	308
1987-1988	65	3	2	70 (24)	203	6	11	220 (76)	290
1988-1989	84	6	24	114 (41)	114	8	42	164 (59)	278
1989-1990	88	5	2	95 (33)	174	11	4	189 (67)	284
1990-1991	108	4	4	116 (38)	178	6	5	189 (62)	305
1991-1992	131	9	2	142 (37)	229	2	3	234 (63)	376
1992-1993	56[a]	5	5	66 (21)	228	9	8	245 (79)	311
1993-1994	118	9	3	130 (33)	247	9	3	259 (67)	389
1994-1995	131	9	12	152 (36)	241	9	17	267 (64)	419
Unit 20F:									
1986-1987	33	1	0	34 (26)	92	2	1	95 (74)	129
1987-1988	19	0	1	20 (20)	69	3	7	79 (80)	99
1988-1989	25	0	6	31 (32)	49	3	15	67 (68)	98
1989-1990	25	3	0	28 (26)	78	3	0	81 (74)	109
1990-1991[b]	38[c]	0	0	38 (31)	84	0	2	86 (69)	124
1991-1992	36	1	0	37 (24)	109	3	6	118 (76)	155
1992-1993	25	0	2	27 (20)	104	1	2	107 (80)	134
1993-1994	22	0	2	24 (26)	65	1	1	67 (74)	91
1994-1995	29	2	0	31 (23)	100	3	3	106 (77)	137
Unit 25C:									
1986-1987	32	0	0	32 (29)	75	1	1	77 (71)	109
1987-1988	22	3	2	27 (28)	66	3	1	70 (72)	97
1988-1989	43	0	1	44 (35)	77	3	1	81 (65)	125
1989-1990	24	2	0	26 (22)	89	3	2	94 (78)	120
1990-1991	38	4	1	43 (23)	129	7	7	143 (77)	186
1991-1992	43	3	0	46 (28)	108	7	3	118 (72)	164
1992-1993	32[d]	7	0	39 (19)	161	5	1	167 (81)	206
1993-1994	47	7	1	55 (25)	157	7	0	164 (75)	219
1994-1995	45	9	1	55 (24)	158	12	1	171 (76)	226

[a] 37% were "local" residents (Nenana, Tanana, Manley Hot Springs, Healy, Clear, Anderson, Lake Minchumina, and Denali Park).
[b] Excludes hunters in permit hunts.
[c] 26% were "local" residents (Tanana, Rampart, Manley Hot Springs).
[d] 36 were "local" residents (Central, Circle, Circle Hot Springs).

Table 4 Residency of successful moose hunters in Units 20C and 20F, 1992–1995

Unit	Town	No. successful hunters
20C	Nonlocal	
	Fairbanks, North Pole, Salcha, Two Rivers	66
	Wasilla, Anchorage, Palmer	28
	Nonresidents	9
	Other residents/unknown	19
	Subtotal	122
	Local	
	Denali Park	2
	Nenana	9
	Tanana	1
	Manley Hot Springs	3
	Healy/Clear/Anderson	9
	Lake Minchumina	6
	Subtotal	30
20F	Nonlocal	
	Fairbanks, North Pole, Eielson	15
	Anchorage, Eagle River	4
	Other residents, unknown	7
	Subtotal	26
	Local	
	Tanana	3
	Manley Hot Springs	3
	Subtotal	6
25C	Nonlocal	
	Fairbanks, North Pole, Ft. Wainwright, Salcha Two Rivers	29
	Anchorage, Chugiak, Elmendorf, Eagle River	9
	Nonresidents	9
	Other residents, unknown	5
	Subtotal	52
	Local	
	Central	2
	Chatanika	1
	Subtotal	3

Table 5 Units 20C, 20F, and 25C moose harvest[a] percent by transport method, 1986–1995

	Method of transportation								
Regulatory year	Airplane	Horse/Dogsled	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unk/other	*n*
Subunit 20C:									
1986-1987	28	1	34	25[b]	0	-[b]	7	7	105
1987-1988	27	1	43	20[b]	0	-[b]	6	3	70
1988-1989	23	2	44	-[b]	0	-[b]	8	6	114
1989-1990	20	2	37	14	0	14	11	3	95
1990-1991	24	0	41	11	0	11	9	3	116
1991-1992	23	0	39	20	0	7	8	3	142
1992-1993	32	0	32	12	6	8	10	0	66
1993-1994	22	2	44	15	1	13	3	0	130
1994-1995	26	1	37	21	0	7	5	1	152
Subunit 20F:									
1986-1987	9	3	38	26[b]	0	-[b]	18	6	34
1987-1988	15	0	30	5[b]	0	-[b]	20	35	20
1988-1989	6	0	55	19[b]	0	-[b]	13	6	31
1989-1990	14	0	50	0	0	11	21	4	28
1990-1991	11	0	63	16	0	0	11	0	38
1991-1992	8	3	57	11	3	3	14	3	37
1992-1993	7	4	44	7	15	0	19	4	27
1993-1994	4	4	38	13	8	4	29	0	24
1994-1995	3	0	39	23	0	13	22	0	31
Subunit 25C:									
1986-1987	9	3	25	16	0	19	22	6	32
1987-1988	11	4	37	15	0	7	19	7	27
1988-1989	7	0	14	21	0	2	52	5	44
1989-1990	4	4	23	27	0	12	31	0	26
1990-1991	2	0	9	35	0	14	37	2	43
1991-1992	11	0	22	44	0	0	20	4	46
1992-1993	18	0	13	33	0	8	26	3	39
1993-1994	9	0	36	24	0	5	24	2	55
1994-1995	13	0	24	38	0	9	15	1	55

[a] Excludes permit hunt harvest. Data through 1988-1989 are from FY89 moose survey-inventory.

[b] 3- or 4-wheeler and ORV combined.

LOCATION

GAME MANAGEMENT UNIT: 20D (5720 mi^2)

GEOGRAPHIC DESCRIPTION: Central Tanana Valley near Delta Junction

BACKGROUND

Unit 20D was created in 1971 from the portion of Unit 20C south of the Tanana River between the Johnson and Delta rivers. From 1962 to 1970, the moose hunting season in the area that is currently Unit 20D consisted of a 70- to 72-day bull season and a 1–8-day antlerless moose season. Fifty-one percent to 74% of the harvest from 1964 to 1970 came from the highly accessible areas near Delta Junction (Clearwater Lake, Donnelly Dome, and the Delta farming area). However, several severe winters in the mid-1960s and early 1970s killed many moose throughout this subunit and other portions of Interior Alaska and set the stage for predation and hunting to compound and aggravate already widespread population declines. The moose hunting season was closed from 1971 through 1973 because the depressed moose population could no longer support the harvest that would result from even the most restrictive seasons (McIlroy 1974). Recruitment of yearling moose to the population had remained poor, causing the continued bulls-only hunting to depress the bull:cow ratio to only 4:100 in more accessible portions of the subunit.

Despite restrictions on hunting, the moose population in Unit 20D continued to decline because of chronically high moose mortality due to other causes. In 1973 the moose population in the area south of the Tanana River and between the Johnson and Delta rivers was estimated to number only 600. When limited moose hunting was resumed in 1974, it was conducted under a registration permit system designed to keep harvest minimal. The population decline in the western portion of the subunit was gradually reversed by wolf control efforts in adjacent Unit 20A (1976–1982) and in western Unit 20D (1980–1983), in combination with continued hunting restrictions and mild winters.

In 1978 the subunit was enlarged by moving the eastern boundary from the Johnson River to the Robertson River. It was further enlarged in 1981 to include all drainages north of the Tanana River from the mouth of the Robertson River to Banner Creek. In 1983 the remaining closed area around Delta Junction was formally named the Delta Junction Management Area (DJMA). The name of the DJMA was changed to the Delta Junction Closed Area (DJCA) in 1990.

For convenience, Unit 20D has been unofficially subdivided into 4 areas for moose management purposes: southwestern Unit 20D, which includes the area south of the Tanana River from the Johnson River to the Delta River; southeastern Unit 20D, which includes the area south of the Tanana River from the Robertson River to the Johnson River; northwestern Unit 20D, which includes the area north of the Tanana River from Banner Creek to and including the Volkmar River; and northeastern Unit 20D, which includes the area north of the Tanana River and east of the Volkmar River.

As moose populations recovered during the mid 1970s and early 1980s, hunting opportunities were extended in southwestern Unit 20D by first eliminating the registration permit requirement and then lengthening the season. Antler restrictions were implemented in 1988 to stabilize the increasing harvest and improve the age structure in the bull segment of the population. In southeastern and northern Unit 20D, the seasons were also increased. The DJCA remains closed to moose hunting due to local preference rather than biological necessity.

MANAGEMENT DIRECTION

MANAGEMENT GOALS AND OBJECTIVES

- Manage for a total posthunting season population of 7000 moose with 3000 in northern Unit 20D, 2500 in southwestern Unit 20D, and 1500 in southeastern Unit 20D.
- Manage for a posthunting season bull:cow ratio of no less than 30 bulls:100 cows.
- Manage for a November calf:cow ratio of no less than 30 calves:100 cows.
- Manage for at least 20% hunter success as long as moose populations are stable or increasing.

METHODS

In fall 1994 density of moose and unbiased composition data were collected in southwestern and northern Unit 20D trend count areas (TCA). TCAs were subdivided into sample units (SU) with each SU having a mean area of approximately 12 mi^2. We surveyed 1 SU at a time, with a search intensity of approximately 4–8 minutes/mi^2. We also estimated sex and age composition in southeastern Unit 20D by flying transect or contour surveys in specified areas. Sex and age composition data collected during these surveys may be biased because different segments of the moose population have varying observer sightability during aerial surveys.

TCAs and aerial composition surveys were flown in a Robinson R-22 helicopter at an altitude of 300–500 feet above ground level and an airspeed of approximately 50–70 mph. A low pass was flown over all moose to determine sex and age, to look for additional moose, and in some areas to estimate antler spread and number of antler brow tines for bulls. Yearling bulls were identified by spiked or forked antlers or by a lack of brow development on palmated antlers. Older bulls with an antler spread less than 50 inches were classified as medium bulls. Bulls with an antler spread of 50 inches or larger were classified as large.

In fall 1995 a population estimation survey (census) was flown in southern Unit 20D to estimate population size and sex and age composition. The census was based on techniques described by Gasaway et al. (1986). Southern Unit 20D, consisting of that portion of the unit south of the Tanana River between the Robertson and Delta rivers, was subdivided into SUs. The SUs were stratified into a low-density and a high-density stratum. Stratification was based on preexisting information about the area, rather than a precensus reconnaissance flight. We surveyed sample units with Piper PA-18 or a Robinson R-22 aircraft, using survey techniques described in Gasaway et al. (1986). Intensive searches were flown in most low- and high-strata SUs, and we monitored and adjusted optimum allocation of effort, using the Moosepop software program (Moose Population Estimation Survey Software, Ver. 2.0, RA DeLong and DJ Reed, ADF&G, Fairbanks, Alaska).

We monitored moose harvest by requiring hunters to acquire moose harvest tickets and report hunting activities. Information collected from harvest ticket returns included hunt location, length of hunt, hunter success, time and location of kill, weapon type, transportation mode, and the antler spread and number of brow tines on killed moose.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Results of the 1995 population estimation survey are preliminary at this time. High winds and loss of snow cover prevented our searching 5 of the randomly selected SUs between the Robertson and Johnson rivers. However, other SUs in this area were surveyed earlier in the census. The 1995 population estimation survey in southern Unit 20D resulted in a mean population estimate of 2522 moose ± 22.0% at the 90% confidence interval (CI) (Table 1). Because this was the first population estimate ever completed in Unit 20D, accurate population trends are not known.

Southern Unit 20D

The management objective to obtain a population of 4000 moose for southern Unit 20D (2500 moose in southwestern Unit 20D and 1500 moose in southeastern Unit 20D) was not met during this reporting period. At the 90% CI, the southern Unit 20D census resulted in a population estimate of 1967–3076 moose ($\bar{x}$ = 2522).

The number of moose observed during 1994 in the Donnelly TCA within southwestern Unit 20D declined slightly from 1993. However, number of moose observed in both 1993 and 1994 were higher than the mean of 335 moose observed/year for the previous 5 years of complete data (excluding incomplete data in 1990) (Table 2). This increase may be due to an increasing number of moose in the nearby 27,000 acre Granite Creek burn, which burned during 1987. Because the number of moose in the burn is increasing, some of this increase is probably being detected in the Donnelly TCA.

The Robertson River composition survey in southeastern Unit 20D was not completed in 1994. Data from the incomplete survey are presented in Table 3.

Northern Unit 20D

The moose population in northern Unit 20D is estimated to be below 3000 moose, and it is assumed no progress was made toward the management objective to increase the moose population to 3000 in northern Unit 20D.

Moose density and trend data were collected in the Central Creek TCA in 1994. Moose density increased from 3.1 moose/mi^2 in 1993 to 3.3 moose/mi^2 in 1994 (Table 4). Even though the density of moose in the Central Creek TCA has increased, based on composition data discussed below, the number of moose in this area is probably decreasing.

Population Composition

Southern Unit 20D. Data collected during the 1995 census resulted in mean calf survival of 33.9 calves:100 cows (range = 28.8–39.1 at 90% CI (Table 5). Mean calf survival met the management objective, although the lower CI of 28.8 calves:100 cows was slightly below the objective. Moose survival to 18 months of age resulted in a mean of 9.1 yearling bulls:100 cows (range = 6.3–11.9 at 90% CI (Table 5).

The bull:cow ratio was below the management objective. The mean bull:cow ratio was 21.1 bulls:100 cows (range = 16.8–25.5 at 90% CI (Table 5). Based on the mean population estimate of 343 bulls in southern Unit 20D, yearling bulls composed 43% of the bull segment of the population, medium bulls composed 46%, and large bulls 12%.

Northern Unit 20D. The Central Creek TCA in northern Unit 20D was surveyed in 1994 only. No surveys were conducted in 1995 because all moose survey effort was put into the southern Unit 20D census.

Calf survival observed in 1994 in the Central Creek TCA continued to be poor and below the management objective with only 16 calves:100 cows (Table 4). Percent calves in the herd was low with only 12% calves. Survival of moose to 18 months of age was also poor with 0 yearling bulls:100 cows in 1994 (Table 4).

Bull:cow ratios have steadily decreased since 1990 but still met the management objective with 35 bulls:100 cows (Table 4). In Central Creek TCA data, the bull segment of the population comprised 0% small bulls, 59% medium bulls, and 41% large bulls.

Distribution and Movements

No data were collected on moose distribution or movements during this reporting period.

MORTALITY

Harvest

Season and Bag Limit. Table 6 lists moose hunting seasons in Unit 20D during the 1994-1995 and 1995-1996 regulatory years.

Board of Game Actions and Emergency Orders. During this reporting period, the Alaska Board of Game (BOG) adopted intensive management of predators and prey in Unit 20D in accordance with SB77. The Board also adopted a moose population goal of 8000–10,000 moose with a harvest goal of 240–500 moose for Unit 20D.

Hunter Harvest. Hunting effort increased in most of Unit 20D during 1993. During the 1993 general hunting season, successful hunters hunted a mean of 5.7 days compared with a mean of 6.5 days for all unsuccessful hunters (Table 10). During the 1994 general hunting season, successful hunters hunted a mean of 5.4 days and unsuccessful hunters hunted a mean of 6.1 days (Table 10).

Estimated moose mortality from human causes in Unit 20D during 1993–1994 totaled 225 moose (Table 7). This total includes 154 moose reported killed by hunters during the general hunting season, an estimate of 27 unreported hunter kills, illegal harvest of 14 moose, and 30 road kills. Most illegal kills and road kills occurred in southwestern Unit 20D. This is the highest kill since at least 1986–1987, higher than the mean of 183 mortalities/year for the previous 5 years (1988–1989 to 1992–1993), and exceeds the range of 154–205 moose mortalities/year during the previous 5 years.

Unit 20D estimated moose mortality from human causes during 1994–1995 totaled 190 moose. This total includes 128 moose reported killed by hunters during the general hunting season, 1 moose killed during the southeastern Unit 20D Tier II hunt, an estimated unreported harvest of 23 moose, 7 moose killed illegally, and 31 road kills (Table 7). Most illegal kills and road kills occurred in southwestern Unit 20D. The 1994–1995 mortality rate is equal to the mean of 190 mortalities/year for the previous 5 years (1989–1990 to 1993–1994), and is within the range of 154–225 mortalities/year during the previous 5 years.

Southwestern Unit 20D. Reported harvest totaled 74 moose during the 1993 general hunting season despite more restrictive antler restrictions (Table 8). Beginning in the 1993 hunting season, hunters were required to shoot only a bull with a spike or forked antler on at least 1 side, or a bull with antler spread of 50 inches or greater, or with at least 4 brow tines on 1 antler. Reported harvest during the 1994 general hunting season declined to 61 bulls (Table 8).

Southeastern Unit 20D. Both the harvest of moose and the number of hunters have remained low in southeastern Unit 20D. Thirty-three hunters killed 9 moose during the 1993 general hunting season and 42 hunters killed 7 moose in the 1994 general season (Table 8). Low numbers of hunters and harvest are partly caused by access restrictions in the Macomb Plateau Controlled Use Area (MPCUA). Access restrictions make moose hunting difficult south of the Alaska Highway; however, access is good along the Tanana and Robertson rivers. A regulation proposal has been submitted to the Alaska Board of Game for the March 1996 meeting to reduce the size of the MPCUA, allowing greater opportunity to hunt moose in this area.

Northwestern Unit 20D. Two hundred fifty-seven hunters killed 58 moose during the 1993 general season, and 267 hunters killed 49 moose during the 1994 general season (Table 8). The number of hunters has continued to increase since 1989.

Northeastern Unit 20D. Number of hunters and harvest remained low in this area with 29 hunters harvesting 11 moose in the 1993 general season. During the 1994 season, 33 hunters harvested 9 moose (Table 8).

This area is difficult to access during the hunting season except along the Tanana River, a few small creeks flowing into the Tanana River, and a few ridgetop airstrips. Poor access and low moose numbers reduce hunter effort and harvest.

Permit Hunts. Tier II permit hunt number 787 was conducted during the 1993–1994 hunting season from 1 January to 15 February 1994. Fifteen permits were issued with a harvest quota of 5 bulls. Eight hunters reported hunting but no moose were killed (Table 11).

Tier II permit hunt number 787 was conducted during the 1994–1995 hunting season from 1 January to 15 February 1995. Fifteen permits were issued with a harvest quota of 5 bulls. Eleven hunters reported hunting and 1 moose was killed (Table 11).

Hunter Residency and Success. As in the past most moose hunters in Unit 20D are local residents of the subunit. During the 1993 general hunting season, 82% of successful hunters and 84% of the unsuccessful hunters were residents of the subunit (Table 9). During the 1994 general season, 81% of successful hunters and 87% of unsuccessful hunters were residents of the subunit (Table 9).

In the southwestern portion of the unit, the number of hunters has remained fairly constant and since 1991 has ranged from 323 in 1993 to 339 in 1994 (Table 8). A 23% hunter success rate met the management objective (at least 20%) during 1993. However, in 1994 hunter success (18%) did not meet our objective. Hunters in the southeastern area had a 27% success rate in 1993 and a 17% success rate during 1994. In the northwestern section hunters met the management objective with a 23% success rate in 1993 and failed to meet the objective in 1994 with an 18% success rate. In the northeastern portion of the unit, hunters met the management objective both years with a 38% success rate in 1993 and a 27% success rate in 1994.

Harvest Chronology. During the 1993 general hunting season, 42% of reported harvest occurred during the first 5 days of the season from 1–5 September. Harvest during the next two 5-day periods was 26% and 28%, respectively (Table 12). Harvest patterns were similar in 1994, with 45% of moose harvested 1–5 September, 25% harvested 6–10 September, and 22% harvested from 11-15 September (Table 12).

Transport Methods. Highway vehicles, 3- or 4-wheelers, and boats are still the most common modes of transportation used by successful hunters in Unit 20D. Highway vehicles, 3- or 4-wheelers, and boats were used by 84% of successful hunters during the 1993 general season and 80% of successful hunters during the 1994 general season (Table 13).

Other Mortality

Road kills averaged 31 for this reporting period. No estimates of natural mortality were calculated during this reporting period. However, predation by wolves, grizzly bears, and black bears is believed significant in Unit 20D. Predation is thought to be limiting moose population growth in the northern half of Unit 20D and accounting for reduced calf survival in portions of southern Unit 20D.

HABITAT

Assessment

We did no habitat assessment during this reporting period.

Enhancement

No habitat enhancement was performed during this reporting period. However, in June and July 1994, the Hajdukovich Creek wildfire burned 22,400 acres in southwestern Unit 20D between the Gerstle River and Sawmill Creek.

CONCLUSIONS AND RECOMMENDATIONS

We did not increase the number of moose to meet population objectives in Unit 20D. The Board revised moose population goals and in 1995 we completed the first moose population estimation survey ever conducted in southern Unit 20D. These data will allow more accurate assessment of population trends in the future.

Based on data from the southern Unit 20D census, the bull:cow ratio is below the objective. With fairly stable harvest in southern Unit 20D, part of this decline may be due to an increasing number of cows in the population. The bull:cow ratio should be monitored closely in southern Unit 20D. If numbers decline to a ratio lower than 20 bulls:100 cows, it may be necessary to implement more restrictive hunting regulations if no other management options are available.

The bull:cow ratio was met in the Central Creek TCA in northern Unit 20D; however, the number of bulls continues to decline. The age structure of the bulls in the Central Creek TCA is skewed toward older bulls, and with poor recruitment in this area, the number of bulls may decline rapidly in the future as these older bulls die. Therefore, the bull:cow ratio should be monitored closely in this area. More restrictive hunting seasons may be necessary unless recruitment increases in the near future under intensive management.

According to the 1995 census, the calf:cow ratio was met in southern Unit 20D; however, it was not met in the Central Creek TCA in northern Unit 20D. Intensive management actions are needed especially in northern Unit 20D to improve recruitment to the moose population.

Hunter success rates were met in Unit 20D during 1993, and were slightly below the management objective during 1994 in most areas. No management actions are recommended to alter hunter success rates.

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Table 1 Preliminary results of a moose population estimation survey from southern Unit 20D, November 1995

Statistic	Strata Low	Strata High	All strata combined
Sample units (N)	73	45	118
No. surveyed (n)	10	19	29
Total area (mi^2)	839.0	521.9	1360.9
Stratum as % of total	61.7	38.3	100.0
Area surveyed (mi^2)	110.1	232.4	342.5
% of stratum surveyed	13.1	44.5	25.2
No. moose seen	60	772	832
Observed density ($moose/mi^2$)	0.5	3.3	1.9
Uncorrected[a] estimate (T_o)	457	1733.7	
Variance $V(T_o)$	9	18	
Degree of freedom $df(T_o)$			
Observed sightability correction factor (SCF_o)	1.07	1.17	
Variance $V(SCF_o)$	0.00313	0.00725	
Degrees of freedom $df(SCF_o)$	7	15	
Corrected estimate (T_e)			2522
Variance $V(T_e)$			104,381.2
Degrees of freedom[b] $df(T_e)$			22
90% CI around T_e			22.0%

[a] Not corrected for sightability.

Table 2 Unit 20D, Donnelly Trend Count Area fall aerial moose composition counts, 1986–1987 through 1994–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
1986-1987	30	12	40	83	24	270	353	3.4
1987-1988	31	15	44	81	25	242	323	--
1988-1989	29	12	47	92	27	251	343	3.2
1989-1990	27	12	27	62	18	290	352	3.4
1990-1991[a]	18	6	31	64	21	240	311	--
1991-1992	16	4	32	73	22	260	333	3.1
1992-1993	27	10	44	83	26	239	322	3.0
1993-1994	26	11	24	75	16	389	464	4.4
1994-1995	25	3	37	97	23	327	414	3.9

[a] Incomplete survey.

Table 3 Robertson River fall aerial contour moose composition counts, 1986–1987 through 1994–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1986-1987	60	15	24	22	13	106	128	41
1987-1988[a]								
1988-1989	45	11	43	34	23	116	150	33
1989-1990	37	5	14	13	9	129	142	27
1990-1991	37	8	29	21	17	100	121	25
1991-1992	31	4	35	30	21	113	143	33
1992-1993	28	11	38	33	23	111	144	28
1993-1994	45	9	18	2	11	17	19	--
1994-1995	29	5	12	8	8	85	99	28

[a] No survey.

[b] Incomplete survey.

Table 4 Central Creek Trend Count Area fall aerial moose composition counts, 19861987 through 1994–1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/mi^2
1986-1987[a]								
1987-1988[a]								
1988-1989	44	6	13	12	8	138	150	2.5
1989-1990	36	4	20	18	13	121	139	2.3
1990-1991	63	4	10	9	6	145	154	2.6
1991-1992	69	6	15	9	8	105	114	1.9
1992-1993[b]	53	8	4	3	3	115	118	2.8
1993-1994	46	5	21	16	13	91	127	3.1
1994-1995	35	0	16	15	12	124	139	3.3

[a] No survey.

[b] TCA boundaries altered.

Table 5 Preliminary results of moose composition data collected during a population estimation survey in southern Unit 20D during fall 1995

Regulatory year	Mean bulls:100 cows (90% CI)	Mean yearling bulls:100 cows (90% CI)	Mean calves:100 cows (90% CI)	Mean Calves (90% CI)	Percent calves (90% CI)	Mean no. Adults (90% CI)	Moose observed	Mean moose/mi^2
1995-1996	21.1	9.1	33.9	552	21.9	1967	832	1.9
	(16.8-25.5)	(6.3-11.9)	(28.8-39.1)	(405-700)	(21.1-22.4)	(1510-2430)		(1.4-2.3)

Table 6 Moose hunting seasons and bag limits in Unit 20D during 1994–1995 and 1995–1996

Year	Area	Season		Bag limit
1994-1995 and 1995-1996	Southwestern	Subsistence/Resident:	1-15 Sep	1 bull with spike-fork or 50-inch antlers
		Nonresident:	5-15 Sep	1 bull with 50-inch antlers[a]
	Southeastern	Subsistence/Resident:	1-15 Sep	1 bull
			1 Jan-15 Feb	1 bull by Tier II permit
		Nonresident:	No season	
	Northern	Subsistence/Resident:	1-15 Sep	1 bull
		Nonresident:	1-15 Sep	1 bull

[a] 50-inch antlers defined as having a spread of at least 50 inches or at least 4 brow tines on 1 side.

Table 7 Unit 20D moose harvest[a] and accidental death, 1986–1987 through 1994–1995

Regulatory year	Harvest by hunters							Accidental death			
	Reported[a]				Estimated						
	M	F	Unk	Total	Unreported[b]	Illegal	Total	Road	Train[c]	Total	Total
1986-1987	130	0	0	130	23	4	27	15	0	15	172
1987-1988	126	0	0	126	22	10	32	26	0	26	184
1988-1989	126	0	0	126	22	13	35	27	0	27	188
1989-1990	127	0	0	127	22	9	31	16	0	16	174
1990-1991	117	1	0	118	21	4	25	11	0	11	154
1991-1992	143	1	0	144	25	11	36	13	0	13	193
1992-1993	142	0	1	143	25	5	30	32	0	32	205
1993-1994	153	0	1	154	27	14	41	30	0	30	225
1994-1995	128	0	0	128	23	7	30	31	0	31	189

[a] Excludes permit hunt harvest.
[b] Based on 17.7% unreported harvest estimated by Gasaway et al. (1992).
[c] Not applicable in Unit 20D.

Table 8 Annual reported harvest of moose and number of hunters during the general open season in southwestern, southeastern, northwestern, and northeastern Unit 20D from 1984 to 1994

Year	Moose harvest						Number of hunters					
	SW	SE	NW	NE	Unk	Total	SW	SE	NW	NE	Unk	Total
1984	39[a]	9[b]	40[c]	14[c]	0	102	236[a]	47[b]	294[c]	48[c]	10	635
1985	48[d]	8[b]	60[d]	14[d]	0	130	236[d]	37[b]	272[d]	50[d]	9	604
1986	76[d]	10[b]	40[d]	10[d]	1	137	250[d]	45[b]	232[d]	57[d]	12	596
1987	66[d]	8[b]	43[d]	9[d]	0	126	296[d]	35[b]	208[d]	35[d]	17	591
1988	60[e]	12[b]	39[d]	12[d]	3	126	244[e]	45[b]	201[d]	37[d]	28	555
1989	60[e]	11[b]	41[d]	10[d]	5	127	303[e]	47[b]	191[d]	39[d]	40	620
1990	58[f]	9[c]	40[g]	7[d]	4	118	270[f]	29[c]	195[g]	26[d]	28	548
1991	54[f]	12[c]	66[g]	9[d]	3	144	331[f]	51[c]	231[g]	26[d]	19	658
1992	59[f]	12[c]	58[g]	5[d]	9	143	329[f]	49[c]	257[g]	34[d]	48	717
1993	74[h]	9	58	11	2	154	323	33	257	29	16	690
1994	61[h]	7	49	9	2	128	339	42	267	33	28	709

[a] Season 1-6 Sep; 1 bull.
[b] Season 1-20 Sep; 1 bull.
[c] Season 1-15 Sep; 1 bull.
[d] Season 1-10 Sep; 1 bull.
[e] Season 1-15 Sep; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on 1 antler.
[f] Subsistence/resident season 1-15 Sep; 1 bull with spike-fork or 50-inch antlers or 3 brow tines on 1 antler. Nonresident season 5-15 Sep; 1 bull with 50-inch antlers or 3 brow tines on 1 antler.
[g] West of pipeline season 1-15 Sep; 1 bull. Nonresident season 5-15 Sep; 1 bull with 50-inch antlers or 3 brow tines on 1 side. Remainder area 1-10 Sep; 1 bull.
[h] Resident season 1-15 Sep; 1 bull with spike-fork or 50-inch antlers or 4 brow tines on 1 antler. Nonresident season 5-15 Sep; 1 bull with 50-inch antlers or 4 brow tines on 1 antler.

Table 9 Unit 20D moose hunter[a] residency and success, 1986–1987 through 1994–1995

Regulatory year	Successful: Local[b] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Unk	Successful: Total	(%)	Unsuccessful: Local[b] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Unk	Unsuccessful: Total	(%)	Total hunters
1986-1987	121	15	1	1	138	(23)	409	45	12	0	466	(77)	604
1987-1988	96	13	7	10	126	(21)	375	24	17	31	447	(79)	591
1988-1989	93	13	9	11	126	(23)	333	36	31	29	429	(77)	555
1989-1990	96	18	8	5	127	(20)	404	57	23	9	493	(80)	620
1990-1991	98	10	4	6	118	(22)	351	51	24	4	430	(78)	548
1991-1992	118	21	4	1	144	(22)	443	51	13	7	514	(78)	658
1992-1993	107	25	8	3	143	(20)	462	61	37	14	574	(80)	717
1993-1994	126	24	2	2	154	(22)	452	63	17	4	536	(78)	690
1994-1995	104	20	2	2	128	(18)	503	62	11	5	581	(82)	709

[a] Excludes hunters in permit hunts.
[b] Local means reside in Unit 20D.

Table 10 Mean days hunted for successful and unsuccessful hunters in southwestern, southeastern, northwestern, and northeastern Unit 20D, 1986–1987 through 1994–1995

Regulatory	Successful hunters					Unsuccessful hunters				
year	SW	SE	NW	NE	Total	SW	SE	NW	NE	Total
1986-1987	3.8	3.0	5.3	4.1	3.9	5.5	10.5	6.1	7.0	6.0
1987-1988	4.4	7.3	4.8	3.9	4.7	5.3	7.5	6.7	6.5	6.1
1988-1989	4.6	6.2	5.3	4.5	5.0	5.9	6.3	5.8	6.5	6.0
1989-1990	4.7	4.5	4.1	5.1	4.6	9.7	5.7	5.9	5.3	5.9
1990-1991	4.9	6.6	3.9	6.5	4.7	3.5	5.6	5.8	6.3	5.9
1991-1992	6.0	4.9	5.5	4.2	5.6	5.9	7.0	6.8	5.6	6.3
1992-1993	4.7	5.7	5.4	4.9	5.0	5.9	5.1	6.8	5.2	6.2
1993-1994	5.4	4.4	6.2	7.5	5.7	6.2	7.5	6.6	9.4	6.5
1994-1995	5.1	6.3	5.9	4.2	5.4	5.9	4.9	6.2	7.2	6.1

Table 11 Unit 20D moose harvest data by permit hunt, 1989–1990 through 1994–1995

Hunt No./Area	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Percent bulls	Percent cows	Unk	Total harvest
988	1989-1990	15	27	91	9	100	0	0	1
987T	1990-1991	15	20	86	14	100	0	0	1
987T	1991-1992	15	67	100	0	0	0	0	0
987T	1992-1993	15	20	91	9	100	0	0	1
787	1993-1994	15	47	100	0	0	0	0	0
787	1994-1995	15	27	91	9	100	0	0	1

Table 12 Unit 20D moose harvest[a] chronology percent by time period, 1990–1991 through 1994–1995

Regulatory Year	Harvest periods				
	9/1-9/5	9/6-9/10	9/11-9/15	Unk	*n*
1990-1991	57	20	23	0	109
1991-1992	60	23	16	10	144
1992-1993	52	31	18	8	143
1993-1994	42	26	28	4	154
1994-1995	45	25	22	8	128

[a] Excludes permit hunt harvest.

Table 13 Unit 20D moose harvest[a] percent by transport method, 1987–1988 through 1994–1995

Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1987-1988	8	2	27	20	0	8	29	6	126
1988-1989	10	2	24	18	0	9	29	9	126
1989-1990	10	3	29	13	0	12	29	3	127
1990-1991	7	0	25	20	0	12	33	3	118
1991-1992	13	3	23	25	0	8	24	3	144
1992-1993	8	1	26	18	0.1	8	36	1	143
1993-1994	6	1	30	25	1	7	29	2	154
1994-1995	4	2	29	28	0	11	23	3	128

[a] Excludes permit hunt harvest.

LOCATION

GAME MANAGEMENT UNIT: 20E (11,000 mi^2)

GEOGRAPHIC DESCRIPTION: Charley, Fortymile, and Ladue River drainages

BACKGROUND

During the 1950s to the early 1960s, synchronous to the federal predator control program, the moose population in Unit 20E increased to a minimum of 12,000 moose. The population declined rapidly between 1965 and 1976, reaching a low of 2200 moose. Since 1976 the moose population in Unit 20E has remained at low densities (0.2–0.5 moose/mi^2). Gasaway et al. (1992) evaluated the roles that predation, nutrition, snow, harvest, and disease played in the decline and in limiting the moose population at low densities. They determined predation was the primary factor and other variables had little to no impact.

In response to declining moose and caribou populations, the Alaska Department of Fish and Game initiated more intensive predator management. Between 1981 and 1983, the wolf population was reduced by 54% in a 3800-mi^2 area of Unit 20E. In 1981 grizzly bear hunting regulations were liberalized, causing area-specific declines and moderate harvest increases in portions of the subunit.

Between 1981 and 1990, the moose population increased by 4–5% per year. The increase was probably due to combined effects of favorable climatic conditions, the wolf reduction program, elevated public harvest of grizzly bears and wolves, and an increase in the area's caribou population which served as alternate prey for predators and hunters.

Unit 20E has been popular among local hunters and hunters from Fairbanks and Southeast Alaska. Historically, harvest was low in relation to the moose population and largely restricted to the Taylor Highway corridor and the Mosquito Fork drainage. During the last population peak, the hunting season was long and the bag limit was 1 moose. As moose numbers began to decline, harvests were reduced by shortening season length in 1973 and by eliminating cow seasons in 1974. However, the population continued to decline unitwide, and in 1977 moose hunting in Unit 20E (then a portion of Unit 20C) was terminated. A 10-day bulls-only season was opened in 1982 and continued until 1991. Despite the increase in hunting opportunity, hunter success was approximately one-half of that reported in 1970.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population in concert with other components of the ecosystem.
- Continued sustained opportunities for subsistence use of moose.
- Maximum sustained opportunities to participate in hunting moose.

- Maximum opportunities for the nonconsumptive use of moose.

Management Objectives

- Maintain a posthunting ratio of at least 40 bulls:100 cows in all areas.

METHODS

Population Census

We conducted moose population estimation surveys (Gasaway et al. 1986; Mark McNay, pers commun; Jay Ver Hoef, pers commun) in southwestern Unit 20E (Mosquito Flats) in 1981, 1988, 1992, and 1995 and in southeastern Unit 20E (Ladue River) in 1992. I calculated population growth rates by comparing the 1992 and 1995 Mosquito Flats superstratification and minicensus results with identical portions of the 1981 and 1988 census areas. I also compared population density and trend between the 1995 Mosquito Flats and Ladue River study areas. The 2 study areas differ in habitat quality, grizzly bear densities, human use, and management directions.

Composition Surveys

Sex and age composition were estimated in October and November 1993, 1994, and in 1 count area in 1995, using aerial contour and transect surveys, and in 1995 while conducting a census in the Mosquito Flats Study Area. All moose observed were classified as large bulls (antlers >50 inches), medium bulls (antlers larger than yearlings but <50 inches), yearling bulls (spike, cerviform, or small palmate-antlered), cows without calves, cows with 1 calf, cows with 2 calves, lone calves, or unidentified moose.

Harvest

Harvest was estimated using harvest report cards. We used information from the reports to determine harvest, hunter residency and success, harvest chronology, and transportation modes.

RESULTS AND DISCUSSION

Population Status and Trend

Population Size

During fall 1981 and 1988, censuses were conducted in a 2978-mi^2 (7700 km^2) area in southwestern Unit 20E. We estimated population sizes of 601 ± 17.1% (90% CI) in 1981 and 1149 ± 13.2% (90% CI) in 1988. Mean densities were 0.23 and 0.39 moose/mi^2 during 1981 and 1988, respectively. Based on census results, the estimated annual finite rate of growth between 1981 and 1988 was 1.09.

In 1992 and 1995, we censused a 964-mi^2 portion of the 1981 and 1988 study area. In this area (Mosquito Flats Study Area [MFSA]), we estimated a population size of 406 ± 24% (90% CI) moose and a density of 0.44 moose/mi^2 in 1992 and 666 ± 38% (90% CI) moose and a density of 0.69 moose/mi^2 in 1995. Using the boundaries of the MFSA, the estimated population size and density for 1981 was 355 and 0.39 moose/mi^2 and 601 and 0.66 moose/mi^2 for 1988. The annual rate of increase between 1981 and 1988 was 1.08, and between 1988 and 1995 it was 1.01. Based on census data, the moose population in Unit 20E increased through the 1980s until 1988. Between 1988 and 1995, the population has remained stable at least in the southwestern portion of the subunit.

In the Ladue River Study Area (LRSA), the 1992 estimated moose population was 652 ± 21% (90% CI). Mean density was 0.89 moose/mi^2, 29% greater than the density found in the adjacent MFSA. The LRSA was not censused during 1981 or 1988 and, consequently, the area's population size and trend prior to 1992 is not known.

Little information is available concerning moose density and trend in northern Unit 20E. The National Park Service conducted a survey in 1994 and found 0.31 moose/mi^2 within the Yukon-Charley Rivers National Preserve west of Washington Creek and south of the Yukon River. Periodic surveys indicate moose densities are lower east of Washington Creek. Incorporating census and trend count data, the total 1995 population estimate for Unit 20E was 5400 moose (0.54 moose/mi^2 within suitable moose habitat).

Whether predator management is biologically justifiable to obtain an elevated moose population in the Upper Tanana/Fortymile River Valleys has been the subject of widespread public and scientific debate. Gasaway et al. (1992) reported the Unit 20E moose population was maintained at a low-density dynamic equilibrium by wolf and grizzly bear predation. Gasaway determined predator management was necessary to increase the moose population and maintain it at higher abundance. In response, opponents of wolf control have argued a wolf control program in Unit 20E would not work because grizzly bear predation is the primary limiting factor on the moose population. They based their conclusions on results of the wolf control program conducted in Unit 20E between 1981 and 1983. Unfortunately, this program was terminated prematurely due to political decisions and, therefore, results are nebulous and difficult to interpret. In an attempt to better predict the outcome of a wolf control program on the subunit's moose population, I entered the current population status and trend data for moose and their predators into a predator–prey model (McNay 1993).

According to the model, under the current management program, the moose population in Unit 20E will remain stable. If a 5-year wolf control program were conducted, a minimum removal of 50% of the wolf population would be necessary to cause a noticeable increase in moose, assuming there were no changes in wolf behavior and kill rates at reduced densities. If 80% of the wolves were removed, the model predicted the moose population would increase 12% annually. This removal rate has been shown to be effective in the Finlayson Study Area in the Yukon (Robert Hayes, pers commun). Currently, there is a proposal to conduct nonlethal wolf fertility control in western Unit 20E. If initiated, the program will cause a 60% reduction in the wolf population using fertility control and translocation. The program area currently supports very low moose densities and natural grizzly and black bear densities. Significant increases in the moose population due to wolf fertility control are not expected. Fertility control will reduce the number of wolves but not the number of packs, and the regulatory effects of wolf predation are not expected to decrease to a level that allows moose numbers to increase.

Population Composition

During 1995 standard contour surveys were not completed; however, composition ratios were estimated from the MFSA census data (Table 1). The 5-year averages for bulls, yearling bulls, and calves:100 cows within the MFSA were 73, 14, and 22:100, respectively. The greatest variance has been in calf survival, ranging from 15:100 to 35:100. The number of yearling recruits between 1988 and 1995 indicates the population was stable to slightly increasing.

Based on census results throughout the unit and on traditional fall moose composition surveys, the bull:cow ratio is well above the management objective and reflects a lightly harvested population. Access into Unit 20E is limited and harvest is generally concentrated along the few access routes. In more popular hunting areas (Nine Mile Trail, Mitchell's Ranch, and along the Taylor Highway), bull populations have declined but still meet or exceed the management objective of 40:100 in all but the Nine Mile Trail area. In response, the Board of Game created a controlled use area designed to give greater protection to bulls in the most heavily hunted areas along the trail in fall. This area also offers excellent moose hunting off the trail with difficult access in fall. The bull:cow ratio in this area is near 80:100. To allow greater hunting opportunity, the board created a winter permit hunt for Alaskan residents without transportation restrictions into this area.

In Unit 20E the average calf:cow ratios increased from 13:100 between 1973 and 1982 to 19:100 between 1982 and 1988, and then to 29 between 1989 and 1993. Between 1982 and 1989, grizzly bear harvests were high and caused an estimated 30% reduction in the bear population in the central portion of Unit 20E (Gardner, in press). Since grizzly bears are the predominant predator on moose calves in this subunit (Gasaway et al. 1992), the increase in calf survival was attributed to a decline in the subunit's grizzly bear population (Boertje et al. 1995). In contrast, the grizzly bear population throughout the remainder of the subunit was lightly harvested and probably remained stable. If grizzly bears were the primary factor in limiting moose calf survival, there should be a difference in calf recruitment between the area which received high bear harvest and an area that received little bear harvest and, presumably, still supported a more natural density of bears. I presented this analysis in Gardner (in press) and the result was no significant difference between the 2 areas.

I do not have any alternate hypotheses for why moose calf survival in the low bear harvest area was comparable with the high harvest area. Five possibilities are: 1) the treatment effect was not adequate to cause an increase in calf survival; 2) effects of the bear harvest extend further than I estimated; 3) bears more vulnerable to harvest were younger and not as efficient predators as the remaining older bears; 4) the burn in a portion of the control area was large enough to cause a decrease in the hunting efficiency of predators; and 5) compensatory wolf predation negated the effects of reduced bear predation.

Distribution and Movements

Moose were well distributed throughout Unit 20E below elevations of 4500 feet. While resident moose remained in the Mosquito Flats area, most others moved seasonally from lowland summer habitat to upland rutting areas, where they remained until winter conditions caused them to move back to lower elevations. In fall 1988 and 1992, early deep snowfall (>22 inches) caused moose to move to lower elevations earlier than in previous years. During 1995 low snowfall allowed moose to remain at higher elevations until at least January 1996.

MORTALITY

Harvest

<u>Season and Bag Limit</u>

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 20E, in the Ladue River Controlled Use Area.		
Resident Hunters: 1 bull with spike-fork antlers or 1 bull by permit.	20-28 Aug 1-15 Sep 1-30 Nov	
Nonresident Hunters: 1 bull with 50" antlers or with 4 or more brow tines on at least 1 side.		5-15 Sep
Unit 20E, that portion draining into the Yukon River upstream from and including the Charley River drainages to and including the Boundary Creek drainages and the Taylor Highway from mile 145 to Eagle.		
Resident Hunters: 1 bull with spike-fork antlers.	20-28 Aug 5-25 Sep	
Nonresident Hunters: 1 bull with 50" antlers or with 4 or more brow tines on at least 1 side.		5-25 Sep

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Remainder of Unit 20E, that portion drained by the Ladue, Sixtymile, and Fortymile rivers (all forks) from 9 1/2 to 145 mile Taylor Highway, including the Boundary Cutoff Road.		
Resident Hunters: 1 bull with spike-fork antlers.	20-28 Aug 1-15 Sep	
Nonresident Hunters: 1 bull with 50" antlers or with 4 or more brow tines on at least 1 side.		5-15 Sep

Board of Game Actions and Emergency Orders. During the spring 1993 meeting, the Board of Game (BOG) created the Ladue River Controlled Use Area which limited use of motorized vehicles to designated trails or strips during September. In spring 1994 the BOG adopted a November drawing permit hunt for Alaskan residents in the Ladue River Controlled Use Area and created an August hunt for spike-fork bulls for residents in Unit 20E.

Hunter Harvest. During 1994 the total reported harvest in Unit 20E was 94 bulls (Table 2) or about 1.8% of the estimated population. The average reported harvest for the last 5 years was 86 (range 46–129), a 79% increase from the previous 5 years. Probable causes for the higher harvest are: 1) hunters displaced by stricter regulations throughout Southcentral Alaska, especially in nearby Unit 13; 2) the Fortymile caribou season was open concurrently with the moose season, attracting hunters interested in hunting both species; 3) maintaining a 1 bull bag limit with relatively liberal season dates gives hunters a false impression on the number of moose in the area; and 4) more hunters are coming to the area looking for a large antlered bull. The preliminary reported harvest during 1995 was 128 bulls. A number of people hunted during the early spike-fork bull season but none was successful.

Of the 94 moose harvested in 1994, 23 (25%) were taken in the Mosquito Fork and 18 (19%) were taken in the Dennison Fork drainages. In northern Unit 20E, 22 (24%) were taken along the Yukon, Charley, and Seventymile rivers (14, 6, and 2 moose, respectively). Traditionally, 61% of the annual harvest comes from these drainages. The harvest of the remaining 31 moose in 1994 was distributed fairly evenly across the subunit. If greater restrictions become necessary to protect the bull population in Unit 20E, they will probably occur in the Mosquito, Dennison/West Fork or Yukon drainages. I recommend access restrictions instead of antler or season length restrictions.

During 1994 the mean antler spread of bulls taken in Unit 20E was 48.25 inches, exceeding the 5-year mean of 46.7 inches. The 1994 average antler spread was the highest recorded since 1987. Seven bulls (7.5%) were yearlings (antlers < 30 inches), 32 (34.0%) were 2 to 4 years old (antler spread 30.0–49.9 inches), and 51 (54.3%) were mature bulls (antler spread >50 inches). Of the mature bulls, 18 (35.3%) had antler spreads >60 inches. Antler spreads were estimated for 214 and 136 bulls observed during posthunting aerial surveys in 1994 and 1995, respectively. Age composition was 21–22% yearlings, 45–50% 2- to 4-year-olds, and 29–33% mature bulls. Because moose density is low in Unit 20E and most hunters are primarily hunting for meat, I doubt many hunters were selective.

Hunter Residency and Success. Of the 94 bulls harvested in 1994, 27 (28.7%) were taken by residents of Units 12 and 20E (Table 3), including 6 taken by residents of Chicken and Eagle. Nonlocal residents reported taking 58 moose in Unit 20E. Twenty-eight of the successful nonlocal hunters were from Southcentral Alaska, 10 from Southeast Alaska, and 20 from Interior Alaska. Nonresident hunters were prohibited from hunting moose in Unit 20E between 1984 and 1991. Since 1991 nonresidents have accounted for an average of 7.4% of the harvest.

During 1994, 487 hunters reported hunting moose in Unit 20E, exceeding the 5-year average of 387. Hunter success was 19%, slightly below the 5-year average of 22%. Success rate of local residents was 22%, compared to an 18% success rate for nonlocals. Local and nonlocal resident success rates have averaged 25% and 21%, respectively, the past 5 years.

Harvest Chronology. Most hunting pressure and most of the harvest has occurred during the first week of the season the past 5 years (Table 4). However, since 1991 more hunters have been taking advantage of the longer season offered in the northern portion of the subunit.

Transport Methods. During the past 5 years, moose hunters used highway vehicles (34%), 4-wheelers (21%), boats (15%), aircraft (12%), and other ORVs (8%). Hunters using highway vehicles had the lowest success rate (13%), while hunters using airplanes and ORVs both had success rates of 37%. Hunters using 4-wheelers had a success rate of 23%, a substantial increase from 14% over 5 years, and the greatest harvest for 1994 (Table 5). Increased success by this group of hunters is due to increasing use of little known trails into moose concentration areas.

The increasing number of hunters who use 3- or 4-wheelers has become a concern in certain areas of Unit 20E. Because hunters using 4-wheelers concentrate in hunt areas, this group of hunters has a greater effect on moose populations, compared to those using other modes of transportation.

Other Mortality

Predation by wolves and grizzly bears is the greatest source of mortality for moose in Unit 20E and is maintaining the population at low density (0.52 moose/mi^2). Using the model presented by McNay (1993), I estimated wolves and grizzly bears are killing 28% of the postcalving moose population; humans are harvestiing 1%.

HABITAT

Assessment

In Unit 20E availability of browse is not limiting moose population growth. Recent browse studies reveal most preferred browse plants are not being utilized and current year's growth use has been less than 5% (Boertje et al. 1985). Over 10% of the subunit, primarily the southeast portion, has burned within the last 25 years, offering excellent browse. However, much of western Unit 20E supports climax forest and does not offer substantial amounts of moose browse.

Enhancement

Implementation of the Alaska Interagency Fire Management Plan is expected to restore a near-natural wildfire regime to over 60% of Unit 20E. Under the plan, much state and federal land was accorded limited fire protection. Unfortunately, nearly all land selected by Native corporations was accorded modified or full-suppression status. Vegetation communities in these areas will continue to degrade to the detriment of moose and other wildlife species that fare best in a fire-shaped environment.

CONCLUSIONS AND RECOMMENDATIONS

Between 1981 and 1988 the moose population in Unit 20E increased from 5% to 9% annually, reaching a density of 0.33 to 0.49 moose/mi^2. Between 1988 and 1995 the population stabilized and is estimated at 0.52 moose/mi^2. Recent research has shown predation by wolves and grizzly bears was the primary factor limiting the subunit's moose population. The combination of wolf and bear predation is taking about 28% of the postcalving moose population annually.

In an attempt to reduce effects of predation on the area's moose population, grizzly bear hunting regulations were liberalized in 1981. As a result, bear harvest increased and caused bear numbers to decline as much as 30% in parts of the subunit. Moose calf survival increased during this period. However, we do not know how much of the increase was due to grizzly bear population decline. I recommend retention of liberal bear regulations, but results of this management technique on moose population growth needs to be closely studied.

Human-induced mortality is having little effect on the subunit's moose population. Annual harvest rates have historically been less than 2% of the fall population estimate and for the past 5 years have been less than 2%. The bull:cow ratio has declined in portions of Unit 20E due to moderate harvest rates in more accessible areas, but the overall subunit bull:cow ratio indicates a lightly harvested population. If current harvest trends continue, stricter hunting restrictions may be necessary to protect the bull segment of the population in only the most accessible areas of the subunit.

In 1994 the Board authorized an early season spike-fork hunt which began in August 1995. The rationale for the hunt was that this class of bulls traditionally represents 11.3% of the bull population in Unit 20E but on average only contributes 1.5% of the harvest. Because of the timing and type of hunt, local residents will probably be the primary participants. Since locals take 30% of the annual harvest, increasing opportunity to harvest this bull class by locals may protect larger bulls during the later season when they are more vulnerable than younger bulls.

Federal, state, and Native land managers with responsibilities for managing wildlife habitat on their lands need to be persuaded to allow a natural fire regime. Degradation of habitat diversity and quality will continue as long as naturally ignited wildfires are suppressed. Allowing a more natural fire regime will benefit the subunit's moose population and eventually subsistence and nonconsumptive users.

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Table 1 Unit 20E aerial moose composition counts, 1988-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Calves	Percent calves	Adults	Moose observed	Moose/hr
1988-1989	78	13	22	117	11	931	1048[a]	30
1989-1990	56	11	43	43	21	158	201	22
1990-1991	64	9	30	105	16	566	671	30
1991-1992	65	14	28	120	14	714	834	42
1992-1993[a]	59	11	17	19	12	141	160	
1992-1993[b]	75	15	28	32	14	200	232	
1993-1994	63	10	28	126	15	727	854	40
1994-1995[c]	74	16	23	65	12	488	553	48
1995-1996[a]	70	16	15	29	8	329	358	

[a] Census results from the Mosquito Flats Study Area.

[b] Census results from the Ladue River Study Area.

[c] Partial survey only; sampled Nine Mile Trail, Prindle Volcano, Sixtymile Butte, and Ketchumstuk.

Table 2 Unit 20E moose harvest and accidental death, 1990-1994

Regulatory year	Harvest by hunters							Accidental death			Total
	Reported				Estimated						
	M (%)	F (%)	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	
1990-1991	46 (100)	0 (0)	0	46	0-5	5-15	9-22	0		0	54-61
1991-1992	90 (99)	0 (0)	1	91	0-5	5-15	9-22	0		0	100-113
1992-1993	68 (99)	0 (0)	1	69	0-5	5-15	9-22	1		1	79-92
1993-1994	128	0 (0)	1	129	0-5	5-15	5-20	0		0	134-149
1994-1995	93	0 (0)	1	94	0-5	5-15	5-20	0		0	99-114

Table 3 Unit 20E moose hunter residency and success, 1990-1994

Regulatory year	Successful				Unsuccessful				Total hunters
	Local[a] resident	Nonlocal resident	Nonresident	Total[b] (%)	Local[a] resident	Nonlocal resident	Nonresident	Total (%)	
1990-1991	16	28		46 (16)	65	176	2	249 (84)	295
1991-1992	34	54	3	91 (21)	112	219	9	343 (79)	434
1992-1993	15	45	4	69 (24)	52	135	9	220 (76)	289
1993-1994	38	77	14	129 (30)	93	188	17	300 (70)	429
1994-1995	27	58	9	94 (19)	97	272	17	393 (81)	487

[a] Residents of Unit 12 and Units 20E and eastern 20D are considered local residents. Major population centers are Eagle, Chicken, Boundary, Northway, Tetlin, Tok, Tanacross, Slana, and Dot Lake.

[b] Difference in total and sum of residency categories equals numbers with unknown residency.

Table 4 Unit 20E moose harvest chronology by time period, 1990-1994

Regulatory year	Harvest periods					Total[a]
	9/1-9/6	9/7-9/13	9/14-9/20	9/21-9/27	9/28-10/5	
1990-1991	20	9	7	6	0	46
1991-1992	25	26	22	14	0	91
1992-1993	29	28	5	5	0	69
1993-1994	52	40	24	8	0	129
1994-1995	47	21	16	8	0	94

[a] Difference between total and summation of harvests by week represents moose taken on unknown dates.

Table 5 Unit 20E moose harvest and percent by transport method, 1990-1994

Regulatory year	Method of transportation (%)								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1990-1991	7 (15)	3 (7)	10 (22)	6 (13)	0 (0)	8 (17)	7 (15)	5 (11)	46
1991-1992	11 (12)	2 (2)	18 (20)	10 (11)	0 (0)	15 (16)	35 (38)	0 (0)	91
1992-1993	17 (25)	1 (1)	4 (6)	21 (30)	1 (1)	7 (10)	15 (22)	3 (4)	69
1993-1994	31 (24)	0 (0)	15 (12)	34 (26)	0 (0)	15 (12)	32 (25)	2 (2)	129
1994-1995	24 (26)	0 (0)	14 (15)	26 (28)	0 (0)	13 (14)	15 (16)	2 (2)	94

LOCATION

GAME MANAGEMENT UNIT: 21B (4871 mi^2)

GEOGRAPHIC DESCRIPTION: Lower Nowitna River, Yukon River between Melozitna and Tozitna Rivers

BACKGROUND

Although the establishment of moose in this portion of Interior Alaska occurred fairly recently in geologic time, moose were present early enough to be mentioned in even the earliest human accounts of the area. Moose had become fairly abundant by the time gold seekers converged on the area in the early 1900s. The village of Ruby had a population of 10,000 people during the 1910 Gold Rush and many moose were hunted to supply the townsfolk and miners with meat. The area was believed to have supported a large moose population from the early 1900s to late 1970s. Several severe winters in the late 1960s and early 1970s initiated widespread declines in moose populations throughout the Interior.

Historically, naturally occurring wildfires have been a major force affecting the productivity and diversity of moose habitat in this area. Large fires before the 1950s burned a major portion of the area. Since the 1950s, fire suppression altered natural fire regimes. The 1982 Tanana–Minchumina Fire Plan provided a mechanism for returning to a natural fire regime in most of this area by allowing some fires to burn with minimal interference.

The Nowitna River (Novi) drainage to the east of Ruby is the main hunting area for residents of Ruby, Tanana, and, to a lesser extent, Galena. It is also a popular hunting area for Fairbanks residents who use boats and aircraft for access. Because of its long history of use by both local and nonlocal hunters, this area has been the focus of much management effort in Unit 21B over the years.

Aerial moose surveys in 1977–1979 indicated moose numbers were declining in the Novi. Wolves were believed abundant compared to the number of moose, and we believe predation by wolves caused the decline in moose numbers. A wolf control program was approved to augment existing harvest by hunters and trappers. Total harvest from the drainage, including part of Unit 21A, during the 3 years of the program was 61 wolves (ADF&G 1983). Hunting restrictions were also implemented while the wolf control program was in effect.

Population estimate surveys (Gasaway et al. 1986) in November 1980 and 1990 in a 2774–mi^2 portion of the subunit that includes the lower Novi indicated the population declined from 2386 ± 429 moose to 1719 ± 237 moose. This difference was significant at the 80% level, but not at the 90% level. Thus, there is a 20% chance the actual 1980 and 1990 population levels were the same. In 1986 a population estimation survey was conducted in 1556 mi^2 within the 1980 census area, and the results indicated a reduction in moose numbers.

Since 1981 hunters have had a 20-day season and a bag limit of 1 bull moose per hunter per season. Harvest reports indicate the number of hunters using the Novi has remained stable and the harvest has averaged 49 bulls over the last 10 years. US Fish and Wildlife Service (FWS) operated a check station at the mouth of the river from 1979 to 1983 and from 1988 to the present.

Besides the lower portion of the Novi drainage, Unit 21B includes the area east of the Ruby–Poorman Road, the banks of the Yukon River from Ruby to Tanana, the Blind River, and the Boney River. These areas produce from 36% to 46% of the reported harvest.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued use of moose by local Alaskan residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Provide for scientific and educational use of moose.

MANAGEMENT OBJECTIVES

- Conduct annual trend area surveys.
- Monitor harvest with harvest reports and check stations.
- Conduct browse surveys.
- Conduct a moose stratification survey.
- Conduct annual trend area surveys.
- Conduct a moose stratification survey.

METHODS

Established trend count areas were surveyed from Piper PA-18 (or equivalent) aircraft to assess population status and trend by cooperative efforts with FWS. Contiguous survey units of approximately 12 mi^2 each were searched at a rate of at least 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability between years. A moose population estimation survey was conducted in November 1995 using a regression survey method that uses a probability sample (Särndal et al. 1992:p 93) and regression estimator

(Särndal et al. 1992:p 245).

We monitored hunting mortality by checking moose harvest reports and collecting information (hunter residency, moose ages, and antler sizes) at a moose hunter check station operated by FWS. We interviewed wolf trappers to monitor mortality caused by predation.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

The population estimation survey in November 1995 covered a 1338 mi^2 area. The area surveyed was based on a polygon of moose calf radio relocations. By using these relocations, we approximated more closely the area used by moose occupying the floodplain of the Nowitna River. The reason for conducting the survey was concern by Tanana residents that moose were harder to find during the September hunting season. Results of the survey using the linear regression program (Table 1) indicate that 908 ± 19% moose were present. Unfortunately only 2 of the past 4 censuses have used the same survey area, which makes comparisons difficult. By comparing moose density it seems the Nowitna moose population declined from 1980 to 1986 but has slowly increased through 1995 (Table 2). If the data are compared using a subset of the previous censuses based on the minimum area sampled common to all 4 censuses (Table 3), the population seems to have declined, increased and declined again. However, the differences between the various censuses were not statistically different (O Huntington, FWS, pers commun).

Using the results of the 1990 and 1995 population estimation surveys, I estimate there are from 2324 to 3530 moose in the subunit. A density of 0.20 moose/mi^2 was applied to the portion of the Little Mud River drainage not included in the population estimation survey; a density of 0.64 moose/mi^2 was applied to the remainder of the subunit. Higher moose densities (2.0 moose/mi^2) exist in favorable habitat along the Nowitna floodplain and immediately adjacent to the Yukon River. Densities are low to moderate (0.2–0.9 moose/mi^2) away from the river.

Moose density data collected from established trend areas along the lower Novi also indicate the population had been increasing along the river until the last few years when it began decreasing (Tables 4 and 5).

Population Composition

Composition data are available from aerial surveys conducted with FWS staff in established trend areas on the Nowitna National Wildlife Refuge (Tables 4 and 5). The 1994–1995 results indicate that bull:cow ratios are declining along the river while calf:cow ratios are down but still acceptable. Overwinter survival of calves to yearling age indicates poor recruitment. The occurrence of twin calves among moose observed in these early winter surveys was very poor, ranging from 0% to 6%. A population with these attributes can be expected to remain stable under light predation. If the bull:cow ratio continues to decline, local restrictions on bull harvest may become necessary along the river corridor (Fig 1).

The 1995 census data indicate the sex and age composition over the entire area was not as depressed as along the river. The bull:100 cow ratio was 32, the yearling bull:100 cow was 7.4, and the calf:cow ratio was 28. All these ratios indicate a stable population.

Distribution and Movements

Early winter surveys indicate moose are more numerous along the floodplains of the Nowitna and Yukon rivers than during the summer. The riparian areas contain extensive *Salix pulchra* and *S. alaxensis* stands, preferred browse species for moose.

Based on the movements of radiocollared cow–calf pairs, most cows spend their summer months around open grass and brush meadows on the floodplain away from the river. In October they move to the riparian areas, where they remain until early May. A few cow moose winter in the hills to the north and south of the Novi.

MORTALITY

Harvest

Season and Bag Limit

Unit and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 21B		
Resident Hunters: 1 bull.	5 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		5 Sep-25 Sep

Board of Game Actions and Emergency Orders. No actions were taken during the report period.

Harvest. The estimated harvest for the subunit remained fairly stable and averaged 93 moose annually over the past 5 years (Table 6). The unreported harvest is estimated at 5 moose per year in the Ruby area and 10 moose per year in the Tanana area. The Nowitna drainage has produced from 54% to 64% of the subunit's harvest during the last 5 years.

Hunter Residency and Success. Since 1988 a moose hunter check station has been located at the mouth of the Novi and operated in cooperation with the FWS to interview hunters using boats on the Novi River. FWS has solely operated the station since 1992. Most hunters came from the Fairbanks area (Table 7). Based on harvest reports (Table 8), most (76%) hunters were Alaskan residents who resided outside the subunit. Sixteen percent of the hunters resided in Ruby, Tanana, or Galena.

Transportation Methods. Because of easy river access, 67% of the hunters used boats for access (Table 9). Another 20% used aircraft, 6% hunted via vehicles on the Ruby–Poorman Road, and 5% were unknown.

Other Mortality

Predation mortality on moose calves is significant in the subunit (Osborne et al. 1991). Black bears were the main predator, killing 38% of all calves. Wolves killed 11% of all calves, unidentified predators killed 8%, grizzly bears killed 2%, and 5% died from other natural causes.

HABITAT

Assessment

No new data were collected on habitat conditions during this report period. Prior observations indicated browse availability is not currently limiting the moose population in the subunit. Regeneration from a fire which burned in 1986 east of the Nowitna River in the Little Mud River drainage is now in the optimal browse stage. During November 1995 surveys, this area was classified as a high-density area for moose. Several adjacent sample units were classified as medium due to the number of moose seen. There is a dense stand of black spruce between the burn and the Nowitna River which should be considered for a prescription burn.

CONCLUSIONS AND RECOMMENDATIONS

Statistical comparison of the 1980, 1986, 1990, and 1995 population estimation surveys indicates the population has fluctuated over the past 15 years. In an analysis of the 1990 and 1995 population estimation surveys, we found no significant difference in the number of moose. Data from the 1990–1995 surveys of permanent trend count areas show the density of moose along the heavily hunted Nowitna River is declining and the number of bulls is decreasing. Away from the river, the number of bulls to cows is higher but not as high as we expect in a lightly hunted population (75 bulls:100 cows).

Predators remain abundant and are the primary factor controlling moose abundance in the area. Harvest of wolves and black bears within the subunit is very low. The moose calf mortality study indicated black bears were the major predator of moose calves (Osborne et al. 1991).

The moose population is below objective levels on the floodplain of the Novi, and the estimated unit moose population falls short of the desired level by 1000–1500 moose.

Additional survey information is needed in the remainder of the unit.

The bull:cow ratio has been declining although the harvest has been stable. The steady harvest of about 49 bulls is adversely affecting availability of bulls for hunting in some areas along the Nowitna River. Further monitoring of the bull:cow ratio should continue.

I recommend the harvest be reduced by 10%. I suggest the general hunting season bag limit be reduced to 1 bull with either spike/fork antlers or with antlers 50 inches or greater or with 4 or more brow tines. Efforts should be made to increase the harvest of predators. In addition, I recommend a prescribed burn in the upland area east of the Novi floodplain north of the Little Mud River to Bering Creek. This area is adjacent to several old burn sites now reaching their peak browse production.

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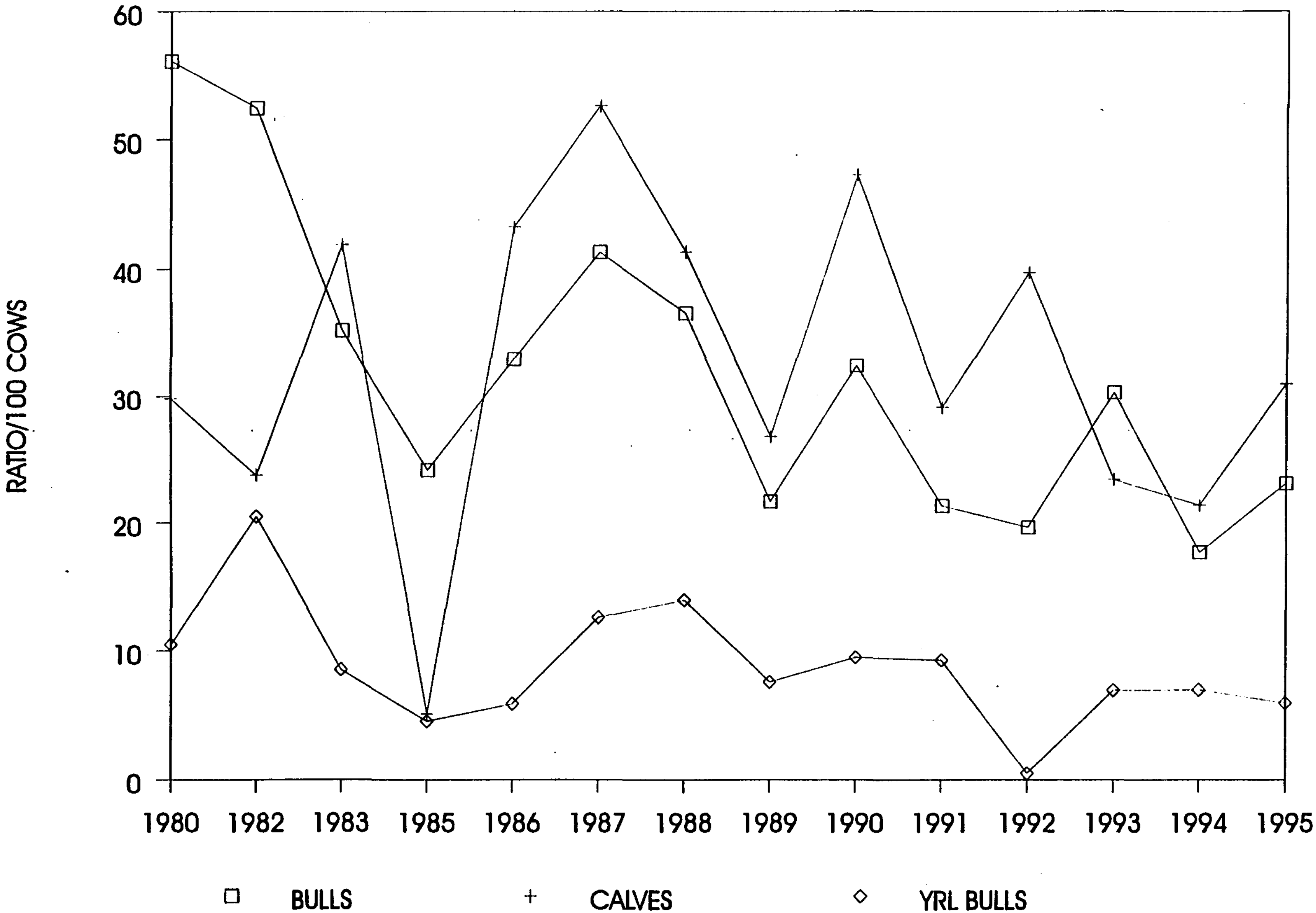

Figure 1 Moose sex and age composition ratio trends along the lower Nowitna River, Unit 21B

Table 1 Moose population estimation for Nowitna drainage Unit 21B using a regression survey method, November 1995

Unit	Area mi²	Population	90% CI[a]	Density	SCF[b]	Variance
Upnovi	365.9	96.3	16.8	0.26	1.00	96.8
Midnovi	443.8	253.3	30.6	0.57	1.05	2232.2
Mouth	528.3	533.8	15.4	1.01	1.29	3082.9
Combined	1338.0	908.0	19.0	0.68	1.21	11090.6

[a] Confidence interval (% ±).
[b] Sightability correction factor.

Table 2 Moose census data from populations estimation surveys 1980-1995 in Unit 21B

Year	Area (mi²)	Corrected density	90% CI	Population estimate	Method
1980	2701	0.72	23.3	1956	Moosepop
1986	1596	0.55	23.8	878	Moosepop
1990	2701	0.64	13.8	1719	Moosepop
1995	1338	0.66	19.0	908	Regression

Table 3 Subset of census data (minimum area sampled) from population estimation surveys 1980-1995, Unit 21B using Moosepop (Gasaway et al. 1986)

Year	Area (mi²)	Corrected density	90% CI	Population estimate
1980	1338	0.82	28	1100
1986	1338	0.66	28	881
1990	1338	1.04	23	1385
1995	1338	0.64	20	1031

Table 4 Unit 21B Novi/Sulatna confluence trend count area (73.1 mi^2) aerial moose composition counts, 1991-1995

Regulatory year	Bulls:100 cows	Yrl bulls:100 cows	Calves:100 cows	Percent twinning	Percent calves	Total moose	Moose/mi^2
1991-1992	21	9	29	8	20	200	2.7
1992-1993	18	1	48	7	29	171	2.3
1993-1994	22	7	20	0	14	195	2.6
1994-1995	16	6	20	4	15	191	1.9
1995-1996	15	4	33	6	22	148	1.5

Table 5 Unit 21B Novi Mouth trend area (60.4 mi^2) aerial moose composition counts, 1991-1995

Regulatory year	Bulls:100 cows	Yrlg bulls:100 cows	Calves:100 cows	Percent twinning	Percent calves	Total moose	Moose/mi^2
1991-1992[a]							
1992-1993	21	0	31	0	20	138	1.8
1993-1994	32	6	32	6	20	189	2.3
1994-1995	19	8	23	0	22	148	1.8
1995-1996	16	5	26	0	18	116	1.4

[a] No survey

Table 6 Unit 21B moose harvest, 1990-1995

Regulatory year	Harvest by hunters Bull	Cow	Unk	Total	Unreported	Total
1990-1991	816	0	0	81	15	96
1991-1992	65	0	0	65	15	80
1992-1993	46	0	0	46	15	61
1993-1994	71	1	0	72	15	87
1994-1995	60	0	0	60	15	75

Table 7 Residency (*N*), harvest (*n*) and success (S%) of moose hunters stopping at the Nowitna River hunter check station, Unit 21B, 1990-1995

	Local villages			Fairbanks			Other residents			Nonresident			Total		
Year	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%	*N*	*n*	S%
1990-1991	23	7	30	67	42	38	26	12	46	14	4	29	130	54	42
1991-1992	21	9	43	72	24	33	44	11	25	17	2	12	154	46	30
1992-1993	24	3	12	38	19	50	53	10	19	10	2	20	125	34	27
1993-1994	19	7	37	58	26	45	35	19	54	20	1	5	133	53	40
1994-1995	16	6	37	63	27	43	41	16	39	13	5	38	134	54	40
1995-1996	16	3	19	63	24	38	44	9	20	9	2	22	132	38	29

Table 8 Unit 21B moose hunter residency and success, 1990-1995

	Successful					Unsuccessful					
Regulatory year	Local resident	Nonlocal resident	Nonresident	Unk	Total	Local resident	Nonlocal Resident	Nonresident	Unk	Total	Total hunters
1990-1991	22	48	8	3	81	10	41	1	1	53	134
1991-1992	21	34	8	2	65	21	56	8	1	86	151
1992-1993	12	31	2	1	46	24	55	10	1	90	136
1993-1994	23	65	3	4	72	7	54	11	0	65	137
1994-1995	12	56	5	2	63	7	50	2	0	52	115

Table 9 Unit 21B moose harvest percent by transport method, 1990-1994

Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowgo	ORV	Highway vehicle	Unk	*n*
1990-1991	11	1	78	0	0	2	6	1	81
1991-1992	9	1	75	0	0	0	10	4	151
1992-1993	10	0	76	1	0	0	8	4	136
1993-1994	9	0	82	3	1	0	3	1	137
1994-1995	21	0	69	2	0	0	6	3	115

LOCATION

GAME MANAGEMENT UNIT: 21C (3671 mi^2)

GEOGRAPHIC DESCRIPTION: Dulbi River above Cottonwood Creek and Melozitna River above Grayling Creek

BACKGROUND

Moose inhabited Unit 21C throughout historic times. Moose densities are generally low. Population trend is unknown. There has been little need to extensively monitor this moose population, as human use is low and not believed to be adversely affecting the population.

Terrain in the subunit is quite mountainous, with peaks as high as 5000 feet. Two large river drainages, the Melozitna (Melozi) and the Dulbi, dissect the mountains. Numerous fires have burned in the area, producing large expanses of excellent winter habitat.

Moose harvests have ranged from 15 to 30 bulls during the past 15 years. Aircraft provide the only practical access to most of the subunit. A waterfall near the mouth of the Melozitna River restricts travel up that river and extensive sand bars impede boat access to the upper Dulbi River.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.

- Provide the greatest sustained opportunity to participate in hunting moose.

MANAGEMENT OBJECTIVES

- Increase the moose population to 2500–3000 moose in the Melozitna River drainage to increase hunting opportunity.

- Maintain the moose population of 550–750 in the Dulbi River drainage to sustain hunting opportunities.

METHODS

A stratification was attempted in November 1995 to assess relative density and to locate areas for possible future surveys. We divided the subunit into 4 sections based on Uniform Coding Unit drainages, and we drew maps of the sample units and calculated areas. To monitor harvest, we reviewed moose harvest reports submitted by hunters. We interviewed wolf trappers to assess mortality by predation.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

The moose stratification was started on 20 November 1995. The 4 sections to be surveyed were the Melozi River 1470.3 mi^2 (121 sample units); Upper Melozi River 600.2 mi^2 (49 sample units); Little Melozi River 576.5 mi^2 (47 sample units); and that portion of the Dulbi River drainage not surveyed in 1987, which included 142.5 mi^2 (12 sample units). We surveyed 17 units before turbulence caused unsafe flying conditions. Over the next 2 days, continuous turbulence prevented completion of the surveys. We managed to survey 200 mi^2. No information was collected on sex or age composition.

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 21C		
Resident and Nonresident Hunters: 1 bull.	5 Sep-25 Sep	5 Sep-25 Sep

Board of Game Actions and Emergency Orders. Seasons and bag limits have remained the same during the past 10 years. No changes were made during this reporting period.

Hunter Harvest. The harvest in the subunit has been stable, ranging from 9 to 27 moose annually for the past 5 years (Table 1).

Hunter Residency. Currently, no one lives within the subunit. Hunters who reported hunting in Unit 21C were either state residents residing outside the subunit or nonresidents (Table 1).

Transportation Methods. Most hunters used aircraft for transport (Table 2).

Other Mortality

There are at least 50 to 60 wolves in the subunit. Grizzly bear habitat is excellent and the estimated density of bears is 1/40 mi^2. Moose and caribou are available as prey for wolves and bears. The Melozitna River also has a major salmon run. Predation is probably the main limiting factor on moose in the subunit.

CONCLUSIONS AND RECOMMENDATIONS

The moose population is thought to be low. Human use of the population remains low. A reasonable estimate of current moose density would be 0.5 to 1.0 moose/mi^2, based on the scant survey data to date, the stratification, and densities observed elsewhere in the Interior. If this estimate were correct, historical harvest levels (15 to 30 moose/yr) take only 0.4% to 1.6% of the projected population of 1836–3671 moose each year. Probably that existing hunting pressure could be sustained, even if the population experienced a 50% reduction. Conversely, if nothing major happens to the population, it should be capable of sustaining double the current harvest without management actions. I recommend minimal commitment of management effort in the subunit until hunting pressure significantly increases.

A stratification survey of the area should be conducted to ascertain moose distribution and relative abundance and to determine areas for future trend surveys. If we use a Supercub for the stratification, moose can be classified as we stratify the area.

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Table 1 Unit 21C moose hunter residency and success, 1990–1994

Regulatory year	Successful					Unsuccessful					Total hunters
	Local resident	Nonlocal resident	Nonresident	Unk	Total	Local resident	Nonlocal resident	Nonresident	Unk	Total	
1990-1991	1	18	5	1	25	0	9	3	0	12	37
1991-1992	0	15	5	0	20	0	17	3	0	20	40
1992-1993	0	7	2	0	9	0	15	7	0	22	31
1993-1994	0	11	9	0	20	0	13	6	0	19	39
1994-1995	0	17	10	0	27	4	14	2	0	20	47

Table 2 Unit 21C moose harvest percent by transport method, 1990–1994

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowgo	ORV	Unknown	Total
1990-1991	19	0	2	0	0	0	0	21
1991-1992	19	0	1	0	0	0	3	23
1992-1993	8	0	1	0	0	0	0	9
1993-1994	14	2	4	0	0	0	0	20
1994-1995	24	0	3	0	0	0	0	27

LOCATION

GAME MANAGEMENT UNIT: 21D (12,113 mi^2)

GEOGRAPHIC DESCRIPTION: Yukon River from Blackburn to Ruby and Koyukuk River drainage below Dulbi Slough

BACKGROUND

Within historic times moose are a relatively new addition to the fauna of Unit 21D. Natives first reported seeing occasional moose tracks during winters in the 1930s. During the 1940s and early 1950s numbers of moose and wolves slowly increased (Huntington 1993). Then during the 1950s, federal wolf control and aerial shooting reduced the wolf population, causing the moose population to grow rapidly during the late 1950s and through the 1960s. Statehood in 1959 brought an end to federal wolf control. Legal aerial shooting was stopped with the passage of the Airborne Hunting Act in 1972. Faced with an abundance of food, wolves once again became abundant. The moose population reached peak numbers about 1970 (S Huntington, pers commun) and then either stabilized or declined slightly in response to increased predation and hunting.

In 1979 the Koyukuk Controlled Use Area (KCUA) was established to reduce participation by hunters from outside the subunit by prohibiting the use of aircraft. However, by 1986 the number of hunters arriving by boat from outside the subunit equaled the number of hunters who previously accessed the area by aircraft.

A moose hunter check station has been operated on the Koyukuk River since 1983. It has enabled me to accurately determine the number of hunters using the river to access the KCUA within Unit 21D. It has also been a valuable method to educate local residents on licensing and reporting requirements.

During the 1974 and 1977 100,000–200,000-acre fires in the uplands along the Koyukuk River, moose winter habitat in the subunit improved. Since 1980 trappers who have used aircraft to land near wolves have been able to consistently shoot enough wolves to stabilize predation on moose. The presence of numerous large lakes and rivers near moose winter concentration areas makes this "land-and-shoot" method particularly effective in Unit 21D.

Moose trend count areas (TCAs) established in 1981 in the Three Day Slough and Yukon floodplain areas have indicated an increasing density of moose. Initially I thought the increase in density was due to better surveys, but a population estimation survey of the Kaiyuh Flats and the eastern drainages of the Koyukuk River in 1987 confirmed the trend. Moose densities were high along the Yukon River floodplain (3–6 moose/mi^2) and very high between the Kateel River and Dulbi Slough, where densities averaged 9 moose/mi^2 in early winter. Nineteen moose radiocollared in 1984 in the Three Day Slough area established distribution patterns for moose in that portion of the subunit. Movement patterns are unknown in the rest of the subunit.

Two population estimation surveys in the subunit during November 1987 found 6340 moose over a 4883-mi^2 area. Extrapolation of these data indicates a subunit population of 9000 to 10,000 moose.

There are 4 villages within the subunit (Kaltag, Nulato, Koyukuk, and Galena) and the residents of each village have traditional hunting areas. However, the area used by Galena residents overlaps those used by residents of other villages because many of the residents of Galena have larger boats and are able to travel farther. Although Huslia is only 30 miles from Unit 21D, its residents rarely hunt for moose within the subunit. Nonresidents and Alaskans residing outside Unit 21D have mainly hunted the Koyukuk River between the Kateel River and the Unit 24 boundary where competition with residents of Subunit 21D was less likely.

The reported harvest prior to 1981 was largely inaccurate because many local residents either did not obtain licenses or failed to report. In 1981 I made it easier for residents of the subunit to obtain harvest reports. Educational and enforcement efforts have increased the reporting rate by local residents.

The fall hunting season was changed numerous times between 1975 and 1981. Since 1981 it has remained a 21-day season allowing cows to be hunted during the last 5 days. Some restrictions have been placed on resident and nonresident hunters, and the definition of a subsistence hunter has changed. In 1991 nonresidents were restricted to bulls with an antler spread of 50+ inches or 3 brow tines on 1 side. In 1992 the minimum number of brow tines on 1 side was increased to 4 and within the Koyukuk Controlled Use Area, the meat of the front and back legs and ribs must remain on the bone until removed from the area. Reporting at Ella's Cabin check station was made mandatory.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat with other components of the ecosystem.
- Provide for continued use of moose by local Alaskan residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Provide for scientific and educational use of moose.

MANAGEMENT OBJECTIVES

Koyukuk River Drainage

- Maintain a population of at least 4000 moose south and east of the river, including the Three Day Slough area.
- Maintain an early winter density of at least 4 moose/mi^2 within the Three Day Slough floodplain.
- Maintain a posthunt ratio of at least 30 bulls:100 cows in the population monitored by the Three Day Slough TCA.
- Develop guidelines for maximum winter browse use within the Three Day Slough area.
- Maintain a moose population level of 900–1000 in the Kateel River drainage and develop a population level for the Gisasa River.

Yukon River Floodplain

- Maintain an early winter density of at least 3 moose/mi^2 in floodplain areas along the Yukon River that are subject to both the September and February hunting seasons.

Elsewhere in the Subunit Including Yuki and Nulato rivers

- Determine the population level and estimate density.

METHODS

Established trend count areas were surveyed from Piper PA-18 (or equivalent) aircraft to assess population status and trend. Contiguous survey units of approximately 12 mi^2 each were searched at a rate of at least 5 min/mi^2 to ensure reasonably high sightability, minimal bias, and data comparability among years. I surveyed these areas with staff from the US Fish and Wildlife Service (FWS) Koyukuk/Nowitna National Wildlife Refuge Complex. Twinning surveys were flown in May using standard search techniques to determine the percentage of twin moose calves.

We monitored hunting mortality and harvest distribution through harvest tickets and check stations. Local residents were encouraged to increase their harvest reporting through school visits and check stations. Predation was monitored by interviewing trappers, relocating radiocollared animals, and conducting track surveys in cooperation with FWS.

We conducted habitat assessment in March by measuring browse-point diameters and by chemical analysis of feltleaf willow (*Salix alexensis)* under a contract with K Keilland, Institute of Arctic Biology, University of Alaska.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Moose populations are healthy throughout most of the subunit except in the Yuki River drainage where moose numbers are lower than in previous years. Moose densities are increasing in areas along the Yukon and Koyukuk rivers, but the trend is unknown in most of the upland areas.

No new data on population size were collected during this report period.

Population Composition

The following guidelines are used to interpret sex and age indices within Units 21 and 24:

1 Bull:cow ratios usually average 30–40 bulls:100 cows after the hunting season. Higher numbers of bulls are good but sometimes misleading because the area is subject to either-sex hunting that can inflate bull numbers. Ratios below 20 would be poor.

2 The calf:cow ratio observed during November surveys provides an index to calf survival during the 5 months following birth. Black bears, grizzly bears, and wolves are the primary predators that reduce calf numbers. A November calf:cow ratio of 30–40:100 would be considered average for this area. A ratio of this magnitude would usually allow a population to remain stable amid moderate predation and hunting. Calf:cow ratios may indicate population change if subsequent overwinter mortality is either consistent or negligible. Ratios of 20 calves:100 cows or less often indicate a population which is decreasing, and ratios of more than 40:100 cows indicate growing populations.

3 The percentage of yearling bulls within the herd provides an index to the addition (recruitment) of young adults to the breeding population. It can also provide an indication of overwinter survival of calves if the calf:cow ratio for the previous fall is known. Generally, the yearling bull percentage averages 4% to 8%, with anything less indicating poor recruitment and anything higher good recruitment.

The number of twins born in May is a good indicator of herd nutritional status. The twinning rate ranges from 25% to 90% in populations below carrying capacity, from 5% to 25% in populations near carrying capacity, and below 5% in those above carrying capacity (Gasaway et al. 1992).

The 1995 posthunt bull:cow ratio for Three Day Slough (Table 1) reflected an unusually high harvest of bulls in 1995 (Table 2). The ratio decreased from the previous 10-year average of 35:100 cows by one third. Yearling and calf numbers were slightly lower than average for the area. Calf twinning rates over the last 2 years have indicated the herd is apparently not being affected by nutrition at this time (Table 3). In 1995 the minimum sample of 50 cows with calves was found in 1 day (Table 3), whereas it usually takes several days to find enough calves to meet the minimum.

In November 1995 the bull segment surveyed in the Three Day Slough TCA included 31% small (≤ 30"), 42% medium, and 27% large- (≥ 50") antlered bulls. This is an increase in observed large-antlered bulls over the past several years (Table 2). The increased harvest in 1995 has led to a decrease in the total number of bulls in the herd but apparently has not affected the percentage of large bulls.

Unfortunately not all TCAs in the Kaiyuh area have been flown every year, but when available data are combined, bull:cow ratios were lower in 1995 (Table 4), which may reflect increased hunting pressure in the area. The calf:cow ratio was very high for an Interior moose population, possibly because of proximity to Koyukuk and of high hunting pressure on black bears, the main predator on moose calves.

Distribution and Movements

Movement patterns of moose in the Three Day Slough area are based on data from radiocollared animals. Most adult and young moose remain in the floodplain area of Three Day Slough from late August until May each year. During May most moose move 10 to 60 miles in either a northerly or southerly direction to upland areas where they spend the summer. In August they return to the floodplain area. Moose movements are unknown in other portions of the subunit. However, local residents believe some moose observed on the Kaiyuh Flats migrate seasonally.

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 21D		
Resident Hunters: 1 moose per regulatory year; however, antlerless moose may be taken only during the periods 21 Sep-25 Sep and 1 Feb-10 Feb. Moose may not be taken within 1/2 mile of the Yukon River during the 1 Feb-10 Feb season.	5 Sep-25 Sep 1 Feb-10 Feb	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side		5 Sep-25 Sep

Board of Game Actions and Emergency Orders. The Middle Yukon Fish and Game Advisory Committee, in conjunction with ADF&G and the Board of Game, has been trying to design a midwinter hunt to meet local needs while minimizing the take of cow moose concentrated in highly accessible riparian areas. The season and areas open to hunting have been changed 12 times in the last 13 years either by board action or emergency orders due to cold weather or snow conditions. The Board of Game has now set a February season of 10 days to avoid those emergency orders, and all land within one-half mile of the Yukon River is closed. The moose population in the hunt area is able to sustain an anticipated winter harvest of 40 moose.

Hunter Harvest. The reported harvest has been about 250–350 moose annually with another 40 moose taken but not reported (Table 5). With the possible exception of the Yuki River drainage, the moose populations in the subunit appear capable of sustaining current harvests. Interest in hunting the Koyukuk River has grown in the last few years and the bull segment of the population may not be able to sustain the increased harvest. Although cows are legal after 21 September, very few are harvested (Table 6).

Stopping at the moose hunter check station on the Koyukuk River was made mandatory in 1990. Data have been collected on residency, harvest chronology, age structure of harvest, antler size, brow tine numbers, and method of transportation. Genetic material has also been collected for antler growth studies at the Kenai Moose Research Center.

The Three Day Slough area has been known as a good area to hunt for large ($\geq$ 50-inch antlers) moose. Usually, about one-fourth to one-third of the bulls observed in the Three Day Slough TCA have large antler spreads. Although the percentage has decreased in recent years, it now appears to be recovering (Table 2).

Beginning with the 1992 fall season, nonresidents hunting in the subunit were required to harvest only bulls with 50-inch or larger antlers or 4 or more brow tines on 1 side. This regulation initially caused nonresident success to decline, but it has since recovered (Table 7). The other new regulation requiring meat to be left on the bone has greatly aided enforcement efforts to stop waste of moose meat. The Board of Game passed the regulation to help keep meat from spoiling since most hunters travel long distance by boat. Meat on the bone lasts longer than boned out meat. At the check station we point out the regulation to all hunters who come through and have only received 1 complaint per year against it. All other hunters have enthusiastically endorsed the regulation; many hunters thought it should be adopted in other game management units.

Hunter Residency and Success. The subunit hunter residency and success (Table 8) is misleading as unit residents rarely report unsuccessful hunt information. During 1994–95 the number of successful local residents decreased almost by half since 1991–92, while nonresident numbers have remained fairly stable during the same time periods. Between these same periods, the number of successful nonlocal residents decreased. In 1994–95 unsuccessful hunters appeared to be primarily nonlocal residents because many unit residents did not report unsuccessful hunts.

<u>Transportation Methods</u>. Boats are the primary transportation method (Table 9) because of the KCUA and the area's extensive river system. Snowmachines were the main transportation method during the winter hunt.

Other Mortality

Unit 21D has high populations of wolves and black bears, and grizzly bears are common in the upland areas of Nulato Hills and Kaiyuh Mountain. Black bears are a substantial source of mortality for moose calves (Osborne et al. 1991), and wolves and grizzly bears prey heavily on calves and adult moose.

The estimated subunit wolf population is about 208 to 304 in 37 packs (Becker et al., in press). This number of packs would probably kill 1000 to 1900 moose per year, based on an average kill rate of 1 moose every 3 to 6 days per pack during winter months (Gasaway et al. 1983). At this rate, wolves in Unit 21D probably kill about 10% to 19% of available moose annually.

HABITAT

Assessment

Feltleaf willow is an important species for moose due to its high annual biomass production. Chemical analysis of 2 to 8 mm diameter twigs typically browsed by moose found crude protein ranging from 8% to 12%, which is twice as much as found in the same willow species on the Tanana River (K Kielland, pers commun). Browse consumption in Three Day Slough survey areas was 24% to 28% of the annual twig production. Abundant high quality forage may thus partly explain the sustained high numbers of moose in the Three Day Slough area.

CONCLUSIONS AND RECOMMENDATIONS

Moose are numerous in the riparian lowlands of Unit 21D. I estimate 9000–10,000 moose are within the subunit. Populations are stable and capable of supporting current predation and harvest if spread over the entire unit.

Prior growth of the moose population has been attributed to the steady and consistent harvest of wolves in the area. However, the growth of the moose population spurred an increase in the number of moose hunters, especially within the KCUA.

All hunters in the KCUA use boats, and currently there is a problem of congestion in suitable areas for camping sites and moose calling areas, as well as other problems associated with crowded hunting conditions. In prior years the area was known as a wild site where people had the opportunity to select a bull, watch bulls rut, and hunt and observe other wildlife such as bears and waterfowl. Increased boat traffic and crowded conditions have made cows more wary and have compromised our goal of viewing and photographing moose.

The regulation requiring meat be left on the bone of legs and ribs has dramatically reduced the number of meat-waste complaints I receive at the check station and in Galena. Although the

Board of Game passed this regulation to prevent meat spoilage, its usefulness as an enforcement tool has proven invaluable. It is much easier to count legs than to estimate weights of meat bags to determine if hunters have salvaged required meat.

The drop in the bull:cow ratio within the KCUA is cause for concern because the number of hunters targeting that area is steadily increasing. I recommend steps be taken to reduce the bull harvest. Habitat is not limiting populations in the area, and additional cows could be taken without weakening the moose population. If the cow season were open at the start of the season, more moose would be available to local hunters.

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Table 1 Summary of fall aerial moose survey data from Three Day Slough count area (83.3 mi^2) in Unit 21D, 1988–1995

Year	Bull:100 cow	Yrlg bull:100 cows	Calves:100 cows	Cows	Calf % in herd	Moose
1988	33	13	45	468	25	832
1989	28	8	25	500	16	763
1990[a]						
1991	34	10	31	551	19	909
1992	35	10	31	657	18	1088
1993	38	9	25	678	16	1106
1994	36	9	28	625	17	1026
1995	23	7	36	662	23	1054

[a] No survey.

Table 2 Bull moose harvest and percentage of large[a] bulls in the harvest from the Three Day Slough (TDS) area compared with percentage of large bulls observed during the early winter aerial survey of the Three Day Slough trend count area, Unit 21D, 1988–1995

Regulatory year	% large bull in harvest (Sep)	Number of bulls measured (Sep)	% large bulls TDS (Nov)
1988-1989	61	96	33
1989-1990	51	95	28
1990-1991	54	91	--[b]
1991-1992	45	134	15
1992-1993	54	88	15
1993-1994	54	105	18
1994-1995	64	93	28
1995-1996	60	157	27

[a] 50 inch or greater antler spread.

[b] No survey.

Table 3 Summary of May aerial moose twinning surveys from Three Day Slough TCA, Unit 21D, 1990–1995

Regulatory year	Cows	Cow + calf	Cow + twin	Twinning %	Yearlings	Dates in May
1989-1990	--[a]	24	21	44	--	21-25
1990-1991	--	--	--	--	--	--
1991-1992	--	22	23	51	--	22-23
1992-1993	296	23	19	44	100	23-25
1993-1994	110	39	11	22	55	23-24
1994-1995	78	37	18	33	38	22

[a] No data.

Table 4 Summary of fall aerial moose survey data from Pilot Mountain, Squirrel Creek, Kaiyuh Slough and Koyukuk Mouth trend areas in Unit 21D, 1987-1995. Not all areas were surveyed each year.

Year	Bull:100 cows	Yrlg bull:100 cows	Calves:100 cows	Total cows	Percent calves	Adults	Total moose	Moose/mi^2
1987	45	16	54	154	27	316	385	3.4
1988-1992[a]								
1993	49	7	39	144	21	354	447	3.6
1994[b]	41	12	33	27	28	97	144	2.2
1995[c]	26	12	43	174	25	178	295	

[a] No surveys.
[b] Kaiyuh Slough only.
[c] Pilot Mountain, Squirrel Creek only

Table 5 Unit 21D moose harvest, 1988-1995

Regulatory year	Harvest by hunters Bull	Cow	Unk	Total	Unreported	Potlatch Stickdance	Total
1988-1989	229	20	2	251	40	3	294
1989-1990	182	22	0	204	40	4	248
1990-1991	256	22	1	279	40	4	323
1991-1992	269	34	0	303	40	11	354
1992-1993	193	22	1	216	40	11	267
1993-1994	233	23	2	258	40	9	267
1994-1995	237	12	0	249	40	8	297

Table 6 Sex of moose checked at Ella's Cabin, 1987-1995

Year	Bull	Cow	% cow	Total
1987	135	10	7	145
1988	172	9	5	181
1989	150	8	5	158
1990	177	6	3	183
1991	199	10	5	209
1992	161	6	4	167
1993	179	6	3	185
1994	192	10	5	202
1995	279	8	3	287

Table 7 Moose harvest by hunters who stopped at the Koyukuk River check station, Unit 21D, 1987-1994

Regulatory	Unit 21 resident		Alaska resident[a]		Nonresident		Total	
year	Hunter	Moose	Hunter	Moose	Hunter	Moose	Hunter	Moose
1983-1984[b]	132	43	29	20	3	2	164	65
1984-1985[b]	92	61	67	36	9	9	168	106
1985-1986[b]	117	32	74	37	4	3	195	72
1986-1987[b]	140	48	80	51	9	7	229	106
1987-1988[b]	151	68	92	61	21	16	264	145
1988-1989[b]	158	73	121	88	20	20	299	181
1989-1990	154	55	125	89	23	14	302	158
1990-1991	137	48	133	105	36	30	306	183
1991-1992	136	49	189	121	55	38	380	209
1992-1993	145	45	173	103	39	19	357	167
1993-1994	115	48	132	109	34	28	281	185
1994-1995	106	34	194	127	56	41	356	202
1995-1996	124	49	260	188	63	50	446	287

[a] Other than Unit 21 residents.

[b] Check not mandatory prior to 1990.

Table 8 Unit 21D moose hunter residency and success, 1988-1995

Regulatory year	Successful: Local[a] resident	Successful: Nonlocal resident	Successful: Nonresident	Successful: Unk	Successful: Total	Unsuccessful: Local[a] resident	Unsuccessful: Nonlocal resident	Unsuccessful: Nonresident	Unsuccessful: Unk	Unsuccessful: Total	Total hunters
1988-1989	94	99	27	31	251	30	34	3	10	77	328
1989-1990	78	98	22	6	204	51	47	8	4	110	314
1990-1991	100	132	35	12	279	33	26	4	6	69	348
1991-1992	106	152	42	6	303	66	91	16	3	176	479
1992-1993	71	111	22	12	216	57	81	14	15	167	383
1993-1994	86	141	23	8	258	55	82	7	2	91	349
1994-1995	58	131	41	19	249	9	47	5	5	57	306

[a] Subunit resident only.

Table 9 Unit 21D moose harvest by transport method, 1988-1995

Regulatory year	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	Total
1988-1989	14	2	196	2	13	0	3	21	251
1989-1990	11	0	167	1	14	1	5	5	204
1990-1991	10	0	246	0	9	0	7	7	279
1991-1992	16	0	260	0	15	0	5	7	302
1992-1993	7	0	189	0	7	0	4	6	216
1993-1994	7	0	228	3	12	0	3	5	258
1994-1995	12	0	233	0	19	2	5	4	275

LOCATION

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

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

BACKGROUND

Before 1930, very few moose were observed on the Seward Peninsula. However, by the late 1960s moose inhabited much of the suitable habitat in Unit 22. Numbers increased during the 1970s and early 1980s and peaked during the late 1980s. Current data indicate densities have since declined.

Demand for moose is high, primarily by recreational and subsistence hunters residing in the unit. Gravel roads, trails, and navigable rivers provide hunters with easy access to suitable moose habitat. Annual harvests reported from 1969 through 1994 ranged from a low of 44 moose in 1972 to a high of 408 moose in 1986 (Table 1). In most years unit residents reported 70% or more of the annual reported harvest.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

The overall management goal for Unit 22 is to maintain a minimum population size of 5700–7300 moose throughout the Unit. In Unit 22A, the objective is to increase population size from the current estimate of 600–800 moose to a minimum of 1000 moose. In Units 22B and 22D, the objective is to maintain the population size at 1500–2500 and 2500–3000 moose, respectively, with a minimum bull:cow ratio of 30:100. In Unit 22C, the objective is to maintain the existing population of 480 animals with a minimum bull:cow ratio of 20:100. In Unit 22E, the objective is to maintain the existing population of 250–350 moose.

MANAGEMENT OBJECTIVES

1 Estimate abundance, sex and age composition, and yearling recruitment and determine trends in population size and composition.

a Complete aerial surveys throughout the unit during late fall and early spring to provide an index of population status and trends, sex and age composition, and yearling recruitment.

b Complete moose censuses in the 5 subunits of Unit 22 to estimate abundance.

2 Monitor human and natural mortality factors affecting the population.

a Evaluate hunting mortality by analyzing all harvest data.

b Improve harvest reporting through public contacts and improved communication.

3 Develop a moose management plan, with special emphasis on areas adjacent to the road system.

METHODS

We estimated sex composition and short yearling recruitment in Unit 22 with spring and fall aerial surveys during the report period. In addition, a modified Gasaway et al. (1986) census developed by department staff to estimate population size and productivity was attempted but not completed in the Unalakleet River drainage of Unit 22A during spring 1994. We used the same census technique to census moose in Unit 22C during March 1995. Harvests were summarized from harvest reports returned by hunters.

During April 1995, we radiocollared 27 female moose in the Niukluk and Fish River drainage of Unit 22B to help determine factors contributing to poor calf recruitment in the area. We used standard capture techniques with immobilizing drugs and captured moose from a Bell Jet Ranger helicopter. We collared the moose with Model 600 collars manufactured by Telonics, Inc. (Mesa, Arizona, US). We completed radiotracking flights during April through June 1995 in either a Piper PA-12 or a Cessna 185 aircraft to relocate the collared moose.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

We do not have a good understanding of factors limiting population size, productivity, and recruitment of the moose population in Unit 22. Although moose numbers in Units 22A, 22C, and 22E increased during the late 1980s, densities were never as high as the densities observed in Units 22B and 22D. Moose densities in Units 22B and 22D, which increased dramatically by the late 1980s, have since declined. Calf survival, particularly in western Unit 22B, has also declined. The winters of 1989, 1990, and 1992 were particularly severe on moose, and limited observations indicate winter mortality was higher than normal during these years.

Population Size

A modified Gasaway et al. (1986) census technique developed by department staff was used in the Unalakleet drainage of Unit 22A during spring 1994 and in Unit 22C during spring 1995 to determine population size, density and short yearling recruitment. These data were compared to previous census data from the same areas.

Because of poor weather and excessively strong winds, we did not complete the census of the Unalakleet River drainage during March of 1994. Although we completed the stratification flights, insufficient sample units were counted to develop a statistically meaningful density estimate. However, subjective evaluation of the stratification results by staff participating in both the 1989 and 1994 censuses of the Unalakleet drainage indicated moose density probably did not change significantly during the intervening 5 years.

During early March of 1995, we completed a census of Unit 22C. Because Unit 22C is small in size (1,368 mi^2), we were able to census the entire subunit. The census yielded a population estimate of 479 moose. We estimated 436–521 moose (+8.9%) at 80% CI and 424–534 moose (+11.5%) at 90% CI. Calf recruitment was estimated at 20% for the census area.

Unit 22C was last censused during March 1990 using techniques developed by Gasaway et al. (1986), and we developed an estimate of 407 moose and 21% short yearlings (Nelson 1993). Calf recruitment appears little changed during the 5-year period. Although the 1995 census results indicate the estimated moose population increased by 18% from 407 moose to 479 moose during the 5-year period, the increase is not statistically significant at the 90% confidence level. However, subjective observations by knowledgeable members of the public and staff indicate the population size probably increased slightly during the 5-year period.

Population Composition

Because of early snowfall, we successfully completed several fall composition surveys in selected drainages in Units 22B, 22C and 22D during October of 1994 (Table 2). Normally, we do not receive adequate snow cover in Unit 22 before December to complete fall composition surveys.

In the American Creek count area (Unit 22B) the total number of moose did not change significantly from 1992 to 1994, but the proportion of bulls in the sample dropped substantially. The bull:cow ratio in the Snake River count area (Unit 22C) remained extremely low, although the productivity of the population appears to have changed little between 1992 and 1994. Both count areas are adjacent to the Nome road system and receive substantial hunting pressure; consequently, the low number of observed bulls is not surprising. This is especially true of the Snake River drainage near Nome, one of the most accessible and heavily hunted drainages in Unit 22. Because of small sample sizes in both count areas, these conclusions should be regarded as tentative.

The Henry and Washington Creek drainage was established as a new trend count area in the upper Kougarok drainage in Unit 22D. Hunting pressure in this area has increased dramatically during the last 3 years, and we anticipate this trend to continue.

We completed spring calf recruitment surveys in Units 22B, 22C and 22D during 1994 and 1995 (Table 3). These annual surveys track recruitment in portions of Unit 22 used heavily by hunters.

As previously reported, recruitment in western Unit 22B remained low during the reporting period. During the 5-year period from 1991 to 1995, the percentage of calves observed during spring surveys in the Fish River count area remained extremely low at 4% to 6%. In the Niukluk River count area, the percentage of calves was slightly higher at 9%. We anticipate the radiotelemetry study initiated during April 1995 will provide additional information regarding the status of recruitment in the Fish and Niukluk River area.

Calf recruitment in Unit 22C remains relatively high compared to the surrounding count areas. The 1995 census of Unit 22C yielded an estimated recruitment rate of 20%, nearly identical to the 21% recruitment rate estimated in 1990 and the 19% recruitment rate in the Snake River count area during 1993.

Spring surveys of the Kuzitrin, Noxapaga and Kougarok River count areas in Unit 22D indicate recruitment rates may have improved during the 5-year period. Recruitment increased from 12% to 16% in the lower Kougarok River count area from 1991 to 1995 and from 11% to 16% in the Kuzitrin and Noxapaga River count area. Census data indicate population levels in Unit 22D declined dramatically during the late 1980s and early 1990s (Nelson 1994). The increased recruitment rates in the Unit 22D count areas indicate a recovering population, although it has not reached the high densities observed during the mid-1980s.

A new count area was established in the American River drainage to monitor the status of moose in western Unit 22D. Although this drainage does not presently receive heavy hunting pressure, we anticipate hunting pressure will increase. Low moose densities in the upper Kougarok drainage adjacent to the Kougarok Road will probably deflect hunters westward to the American River as they search for productive hunting areas.

MORTALITY

Harvest

Season and Bag Limit.

	Resident/ Subsistence Hunters	Nonresident Hunters
Unit 22A One bull	1 Aug.-30 Sep. 1 Dec.-31 Jan.	1 Aug.-30 Sep.
Unit 22B One moose; however, antlerless moose may be taken only from Dec. 1-Dec. 31. No person may take a cow accompanied by a calf.	1 Aug.-31 Jan.	1 Aug.-31 Jan.
Unit 22C One bull	1 Sep.-14 Sep.	1 Sep.-14 Sep.
Unit 22D One moose; however, antlerless moose may be taken only from Aug. 1-Dec. 31. No person may take a cow	1 Aug.-31 Jan.	1 Aug.-31 Jan.

accompanied by a calf. Only antlered moose may be taken from Jan. 1-Jan. 31.		
Unit 22E One moose.	1 Aug.-31 Mar.	1 Aug.-31 Mar.

Board of Game Actions and Emergency Orders. No regulatory changes or emergency orders were enacted for Unit 22 during the reporting period.

Hunter harvest. During the 1993–94 season, 553 hunters reported a harvest of 247 moose (225 males, 21 females and 1 of unknown sex). A harvest of 211 moose (201 males and 10 females) were reported by 486 hunters during the 1994–95 season (Table 1). Hunter harvests in Unit 22 have declined by nearly 50% from 405 moose reported during the 1983–84 regulatory year to 211 moose reported during the 1994–95 regulatory year (Figure 1). In addition, the number of individuals hunting moose in Unit 22 has declined by 62% from 1292 hunters during 1983–84 to 486 during 1994–95. Declining numbers of moose reduce hunter effort and harvest in areas accessible to hunters.

Hunter Residency and Success. Local Unit 22 residents took 74% of the harvest during 1993–94 and 73% during 1994–95 (Table 4). The proportion of the harvest attributable to local residents has remained remarkably constant during the last 5 years, ranging from 70% to 74% of the harvest. Alaska residents accounted for 86% and 85% of the reported harvest, respectively, during the 1993–94 and 1994–95 regulatory years.

Hunter success was 45% for the 1993–94 season and 43% for the 1994–95 season (Table 1). Although the size of the harvest and the number of hunters have declined in Unit 22 during recent years, hunter success rates have remained relatively stable during the last 5 years, ranging from 40% to 50%.

Harvest Chronology. Most of the hunter effort and reported harvest (75% during the 1993–94 and 1994–95 regulatory years) occurred during August, September, and October when access from roads and rivers was most favorable (Table 5). Hunting for antlerless moose also occurred during December in Units 22B and 22D. This is similar to the harvest pattern reported by Nelson (1995) for the previous reporting period.

Transport Methods. Hunters using highway vehicles, off-road vehicles and four wheelers, boats equipped with jet units, and snowmobiles accounted for over 90% of the harvest in Unit 22 during the reporting period (Table 6). Only 4% of the successful hunters during 1993–94 and 8% during 1994–95 reported using aircraft for access. Nelson (1995) reported a similar aircraft usage pattern during the previous reporting period.

The number of hunters harvesting moose along the road system using highway vehicles for transportation has declined substantially during recent years. Hunters using only highway vehicles accounted for 30% of the harvest (90 moose) during 1991–92, 24% (70 moose) during 1992–93, 18% (45 moose) during 1993–94, and 17% (35 moose) during 1994–95. During the period from 1991 to 1994, the reported moose harvest for Unit 22 declined by 30% (91 moose). Hunters using highway vehicles as their only method of transportation caused 61% of the harvest decline (55 out of 91 moose). Moose densities are now very low along the road corridor and hunters must travel to areas far from the road system to find suitable numbers of animals.

Some local residents believe the use of four wheelers by hunters is too efficient and should be more heavily regulated. Four-wheel-drive four wheelers, which became widely available during the late 1980s, have improved access to remote areas, particularly in areas characterized by open terrain such as Unit 22D. However, harvest data indicate the number of successful hunters using four wheelers as transportation has declined from 68 (23% of the harvest) during 1991–92 to 39 (18% of the harvest) during 1994–95, presumably because fewer moose were available in the areas accessible by four wheelers.

The number of successful hunters using aircraft, boats, and snowmobiles for transportation has remained relatively stable since 1991. Since the overall harvest in Unit 22 has declined, the proportion of the harvest attributable to these means of transportation has increased. During the 1991–92 regulatory year, hunters using aircraft, boats and snowmobiles accounted for 6%, 17%, and 15% of the harvest, respectively. During the 1994–95 regulatory year, hunters using aircraft accounted for 8% of the harvest, boats 27% of the harvest, and snowmobiles 24% of the harvest.

Other Mortality

We did not complete surveys to determine natural mortality rates among Seward Peninsula moose during the reporting period. However, observations reported by local residents and agency staff suggest overwinter mortality rates during late winter and early spring 1995 were substantial in some portions of Unit 22B and 22C. Heavy snowfall came unusually early during October 1994, and by March 1995 snow depths were deep, particularly in the southern Seward Peninsula region. Many of the moose handled during the 1995 collaring project in Unit 22B were in relatively poor condition, presumably from physical stress caused by deep snow conditions.

Habitat

Assessment

Winter ranges, particularly in portions of Units 22B, 22C, 22D and 22E, have been heavily browsed during past years. We have not completed quantitative assessments to determine the availability and quality of winter ranges in Unit 22. However, during April 1995 staff observed that willows in some lowland riparian habitats in the Fish River drainage were not available to moose because of heavy snowfall. Moose were forced to browse on large-diameter, less nutritious willow branches because of poor browse availability.

CONCLUSIONS AND RECOMMENDATIONS

The moose population, which had grown steadily in size during the 1960s and 1970s, began to decline during the late 1980s and early 1990s. Noticeable declines in density and productivity are now evident in portions of Unit 22. Data from censuses and surveys during the late 1980s show the population reached a maximum size of 7000 to 10,000 moose. Subsequent declines caused by winter mortality, reduced productivity, and increased natural mortality have reduced the population size to between 5000 and 7000 animals (Nelson 1995). Comparison of recent census results from Units 22B and 22D with previous census data supports the conclusion that moose numbers have declined. Although some portions of Unit 22 show increased recruitment rates and population recovery, low recruitment rates are probably preventing recovery of the population in western Unit 22B.

We began a research study to evaluate factors contributing to low recruitment in western Unit 22B. We radiocollared 27 female moose and plan to relocate these animals and their calves at periodic intervals to determine distribution and calf survival. These data will help identify the factors responsible for low recruitment rates. Preliminary results of this study will be presented in the next segment report.

Interest in hunting moose in Unit 22 was moderate throughout the 1970s. However, this interest sharply increased during the early 1980s and peaked in 1983 when 1292 individuals hunted in Unit 22 (Table 1). Although hunter effort has since declined, hunter success rates have remained high.

Reported harvests fell to a 15-year low during the 1994–95 season in response to decreasing numbers of available moose. Most of the decline was borne by individuals who hunted on the Nome road system and only used a highway vehicle as transportation to access hunting areas. Observations by the public, staff, and harvest reports indicate moose numbers along the road corridor are now very low, particularly in Units 22B and 22D.

The reported number of moose harvested by hunters using four-wheelers has declined during the reporting period. Since their introduction during the 1980s, the use of four-wheelers has become extremely popular among Seward Peninsula residents, particularly those with access to the Nome road system. Although they are very efficient for use in the open country (western Unit 22), their range is limited to within 20 to 30 miles of the road. Their use has allowed hunters using the road system to extend available hunting area. The harvest decline for hunters using four-wheelers is in response to reduced numbers of moose in the areas accessible by four-wheelers.

Although moose numbers seem to be recovering in portions of Unit 22, large areas accessible to hunters still have very few moose. During the fall of 1993 and 1994 in Unit 22B, 22C, and 22D, large concentrations of rutting moose were observed only in remote areas characterized by poor access. This pattern has become especially noticeable during the last 3 years. Because of open terrain that characterizes much of Unit 22, moose are very vulnerable to hunters, particularly during the rutting period. To increase moose densities in areas accessible to hunters, more regulatory restrictions will be necessary. These restrictions may include, but are not limited to, reduction or elimination of cow seasons, antler size restrictions for bulls, shorter seasons, and vehicle access restrictions.

Illegal and/or unreported harvest remains a problem throughout the unit because some local residents do not acquire harvest tickets prior to hunting and moose are taken out of season. It is difficult to accurately measure the illegal harvest. However, Nelson (1995) estimated the illegal harvest ranged from 10 to 20 percent of the reported harvest. Public education programs and a visible enforcement effort must be maintained to gain compliance with current regulations.

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Table 1 Unit 22 historical moose harvest by sex, hunter effort, and success rate for regulatory years 1969–94

Regulatory year	Males	Females	Unknown sex	Harvest	Hunters	Percent success
1969-70	69	1	2	72	182	40
1970-71	70	0	1	71	139	51
1971-72	59	0	1	60	168	36
1972-73	44	0	0	44	99	44
1973-74	103	32	1	136	317	43
1974-75	149	72	1	222	479	46
1975-76	136	0	2	138	389	25
1976-77	186	51	3	240	611	39
1977-78	151	88	5	244	457	53
1978-79	198	97	2	297	596	50
1979-80	193	75	2	270	760	36
1980-81	156	71	1	228	492	46
1981-82	225	72	1	298	696	43
1982-83	244	100	0	344	904	38
1983-84	291	68	46	405	1292	31
1984-85	298	91	6	395	1086	36
1985-86	279	92	3	374	876	43
1986-87	306	101	1	408	892	46
1987-88	286	20	4	310	775	40
1988-89	332	36	7	375	748	50
1989-90	208	82	0	290	713	41
1990-91	280	70	0	350	700	50
1991-92	207	95	0	302	656	46
1992-93	217	72	0	289	645	45
1993-94	225	21	1	247	553	45
1994-95	201	10	0	211	486	43

[a] Minimum known number of hunters.

Table 2 Unit 22 aerial moose composition surveys, fall of 1992 and 1994

Survey area	Year	Bulls per 100 cows	Yearling bulls per 100 cows	Calves per 100 cows	Calves	Percent calves	Adults	Moose
American Creek	1992	58	17	10	4	10	38	42
(Unit 22B)	1994	28	28	28	8	18	37	45
Snake River	1992	11	3	30	11	21	41	52
(Unit 22C)	1994	14	11	32	12	22	42	54
Henry/Washington Creek (Unit 22D)	1994	40	19	23	22	14	133	155

Table 3 Unit 22 short yearling recruitment surveys, spring of 1991–95

Count area	Year	Calves	Adults	Moose	Percent Calves
Fish River	1991	12	202	214	6
(Unit 22B)	1993	11	227	238	5
	1994	15	255	270	6
	1995	16	384	400	4
Niukluk River	1991	30	319	349	9
(Unit 22B)	1995	13	133	146	9
Snake River	1993	15	63	78	19
(Unit 22C)	1994	18	39	57	32
Lower Kougarok River	1991	14	103	117	12
(Unit 22D)	1994	33	153	186	18
	1995	42	227	269	16
Kuzitrin/Noxapaga River	1991	23	191	214	11
(Unit 22D)	1994	16	71	87	18
	1995	67	348	415	16
American River	1995	51	248	299	17
(Unit 22D)					

Table 4 Residency and success of moose hunters in Unit 22 subunits for regulatory years 1993–94 and 1994–95

	Successful hunters residency					Unsuccessful hunters residency				
	Unit	State	Nonresident	Unknown	Total	Unit	State	Nonresident	Unknown	Total
1993-94										
22A	20	2	0	0	22	52	4	1	0	57
22B	49	13	19	2	83	39	17	10	1	67
22C	20	3	0	0	23	27	4	3	0	34
22D	77	11	10	2	100	95	14	8	4	121
22E	16	2	1	0	19	4	0	0	0	4
22 unknown	0	0	0	0	0	17	5	1	0	23
Total	182	31	30	4	247	234	44	23	5	306
1994-95										
22A	14	0	1	3	18	34	0	0	0	34
22B	30	9	17	0	56	44	12	7	0	63
22C	26	3	0	0	29	42	8	0	1	51
22D	65	14	8	1	88	94	21	5	1	121
22E	18	1	0	1	20	3	0	0	0	3
22 unknown	0	0	0	0	0	3	0	0	0	3
Total	153	27	26	5	211	220	41	12	2	275

[a] Local resident of Unit 22
[b] Nonlocal Alaska resident

Table 5 Chronology of the Unit 22 moose harvest by Subunit for regulatory years 1993–94 and 1994–95

Subunit	Month of harvest								Unknown	Total
	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.		
1993-94										
22A	5	13	1	0	0	2	0	0	1	22
22B	6	39	17	5	11	2	0	0	3	83
22C	0	23	0	0	0	0	0	0	0	23
22D	16	43	18	0	18	3	0	0	2	100
22E	2	2	0	3	3	3	3	3	0	19
Total	29	120	36	8	32	10	3	3	6	247
1994-95										
22A	2	9	0	0	3	2	0	0	2	18
22B	5	28	10	7	4	1	0	0	1	56
22C	0	29	0	0	0	0	0	0	0	29
22D	15	42	17	1	8	2	0	0	3	88
22E	0	2	0	1	4	0	3	10	0	20
Total	22	110	27	9	19	5	3	10	6	211

Table 6 Means of transport reported by successful Unit 22 moose hunters for regulatory years 1991–94

Subunit	Aircraft	Horse	Boat	3- or 4-Wheeler	Snowmobile	Off-road vehicle	Highway Vehicle	Unknown	Total
1991-92									
22A	1	0	11	5	7	0	1	0	26
22B	13	0	14	14	14	1	10	1	67
22C	0	0	2	5	0	1	11	1	20
22D	4	0	23	43	15	17	68	7	177
22E	0	0	1	1	10	0	0	0	12
Total	18	0	51	68	46	19	90	9	302
1992-93									
22A	0	0	8	0	7	0	0	1	16
22B	9	0	7	15	20	5	8	1	65
22C	1	0	4	6	1	0	11	0	23
22D	9	0	18	35	36	11	51	4	167
22E	0	0	3	0	15	0	0	0	18
Total	19	0	40	56	79	16	70	6	289
1993-94									
22A	0	0	17	2	3	0	0	0	22
22B	5	0	27	12	24	3	11	1	83
22C	0	0	0	5	0	2	15	1	23
22D	4	1	22	25	20	4	19	5	100
22E	0	0	3	1	12	1	0	2	19
Total	9	1	69	45	59	10	45	9	247
1994-95									
22A	1	0	11	0	6	0	0	0	18
22B	8	0	12	12	14	5	5	0	56
22C	0	0	6	8	0	2	12	1	29
22D	7	0	27	19	13	4	18	0	88
22E	0	0	2	0	18	0	0	0	20
Total	16	0	58	39	51	11	35	1	211

LOCATION

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

GEOGRAPHIC DESCRIPTION: Western Brooks Range and Kotzebue Sound

BACKGROUND

Moose recolonized Unit 23 during the 1940s and rank second to caribou as a source of red meat for most residents of Unit 23. Local and nonlocal residents, and nonresident hunters avidly hunt moose. Moose hunting provides significant income to guides, outfitters, and transporters who operate within Unit 23. The wide distribution, abundance, and occurrence of moose along river corridors makes them an important wildlife species to nonconsumptive users (e.g., floaters and photographers).

From the time moose reappeared in Unit 23 through the late 1980s, evidence from public comments, trend count surveys, and opportunistic observations by the department shows that moose populations increased throughout the region. The period of 1988–89 through 1990–91 was characterized by severe winters and extensive spring flooding, causing moose populations to stabilize or decline throughout the Kotzebue Basin.

MOOSE SURVEYS

From 1959 until the mid-1980s, we conducted numerous aerial moose counts in Unit 23. Unfortunately, these surveys were not consistent in terms of search intensity, search areas and sex/age classification. The parameters used to monitor moose populations were percentage of calves, percentage of cows with twins, and number of moose observed per hour of aerial survey.

By the mid-1980s, the need for standardized quantitative moose survey techniques was recognized by many biologists throughout the state. In Unit 23 "Gasaway-type" (Gasaway et al. 1986) censuses and trend counts were initiated in 1985 to help standardize data collection procedures. Unfortunately, early attempts to conduct Gasaway censuses were plagued with errors. As a result, Gasaway censuses were abandoned in favor of trend counts for monitoring moose populations in Unit 23.

By 1990, it was evident that trend counts were inadequate for monitoring Unit 23 moose populations. In 1992 we began replacing moose trend counts with more rigorous census techniques. Currently, only the moose population in the Tagagawik area is estimated with trend counts in Unit 23.

In place of trend counts, we initiated a rotating schedule of moose census areas, ranging in size from 1400–2000 mi^2, during November of each year. The census areas include the Squirrel, middle Noatak, upper Kobuk, Tagagawik, and Northern Seward Peninsula drainages. Under the current schedule, 1 census will be attempted each year and each census area will be repeated every fifth year. If possible, full-size censuses will be supplemented with reduced-size censuses (750–1000 mi^2) in drainages where moose populations are declining. Whenever possible, censuses will be conducted cooperatively with federal land managers.

MOOSE TELEMETRY PROJECTS

To further improve our information on moose movements, yearling recruitment, mortality and habitat relationships, we initiated 2 radiotelemetry projects in Unit 23. The middle Noatak telemetry project was started in 1992 and the Tagagawik telemetry study was started in 1994.

The middle Noatak moose telemetry project, a cooperative study with the National Park Service Northwest Areas Park (NPS–NAP), was started for the primary purposes of delineating a suitable moose census area in the middle Noatak drainage and for evaluating the causes and extent of moose mortality in this area. We also hope to evaluate calf production and yearling recruitment as a supplement to census results. Moose have been collared annually from 1992 through 1995, and we plan to continue the radiotelemetry studies into the next reporting period.

The Tagagawik moose telemetry project is an ongoing cooperative study with the Fish and Wildlife Service (FWS) Selawik National Wildlife Refuge acting as the lead agency. The purposes of this telemetry project are the same as the Noatak moose telemetry project. Additionally, we will evaluate moose habitat in the Selawik Refuge.

MANAGEMENT DIRECTION

MANAGEMENT GOALS AND OBJECTIVES

1 Develop an area management plan for Unit 23 by December 1999. This plan needs to consider user-group conflicts as well as biological parameters of the moose population.

2 Monitor the middle Noatak and Tagagawik moose populations using radiotelemetry techniques to improve survey and census techniques for monitoring population size and sex/age composition, and to evaluate the magnitude and causes of moose mortality in these study areas.

3 Monitor the size and sex/age composition of moose populations in the Noatak, Squirrel, upper Kobuk, Tagagawik and Northern Seward Peninsula drainages.

4 Maintain a minimum November bull:cow ratio of 40:100 in each major drainage in Unit 23.

METHODS

Population trend and sex/age composition data were collected from aerial censuses of moose in Unit 23. Stratified random sampling (Gasaway et al. 1986) was used for most censuses; however, simple random sampling was used for the middle Noatak reduced census area during 1995, and linear regression estimation (Ver Hoef, pers commun) was used for the 1995 upper Kobuk census area. We use linear regression census techniques because they accommodate weather delays better than the Gasaway stratified sampling design (Dau et al. 1996). For all censuses, total area of the sample units was calculated, excluding large lakes and mountains devoid of moose habitat.

In this report the term 'full census' refers to a standardized Gasaway census applied to an area of 1400 to 1700 mi^2. The term 'reduced census' refers to a Gasaway census applied to a smaller area, approximately 800 to 1000 mi^2.

A Gasaway census with poor precision was completed on the middle Noatak drainage in March 1985 (James and Cannon 1985). Gasaway censuses were also unsuccessfully attempted in the Selawik National Wildlife Refuge during October 1985 (Larsen et al. 1986*a*), and in the Squirrel drainage during November 1985 (Larsen et al. 1986*b*).

Successful Gasaway censuses were completed for: 1) the entire Squirrel River in cooperation with the Bureau of Land Management (BLM) in 1992 (Morkill and Dau 1993), and 2) the entire middle Noatak drainage in cooperation with NPS–NAS in 1993 (Dau et al. 1994). A linear regression census was completed in the upper Kobuk drainage during 1995 in cooperation with NPS Gates of the Arctic Park (NPS–GAA; Dau et al. 1996).

A standard Gasaway census was conducted in the western portion of the middle Noatak census area in 1994 (Shults et al. 1995). The western portion of the middle Noatak census area was censused in November 1995 using a simple random sample design (Shults, unpubl. data). A portion of the Salmon River census area was completed in 1995 loosely following the Gasaway technique (Shults, unpubl. data). In the Salmon River census, some sample units were arbitrarily selected prior to completion of the stratification surveys under the assumption that most moose would inhabit riparian habitat along the lower Salmon and main Kobuk Rivers. Sample unit surveys were completed before stratification was finalized because completion of the census was determined by available funding, not by achieving a desired level of variance. All of these "reduced" censuses were conducted in cooperation with NPS–NAP.

We determined natural mortality, distribution, and movements of moose in the Noatak and Tagagawik drainages, using standard radiotelemetry techniques (Dau and Ayres 1993). We collared moose in the Noatak drainage each April during 1992 through 1995, using standard helicopter immobilization techniques. We collared moose in the Tagagawik drainage during April 1994 and 1996, using standard helicopter immobilization methods.

We derived harvest information from hunter harvest reports, the Noatak moose telemetry project, and from conversations with local residents.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Since the 3 Gasaway censuses attempted in Unit 23 during 1985 were unsuccessful, we do not have good estimates of population size and composition based on standardized census techniques (Dau et al. 1994). Results of the 1993 middle Noatak full census confirmed that trend count data do not accurately reflect moose population density or composition outside the trend count area (Dau et al. 1994). Consequently, it is inappropriate to compare results of the 1992–95 censuses with previous survey results to quantify temporal changes in moose density or composition. However, opportunistic observations by department staff and reports from local residents, transporters, and guides indicate that moose density in the middle Noatak drainage declined substantially during 1988–91.

Full censuses conducted since 1992 indicate moderate moose densities throughout Unit 23 (Table 1). Moose density was the highest in the Squirrel drainage (0.95 moose/mi^2, and 0.77 adult moose/mi^2) and the lowest in the upper Kobuk drainage (0.57 moose/mi^2, and 0.51 adult moose/mi^2). Moose density in the middle Noatak drainage was at an intermediate level (0.69 moose/mi^2, and 0.59 adult moose/mi^2).

Full census areas are 4 to 10 times larger than the size of trend count areas, and reduced censuses are 2 to 4 times larger than trend count areas. Because of their larger sizes, full census and reduced census estimates are better indicators of overall moose populations than trend counts. Even so, census data are subject to some of the same limitations inherent in trend counts. For example, differences between the 1993 middle Noatak full census and reduced census estimates of moose density and population composition illustrate that census results are often affected by the size and geographic location of the census area. Therefore, census estimates are best used to reflect temporal changes in population parameters rather than cardinal estimates of abundance or composition. Census results should be viewed as indicators for larger areas, but they should not be extrapolated to areas outside census boundaries.

Multiple census estimates are available only for the middle Noatak drainage in Unit 23. These results indicate that moose density in the reduced census area is probably stable (Table 1). The apparent increase in density during 1995 should be viewed with caution, considering the high variance of the estimate. We conducted the 1995 reduced census as a simple random sample (i.e., without stratification), hence the large variance. This does not necessarily mean the overall middle Noatak drainage moose population is stable. The middle Noatak reduced census area contains areas that consistently receive high use by moose. High-use areas are probably less sensitive to changes in abundance than moderate- and low-use areas. Reduced censuses in this area are useful for monitoring changes in population composition, but they may not accurately reflect changes in abundance.

Population Composition

Census results indicate bull:cow ratios are above the Unit 23 population objective of 40:100 in the upper Kobuk and Salmon drainages (Table 1). The Salmon drainage is totally within Kobuk Valley National Park. This area is closed to all hunters not recognized by the NPS as subsistence users, and it is closed to the use of aircraft for hunting (regardless of subsistence-user qualification). Therefore, essentially no trophy hunting occurs in this drainage. The subsistence harvest of moose in the Salmon drainage is low because moose are available near villages in the area.

The upper Kobuk moose population received little hunting pressure until approximately 1993–94. Access into this area is limited, and the area is difficult to hunt because of expansive, dense spruce forests and long distances to the regional supply centers of Kotzebue and Bettles. Little subsistence harvest of moose occurs east of the Pah River because moose are available closer to neighboring villages and the upper Kobuk River is too shallow to allow travel with propeller-driven outboard boats. However, we believe the number of commercial operators in the upper Kobuk drainage is increasing, and with relatively low densities of moose in this area, increased hunting harvest could affect bull:cow ratios, despite difficult hunting conditions in this area.

Bull:cow ratios in the Squirrel and middle Noatak drainages were slightly below the moose population objective in 1992 and 1993, respectively (Table 1). This is the consequence of intense trophy hunting by nonlocal resident and nonresident hunters. Reduced census results in the middle Noatak drainage during 1993, 1994 and 1995 indicate the bull:cow ratio is declining. Numbers of guides and transporters operating in the Squirrel drainage increased during 1993–95 which greatly increased numbers of nonlocal hunters. During the fall 1995–96 hunting season, few caribou migrated through the Squirrel drainage so hunters concentrated their effort on moose. As a result, bull:cow ratios may be declining in the Squirrel drainage.

Calf:cow ratios varied widely among census areas and/or years (Table 1). Compared to other census areas, this ratio was consistently low in the middle Noatak drainage during 1993–95.

Distribution and Movements

Noatak moose telemetry project. The lower Kelly River, lower Wrench Creek, and that portion of the Noatak River between the Agagashashok and Kugururuk Rivers consistently contains a large proportion of the middle Noatak moose population from mid November through early May. This is particularly true during heavy snow years. In years of light snow cover, large bulls tend to segregate from small bulls, cows, and calves by remaining in the upper portions of major Noatak River tributaries. Use of the middle and lower Kugururuk River varies from very light to heavy by wintering moose. Deep, wind-consolidated snow in riparian habitat forces moose to aggregate in open tundra and crater for food much like caribou.

During September through early November, moose use treeline areas heavily in the Mulgrave Hills. Moose are widely dispersed during this time of year.

The distribution of moose is least clumped during summer. Calving begins in late May and extends into mid to late June. Cows are found in dense spruce or willow habitat during parturition.

Collared Noatak moose have exhibited a variety of movements. In each of the winters of 1992–93, 1993–94 and 1994–95, 1 to 4 collared bulls moved into the northern foothills of the DeLong Mountains and onto the North Slope, where most survived the winter and returned to the Noatak drainage the following summer or fall. Bulls and cows also traveled south to the northern tributaries of the Kobuk River, and on 2 occasions were found within several miles of the Kobuk River. A bull collared on the Nimiuktuk River traveled 68 miles east to the Pupik Hills and died. A cow collared in the southern Noatak Flats first traveled 30 miles east to the upper Squirrel River, and then 114 miles northwest to die approximately 10 miles northwest of Cape Thompson (all distances are straight-line statute miles).

Although the Noatak drainage seems to be the core range of this moose population, it is only part of a much larger area used by moose. The area used by moose extends from the western Alaska coast to Howard Pass, and from the Kobuk River to at least 30 miles onto the North Slope. Movements of radiocollared moose in this area indicate that animals which leave their established home ranges and travel long distances suffer higher mortality rates than moose which remain in small areas.

Tagagawik moose telemetry project. Unlike the wide-ranging moose in the Noatak moose telemetry project, moose collared in the Tagagawik drainage have exhibited extreme fidelity to the main Tagagawik River and north facing hillsides immediately west of the river. One bull moved to the headwaters of the Inglutalik River and East Fork of the Koyuk River. Another bull moved west to the hills north of Granite Mountain and was not located again. A third bull spent the rut on the south side of the Waring Mountains and then returned to the Tagagawik River area.

MORTALITY

Harvest

Seasons and Bag Limits.

1993-94 and 1994-95

	Resident/ Subsistence Hunters	Nonresident Hunters
Noatak drainage		
One moose, however, antlerless moose may be taken 1 Nov.-31 Mar.; cows with calves may not be taken	1 Aug.-15 Sep. 1 Oct.-31 Mar.	
One antlered moose with spike-		1 Sep.-15 Sep.

fork or 50-inch antlers

Remainder of Unit 23

One moose, cows with calves may not be taken	1 Aug.-31 Mar.
One antlered moose with spike-fork or 50-inch antlers	1 Sep.-20 Sep.

Board of Game Actions and Emergency Orders. In 1993–94, all moose hunting in the Noatak drainage was closed during September 16–30 to reduce the moose harvest in that area. Previously, the resident hunting season ran continuously from August 1–March 31, and the nonresident hunting season extended from September 1–September 20. Additionally, the resident antlerless hunting season was shortened from August 1–March 31 to November 1–March 31 in the Noatak drainage. The Board of Game reauthorized the Unit 23 antlerless moose season in 1994–95, following the same modifications for the 1993–94 hunting season.

In 1994–95, the Noatak Controlled Use Area (NCUA) was increased in size to reduce conflicts between local and nonlocal hunters. The original controlled use area extended 5 miles on either side of the Noatak River from the mouth of Sapun Creek to the mouth of the Kugururuk River, a length of roughly 65 miles and an area of approximately 650 mi^2. The enlarged NCUA extended 5 miles on either side of the Noatak River from the mouth of Sapun Creek to the mouth of the Noatak River, a length of roughly 160 miles and an area of approximately 1600 mi^2. In April 1995 the Board of Game took no action on a proposal to reconsider the size of the NCUA because information from 1 hunting season (1994–95) was inadequate to evaluate effects of the increased size of the NCUA.

Hunter Harvest. Casual conversations with numerous local residents indicate a substantial number of moose harvested by unit residents are not reported each year. Quimby and James (1985) estimated residents of Unit 23 report only 14–24% of the actual moose harvest.

Community-based moose harvest assessments in Kivalina (1984), Shishmaref (1989), and Kotzebue (1991), when extrapolated to similar villages throughout Unit 23, indicate approximately 177–343 moose are harvested by local residents annually (ADF&G Subsistence Div., unpubl. data). This range does not reflect a confidence interval around a point estimate of harvest. Instead, it represents 2 community-based estimates (66 vs. 234) of the number of moose harvested by residents of Kotzebue. The actual number of moose harvested by residents of Unit 23 is probably within this range during most years.

In comparison, the mean annual reported harvest for residents of Unit 23 has been 80 moose (SD = 28) during the period 1984-85 through 1994–95. Ignoring the influence of the declining trend in local resident moose harvest (Figure 1), the difference in these harvest estimates indicates that reported harvests underestimate the actual harvest of moose in Unit 23.

The underreporting of moose harvest by local residents may pose a problem if harvest levels increase unexpectedly. Current harvests show that even when caribou are available, local residents harvest a substantial number of moose in Unit 23. If caribou become unavailable, either through a shift in distribution or population decline, the harvest of moose by local residents of Unit 23 would almost certainly increase. If the increase in harvest is not identified through harvest reports, the effect on the moose population may not be detected in a timely manner.

Harvest data for nonlocal hunters appear more accurate than for local hunters. Harvest estimates do not include moose killed in defense of life or property, wounding losses, or illegal kills.

Reported moose harvests during 1993–94 and 1994–95 were lower than any year since 1985–86 (Table 2). The Unit 23 reported moose harvest has steadily declined since 1988-89, the highest reported year (Fig. 1).

Reported harvests probably substantially underestimate actual harvests. If only 10–20% of the actual harvest is reported by local hunters, Unit 23 residents alone could have taken 80–160 moose in 1993–94 (vs. 16 moose reported) and 30–60 moose in 1994–95 (vs. 6 moose reported). It is reasonable to consider that local residents could harvest 150–200 moose annually for food in Unit 23. This approximation of moose harvest by local residents of Unit 23 is strongly influenced by the availability of caribou.

The harvest of female moose was small during 1993–94 and 1994–95 (Table 3) and also small in relation to the total harvest (13% and 5%, respectively). No radiocollared female moose have been harvested in the Noatak or Tagagawik drainages (Tables 4 and 5). Since the 1988–89 regulatory year, numbers of harvested males and females have been almost equal (38 males and 33 females) during January 1–March 31 when most bulls are without antlers. In every year since 1988–89, more female moose were harvested before January 1 than after this date.

No change in harvest among antler-width classifications was evident during 1993–94 or 1994–95 compared to previous years (Table 6).

In 1993–94, the Noatak drainage provided 36% of the moose harvest (48 of 135 moose; Table 7) in Unit 23. In 1994–95, the percentage was 42% of the moose harvest (56 of 133 moose). A total of 125 moose hunters were in the Noatak drainage in 1993–94 and 114 hunters were present in 1994–95, substantially fewer than since 1985–86. In both years hunting seasons and bag limits were identical. Hunter success rates were 38% (1993–94) and 49% (1994–95). Fewer hunters in the Noatak drainage during this reporting period may be explained by: 1) extension of the Noatak Controlled Use Area (NCUA) during the 1994–95 regulatory year; 2) word-of-mouth dissatisfaction with moose hunting conditions in the Noatak drainage (crowding and escalating user-group conflicts near Noatak village);

3) local departmental hunting advisory of declining bull:cow ratios in the Noatak drainage or; 4) random annual variability in the distribution of hunters among Unit 23 drainages.

In 1993 the adult moose mortality rate in the Noatak telemetry project area (27 deaths:100 adults; Table 4) exceeded calf recruitment (18 calves:100 adults, 1993 middle Noatak full census; Table 1). In 1994, adult mortality again exceeded calf recruitment (20 adult deaths:100 adults vs. 11 calves:100 adults), although the Noatak reduced census area may underestimate calf production (see comparison of the 1993 Noatak full census and reduced census; Table 1). However, there is considerable uncertainty associated with adult mortality and calf recruitment estimates. For example, the 80% binomial confidence interval for adult mortality ranges from 18–37 adult deaths:100 adults in 1992, 19–37 in 1993, and 13–38 in 1994. Similarly, the 80% confidence intervals for recruitment probably ranges more than 50% below and 50% above the calf:100 adults ratio.

The uncertainty associated with the estimates of mortality and recruitment does not devalue the quantitative information collected to monitor the Noatak moose population. On the contrary, if our estimates indicate mortality is consistently exceeding recruitment, the population is probably declining, even if this trend is not statistically significant. In this case, quantitative information with high variability supports the qualitative assessment of population decline.

Natural mortality was the primary factor influencing the overall Noatak moose mortality rate in 1992 and 1993 (Table 4). In 1994, however, human harvest exceeded natural mortality, but this may be an artifact of small sample sizes rather than actual changes in sources of mortality.

Telemetry results indicate adult moose mortality is lower in the Tagagawik drainage than in the Noatak drainage (Tables 4 and 5). Currently, there are no satisfactory estimates of recruitment for comparison with adult mortality rates in this area. Estimates of calf recruitment from trend counts indicate that adult mortality exceeded the fall calf:adult ratio in both 1994 (14 adult deaths:100 adults vs. 10 calves:100 adults) and 1995 (12 adult deaths:100 adults vs. 9 calves:100 adults). Throughout Alaska, however, trend count data are considered unreliable for monitoring moose population size or composition. The similarity of estimated adult mortality and calf recruitment in both years indicates the population could be stable or even increasing in size, given the imprecision and possible bias of these estimates.

Hunter Residency and Success. The reported number of moose hunters in Unit 23 has been declining since 1991–92 (Fig. 3). Numbers of nonresident and local resident moose hunters have declined since 1988–89 (Figs. 4 and 1, respectively), while numbers of nonlocal resident moose hunters have increased during the same time period (Fig. 5). Moose hunter success has declined since 1987–88 (Fig. 6).

As in the past, nonlocal resident Alaskans and nonresidents comprised the majority of hunters (79% in 1993–94 and 87% in 1994–95) who reported hunting moose in Unit 23 (Table 2). Harvest data substantially underestimates the number of local resident moose hunters because many local hunters do not purchase hunting licenses or return moose harvest reports. In addition, since local hunters select female moose after the rut begins, we probably disproportionately underestimate numbers of female moose harvested in relation to harvested bulls. Despite poor compliance with reporting requirements by local hunters, the reported harvest serves as an index of the long-term decline in numbers of moose taken by local residents. Local residents prefer caribou rather than moose, and as the Western Arctic Caribou Herd has grown, fewer local residents have harvested moose.

Substantial numbers of nonlocal hunters use Unit 23 for moose hunting in September. Nonlocal moose hunters are not distributed evenly throughout the Unit (Table 3). Most nonlocal hunters use the Noatak, Squirrel, and Tagagawik drainages, although the number of nonlocal hunters has increased in the Kiwalik drainage since 1993. The low bull:cow ratios in the middle Noatak and the Squirrel drainages, compared to other portions of Unit 23, are probably the result of nonlocal hunters' harvesting bulls from this portion of the population.

Nonlocal hunter demand for transporter services in Unit 23 exceeds the availability of these services, despite recent increases in transporters, pilots, aircraft, and guides transporting hunters peripheral to their guiding operations. The disparity between transporter supply and hunter demand has resulted in a proliferation of illegal transporters using boats or airplanes to transport hunters in Unit 23. According to long-time guides, transporters, and residents of northwest Alaska, this problem has a long history in the unit. Because it is relatively easy to conceal illegal activity, the magnitude of this problem has never been determined. The problem is genuine and deserves attention. If illegal transporters are allowed to continue to operate in Unit 23, they will reap large personal financial gains at the expense of law-abiding hunters, commercial operators, and wildlife resources.

The large gap between transporter supply and demand by nonlocal hunters also raises the possibility that Unit 23 could experience rapid increases in nonlocal hunters if transporter services suddenly increase. This could cause overharvest of moose in high-use areas and increased conflicts between local and nonlocal hunters. It will be difficult for the department to respond to rapid seasonal increases in hunter harvests, even through emergency order actions because it is difficult to assess the number of hunters and notify them of emergency regulatory actions.

Bull:cow ratios of <40:100 in the Noatak and Squirrel drainages indicate that nonlocal hunters are already affecting the composition of these moose populations. The large number of nonlocal moose and caribou hunters has also intensified conflicts between local and nonlocal hunters. Finally, many nonlocal hunters believe the quality of hunting in Unit 23 has deteriorated due to localized crowding, unethical activities by guides and transporters, frequent low overflights by small aircraft, and reduced numbers of large bull moose in some portions of the unit.

<u>Harvest Chronology</u>. Just as hunting effort has an uneven spatial distribution in Unit 23, the timing of hunting effort is not distributed evenly throughout the legal hunting season

(Fig. 7). Despite an 8-month moose season in most of the unit, 77% of the reported harvest during the period 1988–89 through 1994–95 has occurred during the month of September (Table 8). Virtually all sport hunting occurs during this time.

Beginning in the 1993–94 regulatory year, the Noatak drainage was closed to all moose hunting Sep 16–31 on state and federal lands to reduce the moose harvest. Noatak drainage moose harvests were lower in 1993–94 and 1994–95 than in any year since 1988–89 (Table 7). However, because moose harvests were already declining before this restriction (Fig. 8), the effect of the 2-week closed season on the Noatak moose harvest is unclear. The proportion of Noatak moose harvested during September declined from an average of 77% (1988–89 through 1992–93) to 72% during 1993–94 and 1994–95. For the period 1988–89 through 1992–93 (prior to the 2-week season closure), only 14% (63 of 462) of the Noatak moose harvest was taken during September 19–30. Therefore, it is not surprising that closing the Noatak drainage to all moose hunting during the last 2 weeks of September did not substantially reduce the Noatak drainage moose harvest. The slight decline in late September moose harvest (after the season closure) suggests a small number of resident moose hunters who intended to hunt the Noatak drainage during late September were displaced and hunted in the Noatak drainage during a different time.

The NCUA was extended from roughly 650 mi^2 to 1600 mi^2 during the 1994–95 regulatory year in an attempt to reduce conflicts between local and nonlocal hunters. The increased size of the NCUA did not reduce the Noatak moose harvest. In 1993–94, the year before the NCUA was expanded, 48 moose were harvested in the Noatak drainage. In 1994–95, the first year of the extended NCUA, 56 moose were harvested. Also, extension of the NCUA did not reduce the success rate of hunters in Noatak drainage. In 1993–94, the Noatak moose hunter success rate was 38%. In 1994–95, the Noatak moose hunter success rate was 49%. Increasing the size of the NCUA undoubtedly displaced some nonlocal hunters in space or time; however, the total effect of this action has been small.

Transport Methods. As reported previously, airplanes were the primary mode of transportation for moose hunters in Unit 23 (Table 9). Hunters using airplanes took 78 (58%) of the reported harvest during 1993–94 and 91 (68%) in 1994–95. Sixty eight percent of hunters reported using airplanes to access moose hunting areas in 1993–94; in 1994–95 this percentage dropped to 65%. Most nonlocal hunters use aircraft for initial access to the area; some then continue hunting by boat. Snowmachines and boats were the next most commonly used means of transportation for taking moose during 1993–94 and 1994–95. Local noncompliance with reporting requirements skews the proportion of hunters accessing hunting areas using airplanes and also distorts the proportion for those using boats and snowmachines; we underestimate the former and overestimate the latter.

Other Mortality

The winter of 1990–91 was exceptionally severe on all ungulates in Unit 23. Winter conditions and spring flooding were also severe during 1988–90. These severe conditions caused drastic winterkill and localized high neonate mortality throughout the unit, especially in the Noatak River drainage. Winterkill was manifested in 2 forms of mortality: direct starvation and predation (predisposed by malnutrition and deep snow). During this period of severe winter conditions, we observed 24 times as many carcasses from winter mortality during spring composition counts in the Noatak and Kobuk River drainages as during any of the preceding 5 years. Combined with high numbers of predators and increasing numbers of nonlocal hunters, the importance of these 3 winters cannot be underestimated in influencing moose populations in Unit 23. This period of time probably represents the inflection point where moose populations changed from a long period of growth to a period of stable or declining numbers.

During the 4 years of the Noatak moose telemetry project, the annual natural mortality rate has averaged 15% (range 7–20%) for the radiocollared moose. Surprisingly, the mean annual natural mortality rate was the same for bulls and cows, although sample sizes yield differing variance around the mean values (SD = 5 and 12 for bulls and cows, respectively). Most sources of natural mortality were not confirmed, but predation appears to be the cause of most deaths. Natural mortality seems to be affecting moose abundance more than hunting mortality. However, like most telemetry studies, the sample sizes for the Noatak moose telemetry study are small, and with only 4 years of data collected, these results should be considered preliminary.

HABITAT

Assessment

The quality of moose habitat has not been critically evaluated in Unit 23. Opportunistic observations indicate moose have moderately or heavily browsed some riparian areas. Even though Unit 23 is at the margin of moose range in Alaska, forage species such as felt leaf willow are capable of producing large quantities of new growth annually in good years (J. Jacobsen and P. Driver, pers commun). The effects of summer growing season conditions and long-term changes in vegetation are probably as important as winter conditions on long-term dynamics of moose populations in Unit 23.

CONCLUSIONS AND RECOMMENDATIONS

A high priority for the department should be the development of a comprehensive area management plan for Unit 23 within the next 2–3 years. This plan should be developed and implemented in cooperation with other land management agencies, local organizations (e.g., NANA and the Northwest Arctic Borough), and all user groups (sport hunters, subsistence users, commercial operators, and nonconsumptive users).

The middle Noatak moose telemetry project should be continued for at least 1–2 more years to monitor the magnitude and causes of moose mortality in this area. Radiocollared moose in the Tagagawik drainage have exhibited strong range fidelity and low mortality. Therefore, the department should remain involved in this project 1 additional year and then reevaluate benefits and costs of this study.

Since hunting pressure in the middle Noatak River drainage continues to be high, bull:cow ratios need to be closely monitored in this area. The management objective of 40 bulls:100 cows should be maintained until a management plan is implemented for the unit. This will maximize management options in the planning process.

Local compliance with harvest reporting requirements continues to be poor. We should continue to inform the public of the need for accurate harvest information. Also, community-based harvest assessment techniques should be employed in Unit 23 villages to estimate moose harvest levels for local residents.

In summary, I recommend the following actions.

1 Draft an area management plan for Unit 23 by December 1999.

2 Continue the Noatak moose telemetry project for at least 1–2 more years.

3 Census a 1400–1600 mi^2 portion of the Tagagawik drainage using linear regression in November 1996, the Squirrel drainage in November 1997, and middle Noatak drainage in November 1998.

4 Conduct community-based harvest estimates of moose for selected villages within Unit 23.

5 Maintain a minimum November bull:cow ratio of 40:100 in each major drainage until a management plan is developed and implemented for Unit 23.

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Figure 1 Three-year running mean number of moose hunters residing in Unit 23, 1979-95

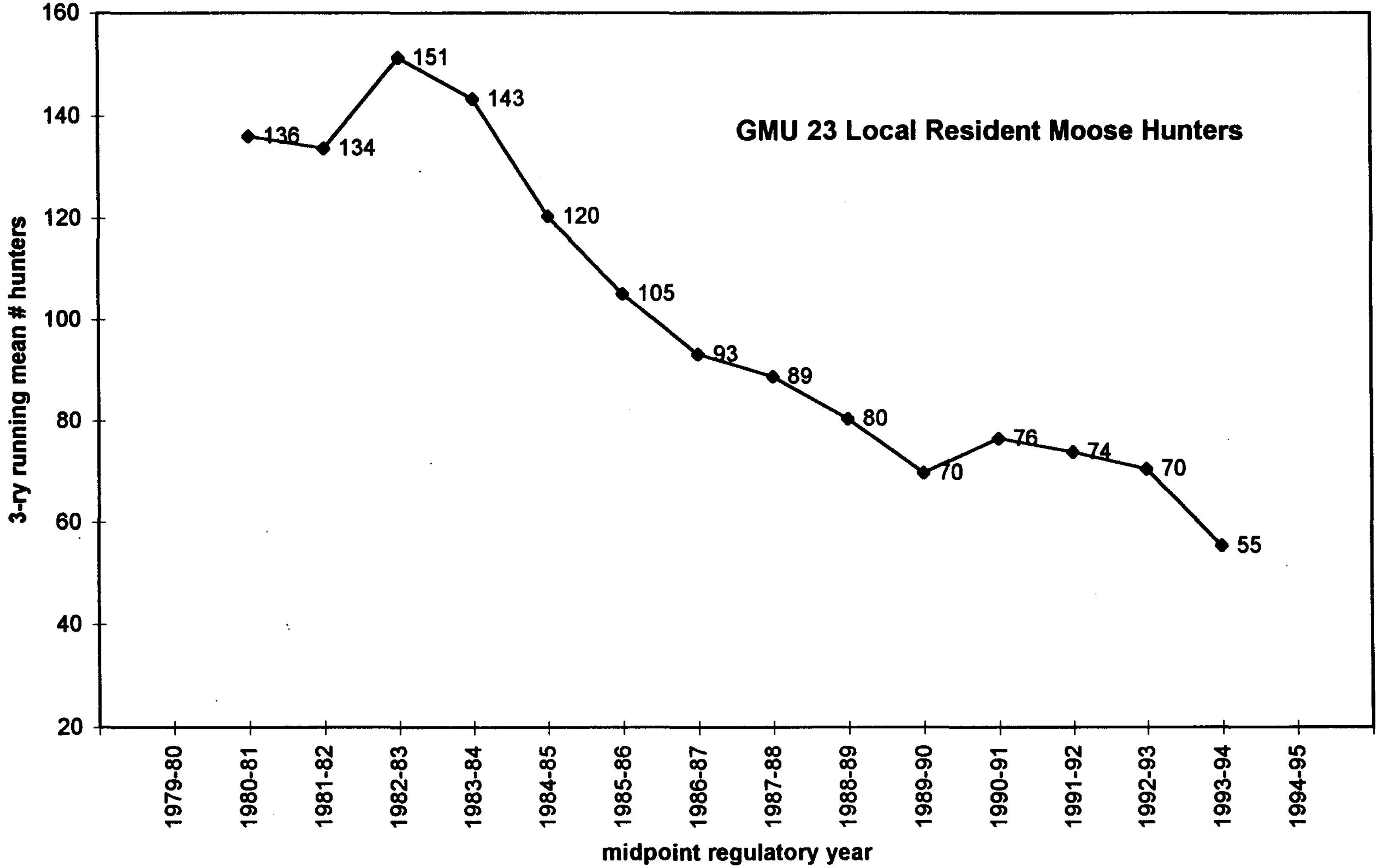

Figure 2 Three-year running mean number of moose harvested in Unit 23, 1979-95

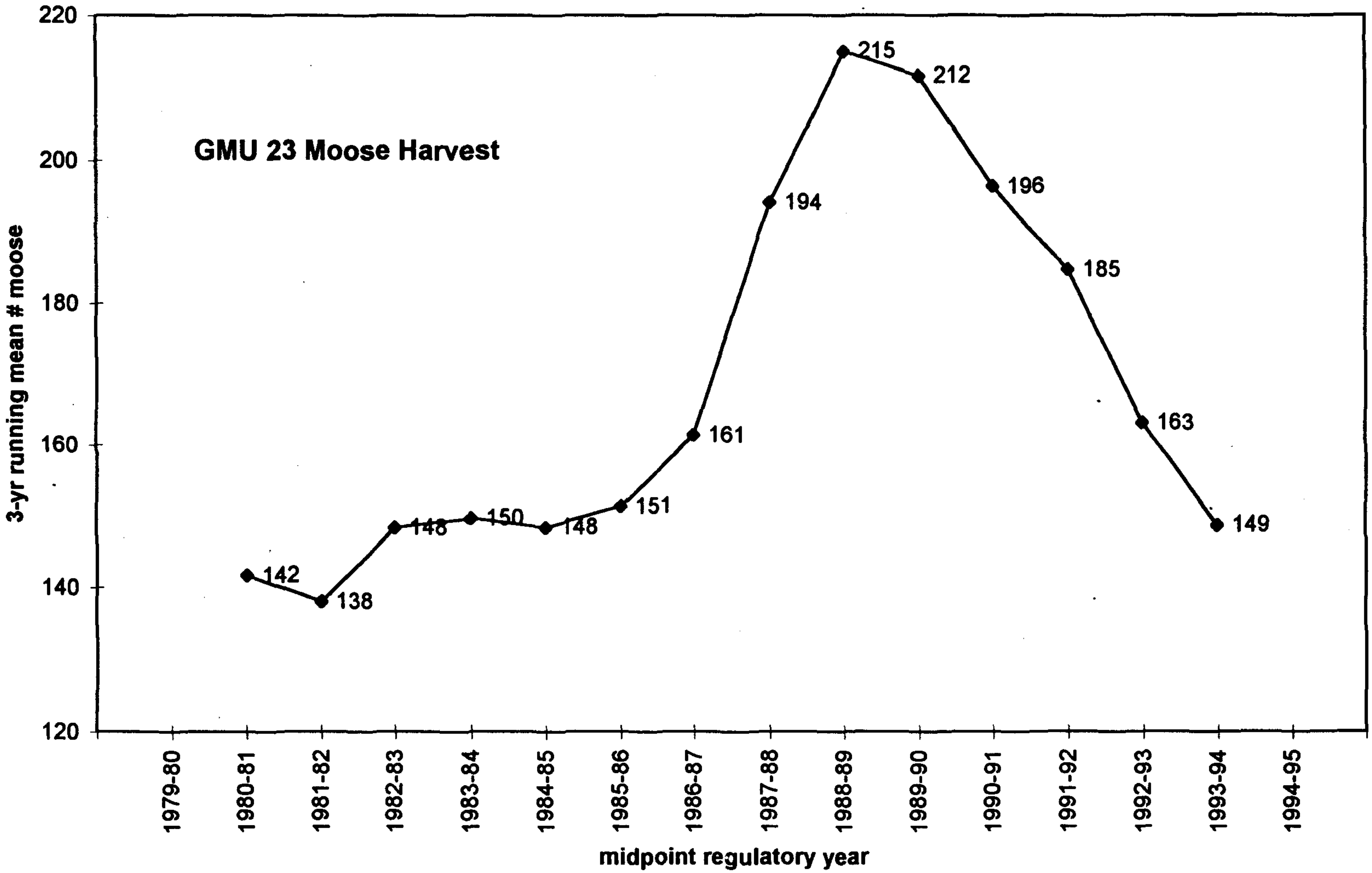

Figure 3 Three-year running mean number of moose hunters in Unit 23, 1979-1995

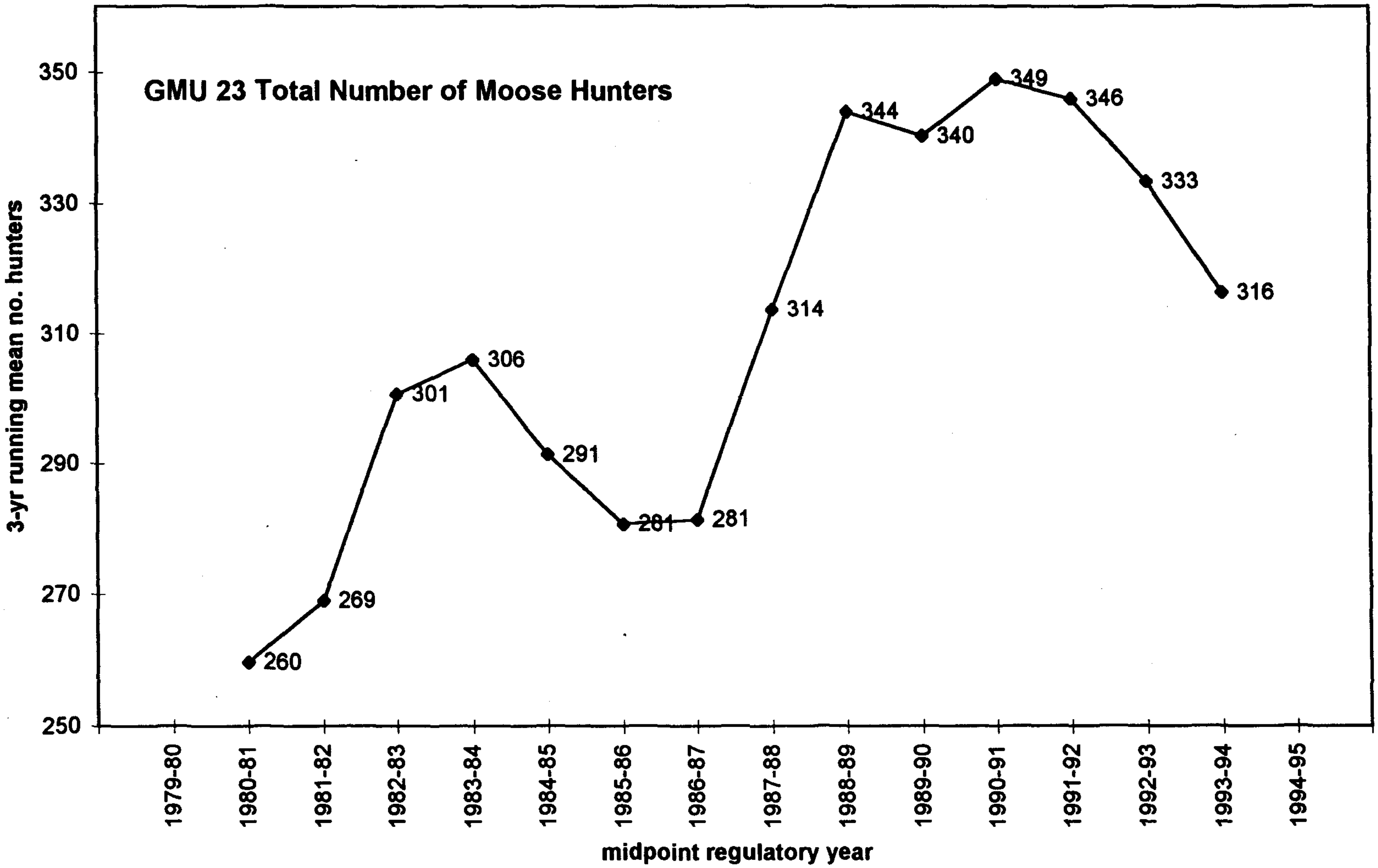

Figure 4 Three-year running mean number of nonresident moose hunters in Unit 23, 1979-95

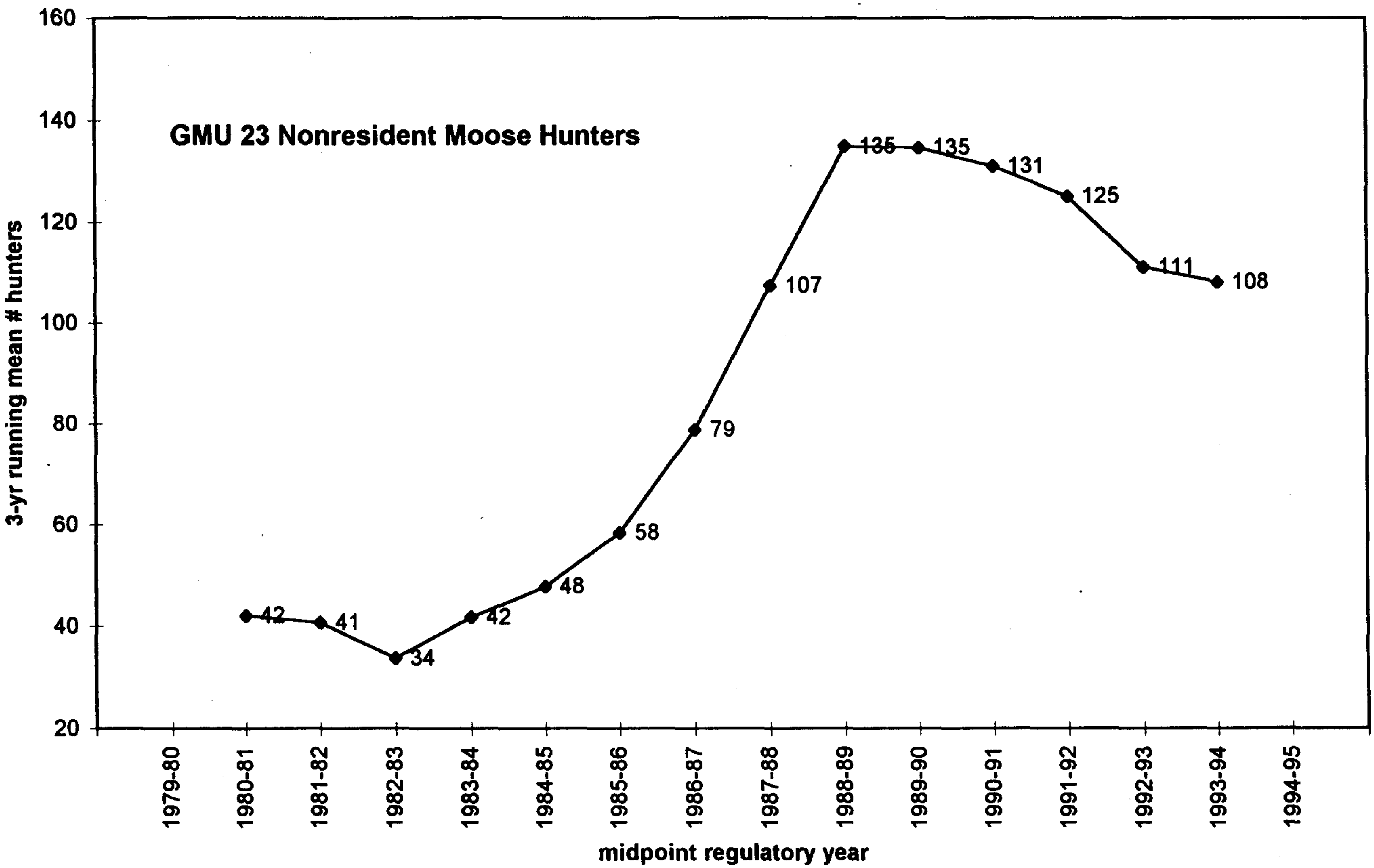

Figure 5 Three-year running mean number of Alaska resident moose hunters residing outside Unit 23, 1980-95

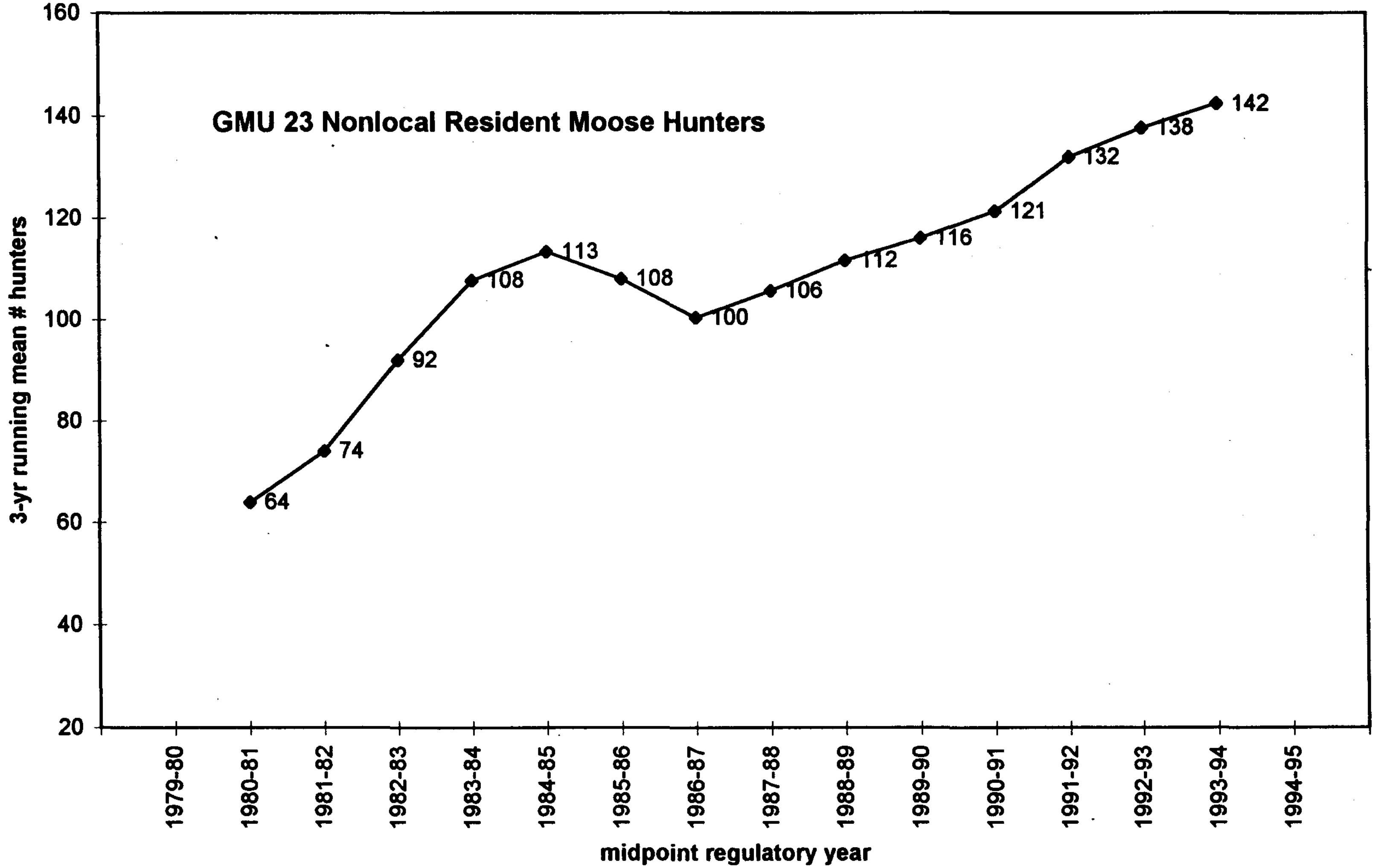

Figure 6 Three-year running mean moose hunter success rate for Unit 23, 1980-95

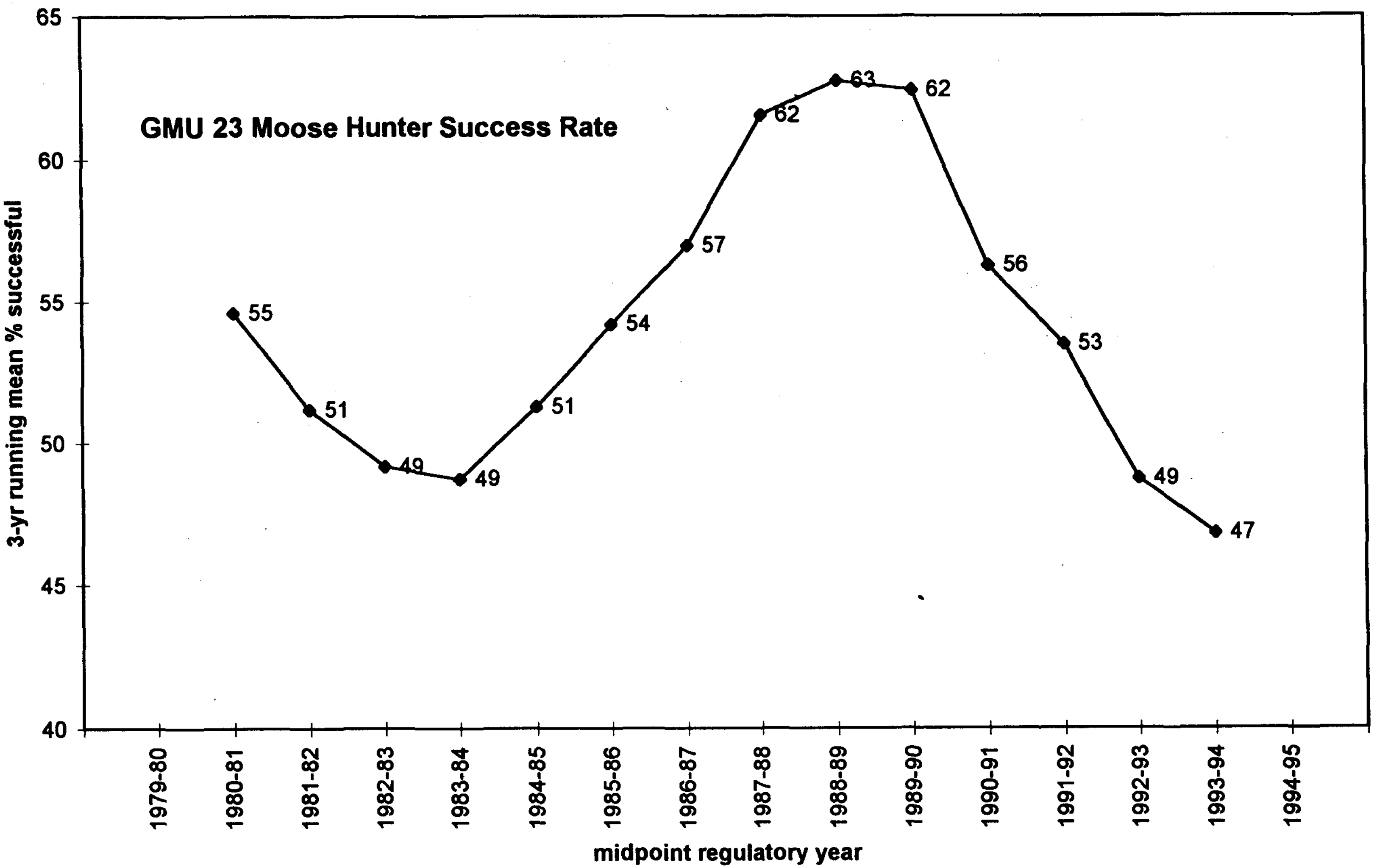

Figure 7 Chronology of Unit 23 moose harvest during 1988-89 through 1994-95 (all years combined)

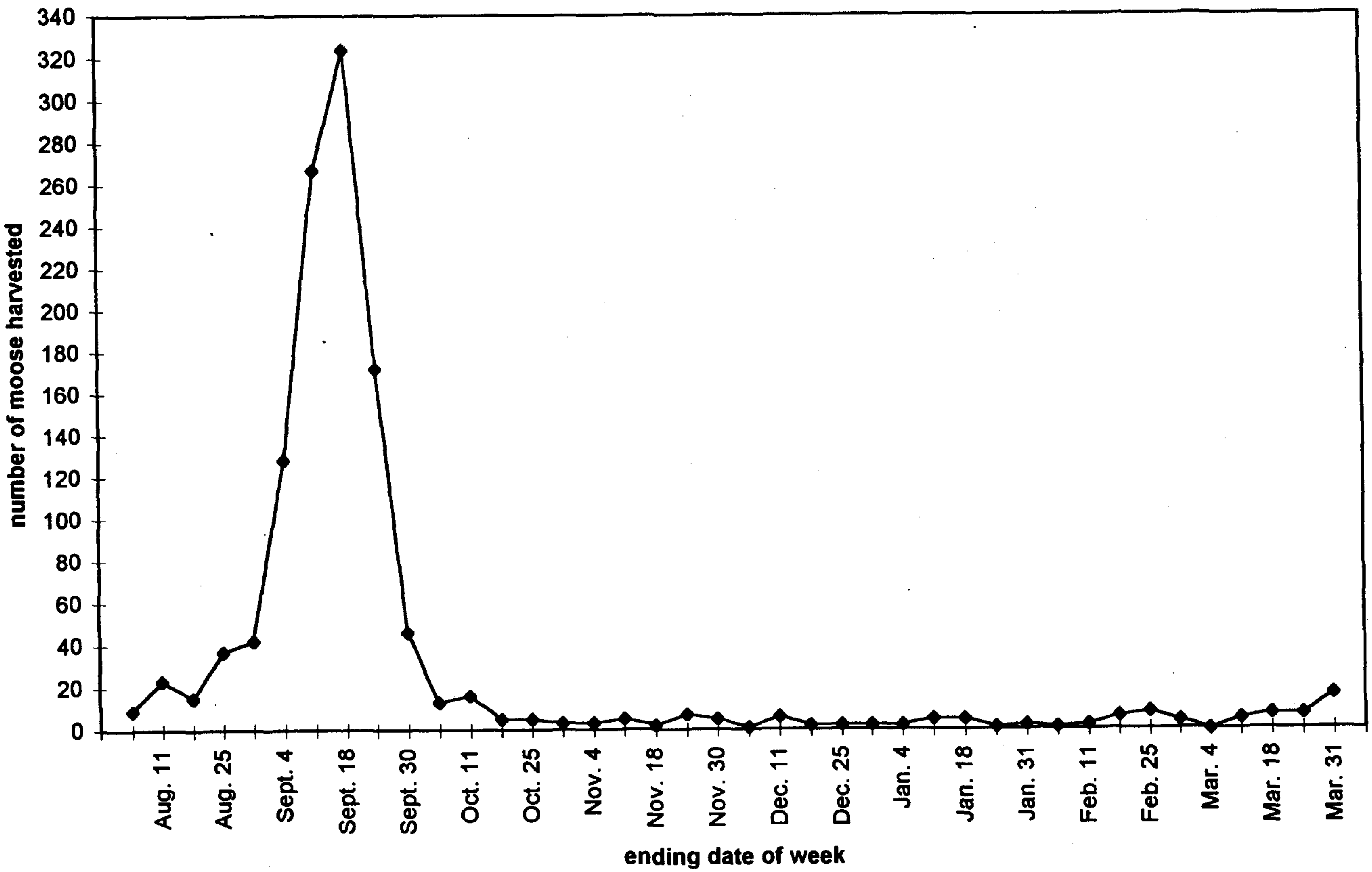

Figure 8. Three-year running mean number of moose harvested in the Noatak drainage, Unit 23, 1978-94

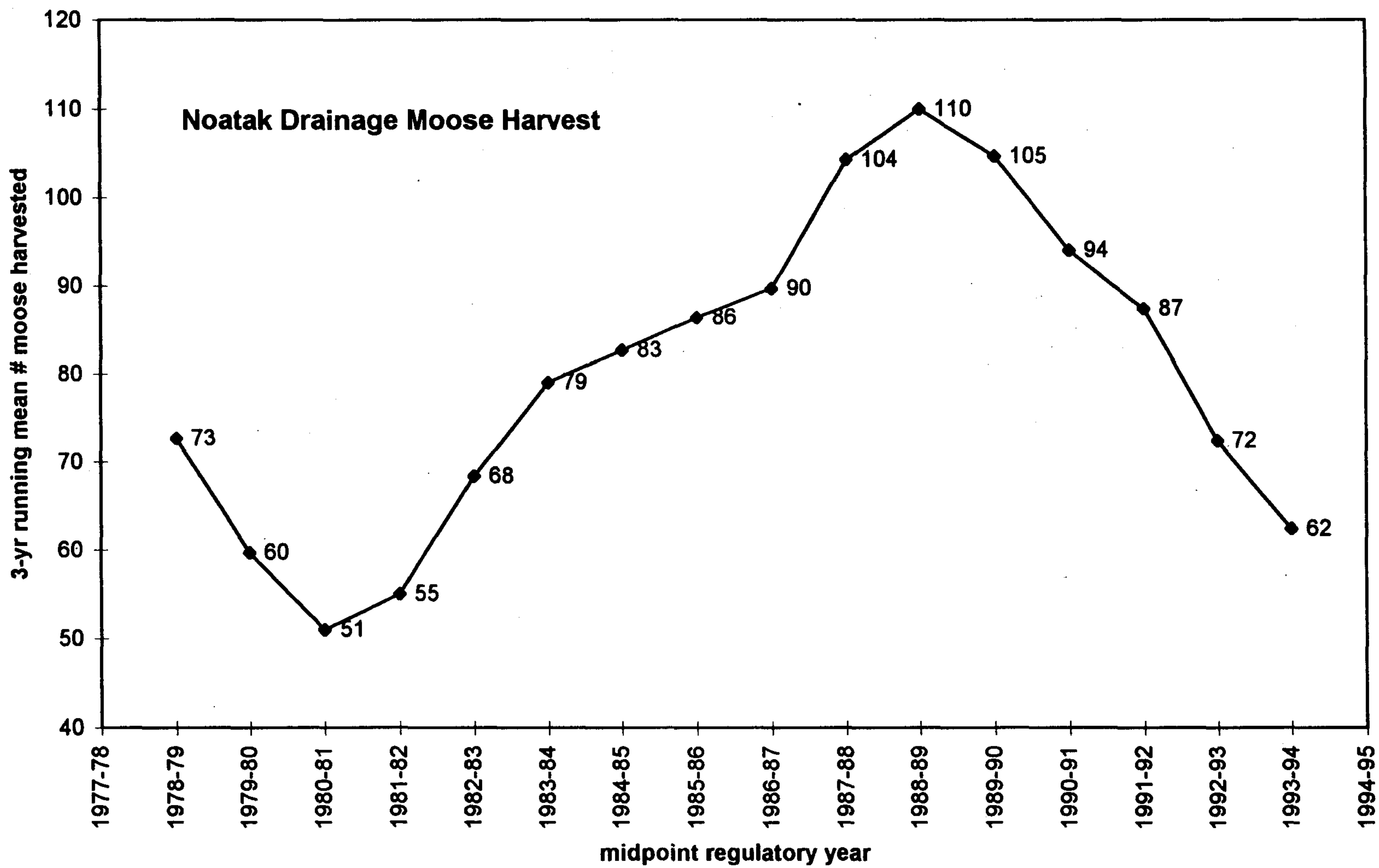

Table 1. Summary of moose census results from Unit 23, 1992-95

			Sample	Moose			Density				Bull:Cow Ratios		Calf:Cow Ratios		
		Area	Units	Observed	Census Estimate		Total	Adult	Estimated No.			80% c.i.		80% c.i	
Census Area	Year	(mi²)	(n)	(n)	Total	80% c.i.	per mi²	per mi²	Adults	Calves	B:100C	B:C ratio	Ca:100C	Ca:C ratio	Method[a]
Squirrel	1992	1440.9	32	346	1372	1124-1621	0.95	0.77	1110	262	37	16	33	17	Std. Gas.
Noatak	1993	1627.9	40	688	1125	989-1260	0.69	0.59	956	169	43	16	25	14	Std. Gas.
W. Noatak	1993	857.5	26	640	977	826-1290	1.14	1.00	855	122	49	17	21	13	Std. Gas.
W. Noatak	1994	857.5	17	564	1000	882-1117	1.16	1.05	897	103	40	33	16	24	Std. Gas.
W. Noatak	1995	857.5	26	544	1140	880-1402	1.33	1.15	986	154	34	13	21	22	SRS
Salmon	1995	891.4	17	147	780	530-1029	0.87	0.67	594	186	78	24	56	16	Std. Gas.
Up. Kobuk	1995	1438.0	37	340	815	633-967	0.57	0.51	730	85	62	32	19	32	Lin. Regr.

[a] Abbreviations are: Std. Gas. = Standard Gasaway technique; SRS = Simple Random Sample; Lin. Regr. = Linear Regression.

Table 2 Annual moose harvest summary: hunter residency and success in Unit 23, 1979-95

	Number and Residency of Hunters					Number of Hunters			Succ	Sex of Harvest		
Year	Local[a]	Nonlocal[b]	Nonres[c]	Unk[d]	Total	Succ.	Unsucc.	Unk.	Rate	Males	Females	Unk.
1979-80	148	51	32	8	239	139	100	0	58	129	10	0
1980-81	99	61	47	4	211	110	101	0	52	97	6	7
1981-82	161	80	47	41	329	176	153	0	53	160	15	1
1982-83	141	81	28	17	267	128	139	0	48	119	8	1
1983-84	152	115	26	13	306	141	165	0	46	129	12	0
1984-85	137	127	71	10	345	180	165	0	52	160	17	3
1985-86	72	98	46	7	223	124	99	0	56	112	12	0
1986-87	106	99	58	11	274	150	124	0	55	139	8	3
1987-88	101	104	132	10	347	210	137	0	61	191	14	5
1988-89	59	114	132	15	320	222	98	0	69	202	14	6
1989-90	81	117	141	26	365	213	152	0	58	200	11	2
1990-91	69	117	131	19	336	200	136	0	60	185	14	1
1991-92	79	130	121	16	346	176	170	0	51	143	33	0
1992-93	73	149	123	11	356	178	178	0	50	154	24	0
1993-94	59	134	89	16	298	135	163	0	45	117	17	1
1994-95	34	144	112	5	295	133	162	0	45	127	6	0

[a] Local residents of Unit 23.

[b] Alaska residents residing outside of Unit 23.

[c] Nonresidents and aliens.

[d] Unknown residency status.

Table 3 Number of moose harvested by sex and drainage in Unit 23, 1993–95

	1993-94				1994-95			
Drainage	Males	Females	Unspec.	Total	Males	Females	Unspec.	Total
Noatak River	42	5	1	48	54	3	0	57
Kobuk River	32	5	0	37	28	2	0	30
Selawik River	25	1	0	26	25	1	0	26
Northern Seward Pen.	15	3	0	18	13	0	0	13
Kivalina/Wulik Rivers	1	2	0	3	7	0	0	7
Unspecified location	2	1	0	3	0	0	0	0
Total	117	17	1	135	127	6	0	133

Table 4. Number and mortality of radiocollared moose by collar-year for the Noatak moose telemetry project, 1992–96

	Apr 92-Mar 93		Apr 93-Mar 94		Apr 94-Mar 95		Apr 95-Mar 96		1996
	N	%[a]	N	%[a]	N	%[a]	N	%[a]	N
Existing collared moose	0		33		37		45		82
Bull mortality	0		16		20		18		41
Cow mortality	0		17		17		27		41
Moose collared this year	51		22		20		59		0
Bull mortality	26		14		10		37		0
Cows	25		8		10		22		0
Capture mortalities	6		1		0		0		
Bull mortality	3		0		0		0		
Cow mortality	3		1		0		0		
Missing moose	0		3		1		0		
Bull mortality	0		2		1		0		
Cow mortality	0		1		0		0		
Total collared moose	45		51		56		104		
Bull mortality	23		28		29		55		
Cow mortality	22		23		27		49		
Harvest-collared moose	3	7	4	8	7	12	8	7	
Bull mortality	3	13	4	14	7	24	8	13	
Cow mortality	0	0	0	0	0	0	0	0	
Natural mortality (all)	9	20	10	20	4	7	14	13	
Bull mortality	4	17	4	14	4	14	6	6	
Cow mortality	5	23	6	26	0	0	8	8	
Total mortality	12	27	14	27	11	20	22	21	
Bull mortality	7	30	8	29	11	38	14	13	
Cow mortality	5	23	6	26	0	0	8	8	
Surviving moose	33		37		45		82		
Bull mortality	16		20		18		41		
Cow mortality	17		17		27		41		

[a] Percentages calculated individually for total, bulls and cows:

% Total mortality = (Total collared moose/Total mortality)*100

% Total bull mortality = (Total collared bulls/Total bull mortality)*100

% Total cow mortality = (Total collared cows/Total cow mortality)*100

Table 5 Number and mortality of radiocollared moose by collar-year for the Tagagawik moose telemetry project, 1994–96

	Apr 94-Mar 95		Apr 95-Mar 96		1996
	N	%[a]	N	%[a]	N
Existing collared moose	0		43		37
Bull mortality	0		23		18
Cow mortality	0		20		19
Moose collared this year	50		0		16
Bull mortality	25		0		8
Cow mortality	25		0		8
Capture mortalities	0		0		0
Bull mortality	0		0		0
Cow mortality	0		0		0
Missing moose	0		1		0
Bull mortality	0		1		0
Cow mortality	0		0		0
Total collared moose	50		42		53
Bull mortality	25		22		26
Cow mortality	25		20		27
Harvest-collared moose	1	2	0	0	
Bull mortality	1	4	0	0	
Cow mortality	0	0	0	0	
Natural mortality all sources	6	12	5	12	
Bull mortality	1	4	4	18	
Cow mortality	5	20	1	5	
Total mortality	7	14	5	12	
Bull mortality	2	8	4	18	
Cow mortality	5	20	1	5	
Surviving collared moose	43		37		
Bull mortality	23		18		
Cow mortality	20		19		

[a] Percentages calculated individually for total, bulls and cows:
% Total mortality=(Total collared moose/Total mortality)*100
% Total bull mortality=(Total collared bulls/Total bull mortality)*100
% Total cow mortality=(Total collared cows/Total cow mortality)*100

Table 6 Number and percent of harvested moose by antler-width classification, Unit 23, 1985–95[a]

	Moose antler-width classes in inches [N and (%)]						
Year	<20	20-<30	30-<40	40-<50	50-<60	>60	Total
1985-86	3	12	15	15	37	26	112
	(3)	(11)	(14)	(14)	(34)	(24)	
1986-87	1	8	28	29	49	15	139
	(1)	(6)	(21)	(22)	(38)	(11)	
1987-88	2	9	17	26	66	51	191
	(1)	(5)	(10)	(15)	(38)	(30)	
1988-89	1	4	24	35	82	41	210
	(1)	(2)	(11)	(16)	(38)	(19)	
1989-90	7	8	21	32	90	34	213
	(4)	(4)	(11)	(17)	(47)	(18)	
1990-91[b]	1	7	15	32	71	53	200
	(1)	(4)	(8)	(17)	(40)	(30)	
1991-92[b]	0	0	13	26	67	21	127
	(0)	(0)	(10)	(20)	(53)	(17)	
1992-93[b]	2	6	15	20	58	34	135
	(1)	(4)	(11)	(15)	(43)	(25)	
1993-94[b]	4	3	11	16	53	20	107
	(4)	(3)	(10)	(15)	(50)	(19)	
1994-95[b]	0	3	9	18	65	25	120
	(0)	(2)	(8)	(15)	(54)	(21	)

[a] Antlers of unknown size are excluded.

[b] Nonresident hunters were restricted to bulls with spike/fork or ≥50 inch wide antlers 1990-91 through 1994-95.

Table 7 Noatak drainage moose harvest summary, Unit 23, 1977-95

Year	Local Resident			Nonlocal Resident			Nonresident			Unknown Residency			Total	Total		Noatak %
	Succ	Unsucc	Total	Succ	Unsucc	Total	Succ	Unsucc	Total	Succ	Unsucc	Total	Hunters	Harvest	% Succ	of Unit 23 total harvest
1977-78	51	30	81	19	4	23	4	0	4	0	0	0	108	74	69	
1978-79	49	51	100	31	16	47	12	1	13	1	1	2	162	93	57	
1979-80	31	22	53	10	3	13	10	0	10	0	1	1	77	51	66	37
1980-81	16	10	26	11	4	15	6	0	6	2	0	2	49	35	71	32
1981-82	27	39	66	19	5	24	20	8	28	1	0	1	119	67	56	38
1982-83	20	21	41	24	16	40	15	2	17	4	2	6	104	63	61	49
1983-84	34	27	61	30	31	61	11	7	18	0	1	1	141	75	53	53
1984-85	25	26	51	42	37	79	32	11	43	0	0	0	173	99	57	55
1985-86	15	11	26	31	25	56	24	13	37	4	0	4	123	74	60	60
1986-87	21	22	43	34	22	56	28	17	45	3	4	7	151	86	57	57
1987-88	26	26	52	20	30	50	62	25	87	1	0	1	190	109	57	52
1988-89	13	2	15	29	12	41	67	10	77	9	1	10	143	118	83	53
1989-90	16	20	36	24	25	49	50	11	61	13	3	16	162	103	64	48
1990-91	14	12	26	35	24	59	40	13	53	4	1	5	143	93	65	47
1991-92	16	15	31	33	27	60	31	18	49	6	3	9	149	86	58	49
1992-93	16	21	37	33	44	77	31	34	65	3	0	3	182	83	46	47
1993-94	13	9	22	17	40	57	16	23	39	2	5	7	125	48	38	36
1994-95	6	6	12	25	33	58	24	17	41	1	2	3	114	56	49	42

Table 8 Chronology of moose harvest in Unit 23, 1988-95

Date	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95
Aug. 4	0	2	2	1	3	0	1
Aug. 11	5	2	7	0	4	1	4
Aug. 18	3	6	0	1	2	1	2
Aug. 25	12	6	3	1	6	5	4
Aug. 31	8	17	1	6	2	2	6
Sept. 4	15	18	24	22	26	10	13
Sept. 11	50	34	42	35	36	38	32
Sept. 18	61	45	61	37	49	39	32
Sept. 25	37	40	21	34	18	13	9
Sept. 30	11	12	12	4	3	3	1
Oct. 4	2	3	2	0	1	1	4
Oct. 11	1	3	2	1	1	5	3
Oct. 18	0	0	0	1	0	2	2
Oct. 25	1	1	1	0	1	1	0
Oct. 31	0	1	1	0	1	0	0
Nov. 4	1	1	0	0	1	0	0
Nov. 11	1	0	2	0	1	0	1
Nov. 18	0	0	0	0	0	2	0
Nov. 25	0	2	3	0	1	0	1
Nov. 30	2	1	0	1	1	0	0
Dec. 4	0	1	0	0	0	0	0
Dec. 11	1	2	2	0	0	0	1
Dec. 18	0	1	0	0	0	0	1
Dec. 25	0	0	0	0	1	0	1
Dec. 31	1	0	0	1	0	0	0
Jan. 4	0	0	0	1	1	0	0
Jan. 11	0	1	1	2	1	0	0
Jan. 18	0	0	1	2	0	0	2
Jan. 25	0	0	0	0	0	0	1
Jan. 31	0	0	1	0	0	0	1
Feb. 4	0	0	0	0	1	0	0
Feb. 11	0	0	0	0	0	1	1
Feb. 18	0	1	2	3	0	0	0
Feb. 25	0	1	0	1	3	1	2
Feb.28/29	0	1	1	0	2	0	0
Mar. 4	0	0	0	0	0	0	0
Mar. 11	0	1	0	1	1	0	2
Mar. 18	1	0	0	2	4	0	0
Mar. 25	1	1	1	1	1	0	2
Mar. 31	3	1	0	7	1	3	1
Unknown	5	8	6	10	7	5	4

Table 9 Number of moose hunters by transportation method in Unit 23, 1993–95

Transportation method	Successful	Unsuccessful	Total
1993-94			
Aircraft	78	113	191
Horse/dogteam	0	0	0
Boat	32	40	72
3/4-wheeler	6	2	8
Snowmachine	15	2	17
Off-roadvehicle	1	0	1
Highwayvehicle	1	1	2
Unknown	2	5	7
Total	135	163	298
1994-95			
Aircraft	91	100	191
Horse/dogteam	0	0	0
Boat	28	45	73
3/4-wheeler	3	2	5
Snowmachine	9	4	13
Off-roadvehicle	0	1	1
Highwayvehicle	0	4	4
Unknown	2	6	8
Total	133	162	295

LOCATION

GAME MANAGEMENT UNIT: 24 (26,055 mi^2)

GEOGRAPHIC DESCRIPTION: Koyukuk River drainage above Dulbi River

BACKGROUND

Moose are a recent addition to the fauna of Unit 24, having moved into the area during the 1930s through the 1950s (Huntington 1993). Colonization was slow until predator control efforts in the 1950s allowed rapid expansion of local populations, especially in the southern third of the unit. During the early 1970s, the population reached a peak and mortality started to exceed recruitment in some areas.

Moose densities are low in the middle third of the unit (Hughes to Bettles, including the Kanuti Controlled Use Area [CUA] and the South Fork drainage) and the population seems to have grown since 1989 within the Kanuti CUA. The increase in population may be due to a variety of factors. Large burns in the mid and late 1970s produced excellent moose browse. In recent years large numbers of caribou have wintered in the area, providing alternate meat for hunters and prey for wolves. The number of wolves taken by hunters has also increased which produces a decreased but stable predation rate.

Habitat is excellent along most of the Koyukuk River lowlands, providing expansive areas of winter browse. Lightning-caused fire is a frequent event and large areas of the burned uplands are producing good moose browse. Browse availability is not limiting the size of the moose population at current moose densities.

Reported harvests during the past 25 years have ranged from 44 to 134, but did not exceed 100 moose until 1980. Unreported harvests during this period probably ranged from 160 to 300 moose per year. Since 1980, reported harvests have exceeded 100 moose because more local residents have become aware of the reporting requirement, compliance with the reporting requirement has increased, and access to the unit has become easier with the opening of the Dalton Highway.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.
- Provide for continued use of moose by local Alaskan residents who have customarily and traditionally used the population.
- Provide the greatest sustained opportunity to participate in hunting moose.
- Provide an opportunity to view and photograph moose.
- Provide for scientific and educational use of moose.

Management Objectives

- Manage a moose population at the current level of 5000 to 7000 in the area south of Hughes, including the Koyukuk CUA.
- Increase the moose population to 5000–6000 in the area from Hughes to Bettles, including the Kanuti CUA and the South Fork drainage.
- Increase the moose population north of Bettles, excluding the Gates of the Arctic National Park, to 3000–3500.
- Maintain the population in the Gates of the Arctic National Park at 1300–1500.

METHODS

No surveys were flown during the report period.

Hunting mortality and distribution were monitored through harvest tickets and check stations. We encouraged local residents to increase their harvest reporting through school visits and check stations.

RESULTS AND DISCUSSION

Population Status and Trend

Moose are numerous in the Koyukuk River lowlands in the southern third of the unit (south of Hughes). The population is believed stable, except near the village of Huslia where moose numbers are increasing.

Moose densities are moderate in the northern third of the unit (north of Bettles, including the Gates of the Arctic National Park), and moose numbers are probably stable in most other areas. However, moose numbers may be slowly declining within the park.

Population Size

I estimate 5000 to 7000 moose are in the southern portion of Unit 24, based on the results of 1988 and 1989 population estimation surveys and extrapolations of density estimates from trend count surveys.

I estimate 3000 to 4000 moose inhabit the middle portion of Unit 24. This estimate is based on population estimation surveys of the Kanuti National Wildlife Refuge in 1993 and the Dalton Highway Corridor in 1991. These surveys indicated a rather low overall early winter density of 0.42–0.76 moose/mi^2.

I estimate 3000 to 4150 moose inhabit the northern portion of Unit 24, including 1500 to 2000 moose within the Gates of the Arctic National Park. This estimate is based on the distribution of moose seen during a 1987 stratification survey and a density estimate of 0.42 moose/mi^2 found by Dale et al. (1995) in the Alatna River drainage within the Gates of the Arctic National Park during their 1990 study of wolf predation.

By extrapolation, the unit population probably numbers between 11,000 and 15,000 moose.

Population Composition

No surveys were conducted during the report period, but previous surveys found good bull:cow and calf:cow ratios of 61:100 and 33:100, respectively (Table 1).

Distribution and Movements

There are little data on movements of moose within the unit. Thirteen moose radiocollared in 1984 in northern Unit 21D had a summer migration into the southwestern parts of Unit 24. During early winter, moose are at treeline in the northern part of the unit and move to the riverbanks during late winter and summer.

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Unit 24, the Koyukuk Controlled Use Area.		
Resident Hunters: 1 moose per regulatory year; however, antlerless moose may be taken only during the periods 21 Sep-25 Sep, 1 Dec-10 Dec, and 1 Mar-10 Mar.	1 Sep-25 Sep 1 Dec-10 Dec 1 Mar-10 Mar	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		5 Sep-25 Sep
Unit 24, the John River drainage within the Gates of the Arctic National Park	1 Aug-31 Dec	No open season

Units and Bag Limits	Resident Open Season (Subsistence and General Hunts)	Nonresident Open Season
Resident Hunters: 1 moose.		
Remainder of Unit 24.		
Resident Hunters: 1 bull.	1 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		5 Sep-25 Sep

<u>Board of Game Actions and Emergency Orders</u>. In fall 1994 heavy rain caused extensive flooding in the upper Koyukuk drainages. The villages of Allakaket and Alatna were destroyed and Hughes was extensively damaged. The flood occurred just before moose season. To aid flood victims, the Board issued numerous emergency orders to extend the hunting season continually from late September until January. The emergency orders affected portions of the unit from Huslia to Bettles.

<u>Hunter Harvest</u>. Hunting seasons in the unit are diverse and reflect various moose densities and consumptive use patterns. Annual reported harvest since 1988 has averaged 135 moose (Table 2). Illegal and unreported harvests by local residents continue to hamper department efforts to manage moose. The actual harvest is estimated to be about twice the reported harvest (Table 2). Moose taken during winter are rarely reported, even when the season is open. Hughes does not have a license vendor and that contributes to the problem of hunters hunting without licenses or harvest tickets. I am working to increase public awareness of the importance of accurate reporting and am attempting to locate additional license vendors. Fortunately, most unreported harvest comes from the southern portion of the unit which has a large enough moose population to support additional harvest.

The estimated annual harvest by residents of Unit 24 is about 172 moose, according to Marcotte (1986), Marcotte and Haynes (1985), and my personal estimates. We estimate residents of Huslia, Hughes, Allakaket/Alatna, Bettles, and Wiseman take 84, 33, 35, 10, and 5 moose, respectively. An additional 5 moose are probably taken by residents of the unit who do not live in one of the villages. To estimate unreported harvest, I subtract the number of moose reported for the above villages from 172 and then use the difference (Table 2).

<u>Hunter Residency and Success</u>. The Dalton Highway was initially closed to the public at the Yukon River bridge. The road was opened to public use throughout Unit 24 in 1981. Hunter

effort and moose harvest is fairly stable at 90–130 hunters and 40–70 moose taken per year (Table 3).

Final harvest data for 1995 were not available at the time of this report. However, over the previous 5 years, the reported harvest averaged 140 moose, with unit residents taking an average of 45 (Table 4). The harvest by nonresident hunters averaged 20 moose per year. During the preceding 5 years, an average of 290 hunters reported hunting, but this average is minimal because of unit residents' failure to report unsuccessful hunts.

Harvest Chronology. Generally 96% of reported moose harvest occurred during the September portion of the hunting season.

Transport Methods. Boats continue to be the primary transportation method in Unit 24 because of the extensive river system, lack of roads, and restrictions on the use of aircraft within the 2 CUAs (Table 5). Highway vehicles are only used on the Dalton Highway which crosses the eastern part of the unit. Snowmachines were the main transportation method used during the winter hunt.

Other Mortality

A minimum of 400 to 440 wolves in 55 to 60 packs and a large population of black bears are inhabit the middle and southern portions of the unit. Grizzly bears are common throughout the montane areas.

Predation on moose is thought to be high, except near the villages of Huslia, Allakaket, and Bettles where predators are kept at lower numbers. Predation is limiting the moose population throughout much of the central portion of the unit.

HABITAT

Assessment

Habitat is excellent throughout much of the unit, with an abundance of successional willow regrowth due to either fire or river erosion. Availability of browse is not limiting the moose population.

NONREGULATORY MANAGEMENT PROBLEMS/NEEDS

Unit residents are not following some reporting and licensing procedures. More emphasis needs to be placed on education, enforcement, and recruitment of license vendors.

CONCLUSIONS AND RECOMMENDATIONS

The previous population objective in the southern portion of the unit was based on the assumed population size. Recent surveys indicated the population is between 5000 and 7000 instead of 3000 to 5000. The status of the population in this area relative to its habitat and human–use demands has not changed.

We need to obtain population estimates for the Hogatza River drainage and the northern area, including Gates of the Arctic National Park. A population estimation survey may be undertaken in cooperation with NPS when funding is available.

Habitat is excellent throughout much of the unit, with an abundance of successional willow regrowth due to either fire or river erosion. Availability of browse is not limiting the moose population.

With the exception of limited areas around Allakaket, Bettles, and Huslia, predation on moose by wolves and bears is the major factor limiting Unit 24 moose populations. Moose numbers will not increase in those areas where the population objectives are not being met unless predation is reduced. Unit residents are meeting their wild food requirements, but hunting opportunities cannot be increased for people living outside the unit until moose numbers increase. The status of moose in the southern Brooks Mountains is unknown.

Unit residents are not following some reporting and licensing procedures. More emphasis needs to be placed on education, enforcement, and recruitment of license vendors.

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Table 1 Summary of fall aerial moose survey data Kanuti area, Unit 24, 1989–1995

Year	Bull:100 cow	Yrl bull:100 cows	Calves:100 cows	Calf % in herd	Moose
1989	65	12	17	9	1172
1990[a]					
1991	54	9	20	12	364
1992[a]					
1993	61	19	33	17	1759
1994[a]					
1995[a]					

[a] No survey.

Table 2 Unit 24 moose hunter harvest success, 1988–1995

Regulatory year	Harvest by hunters				Unreported harvest	Total
	Bull	Cow	Unk	Total		
1988-1989	132	5	0	124	124	261
1989-1990	119	8	1	128	125	253
1990-1991	141	2	1	144	120	264
1991-1992	141	2	1	144	120	264
1992-1993	118	5	0	123	119	242
1993-1994	139	12	0	151	116	267
1994-1995	134	8	0	142	135	277
1995-1996[a]						

[a] Data not available at this time.

Table 3 Unit 24 moose harvest by hunters who use the Dalton Highway for access, 1988–1995

Regulatory year	Dalton Highway	
	Successful	Unsuccessful
1988-1989	50	44
1989-1990	57	35
1990-1991	67	61
1991-1992	55	33
1992-1993	27	100
1993-1994	36	61
1994-1995	60	42
1995-1996	41	37

Table 4 Unit 24 moose hunter residency and success, 1988–1995

Regulatory year	Successful					Unsuccessful					Hunters
	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	Local[a] resident	Nonlocal resident	Nonresident	Unk	Total	
1988-1989	41	57	16	23	137	13	63	18	25	119	256
1989-1990	40	68	17	3	140	28	107	16	4	155	283
1990-1991	43	71	22	8	144	17	81	16	9	123	267
1991-1992	43	77	23	1	144	14	138	16	3	171	315
1992-1993	48	62	7	6	123	27	129	27	3	186	309
1993-1994	56	68	25	2	151	24	94	23	1	142	293
1994-1995	37	78	25	2	142	10	90	21	3	124	266

[a] Subunit resident only

Table 5 Unit 24 moose harvest percent by transport method, 1988–1994

Regulatory year	Method of transportation								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1988-1989	23	1	49	1	0	3	13	9	137
1989-1990	19	1	44	1	1	1	24	9	140
1990-1991	16	3	56	3	1	2	16	3	144
1991-1992	25	2	44	3	1	2	17	5	144
1992-1993	16	0	56	3	5	1	13	6	123
1993-1994	15	0	60	6	5	2	7	4	151
1994-1995	17	2	53	3	5	4	12	4	142

LOCATION

GAME MANAGEMENT UNIT: 25A, 25B, and 25D (49,000 mi^2)

GEOGRAPHIC DESCRIPTION: Upper Yukon River Valley

BACKGROUND

Moose have been scarce in the upper Yukon River valley during most of historic time. Long-time residents of the area report moose were hard to find in the early 1900s and have been more common in recent years (F Thomas, H Petersen, K Peter, pers commun). Compared with many other areas, moose density continues to be low, especially in the western and northern parts of Unit 25. Systematic surveys were done in the late 1970s, and more extensive surveys began in 1981 when ADF&G established a Fort Yukon office. Survey techniques were modified to reflect advances in sampling techniques and accommodate the area's relatively low moose density.

Hunting in Unit 25D West has been regulated by permit systems since 1983, when a registration permit hunt was established. Winter seasons were added in 1984 to accommodate traditional hunting practices. In 1985 permits were limited to qualified Tier II applicants. In 1986 permits were further limited to residents of Unit 25D West, and a harvest quota was established. Regulations were largely unchanged until 1989. In 1991 a federal permit system was established for residents to hunt on federal land.

Unit 25D has been divided into Units 25D West and 25D East to allow the use of regulatory schemes that reflect the generally different status of moose populations. The boundary between the 2 areas lies along Preacher and Birch creeks south of the Yukon River and along the Hadweenzic River to the north. Moose density is generally lower in Unit 25D West; combined with the local residents' relatively high demand for moose, this has resulted in the use of permit systems that limit hunting largely to residents of Unit 25D West.

Trend surveys and observations by local residents indicate that moose numbers increased during the 1980s in Units 25D West and in 25D East. However, trend counts during and after 1991, a census in Unit 25D West in 1992, and a mini-census in Unit 25D East in 1995 indicate this increase has slowed or stopped. This means the complicated regulations governing moose hunting in the unit cannot be liberalized, and thus simplified, as was hoped. Composition surveys were last conducted in Unit 25A in 1991 and in Unit 25B in 1987. As discussed below, moose population status has not changed dramatically in most areas, although there are some trends that cause concern.

Results of moose telemetry studies conducted in Unit 25D West from 1983 to 1987 and in Unit 25D East from 1989 to 1991, as well as studies of moose population dynamics in similar habitat elsewhere, indicate that predation by black bears, brown bears, and wolves is the primary cause of summer mortality, with wolves and illegal hunting of cow and bull moose important sources of winter mortality. Predation and illegal hunting are major factors determining moose population welfare. Moose browse is abundant and used at a low rate. The area is characterized by low to moderate snowfall, and malnutrition because of deep snow is rare.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

Unit 25 Overall

- Protect, maintain, and enhance the moose population and its habitat in concert with other components of the ecosystem.

Unit 25A

- Provide an opportunity to hunt under aesthetically pleasing conditions and provide for subsistence use.

Units 25B and 25D

- Provide for subsistence use and for the greatest opportunity to harvest moose.

MANAGEMENT OBJECTIVES

Unit 25 Overall

- Continue efforts to communicate with and educate local residents about moose management.
- In cooperation with US Fish and Wildlife Service (FWS), monitor moose population status as funding permits.
- Cooperate with FWS in periodically determining population status.

Unit 25A

- Evaluate possible effects of increasing hunting on moose along major drainages along the Brooks Range.
- Educate local residents regarding the importance of not taking cow moose.

Unit 25B

- Plan for and conduct biannual trend counts in selected areas for comparison with previous trend counts.

Unit 25D

- In cooperation with FWS, plan for and conduct periodic moose population surveys in the eastern and western portions of the subunit.

METHODS

Moose composition surveys were flown in PA-18 aircraft about 500 feet above ground level at 70 miles per hour. We circled moose to determine sex, age, antler size of bulls, and locate other moose. We searched moose habitat in established count areas systematically at an intensity of at least 4 minutes/mi^2. A moose census (Gasaway et al. 1986) was conducted in November 1992 in Unit 25D West using multiple PA-18 aircraft and a C-185 for stratification. A mini-census using similar techniques was conducted in Unit 25D East in November 1995. Mandatory harvest reports provided information on hunter effort, residency, success, transportation, and antler size. Informal visits with area residents, moose hunter check stations on the Porcupine River, and discussions at advisory committee and other meetings have provided insight into hunter effort and attitudes since 1991.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

Extrapolations from trend surveys and stratification efforts have resulted in estimates of 1253 moose in 1984 and 2000 moose in 1989 in a 5400-mi^2 area in Unit 25D East (Maclean and Golden 1991). Population density on the Yukon Flats has ranged from a low of 0.1 moose/mi^2 in the west in 1984 to 0.64 moose/mi^2 in the east in 1989 (ADF&G files). The 1992 census in Unit 25D West resulted in an estimate of 602 moose (± 22%) in an area of 4544 mi^2, a density of 0.12 moose/mi^2. A population mini-census in Unit 25D East in 1995 resulted in an estimate of 704 moose (± 33%) in a 1534 mi^2 area encompassing the core hunting areas adjacent to Fort Yukon. Estimated moose density varied considerably among 3 subunits in the sample area, ranging from 0.12 moose/mi^2 around Fort Yukon to 0.75 moose/mi^2 in the Graveyard Lakes area. Moose density is low relative to most other areas in Interior Alaska, especially in Unit 25D West, and is well below the level that could be sustained by existing habitat.

Population Composition

Trend surveys in Unit 25A in 1987, 1989, and 1991 indicated that populations in this area have high bull:cow ratios, ranging from 60 bulls:100 cows to 90 bulls:100 cows, and moderate calf and yearling survival (Table 1). Weather precluded more recent survey attempts, but moderate to low harvests related to poor weather indicate that bull:cow ratios remain high.

Surveys have not been conducted in Unit 25B in recent years (Table 1). However, reports from hunters in the area suggest that moose continue to be moderately abundant south of the

Porcupine River and in the upper Black River drainage but scarce in the Porcupine River drainage to the north. Reports from some knowledgeable observers suggest moose numbers in northern Unit 25D East and Unit 25B, and southern Unit 25A have declined in recent years.

Relatively good survey conditions in Unit 25D East allowed complete trend counts in 1994 and a mini-census in 1995. Poor conditions limited surveys in 1990 and none was attempted in 1992. Although trends in indicators of population welfare are not uniform, it seems there has been a moderate decline in the proportion of bulls and yearlings compared with the early and mid 1980s (Table 2). Moose density also may have declined. The increase in numbers that occurred during the 1980s has apparently slowed or stopped. The bull:cow ratios suggest the limited harvest is affecting the proportion of bulls.

In Unit 25D West, a census in 1992 and trend counts in 1993 and 1994 indicate moose density continues to be low. Table 3 summarizes composition and population data for Unit 25D West. It appears most parameters of population welfare have been fairly stable during the past several years, with moose persisting at a chronically low density. Reports from hunters and other longtime observers suggest abundance has declined over the last several years.

Bull, yearlings, and calf:cow ratios continue to be relatively high in Unit 25D West, but composition data should be used with caution. Harvest of cow moose is known to be significant near settlements and major travel routes. Thus, sex ratio data cannot be interpreted as they would be in areas where cows are rarely taken.

Distribution and Movements

Moose are throughout the area but density varies greatly. Large areas currently support low densities ranging from 0.1 to 0.3 moose/mi^2. Densities approach or exceed 1 moose/mi^2 in very limited areas in Unit 25D West and in more extensive areas in Unit 25D East in the lower reaches of the Black and Porcupine River drainages. During early winter moose concentrate along the upper Sheenjek and Coleen rivers in Unit 25A, but these concentrations are limited in extent. A stratification effort in November 1991 found moose were scarce in most of the middle and lower portions of these drainages in Unit 25A, and in northern Unit 25B as well, with most sample units showing no sign of moose. Telemetry studies in Units 25D East and 25D West indicate some moose are migratory, often moving between higher elevation, early winter range to low elevation, late winter and summer ranges (Maclean and Golden 1991). In March 1995 FWS initiated a telemetry study to determine moose seasonal movements and distribution, fidelity to winter range, and relationship between fall moose concentrations and harvest in Unit 25A. Fifty-seven moose (44 females and 13 males) were radiocollared in the Sheenjek, Coleen and Firth drainages and relocated approximately 1 each month (F Mauer, pers commun). A strong pattern of annual movement was evident during the first year of monitoring, with over 40 moose migrating to the Old Crow Flats in the Yukon during spring and remaining there until late August, when moose began moving back into Alaska. By early October only 1 moose that we were monitoring remained in Canada, and all had returned to Alaska by early November. Most moose returned to areas where they were collared, but some were located in other drainages. Continued monitoring will provide greater insight into home range fidelity and movements.

MORTALITY

Harvest

<u>Seasons and Bag Limit</u>

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 25A		
All hunters: 1 bull.	5 Sep-25 Sep	5 Sep-25 Sep
Unit 25B		
Upstream from the Coleen River drainage: 1 bull.		
Resident Hunters: 1 bull.	20 Sep-30 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers.		20 Sep-30 Sep
Remainder of Unit 25B		
Resident Hunters: 1 bull.	5 Sep-25 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers.	1 Dec-15 Dec	5 Sep-25 Sep
Unit 25D West		
All hunters, 1 bull by Tier II subsistence hunting permit only; up to 125 permits will be issued.	25 Aug-25 Sep 1 Dec-10 Dec 18 Feb-28 Feb	No open season

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 25D East		
Remainder.		
Resident Hunters: 1 bull.	10 Sep-20 Sep	
Nonresident Hunters: 1 bull with 50-inch antlers.	1 Dec-10 Dec	10 Sep-20 Sep

Board of Game Actions and Emergency Orders. In 1990 the Federal Subsistence Board was established and promulgated regulations for subsistence use on federal lands. These regulations took effect 1 July 1991. A federal subsistence moose permit system was established in Unit 25D West that provided an unlimited number of permits to residents of the subunit and allowed them to hunt bull moose on federal lands. The state Tier II permit system remained in effect and applied to both private and federal lands. Dual management also affected regulations in Units 25A, 25B, and 25D East. Seasons for eligible local residents are longer (generally from 25 August to 25 September and from 1 December to 20 December) on federal land than the state season which applies to all hunters on private and state lands and for nonlocal hunters on federal lands.

In 1993 the way regulations were applied in Unit 25D West was changed. The federal regulations dictated that federal permits were required on federal land and nonlocal residents were excluded from hunting moose on federal land. State Tier II permits applied only to hunting on private lands. A maximum of 30 federal permits and 125 State Tier II permits may be issued each year.

Hunter/Trapper Harvest. Harvest of moose has varied considerably in most of Unit 25 during the past 5 years (Tables 4, 5, 6) largely because of weather conditions. Reported harvest for Units 25A, 25B, and 25D East has ranged from 156 moose in 1990 to only 54 in 1992. Low harvests in 1989 and 1992 coincided with unusually cold or rainy weather during September. In 1992, in particular, a near record early freeze-up in mid September greatly limited hunting effort, even at low elevation near Fort Yukon. An extensive flood in May 1992 also contributed to poor success in the Fort Yukon area. Local residents report that widespread flooding pushed moose back away from rivers. Moose were unusually scarce in flooded areas throughout the summer and fall of 1992. The reported harvest in 1993 was 98, with 84 moose reported harvested in 1994.

The reported harvest in connection with the Tier II and federal permit hunts in Unit 25D West is very small (Table 7), with 9–15 moose reported taken annually in the last few years. The reporting rate has been poor for this hunt but has improved recently because of the use of reminder letters. The actual number of moose harvested in Unit 25D West is unknown, but verbal reports by village residents suggest the number of bulls harvested may approach the present quota of 35.

Unreported harvest, particularly by local residents, is a chronic problem in the upper Yukon River valley. The previous area biologist estimated the unreported harvest at 100-200 moose annually. Preliminary results from a cooperative harvest monitoring effort funded by FWS support this estimate. Current information indicates cow moose are taken at any time of year, especially in areas near and between communities. The illegal taking of moose is still common, even though it has declined and many residents disapprove of it. Two educational videos were produced in 1993 in a cooperative effort between FWS and ADF&G to present the effects of shooting cow moose. These videos will be used to educate people about moose management.

Permit Hunts. Although the Tier II moose permit hunt in Unit 25D West is largely supported by local residents, a number of problems are associated with it. These include confusion about differences in applicability of federal and state permits, boundaries of federal and private lands (which are subject to different seasons and permit requirements), and the fact that local residents have not submitted enough applications to acquire all 125 permits available. Increased efforts by community leaders and involved agencies are required if existing regulations are to accomplish the intended goals.

Data on moose populations in Unit 25D West indicate that liberalization and simplification of regulations for Unit 25D West are not warranted. Efforts should be focused on making the present system function better. An increase in the number of local applicants, clarification of permit conditions, and better harvest reporting are all necessary.

Hunter Residency and Success. As in previous years, most hunters reporting from Units 25A, 25B, and 25D are Alaska residents (Tables 8, 9, 10). The proportion of nonresidents is greatest in the most remote portion of Unit 25A (Table 8), where guiding activity and float trips are more common. Local residents outnumber other hunters by a wide margin in Unit 25D East (Table 10). The number of local participants in moose hunting is underrepresented because of a low reporting rate, especially in Unit 25D East. Success among reporting hunters is high, often approaching or exceeding 50% in Units 25A and 25B (Table 9) and ranging from 40% to 50% in Unit 25D East. Success in 1991 and 1992 was low due to weather, but has since increased.

Harvest Chronology. Most moose taken in Unit 25 are killed during the second and third weeks of September, with a few reported killed before and after this period (Tables 11, 12, and 13). A number of moose are also taken in late August when the state Tier II and federal subsistence seasons open on 25 August. A few moose are reported taken in the 1-10 December open season, but hunting is almost exclusively by local residents during this period, and the number of moose killed is probably greater than reported.

Transport Methods. Aircraft are the most common transport mode in Unit 25A, used by more than 50% of the successful hunters. Horses and boats each account for 10% to 25% of the remainder (Table 14). Boats are used by 75% of successful hunters in Unit 25B, with airplanes being used in 25% of successful hunts (Table 15). A similar pattern characterizes Units 25D East (Table 16). Snowmachines are used in taking a small percentage of the moose killed in both Units 25B and 25D, but the occurrence of both snowmachines and boats is underrepresented because local hunters often do not report.

HABITAT

Assessment and Enhancement

No systematic evaluation of habitat took place during this period. However, previous work, empirical observations, and comparison with habitat elsewhere indicate the upper Yukon River valley provides excellent moose habitat. Moose populations are well below densities that the habitat could support.

The upper Yukon area has the shortest fire cycle in Alaska; extensive fires have created and maintained large areas of good habitat for moose. With the low snow accumulation typical of the area, conditions are more than adequate to support present moose numbers.

CONCLUSIONS AND RECOMMENDATIONS

The overall status of the Unit 25 moose population has not changed dramatically in the last few years. However, signs of a decline in recruitment rates are evident in some areas, and a decline in numbers may have occurred in parts of the unit. In terms of previously established management objectives, moderate progress has been made in some areas. Objectives for Unit 25A are generally being met, and in the remainder of the unit, the harvest of moose seems to satisfy local subsistence needs and provide a moderate amount of hunting for other Alaskans and nonresidents.

Political, biological, and logistical realities affecting moose management in Unit 25 indicate that some basic questions need to be addressed by the public and governmental agencies. A basic issue that remains unsettled is whether the local public wants and would support measures to increase moose numbers to levels commensurate with habitat potential. The fact that moose are noticeably more abundant now than in earlier times and many local residents are satisfied contributes to the confusion. More important, however, are political considerations relating to management authority, priority, and exclusivity of wildlife uses.

These considerations generally dominate public discussions. The actual abundance and welfare of wildlife populations is generally less an issue than are perceived problems with competition from other hunters and reluctance to participate in what are viewed as external management systems. Until there is more agreement on management goals and the role and responsibilities of public and private entities in achieving them, maintaining and enhancing moose populations will be difficult. The practice of shooting cow moose, for example, probably will not lessen unless local citizens decide it is in their best interest to play an active part in fostering increased moose numbers.

At present, there are relatively narrow problems in individual subunits that should be addressed or more clearly monitored. Effects of increased hunting on concentrations of moose in the Sheenjek and Coleen drainages in Unit 25A are being evaluated. Air taxi operators who fly hunters to these areas are aware of potential problems and have agreed to distribute and limit hunting pressure. In cooperation with FWS, we should help users maintain the opportunity for high quality hunting in these areas. Ongoing telemetry studies of moose movements and population identity will help evaluate effects of hunting in these areas.

More time should be spent monitoring the Tier II harvest in Unit 25D West. The actual harvest of moose is unknown, making it impossible to know whether the upper limit of 35 bulls is being exceeded. Confusion over state and federal permits is substantial and a better understanding of the situation is important. A related problem is the potential to exceed the harvest quota because harvest reporting is not timely or uniform. Under a cooperative agreement between FWS and local governments, a harvest monitoring program was initiated in 1993. This effort should contribute to the knowledge of wildlife harvests in the area. A final report is expected soon.

There is considerable confusion about the relatively long federal subsistence seasons and the short state general hunting season in Units 25A, 25B, and 25D East. While some confusion is inherent in the regulations, making maps available that show land status, hunting seasons, and bag limits would help clarify regulations. Such maps should be posted in public buildings in local communities beginning midsummer. Staff visits to local communities to explain regulations before the hunting season and hunter contact by riverboat during the hunting season should continue.

Trend surveys in representative areas of various subunits should be continued to clarify trends in recruitment and moose numbers. In early 1992 ADF&G and FWS conducted a cooperative survey to determine wolf numbers on the Yukon Flats. Knowledge of wolf numbers will help us determine effects of wolf predation on the moose population.

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Table 1 Units 25A and 25B early winter aerial moose composition counts, 1986-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
Unit 25A								
1986-1987[a]								
1987-1988[b]	63	9	33	--	17	--	149	--
1988-1989[a]								
1989-1990[c]	75	18	29	52	14	--	367	1.01
1990-1991[a]								
1991-1992[d]	55	--	26	8	19	41	49	--
1991-1992[c]	91	13	31	44	14	--	314	0.87
1992-1993[e]				8	15	44	52	--
1993-1994[a]								
1994-1995[a]								
1995-1996[a]								
Unit 25B[f]								
1987-1988	119	6	10	6	5	105	111	

[a] No survey.
[b] Upper Sheenjek River only.
[c] Includes upper Sheenjek and Coleen rivers.
[d] Observed during moose stratification flights in lower Sheenjek, Coleen, and East Fork Chandalar rivers.
[e] March 1993 survey in East Fork of Chandalar drainage around Arctic Village.
[f] The only early winter composition count in this area during 1986-1995.

Table 2 Unit 25D East early winter aerial moose composition counts, 1986-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
1986-1987	84	13	34	26	15	144	170	0.7
1987-1988	81	18	27	29	13	196	225	0.9
1988-1989[a]								
1989-1990	63	9	41	59	20	235	294	1.0
1990-1991[b]	64	5	32	7	16	36	43	0.7
1991-1992[c]	66	9	26	25	13	168	193	0.7
1992-1993[a]								
1993-1994	38	8	40	37	22	128	165	1.0
1994-1995	68	20	25	24	12	160	184	0.6
1995-1996[d]	50	7	30	39	16	193	232	0.6

[a] No survey.
[b] Poor survey conditions, partial count.
[c] Part of the Graveyard trend area was not completed.
[d] Based on composition observed in mini-census.

Table 3 Unit 25D West early winter aerial moose composition counts, 1986-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
1986-1987	78	23	27	20	13	132	152	0.42
1987-1988	71	8	25	13	13	87	100	0.57
1988-1989	84	18	29	13	14	83	96	0.55
1989-1990[a]								
1990-1991[b]	44	12	29	4	15	23	27	--
1991-1992[c]	98	8	31	15	13	97	112	0.47
1991-1992[d]	146	8	46	6	16	32	38	0.22
1991-1992[e]	81	8	25	9	12	65	74	1.15
1992-1993[f]	71	12	25	48	13	345	393	0.12
1992-1993[g]	70	11	19	5	10	46	51	0.47
1993-1994[h]	51	14	30	17	16	86	103	0.50
1994-1995[i]	115	23	45	9	14	56	65	0.63
1995-1996[a]								

[a] No survey.
[b] Poor survey conditions, only Meadow Creek area surveyed.
[c] Includes both low and high elevation surveys.
[d] Includes only low elevation count areas (Meadow Creek and Birch Creek).
[e] Mt Schwatka area only.
[f] Data from Unit 25D West census.
[g] Data from Meadow Creek and Mud Lakes trend areas within census area.
[h] Data from Meadow Creek and Mud Lakes trend areas. Mt Schwatka area not surveyed.
[i] Mud Lakes area not surveyed.

Table 4 Unit 25A moose harvest and accidental death, 1986-1994

Regulatory year	Harvest by hunters: Reported[a]				Harvest by hunters: Estimated[b]			Accidental death[c]			
	M	F	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1986-1987	47	0	0	47							47
1987-1988	41	0	0	41							41
1988-1989	39	0	0	39							39
1989-1990	25	0	0	25							25
1990-1991	56	0	0	56							56
1991-1992	47	0	0	47							47
1992-1993	17	0	0	17							17
1993-1994	27	0	0	27							27
1994-1995	24	0	0	24							24

[a] Source: moose harvest reports.
[b] No data.
[c] No roads or railroads in subunit.

Table 5 Unit 25B moose harvest and accidental death, 1986-1994

Regulatory year	Harvest by hunters: Reported[a] M	F	Unk	Total	Estimated[b] Unreported	Illegal	Total	Accidental death[c] Road	Train	Total	Total
1986-1987	27	0	0	27							27
1987-1988	26	0	0	26							26
1988-1989	28	0	0	28							28
1989-1990	24	0	0	24							24
1990-1991	47	0	0	47							47
1991-1992	32	0	0	32							32
1992-1993	18	0	0	18							18
1993-1994	43	0	0	43							43
1994-1995	33	0	0	33							33

[a] Source: moose harvest reports.

[b] No data.

[c] No roads or railroads in subunit.

Table 6 Unit 25D East moose harvest and accidental death, 1986-1994

Regulatory year	Harvest by hunters										
	Reported[a]				Estimated[b]			Accidental death[c]			
	M	F	Unk	Total	Unreported	Illegal	Total	Road	Train	Total	Total
1986-1987	39	0	0	39							39
1987-1988	47	0	0	47							47
1988-1989	32	0	0	32							32
1989-1990	38	0	0	38							38
1990-1991	52	0	1	53							53
1991-1992	29	0	0	29							29
1992-1993	19	0	0	19							19
1993-1994	27	1	0	28							28
1994-1995	27	0	0	27							27

[a] Source: moose harvest reports.

[b] No data.

[c] No roads or railroads in subunit.

Table 7 Unit 25D West moose harvest data by permit hunt, 1986-1994

Hunt No./Area	Regulatory year	Permits issued	Did not hunt (%)	Unsuccessful hunters (%)	Successful hunters (%)	Bulls (%)	Cows (%)	Unk (%)	Total harvest
994T	1989-1990	50	1 (2)	8 (16)	7 (14)	7 (100)	0 (0)	0 (0)	7
	1990-1991[a]	60	9 (15)	3 (5)	4 (7)	4 (100)	0 (0)	0 (0)	4
	1991-1992[b]	57	44 (77)	13 (23)	6 (11)	6 (100)	0 (0)	0 (0)	6
	1992-1993[c]	95	67 (71)	21 (22)	5 (5)	5 (100)	0 (0)	0 (0)	5
	1993-1994	125	54 (43)	40 (32)	10 (8)	10 (100)	0 (0)	0 (0)	10
	1994-1995	120	63 (53)	30 (25)	10 (8)	10 (100)	0 (0)	0 (0)	10

[a] Additional harvest reported under federal permit system = 11.
[b] Additional harvest reported under federal permit system = 8.
[c] Additional harvest reported under federal permit system = 4.

Table 8 Unit 25A moose hunter residency and success, 1986-1994[a]

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1986-1987	4	22	6	5	37 (60)	2	13	10	0	25 (40)	62
1987-1988	4	16	18	3	41 (61)	4	14	3	5	26 (39)	67
1988-1989	3	19	11	6	39 (59)	2	15	9	3	29 (41)	68
1989-1990	3	12	10	0	25 (52)	4	14	5	0	23 (48)	48
1990-1991	5	27	22	2	56 (72)	1	16	5	0	22 (28)	78
1991-1992	4	21	22	0	47 (57)	0	22	13	0	35 (43)	82
1992-1993	2	7	7	1	17 (35)	5	20	6	0	31 (65)	48
1993-1994	3	13	10	1	27 (51)	0	18	8	0	26 (49)	53
1994-1995	1	14	8	1	24 (55)	2	13	5	0	20 (46)	44

[a] Source: moose harvest reports.
[b] Resident of Unit 25A.

Table 9 Unit 25B moose hunter residency and success, 1986-1994[a]

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1986-1987	9	10	3	5	27 (47)	6	18	2	5	31 (54)	58
1987-1988	9	10	1	6	26 (53)	5	9	6	3	23 (47)	49
1988-1989	9	9	8	2	28 (50)	2	20	6	0	28 (50)	56
1989-1990	7	16	1	0	24 (40)	9	24	1	2	36 (60)	60
1990-1991	9	31	5	2	47 (57)	9	25	2	0	36 (43)	83
1991-1992	9	17	4	2	32 (46)	12	22	4	0	38 (54)	70
1992-1993	6	9	2	1	18 (19)	7	61	4	3	76 (81)	94
1993-1994	13	24	6	0	43 (52)	4	29	5	1	39 (48)	82
1994-1995	6	19	5	3	33 (34)	5	39	14	6	64 (66)	97

[a] Source: moose harvest reports.
[b] Resident of Unit 25B.

Table 10 Unit 25D East moose hunter residency and success, 1986-1994[a]

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1986-1987	23	10	1	5	39 (42)	29	22	1	1	53 (58)	92
1987-1988	24	16	6	1	47 (53)	22	13	3	3	41 (47)	88
1988-1989	18	5	4	5	32 (47)	19	8	4	5	36 (53)	68
1989-1990	24	11	2	1	38 (44)	24	20	5	0	49 (56)	87
1990-1991	35	17	0	1	53 (46)	31	26	4	1	62 (54)	115
1991-1992	17	11	1	0	29 (32)	31	31	0	0	62 (68)	91
1992-1993	10	8	1	0	19 (23)	31	31	3	0	65 (77)	84
1993-1994	14	10	3	1	28 (36)	22	24	0	3	49 (64)	77
1994-1995	16	9	0	2	27 (30)	29	31	3	0	63 (70)	90

[a] Source: moose harvest reports.
[b] Resident of Unit 25D.

Table 11 Unit 25A reported moose harvest chronology[a], percent by time period, 1986-1994

Regulatory Year	Harvest periods 9/1-9/7[b]	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5[c]	Unk	*n*
1986-1987	32	43	13	11		2	47
1987-1988	12	34	34	17		2	41
1988-1989	10	54	31	3		3	39
1989-1990	20	36	40	4		0	25
1990-1991	21	54	20	4		2	56
1991-1992	19	43	32	2		4	47
1992-1993	12	41	35	12		--	17
1993-1994	30	48	19	4		0	27
1994-1995	44	52	4	0		0	24

[a] Source: moose harvest reports.
[b] Includes 1 moose reported taken in late Aug.
[c] No open season.

Table 12 Unit 25B reported moose harvest chronology[a], percent by time period, 1986-1994

Regulatory year	Harvest periods 9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Dec	Unk	*n*
1986-1987	7	22	52	7	-[b]	0	11	27
1987-1988	8	19	39	19	4[b]	8	4	26
1988-1989	4	41	44	4	-[b]	4	4	27
1989-1990	8	21	42	13	-[b]	17	0	24
1990-1991	11	28	34	13	2	11	2	47
1991-1992	3	41	38	13	0	3	3	32
1992-1993	11	44	17	0	0	28	0	18
1993-1994	12	33	35	12	0	7	2	43
1994-1995	3	38	44	13	0	3	0	33

[a] Source: moose harvest reports.
[b] No open season.

Table 13 Unit 25D East reported moose harvest chronology[a], percent by time period, 1986-1994

Regulatory	Harvest periods							
year	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Dec	Unk	*n*
1986-1987	0	56	31	3	-[b]	8	3	39
1987-1988	0	20	53	13	-[b]	7	7	45
1988-1989	0	47	31	3	3	13	3	32
1989-1990	0	45	24	11	3	13	3	38
1990-1991	8	37	40	2	2	6	6	52
1991-1992	17	55	24	3	0	0	0	29
1992-1993	0	42	53	5	0	0	0	19
1993-1994	18	32	29	0	4	11	7	28
1994-1995	8	54	27	8	0	0	0	27

[a] Source: moose harvest reports.
[b] No open season.

Table 14 Unit 25A moose harvest percent by transport method, 1986-1994[a]

Regulatory	Method of transportation							
				3- or			Highway		
year	Airplane	Horse	Boat	4-wheeler	Snowmachine	Other ORV	vehicle	Unknown	*n*
1986-1987	72	17	8	0	0	0	0	2	47
1987-1988	61	12	17	0	0	0	2	7	41
1988-1989	61	17	20	0	0	0	5	5	41
1989-1990	56	16	24	0	0	0	4	0	25
1990-1991	61	11	27	0	0	0	0	2	56
1991-1992	77	15	9	0	0	0	0	0	47
1992-1993	76	6	12	0	0	0	0	6	17
1993-1994	56	26	15	0	0	0	4	0	27
1994-1995	75	4	13	0	0	0	9	0	24

[a] Source: moose harvest reports.

Table 15 Unit 25B moose harvest percent by transport method, 1986-1994[a]

Regulatory year	Method of transportation								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-1987	30	0	63	0	0	0	0	7	27
1987-1988	27	0	65	0	4	0	0	4	26
1988-1989	29	0	61	0	4	0	0	7	28
1989-1990	21	0	75	0	0	0	0	4	24
1990-1991	23	0	68	0	6	2	0	0	47
1991-1992	9	0	78	0	0	0	0	12	32
1992-1993	22	6	61	0	11	0	0	0	18
1993-1994	12	2	77	2	2	2	0	2	43
1994-1995	22	0	73	0	0	0	0	6	33

[a] Source: moose harvest reports.

Table 16 Unit 25D East moose harvest percent by transport method, 1986-1994[a]

Regulatory year	Method of transportation								n
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	
1986-1987	13	0	67	0	5	0	3	13	39
1987-1988	17	0	66	0	6	0	2	8	47
1988-1989	28	0	47	0	16	0	0	9	32
1989-1990	26	0	51	0	13	0	3	8	39
1990-1991	26	0	64	2	2	0	0	6	53
1991-1992	21	0	72	0	0	7	0	0	29
1992-1993	42	0	53	0	0	5	0	0	19
1993-1994	14	0	75	0	4	0	0	7	28
1994-1995	8	0	78	4	0	0	0	11	27

[a] Source: moose harvest reports.

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 1940, moose populations have increased in size and have become well established in Unit 26A. Although moose are throughout the unit during summer, they are confined to riparian habitat along river corridors during winter. The largest winter concentrations of moose are 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, and 1991. Throughout the period from 1970 to 1991, the population was stable and increasing slowly. In 1991 the population size was 1535 moose. Trend counts show the population began declining in 1992 and 1993.

Regular harvest by hunters using aircraft as transportation began in the early 1970s. The mean reported harvest from 1985 to 1992 was 59 moose per year, with a high of 67 in 1991. Hunting pressure and predation by wolves and bears have increased during recent years.

MANAGEMENT DIRECTION

MANAGEMENT GOALS

- Maintain the moose population in Unit 26A at a minimum of 1200 moose.
- Maintain the bull:cow ratio at a minimum of 30 bulls:100 cows.

MANAGEMENT OBJECTIVES:

1. Conduct spring surveys to monitor short-yearling survival and population numbers.
2. Conduct fall trend counts to monitor sex and age composition in the population.
3. Census the population at intervals of 7 years or less.
4. Maintain hunter success level at >50%.
5. Manage the hunter harvest for spatial and temporal separation of recreational and local hunters.
6. Establish a management plan and a maximum harvest limit for moose.

METHODS

We used a Cessna 185 and a Piper PA-18 aircraft to survey trend count areas along the Colville, Chandler, and Anaktuvuk rivers during 1–3 Nov 1993, 5–10 Apr 1994, and 11–13 Nov 1994 and to complete a census of all of Unit 26A during 6–9 Apr 1995. For all surveys we flew over suitable riparian habitat and attempted to locate all the moose in the survey areas. We determined sex and age composition during the fall surveys and estimated short-yearling recruitment and total number of moose during spring surveys.

We determined early summer calf survival with aerial surveys on 23 and 24 June 1994. These surveys were flown similarly to spring trend counts, but we counted neonates rather than short yearlings. We assessed calving success and calf survival with aerial surveys on alternate days between 23 May and 9 June 1995. We used a PA-18 aircraft to locate cow moose and marked their locations with GPS coordinates. As much as possible, we returned to the GPS locations to observe cows to determine calving dates and success, calf survival, and the causes of death of calves that did not survive.

We used a PA-18 aircraft on skis to collect fecal samples from 27 female moose 10–11 April 1995. These samples were analyzed for progesterone metabolites at the National Zoological Park in Virginia to determine pregnancy rates of moose in the sample areas. During the same time, we examined the quality of moose forage (willow) and collected samples for analysis of nutritional content.

When dead moose were reported along the Chandler and Anaktuvuk rivers during the summer of 1995, we examined several of the carcasses. Specimens and tissue samples were collected for analysis of indications of diseases, mineral deficiencies, contaminants, and symptoms of starvation.

We compiled harvest data from harvest reports submitted by hunters. We also gathered harvest data by contacting and monitoring hunters near Umiat during the first week of September.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size and Trend

We observed 983 moose in the 1994 spring survey; we counted 407 of these moose within established trend count areas. This shows a decline from previous trend counts (Table 1). We also surveyed outside of the trend count areas and found very low calf survival rates throughout Unit 26A.

We counted 757 moose in the census conducted in 1995. This indicates a decline of 51% from the 1535 moose counted in 1991. Census results of 1219, 1258, 1447, and 1535 in 1970, 1977, 1984, and 1991, respectively, indicate the population was stable for at least 20 years before the recent decline (Table 2).

Population Composition

The percentage of short yearlings was 3% in the 1994 spring trend count areas and 2% in the Unit 26A census in 1995. This is a sizable decrease from previous short-yearling counts in trend count areas (Table 1) and unitwide censuses (Table 2).

During a calf survey conducted on 23 and 24 June 1994, we observed 129 moose, including 70 cows and 15 calves (21 calves:100 cows or 12% calves). During calving surveys conducted between 21 May and 9 June 1995, we found 4 calves among the 30–35 cows observed at 2-day intervals during the survey. The first calves were seen on 29 May, which was a week later than the dates reported by local guides as the beginning of calving in previous years. Pregnancy status determined from the analysis of fecal samples collected during April 1995 indicated 19 of 27 female moose sampled were "likely pregnant." It is not clear why the percentage of calves seen with cows based on aerial surveys is significantly less than the percentage of pregnant cows based on fecal sample tests. During April 1996 we plan to radiocollar 30 cow and 5 bull moose so we can periodically follow individual moose to determine calving rates and subsequent mortality of adults and calves.

During fall 1993 composition surveys, we observed 397 moose in the following classes: 101 bulls (36 bulls:100 cows), 280 cows, and 16 calves (4% calves). The estimated antler widths of the bulls are listed.

Inches	<30	30-39	40-49	50-59	60+
Percent	16%	25%	14%	36%	10%

We observed 293 moose during the fall 1994 composition surveys in the following classes: 74 bulls (35 bulls: 100 cows), 213 cows, and 6 calves (2% calves). The estimated antler widths of the bulls were as follows.

Inches	<30	30-39	40-49	50-59	60+
Percent	9%	12%	27%	38%	17%

The ratio of bulls:100 cows remained stable, but the percentage of calves surviving the summer declined dramatically from 23% in 1992 to 4% in 1993 and 2% in 1994 (Table 3).

Distribution and Movements

Moose are widely dispersed during the summer months, ranging from the northern foothills of the Brooks Range mountains to the arctic coast. During the fall, as snow cover accumulates, moose move to the riparian corridors of the large river systems, primarily the Colville River drainage. During April, when snow cover begins to disappear in the foothills, moose begin to move away from the riparian corridors.

MORTALITY

Harvest

Season and Bag Limit.
1993–94 and 1994–95

	Resident Open Season	Nonresident Open Season
Unit 26A That portion in the Colville River drainage upstream from and including the Chandler River drainage:		
Resident Hunters: One moose. However, no person may take a cow accompanied by a calf.	1Aug–31 Mar.**	

Nonresident Hunters:
One bull with 50 inch antlers or antlers with 4 or more brow tines on one side. — 1 Sep.-31 Dec.

Remainder of Unit:

Resident Hunters:
One moose. However, no person may take a cow accompanied by a calf. — 1 Aug.-31 Dec.**

Nonresident Hunters:
One bull with 50 inch antlers or antlers with 4 or more brow tines on one side. — 1 Sep.-31 Dec.

Hunters may not hunt moose during August or from 1 January through 31 March using aircraft for transportation or for carrying meat.

Board of Game Actions and Emergency Orders. The Board of Game approved a proposal from North Slope hunters to extend the open season in the Colville River drainage upstream from and including the Chandler River drainage from August 1–December 31 (during the 1993 hunting season) to August 1–March 31 in 1994. The season remained the same for the remainder of Unit 26A. The stipulations of the Controlled Use Area prohibiting the use of aircraft to hunt moose were extended to include August and the period from January 1 to March 31 for the 1994 season. The bag limit for nonresidents was changed from "one bull with 50-inch antlers" during 1993 to "one bull with 50-inch antlers or 4 or more brow tines on one side" in 1994.

Hunter Harvest. Hunter harvest reports indicate 61 moose (53 bulls and 8 cows) were harvested during fall of 1993, and 40 moose (36 bulls and 4 cows) were taken in 1994. The 1994 harvest was considerably smaller than average harvest (Table 4) and may have been the result of extreme flooding on the Colville River drainage during much of the hunting season. Alternatively, the low harvest rate in 1994 may reflect the declining numbers of moose in the population in Unit 26A. During 1993–94 the antler width of harvested moose was similar to previous size patterns. In 1994–95 more 50–59-inch antlered moose and fewer 60+-inch antlered moose were harvested than in previous years (Table 5).

Hunter Residency and Success. Flooding of the Colville River reduced the number of hunters in 1994 compared to previous seasons. The total number of local residents, nonlocal residents, and nonresidents was lower than the average number of hunters (Table 6). Hunter success rates, 79% in 1993 and 74% in 1994, reached their highest values during the reporting period and were well above the management objective of 50% success.

Harvest Chronology. Most of the harvest occurred during the first 2 weeks of September (Table 7). This pattern is similar to previous years, except that high harvest also occurred during the third week of September in 1994 because of flooding.

Transport Methods. As reported in previous years, most hunters used aircraft or boats for transportation (Table 8).

Other Mortality

Natural mortality is the major cause of the decline of moose in Unit 26A. Fall surveys in 1993 and 1994 and calving surveys in 1994 and 1995 indicated low numbers of calves. Either productivity of cows (calving rate) was initially low or summer calf mortality was high. In addition to low recruitment, the number of adults in the population declined from 1231 to 746 between 1991 and 1995.

Wolf and grizzly bear numbers are at relatively high levels and have been factors in the decline in numbers of moose. We used probability sampling designs to estimate wolf densities within the range of the moose population during April 1992 and April 1994, and we found 4.2 and 4.1 wolves / 1000 km^2, respectively. Traditional track surveys during 1986 and 1987 in approximately the same area yielded density estimates of 2.6 wolves/1000 km^2 and 2.7–3.2 wolves/1000 km^2 (Trent 1988). These estimates indicate the number of wolves have increased and remained stable at higher densities during the period of moose population decline. Grizzly bear research conducted in the western portion of the Brooks Range in Unit 26A (Reynolds 1989) and reports from guides, pilots, and hunters indicate grizzly bear numbers are also increasing in Unit 26A. Bear predation may be a major cause of poor calf survival in summer.

During the summer of 1995, 38 dead moose were found along the Anaktuvuk and Chandler river drainages. Most of these animals were adults and did not appear to have been killed by predators. Decomposition of the carcasses made pathological examination difficult, but tissue samples were collected and submitted for analysis of factors contributing to moose mortalities. Factors we are considering include disease, mineral deficiency, malnutrition, insect harassment, weather, and poor range conditions.

CONCLUSIONS AND RECOMMENDATIONS

The moose population in Unit 26A declined from 1535 animals in 1991 to 757 animals in 1995, a decline of 51%. In addition, recruitment has been very low with the percentage of short yearlings counted during the spring of 1994 and 1995 at 3% and 2%, respectively. The low percentage of calves counted during fall surveys, 4% in 1993 and 2% in 1994, indicates either high summer calf mortality or low productivity of cows at calving. In addition to poor recruitment, we found 38 dead adult moose along the Chandler and Anaktuvuk river drainages during the summer of 1995. Many of these moose had died during the summer and had not been killed by people or predators. Tissue samples are being analyzed to help determine cause of death of these adult moose.

Factors contributing to the population decline may include the following.

1 Predation from high densities of bears and wolves during the period of the decline, especially bear predation on calves.

2 Starvation and/or mineral deficiencies affecting productivity and the survival of both calves and adults. One possibility is the population exceeded the carrying capacity of the range, causing poor nutrition of the moose. In addition, during the moose population decline, the snowshoe hare population erupted, placing hares in direct

competition with moose for willows for food. Insect harassment was intense during the summer of 1995 and may have led to starvation of some moose.

3 Disease affecting adult moose, such as those found dead along the Anaktuvuk and Chandler rivers.

4 Regional weather patterns. Widespread declines in moose numbers have occurred throughout northern and northwestern Alaska (Units 22, 23, 26A, 26B, 26C); weather may be a factor. However, in searching weather records, none of the recent winters has seemed particularly severe in Unit 26A.

5 Hunting as a contributing mortality factor during periods of poor recruitment in the Unit 26A moose population. Before 1991, a mean of 295 short yearlings were being added to the population each year and a mean of 58 moose per year were being harvested. However, recruitment has been poor in recent years and harvest rates high, so hunter harvest may have contributed to the decline. Between 1991 and 1995 the number of adults in the population declined by 485 animals and during the same period hunters harvested 228 moose.

To help determine the causes of the population decline, we will begin a project in the spring of 1996 to radiocollar and examine the physical condition of moose. We will use standard immobilization techniques to capture 30 female and 5 male moose. A veterinarian and a pathologist will examine the moose for physical condition, pregnancy status, and evidence of disease. Blood, serum, feces, hair, and samples of suspicious tissues or lesions will be collected to test for indications of disease, pregnancy status, contaminants, parasites, and mineral deficiencies. We will use aerial surveys and radiotelemetry equipment to monitor the movements, productivity, and mortality of instrumented moose. Surveys will be flown during and after calving season to evaluate the mortality rate of calves. Using radiocollars with mortality sensors, we will fly to and examine dead moose as soon as possible after they die to investigate cause of death and collect samples for toxicology, essential minerals, and histopathology. Visibly sick or weakened animals may be collected for thorough examination.

We need to make licenses and harvest tickets more available to local hunters and explain the reasons for harvest reporting requirements in Unit 26A. The inability of the state to resolve the subsistence harvest issue has confused and alienated many North Slope residents and has impeded our efforts to bring hunters into the regulatory system of licenses, open seasons, and harvest reports. We anticipate little improvement in harvest reporting and compliance with regulations until this issue is resolved.

The goal of spatial and temporal separation of recreational and local hunters was achieved by establishing a controlled use area in Unit 26A. The stipulation prohibiting aircraft for hunting during August allows local residents to hunt using boats before recreational hunters arrive in September. Spatial separation occurs because local residents concentrate their hunting efforts with boats on the lower portions of the Colville River, whereas recreational hunters generally use aircraft to access the upper portions of the drainage.

In response to the severe population decline, we are changing the management goal from maintaining the population to rebuilding it. We are initiating a research project to help identify factors contributing to the decline and, hopefully, identify methods to help with recovery of the population. We are also proposing regulations to reduce and/or eliminate hunting pressure. While hunting was not the major cause of the decline, it is a contributing factor and one that can be changed to help begin rebuilding the population.

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Table 1 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, 1974–81, and 1983–95

Year	Moose	Adults	Calves	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

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

Table 2 Number of adult and calf moose from Unit 26A censuses, 1970–1995

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

Table 3 Unit 26A fall aerial moose composition counts 1983–94

Regulatory Year	Bulls:100 Cows	Calves:100 Cows	Calves (%)	Adults	Moose
1983-84	54	38	20	150	188
1986-87	47	18	11	302	339
1987-88	39	21	13	101	104
1990-91	33	45	25	277	371
1991-92	40	39	22	254	325
1992-93	36	41	23	190	248
1993-94	36	6	4	381	397
1994-95	35	3	2	287	293

Table 4 Unit 26A moose harvest, 1985–94

Regulatory Year	Reported Hunter Harvest		
	Male	Female	Total
1985-86	50	15	65
1986-87	46	6	52
1987-88	49	13	62
1988-89	51	6	57
1989-90	41	3	44
1990-91	60	4	64
1991-92	59	8	67
1992-93	52	8	60
1993-94	53	8	61
1994-95	36	4	40

Table 5 Percent antler width categories (inches) among moose harvested in Unit 26A, 1983–94

Year	<20	20-29	30-39	40-49	50-59	60+	N
1983	0	4	35	15	35	12	26
1984	3	5	18	33	30	13	40
1985	0	7	11	18	47	19	45
1986	0	7	18	29	42	4	45
1987	0	0	20	24	47	9	45
1988	2	2	0	27	55	14	49
1989	0	3	14	14	51	18	39
1990	0	4	15	10	59	12	57
1991 (16% unknown)	0	3	3	13	49	16	56
1992 (13% unknown)	0	2	5	7	48	25	52
1993 (15% unknown)	3	2	5	11	49	15	53
1994 (10% unknown)	1	2	8	9	62	8	40

Table 6 Moose hunter residency and success, Unit 26A, 1987–94

Regulatory year	Successful hunters: Local res[a]	res[b]	Nonres[c]	Unk[d]	Total	(%)	Hunters: Local res[a]	Nonlocal res[b]	Nonres[c]	Unk[d]	Total
1985-86	-	-	-	-	65	66	29	45	24	0	98
1986-87	-	-	-	-	52	65	29	33	18	0	80
1987-88	-	-	-	-	62	61	40	20	39	0	99
1988-89	-	-	-	-	57	69.	12	30	37	5	84
1989-90	9	13	21	1	44	66	10	23	33	2	68
1990-91	8	19	35	2	64	65	13	40	43	3	99
1991-92	9	37	29	1	67	66	13	51	37	1	102
1992-93	12	16	29	3	60	57	25	35	41	4	105
1993-94	7	22	29	3	61	79	11	30	32	4	77
1994-95	8	7	24	1	40	74	11	14	29	0	54

[a] Local resident hunters are residents of the North Slope Borough.

[b] Nonlocal resident hunters are residents of the State of Alaska.

[c] Nonresident hunters.

[d] Unknown residency.

Table 7 Percent chronology of moose harvest, Unit 26A, 1987–94

Regulatory year	Harvest periods: Aug	Sep 1-7	Sep 8-14	Sep 15-21	Sep 22-31	Oct-Dec	*N*
1987-88	9	36	35	6	4	10	62
1988-89	9	45	34	6	3	0	57
1989-90	17	48	18	16	0	2	44
1990-91	4	44	39	6	5	2	64
1991-92	10	55	22	10	0	3	67
1992-93	9	58	20	3	8	2	60
1993-94	7	62	23	3	3	2	61
1994-95	3	50	19	18	5	5	40

Table 8 Percent transport methods for moose harvest in Unit 26A, 1987–94

Regulatory Year	Method of transportation (%): Airplane	Boat	3 or 4-wheeler	Snowmachine	ORV	*N*
1987-88	80	15	2	1	2	59
1988-89	81	18	1	-	-	53
1989-90	84	14	2	-	-	40
1990-91	62	28	3	2	3	61
1991-92	85	7	3	3	2	67
1992-93	85	13	0	2	0	60
1993-94	83	17	0	0	0	61
1994-95	78	18	0	2	2	40

LOCATION

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

GEOGRAPHIC DESCRIPTION: North Slope of the Brooks Range and Arctic Coastal Plain east of the Itkillik River

BACKGROUND

Moose were scarce in arctic Alaska before the early 1950s when populations grew, reaching high densities in the limited riparian habitat in major drainages (LeResche et al. 1974). Predation and hunting contributed to the historical scarcity of moose. The reduction of wolf numbers by federal control programs during the late 1940s and early 1950s was important in allowing moose populations to increase and become established in most of the riparian shrub habitat on the North Slope. Moose are at the northern limit of their range in the eastern Arctic.

Composition surveys have been conducted by the staff of the US Fish and Wildlife Service (FWS), Arctic National Wildlife Refuge (ANWR) (Martin and Garner 1984, Weiler and Leidberg 1987, Mauer and Akaran 1994, Mauer 1995). The Canning River has been surveyed almost annually since 1983, and areas to the west were surveyed in 1986, 1988, 1989, 1990, 1991, 1994, and 1995. No surveys were accomplished in Units 26B and 26C in 1992 or 1993 because of poor survey conditions.

Habitat severely limits the number of moose that can be sustained and harvested, and the concentrated nature of moose distribution and open habitat create the potential for excessive harvest in accessible areas. Although travel to the area is expensive and often logistically difficult, hunting pressure around the larger and better known aircraft landing sites is considerable. Guides, outfitters, hunters, and ANWR staff have expressed concern about the excessive concentration of hunters. The Dalton Highway in central Unit 26B provides unique opportunities for viewing and photography but has also created the potential to adversely affect moose populations and associated human uses by increasing access to certain areas.

Government agencies and the public have also shown concern recently about increased hunting by people living outside the area. The opening of the Dalton Highway to commercial use in 1978, to the general public in 1995, and establishment of guide and outfitter bases at points along the road increased hunting pressure on moose. National publicity about wildlife resources in ANWR may have also contributed to more hunters using the area.

Kaktovik and Nuiqsut are the only subsistence communities in the area, and residents take 5 to 10 moose annually. Scarcity of moose near Kaktovik causes this small subsistence harvest. Another factor is that Nuiqsut residents hunt in the Colville River drainage in adjacent Unit 26A.

The Dalton Highway Management Area (DHMA) continues to be closed by Alaska statute to the use of firearms and off-road vehicles within 5 miles of the highway north of the Yukon

River. In 1987 the Board of Game prohibited use of motorized vehicles except aircraft, boats, and licensed highway vehicles for transporting game or hunters in the DHMA, bringing hunting regulations into alignment with Alaska statutes. The board's actions also created a penalty for violations, something that had not been included in the statute passed by the legislature.

Moose hunting regulations are more restrictive now than they were several years ago. In 1987 the open season for most hunters was shortened to 1–30 September and the previous bag limit of 1 moose was changed to 1 bull. At the same time, the season for qualified subsistence hunters residing in Unit 26 was lengthened to 1 August–31 December and the bag limit of 1 moose of either sex continued. Changes in season and bag limit during the late 1980s apparently reduced the harvest to a sustainable level in the DHMA and in the remainder of Unit 26B. A significant decline in moose numbers in the early 1990s led to a 50-inch minimum moose antler size limit for all nonlocal hunters in 1994.

MANAGEMENT DIRECTION

Management Goals

- Provide the greatest opportunity to participate in hunting moose.
- Provide sustained opportunities for subsistence use of moose.

Management Objectives

- Determine population distribution, composition, density, and trends.
- Determine movements and habitat use in heavily harvested drainages.
- Maintain an annual posthunting sex ratio of at least 50 bulls:100 cows
- Maintain a mean antler spread of at least 50 inches among bull moose harvested during the general season.
- Maintain an annual hunter success rate of at least 40%.
- Determine subsistence needs and harvest levels.

METHODS

Riparian willow habitat associated with drainages of Unit 26B is usually surveyed during early winter using Piper PA-18 aircraft at 70–90 miles/hour and at altitudes of 200–600 feet above ground level. Mandatory hunter harvest reports provided data on harvest characteristics and hunter effort.

RESULTS AND DISCUSSION

POPULATION STATUS AND TREND

Population Size

A complete moose population survey has not been conducted in Units 26B and 26C, although trend surveys probably account for a large percentage of the moose in areas supporting major concentrations. During years when we accomplished the most complete surveys, we counted 629 moose in 1988 and 600 in 1989. Before 1992 the population was thought to include 1000–1200 moose in Unit 26B and 700–800 in Unit 26C, or 1700–2000 (F Mauer, FWS, pers commun) in the units.

Population surveys in 1994 indicated moose numbers had declined by approximately 40%, compared to surveys in the late 1980s. This decline continued and accelerated. Surveys in fall 1995 indicated moose numbers declined by 60% since 1994, with an overall decline of 75% since the late 1980s. The reasons for the dramatic decline are not well understood, but available evidence indicates predation, insect harassment, and range deterioration may all be factors. Calf survival and recruitment have been extremely low in the last few years. Unless conditions improve, moose populations on the North Slope will probably persist at low density.

Population Composition

Survey results in Unit 26B indicate moose population status changed dramatically during the past 5 years (Table 1). Calf survival declined sharply in 1989, when only 5% of the moose seen were calves. The 1990 and 1991 surveys indicated survival returned to previous levels. Weather precluded surveys in 1992 and 1993, but in 1994 and 1995 composition data showed calf survival to fall was low. A similar pattern is apparent in Unit 26A, where surveys indicate calf survival declined sharply beginning in 1993.

No surveys have been completed in the Firth and Mancha areas in eastern Unit 26C since 1991, and the status of these populations is unknown (Table 2).

Surveys in the Canning River area (boundary between Units 26B and 26C) indicate moose numbers declined steadily after 1985. Various indices to population welfare including total numbers observed; calf:cow, bull:cow, and large bull:cow ratios; and yearling recruitment indicate recruitment into the population has been chronically low and harvest of bulls has noticeably affected the population (Table 3). The number of moose observed during standardized trend counts has declined from a high of 203 in 1985 to 16 in 1995. The decline in total numbers, chronically poor calf survival and yearling recruitment, declining bull:cow ratios, and the small number of bulls in the population indicate that we should consider further restrictions on hunting. Although other factors such as habitat quality and increased predation by wolves and bears have probably been responsible for causing and perpetuating the decline, at this point hunting is a contributing factor and the present season should be reconsidered.

Distribution and Movements

Except for some summer dispersal, moose are limited to narrow strips of shrub communities along drainages. The greatest concentrations are along the Canning, Kavik, Ivishak, Toolik, Kuparuk, and Kongakut rivers. Moose movements have not been intensively studied, but casual observations suggest there may be seasonal movements within or between North Slope drainages. Telemetry studies begun in 1995 show many moose that winter in the upper Konguakut River migrate south and east to summer on the Old Crow Flats in Canada (F Mauer, pers commun).

MORTALITY

Harvest

Season and Bag Limit.

Units and Bag Limits	Resident Open Season	Nonresident Open Season
Unit 26B, that portion within the Dalton Highway Corridor Management Area:		
All Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side by bow and arrow only.	5 Sep-15 Sep	5 Sep-15 Sep
Remainder of Unit 26B and 26C, the Canning River drainage:		
Resident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side. 1 bull.	5 Sep-15 Sep 1 Nov-31 Dec	
Nonresident Hunters: 1 bull with 50-inch antlers or antlers with 4 or more brow tines on 1 side.		5 Sep-15 Sep
Remainder of Unit 26C.		
Resident Hunters: 1 bull.	1 Sep-15 Sep	
Nonresident Hunters: 1 bull.	1 Dec-31 Dec	5 Sep-15 Sep

Board of Game Actions and Emergency Orders. Beginning in 1990, all Alaska residents qualified as subsistence users under state law. To compensate for the large increase in hunters eligible for the subsistence season, the season was shortened to 5–15 September and 1 November–31 December, and the 1-bull bag limit was extended to all hunters. Additionally, a

50-inch minimum antler size was established for nonresidents. A significant decline in moose numbers and calf survival first observed in 1994 prompted the board to also apply the 50-inch minimum antler size to resident hunting in 1995. This regulation affected Unit 26B and the Canning River drainage in Unit 26C. An oversight in the proposal resulted in the 50-inch provision for nonresident hunters in Unit 26C East of the Canning River drainage being inadvertently deleted. Although few moose are taken in this area, the error will be addressed at a future Board of Game meeting.

Hunter/Trapper Harvest. The reported moose harvest in Unit 26B has ranged from 24 in 1990 to 52 in 1986 (Table 4). Prior to 1995, harvests in Unit 26B were fairly stable despite a general increase in hunting activity adjacent to the Dalton Highway. Preliminary data for 1995 indicate harvest declined to less than 15 moose. Hunter reports and survey data indicate a continued decline in moose numbers is the major reason for the decline in harvest. In Unit 26C the harvest has declined substantially from 17 in 1987 to from 4 to 6 from 1991 to 1994 (Table 5), probably because of the decline in moose numbers in the Canning River area.

Permit Hunts. There are no permit hunts in Units 26B and 26C.

Hunter Residency and Success. The proportion of resident hunters has increased in recent years, and since 1992 they have outnumbered nonresident hunters based on hunter reports. Alaska residents living outside the area comprised all but a few of the resident hunters (Table 6). Although reporting by local residents is considered poor, relatively few people reside in the area, and many of these do not emphasize hunting moose.

Hunter success declined to below 50% in 1993 and 1994. Nonresidents report a higher success rate than Alaska residents, probably because nonresidents benefit from guide/outfitter services. Hunting success in the Canning River area declined dramatically after 1988, with 0 to 5 moose reported taken each year since then (Table 7).

Harvest Chronology. Most moose killed in Units 26B and 26C are taken during the first 2 weeks of September (Table 8). The concentration of hunting activity in early autumn results from the relatively early onset of winter in the region.

Transport Methods. Aircraft continued as the predominant transport method and was used by over 70% of the successful moose hunters (Table 9).

Natural Mortality

Although there have been no intensive studies of natural sources of moose mortality in the eastern arctic, it is probable that predation by bears and wolves and periodic malnutrition during severe winters are most important. Wolves and bears are common in the region, particularly in the mountains and northern foothills of the Brooks Range, and incidental observations by biologists, hunters, and pilots suggest wolf numbers increased during the early 1990s. Winter 1989–1990 was unusually severe and noticeably affected calf survival and yearling recruitment. Similar losses can be expected when snow accumulation is exceptionally great. Incidental observations during summer 1995 indicate unusually high mortality from causes other than predation. Observations of intense harassment of moose by mosquitoes, which were unusually abundant due to an early spring and favorable moisture and temperature, may have contributed to the demise of both calf and adult moose.

A habitat reconnaissance in April 1994 indicated that browsing intensity on favored species was relatively heavy, but forage was not in critically short supply. Efforts to enhance habitat have not been contemplated and do not seem feasible. Fire is not a factor in maintaining moose habitat in this area.

CONCLUSIONS AND RECOMMENDATIONS

Although most population and use objectives were met during the early 1990s, changes in moose population status indicate changes in regulations are warranted, especially for the Canning River area. Knowledge of population status and trend is generally adequate, and the objective of maintaining 50 bulls:100 cows in posthunting season populations has been marginally met. Hunter success has declined as a result of recent declines in moose numbers.

Shortcomings in our knowledge concern movements, habitat condition, the causes and patterns of natural mortality, and reasons for the precipitous decline in moose numbers and survival.

The combination of low numbers and chronically low recruitment in Units 26B and 26C indicates the population should be managed more conservatively, even though the present harvest is small. Although hunting was probably not a primary factor in initiating and maintaining the decline, it is a source of mortality that can be easily controlled. However, without a sustained increase in calf survival and recruitment, population recovery seems improbable.

We should continue annual trend surveys. Better information on moose movements, mortality, and habitat condition is necessary to understand causes of the recent decline and to explore ways to improve the status of moose in the area.

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Table 1 Unit 26B early winter aerial moose composition, 1986-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
1986-1987	57	9	29	87	15	477	564	1.33
1987-1988[a]								
1988-1989	59	30	21	75	12	534	629	1.42
1989-1990	54	13	9	32	5	568	600	1.35
1990-1991	59	7	26	63	14	383	446	1.54
1991-1992	47	10	21	66	13	352	518	1.48
1992-1993[a]								
1993-1994[a]								
1994-1995	39	8	5	14	4	367	381	1.06
1995-1996	66	11	8	7	5	138	145	0.40

[a] No survey.

Table 2 Unit 26C, Kongakut and Firth rivers and Mancha Creek early winter aerial moose composition counts, 1987-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
1987-1988[a]								
1988-1989[a]								
1989-1990[b]	114	7	24	17	10	152	169	0.47
1990-1991[a]								
1991-1992[c]	85	10	34	63	15	343	406	0.47
1992-1993[a]								
1993-1994[a]								
1994-1995[a]								
1995-1996[a]								

[a] No survey.
[b] Firth/Mancha area only.
[c] Includes Kongakut and Firth/Mancha count areas.

Table 3 Canning River (on boundary of Unit 26B and 26C) early winter aerial moose composition counts, 1986-1995

Regulatory year	Bulls:100 Cows	Yearling bulls:100 Cows	Calves:100 Cows	Total calves	Percent calves	Adults	Total moose observed	Moose/mi^2
1986-1987	75	15	18	13	9	126	139	0.80
1987-1988[a]								
1988-1989	51	4	16	11	9	107	118	0.68
1989-1990	45	8	10	7	6	106	113	0.65
1990-1991	43	2	12	5	8	60	65	0.87
1991-1992	49	7	5	3	3	85	88	0.94
1992-1993[a]								
1993-1994[a]								
1994-1995	31	0	0	0	0	38	38	0.22
1995-1996	77	11	0	0	0	15	16	0.09

[a] No survey.

Table 4 Unit 26B moose harvest and accidental death, 1986-1994

Regulatory year	Harvest by hunters				
	Reported[a]				
	M (%)	F (%)	Unk	Total	Total
1986-1987	43 (83)	9 (17)	0	52	52
1987-1988	37 (100)	0 (0)	0	37	37
1988-1989	33 (100)	0 (0)	0	33	33
1989-1990	24 (100)	0 (0)	1	25	25
1990-1991	24 (100)	0 (0)	0	24	24
1991-1992	28 (100)	0 (0)	0	28	28
1992-1993	45 (100)	0 (0)	0	45	45
1993-1994	30 (100)	0 (0)	0	30	30
1994-1995	37 (100)	0 (0)	0	37	37

[a] Source: moose harvest reports.

Table 5 Unit 26C moose harvest and accidental death, 1986-1994

Regulatory year	Harvest by hunters				
	Reported[a]				
	M (%)	F (%)	Unk	Total	Total
1986-1987	6 (60)	4 40)	0	10	10
1987-1988	16 (94)	1 (5)	0	17	17
1988-1989	10 (100)	0 (0)	0	10	10
1989-1990	1 (100)	0 (0)	0	1	1
1990-1991	3 (100)	0 (0)	0	3	3
1991-1992	6 (100)	0 (0)	0	6	6
1992-1993	4 (100)	0 (0)	0	4	4
1993-1994	4 (100)	0 (0)	0	4	4
1994-1995	6 (100)	0 (0)	0	6	6

[a] Source: moose harvest reports.

Table 6 Units 26B and 26C moose hunter residency and success, 1986-1994[a]

Regulatory year	Successful					Unsuccessful					Total hunters
	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	Local[b] resident	Nonlocal resident	Nonresident	Unk	Total (%)	
1986-1987	0	33	20	9	62 (86)	0	8	0	2	10 (14)	72
1987-1988	0	21	22	11	54 (64)	1	21	5	3	30 (36)	84
1988-1989	0	13	26	4	43 (64)	0	14	6	4	24 (36)	67
1989-1990	0	11	15	0	26 (32)	0	24	6	26	56 (68)	82
1990-1991	0	7	18	2	27 (51)	0	21	5	0	26 (49)	53
1991-1992	1	11	19	3	34 (57)	1	13	10	2	26 (43)	60
1992-1993	0	23	25	1	49 (52)	0	43	2	1	46 (48)	95
1993-1994	2	23	8	1	34 (37)	1	44	11	1	57 (63)	91
1994-1995	0	24	19	0	43 (44)	2	34	15	3	54 (56)	97

[a] Source: moose harvest reports.

[b] Reside in Units 26B or 26C.

Table 7 Number of moose hunters, moose harvest, and percent success in the Canning River drainage, 1983-1995[a]

Regulatory year	Hunters	Harvest	Percent success
1983-1984	3	1	34
1984-1985	8	7	88
1985-1986	8	6	75
1986-1987	15	6	40
1987-1988	36	14	40
1988-1989	17	8	47
1989-1990	10	1	10
1990-1991	8	1	13
1991-1992	5	0	0
1992-1993	1	1	100
1993-1994	5	2	40
1994-1995	6	5	83
1995-1996	5	3	60

[a] Source: moose harvest reports.

Table 8 Units 26B and 26C moose harvest chronology, percent, (n) by time period, 1986-1994[a]

Regulatory year	Harvest periods								
	9/1-9/7	9/8-9/14	9/15-9/21	9/22-9/28	9/29-10/5	Oct	Nov	Dec	n
1986-1987	41.1	23.2	10.7	8.9	0.0	3.6	3.3	7.1	56
1987-1988	36.5	32.7	23.1	5.8	--[b]	--[c]	--[c]	1.9	52
1988-1989	41.6	25.0	22.2	11.1	--[b]	--[c]	--[c]	--[c]	36
1989-1990	26.9	30.8	30.8	3.8	3.8	--[c]	--[c]	--[c]	26
1990-1991	37.1[d]	51.8	3.7[e]	--[f]	--[f]	--[f]	--[g]	2.0[g]	27
1991-1992	52.9	41.2						5.9	34
1992-1993	63.3	36.7							49
1993-1994	50.0	44.1	2.9					2.9	34
1994-1995	53.7	43.9	2.4					2.4	41

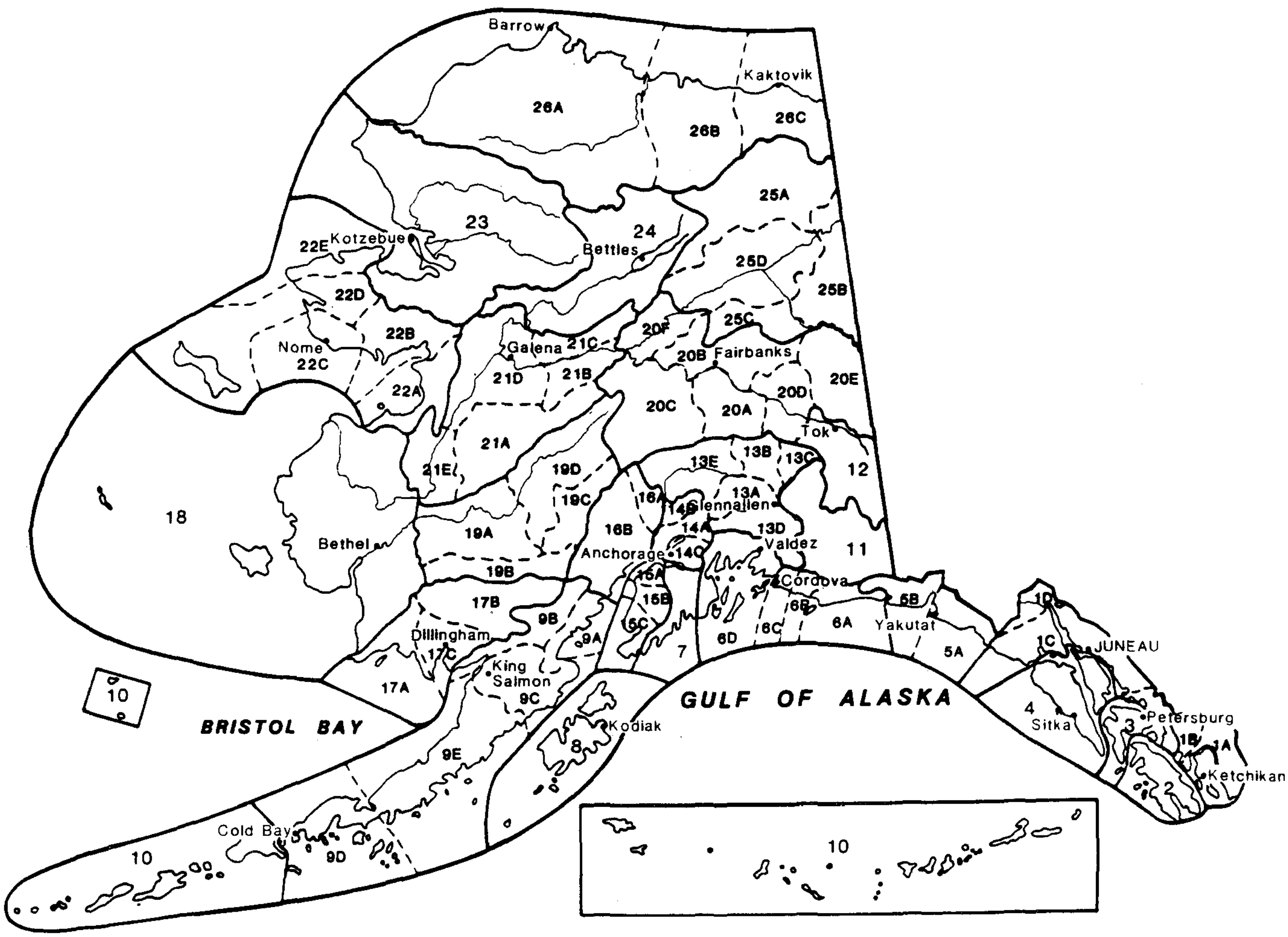
[a] Source: moose harvest reports.
[b] General season closed 30 Sep.
[c] Subsistence.
[d] General season opened 5 Sep.
[e] General season closed 15 Sep.
[f] No open season.
[g] Alaska resident only.

Table 9 Units 26B and 26C moose harvest percent by transport method, 1986-1994[a]

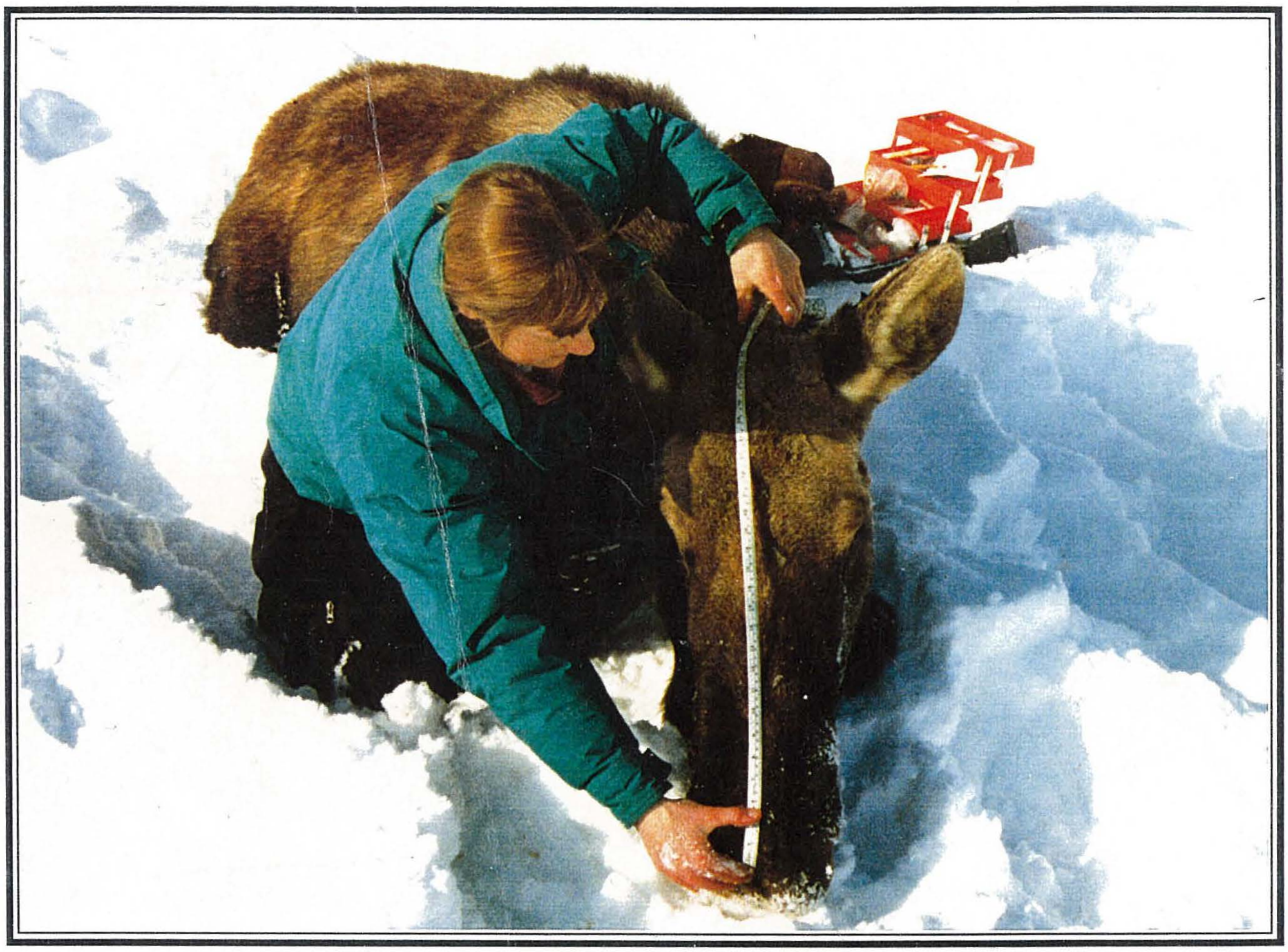
Regulatory year	Method of transportation								
	Airplane	Horse	Boat	3- or 4-wheeler	Snowmachine	Other ORV	Highway vehicle	Unknown	*n*
1986-1987	75	0	0	3	12	3	7		60
1987-1988	94	0	4	0	2	0	0		47
1988-1989	83	2	5	0	2	0	7		41
1989-1990	96	0	4	0	0	0	0		26
1990-1991	75	4	21	0	0	0	0		24
1991-1992	76	0	15	0	6	0	0	3	34
1992-1993	84	0	8	0	0	0	8	0	49
1993-1994	71	0	21	0	3	0	6	0	34
1994-1995	74	0	19	0	2	0	5	2	43

[a] Source: moose harvest reports.

Alaska's Game Management Units



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



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